SENIOR DESIGN AND PREFESIONALISM I

FALL 2020

STATUS REPORT 5

TOPICS COVERED IN STATUS REPORT 5

Literature Review

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
Status Report 5A on Literature Review

Assigned 09/16/20 **Due: 09/24/20**

This status report covers the information on the Literature Review chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class for the assignment #2. The report should be prepared using the chapter title. " **3. LITERATURE REVIEW**". The subsections highlighted in blue fonts should be used in the status report.

3. LITERATURE REVIEW

1. Provide introductory paragraphs for this chapter that discuss the purpose of the chapter.

3.1 Identification of Information Relevant to the Project

2. **Identify and** list the types of information needed to be reviewed for a complete understanding of all aspects of the project. **Describe in detail how you identified the types of information relevant to the project as an introduction to your response to this question.**

3.2 Potential Sources of Information for Project

3. For each information type listed in item 2 above, identify the sources you will need to use to obtain the information. This will also serve as a partial reference list for your project. Refer to how to list references in the Senior Project manual for the format for this section. **Describe how you identified the sources as an introduction to the answer for this question**.

4. Plan the literature review chapter by carefully developing a Table of Content page for the subsections to be included in the literature review. See example below

3. LITERATURE REVIEW …….. 13

3.1 Identification of Information Relevant to the Project …… 14
3.2 Potential Sources of Information for Project…….. 14
3.3 Major Subsection Title 3 …… 14
3.3.1 Minor subsection title 1…….. 15
3.3.2 Minor subsection title 2 …….. 15
3.4 Major Subsection Title 4 ……. 18
3.4.1 Minor subsection title 1 …… 20
3.4.2 Minor subsection title 2 ……. 21
Etc.

5. Using the sources identified in item 2, and following your planned table of content, develop a well planned and exhaustive literature review for your project. The literature review should focus on relevant items that would help you with the design. This should include but not limited to:

- existing similar designs and how each functions, advantages and disadvantages of each of the existing designs;
- identifying the major components of the existing similar designs and how they function;
- identifying subject areas that are relevant as well as the design equations in these subject areas that are relevant for the design analysis that can be used for sizing and specifying the components of the design;
- identifying fabrication and testing methods and procedure for similar designs.
- Identifying codes and standards applicable to the design

6. References should be properly cited in the literature review, and a list of references provided using the format provided in the Senior Project Manual which is available to you free on e-course.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheet)

Assignment for Assessing Outcome c.2

Grading Scheme for
Status Report on Literature Review

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Introduction paragraphs for chapter provided	5	
2	Description provided on how information was identified Types of information completely identified to a level that shows the group has a grasp of what they need to look for on the project	3 12	
3	Description provided on how potential sources of information were identified. For each information, sources needed are adequately identified.	3 12	
4	Literature review topics are well planned and broken down into appropriate logically sequenced Sections and sub-sections in a TOC format Content of TOC for Literature Review are related to the 5 listed objectives for literature review	15 5	
5	The literature review is detailed and focused on relevant items related to the project, include existing similar designs, components needed, relevant design analysis methods, fabrication, and testing. Relevant codes & standards Figures & Tables properly numbered, titled and cited in the report	110 10	
6	References properly cited and appropriate list of references provided	20	
7	Copy of Status request attached	5	
	Total	200	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Literature Review

GROUP NUMBER: 7

Progress Report Title: Status Report V
Due Date: 10/01/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan** DocuSigned by: D752FAC3D5EC429...	**Introduction paragraphs:** N/A **Section work:** 3.3 **Topics:** Rope Mop Skimmer **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
2	**David Trevino** DocuSigned by: David Trevino CE078BB05575484...	**Introduction paragraphs:** N/A **Section work:** 3.3 **Topics:** Belt Type Skimmers **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
3	**Amna Ansari** DocuSigned by: Amna Ansari E25E51620421451...	**Introduction paragraphs:** 3.2 **Section work:** 3.6 **Topics:** Operational Environment **Minutes:** Record meeting minutes for each meeting and record of attendance. **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
4	**Demetrious Sandford** DocuSigned by: Demetrious Sandford C7D32FE84B0A419...	**Introduction paragraphs:** Chapter 5 **Section work:** 3.3 **Topics:** Drum Skimmers **Proofreading:** Full report **Formatting:** indenting sections, font type and size consistency. **Meeting:** Organize meeting times. **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
5	**Caleb Riggins** DocuSigned by: Caleb Riggins 41AFA2385BEE4BC...	**Introduction paragraphs:** Discussion **Section work:** 3.3 **Topics:** Disc Skimmers **Technical writing review:** Full report **Formatting:** indenting sections, font type and size consistency. **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
6	**Ximena Cifuentes** DocuSigned by: Ximena Cifuentes BD1F416D20884F6...	**Introduction paragraphs**: Main Introduction **Section work:** 3.5 **Topics:** Weir Skimmers **Formatting:** Cover page, empty report sheet, indenting sections, font consistency. **Communication:** Send report to Dr. Park for feedback, assign tasks.. **Attendance:** attend meetings. **Participation:** participate in meetings.	**100%**	
7	**Aamna Jangda** DocuSigned by: Aamna Jangda 781C4B4D2C9D46D...	**Introduction paragraphs:** 3.1 **Section work:** 3.4 **Topics:** Non-Oleophilic Skimmers **Formatting:** Font consistency within certain parts **Attendance:** Attend meetings **Participation:** Participate in meetings	**100%**	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
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Assignment for Assessing Outcome c.2

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5	fabrication, and testing. Relevant codes & standards Figures & Tables properly numbered, titled and cited in the report	10	
6	References properly cited and appropriate list of references provided	20	
7	Copy of Status request attached	5	
	Total	200	

3. LITERATURE REVIEW

1. Provide introductory paragraphs for this chapter that discuss the purpose of the chapter.

This chapter discusses different types of oil skimmers covered in our project. The oleophilic skimmers focused on include the disk-type, belt-type, drum-type and rope mop-type which all have different and unique ways to extract oil from water. The Non-Oleophilic skimmer types include Vacuum and Suction types, and Belt Mop-type. The topics for Weir skimmers include specific gravity and operational environment, as well as weir skimming operations. The last section covered over operational environment of skimmers include weathering and oil spill classification.

3.1 Identification of Information Relevant to the Project

2. **Identify and** list the types of information needed to be reviewed for a complete understanding of all aspects of the project. **Describe in detail how you identified the types of information relevant to the project as an introduction to your response to this question.**

Research was done by each group member on the various types of skimmers currently in the market. Gaining a better understanding of the information needed to complete this project was carried out by first, identifying the relevant subject areas, and then analyzing previous skimmers that are currently in the market. First, the advantages and disadvantages of the existing designs were listed by each group member. Understanding the mechanics behind the different designs of existing skimmers was executed. Design analysis research was explored to aid with sizing and specifications for the current project.

Below is a list of main topics and their respective subtopics. Throughout the report every topic will be discussed in detail and the figures will give a visual representation of each topic.

- Oleophilic Skimmers
  - Disk-Type Skimmers
  - Belt-Type Skimmers
  - Drum-Type Skimmers
  - Rope Mop Skimmer
- Non-Oleophilic Skimmers
  - Vacuum and Suction Skimmers
  - Belt Mop Oil Skimmer
- Weir Skimmers
  - Specific gravity and operational environment
  - Weir skimming operation
- Operational Environment of Skimmers
  - Weathering
  - Oil Spill Classification

- Major Skimmer Components
- Relevant Analysis
- Codes and Standards
  - Oil Pollution Regulation Programs

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Sources have been gathered from using online scholarly databases such google scholars, University library, books, or any other online articles that have reliable secondary sources. Websites that allow multiple editors such as Wikipedia have been avoided to ensure information accuracy. In the list below you will find the different sources that were used in each section of the literature review.

- Oleophilic Skimmers
  - [1]~~Grill,Peter. Linde, Fredrik~~, Oil Skimming **,**Business Potential and Strategic Options Facing a Marginalised Business Segment at Sandvik Process Systems, Master of Science Thesis KTH School of Industrial Engineering and Management Energy Technology EGI-2013-077MSC SE-100 44 STOCKHOLM, pp 27-28
  - [2] Robert Governale, inventor; Miller Environmental Group, Inc., assignee. Oil Skimming Apparatus, United States patent US 5,685,979, 1997 Nov 11.
  - [3] Ray Ayers,Kenneth L. Bickham inventors; Shell Oil Company, assignee. Fibrous Disc Oil Skimmer, United States patent US 4,264,450, 1981 Apr 28.
  - [4] Agnew, R.W., *Free floating endless belt oil skimmer* United States Environmental and protection agency, 1972
  - [5] Philip C. Lewan, inventor; Camshaft Machine Company assignee. Belt Type Oil Skimmer with Horizontal Rotors, United States patent US 5,062,953, 1991 Nov 5.

- [6] Gregory A. Ettelt, Alfred L. Cohen, inventor; Tenco Hydro/Aero ScienceS, Inc., assignee. Belt Type Oil Removal Unit, United States patent US 4,089,784, 1978 May 16.

- [7] Philip C. Lewan, inventor; Miller Environmental Group, Inc., assignee. Belt Oil Skimmer Apparatus, United States patent US 5,015,378, 1991 May 14.

- [8] INC., Elastec. "Drum Oil Skimmers: Oleophilic Skimmer." *Elastec*, 17 Sept. 2020, www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/.

- [9] Donald L. Wilson, Jerry C. Trippe, inventors; Elastec Inc., assignee. Device for skimming oil from water. United States patent US 4,957,636, 1990 Sep 18.

- [10] J. S. Shum and M. Borst Mason & Hanger-Silas (*2015*) OHMSETT TESTS OF A ROPE-MOP SKIMMER IN ICE-INFESTED WATERS. International Oil Spill Conference Proceedings: February 2015, Vol. 2015, No. 1, pp. 31-34.

- [11] Alves, Tiago M et al. 2015. "Modelling of Oil Spills in Confined Maritime Basins: The Case for Early Response in the Eastern Mediterranean Sea." Environmental Pollution 206: 390–99

- Non-Oleophilic Skimmers

  - [12] Al-Majed et al., 2012 A.A. Al-Majed, A.R. Adebayo, E.M. Hossain A sustainable approach to controlling oil spills J. Environ. Manag., 113 (2012).

  - [13] Anh Tuan Hoang & Minh Quang Chau, 2018. "A Mini Review of Using Oleophilic Skimmers For Oil Spill Recovery," Journal of Mechanical Engineering Research & Developments (JMERD), Zibeline International Publishing, vol. 41(2), pages 92-96, July.

  - [14] ITOPF. (2012). The Fate of Marine Oil Spills. London, UK: The International Tanker Owners Pollution Federation.

  - [15] NOAA. (2010). Fact Sheet: Skimmers. Mobile, AL: National Oceanic and Atmospheric Administration.

  - [16] Ortega AE, Walker JT, Whitfield WW, Bostwick J (2011) Materials and methods for removing oil from bodies of water Google Patents.

- Weir Skimmers

- [17] Grill, P., Linde, F., *Oil Skimming Business Potential and Strategic Options Facing a Marginalised Business Segment at Sandvik Process Systems*, EGI-2013-077MS, The Royal Institute of Technology Stockholm, 2013, pp 24-90

- [18] N.O.A.A., *Fact Sheet: Skimmers*,National Oceanic and Atmospheric Administration,2010

- [19] I.T.O.P.F., *The Fate of Marine Oil Spills*, International Tanker Owners Pollution Federation, 2012

- [20] Hammoud, A.H. *Enhanced oil spill recovery rate using the weir skimmer* Mechanical Engineering Department, Beirut Arab University, pp 1

- [21] Cengel, Y.M., Cimbala, J.M., *Fluid Mechanics: Fundamentals and Applications*, McGraw-Hill, New York, 2014, pp 39,980

- [22] Kaperick, J.A., *Oil Beneath the Water Surface- and-Review of Currently Available-Literature on Group V Oils: An Annotated Bibliography Report,* HMRAD 95-8, National Oceanic and Atmospheric Administration, 1997, pp 3,9,18

- [23] SpillPro: *Oil Spill Control and Management*, https://spillpro.com.au/ 2017

- Operational Environment of Skimmers
  - [24] *Northwest National Petroleum Reserve-Alaska: Draft integrated activity plan/environmental impact statement* (Vol. 2). (2003). Anchorage, AK: U.S. Dept. of the Interior, Bureau of Land Management.

  - [25] Hoang, A., Pham, V., & Nguyen, D. (n.d.). *A Report of Oil Spill Recovery Technologies* (Vol. 13, 0973-4562, pp. 4915-4928, Rep.). Research India Publications. Retrieved 2018.

  - [26] ITOPF. (2014). Effects of oil pollution on the marine environment (Technical Information Paper 13). London, UK: ITOPF Ltd.

- Relevant Analysis
  - Grill, P., Linde, F., *Oil Skimming Business Potential and Strategic Options Facing a Marginalised Business Segment at Sandvik Process Systems*, EGI-2013-077MS, The Royal Institute of Technology Stockholm, 2013, pp 20-90

- Codes and Standards
  - Oil Spills Prevention and Preparedness Regulations. (2020, August 05). Retrieved October 01, 2020, from https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations

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3.4.2 Belt Mop Oil Skimmer …….. 19
3.5 Weir Skimmers ……. 20
3.5.1 Specific gravity and operational environment…… 20
3.5.2 Weir skimming operation …… 20
3.6 Operational Environment of Skimmers ……. 21
3.6.1 Weathering…….. …… 21
3.6.2 Oil Spill Classification ……... 22
3.7 Major Skimmer Components…….. 24
3.8 Relevant Analysis.…… 24
3.9 Codes and Standards…… 24
3.9.1 Oil Pollution Regulation Programs…..…….. 24

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LITERATURE REVIEW

Introduction

Environment preservation is a topic often overlooked by society. throughout the years the human population has had to jeopardize the well being of the earth to be able to fulfil the population needs. therefore, the world has reached a level where immediate action to preserve the environment needs to be taken and this literature review will focus on the preservation of the earth's bodies of water using different types of skimmers.

Industries that develop and enable the population to have access to sources derived from the oil exploitation have experienced major failures in their systems. These failures have open room for multiple and critical oil spills in the ocean. As a result, the quality of these bodies of water has been negatively affected and marine life is suffering major consequences. As a consequence, immediate need for an effective oil recovery system has grown and the development of new oil recovery technologies has been requested.

To further the discussion of oil recovery, it is extremely important to recognize that the recovery operation is broken into two different categories. One of the categories is the ability to immediately and effectively contain oil spills. On the other side, the other category is based on the different

types of oil recovery methods and devices. This literature report will focus on the different types of skimmers and the oil behavior on the skimmers operational environment.

In this literature report, there are two main types of skimmers that are discussed. The first type of skimmer consists of a oleophilic skimmer that utilizes a belt, disc, drum, tube, brush, grooved disc, smooth drum, and grooved drum to safely remove oil from water. The second type is considered to be called a non-oleophilic skimmer that employs a weir, belt mop or suction components in order to separate the oil. Each variant of skimmer has it's advantages and some may contain more than one component in order to improve the efficiency of the skimmer.

3.3 Oleophilic Skimmers

3.3.1 Disk-Type Skimmers

Disk skimmers operate by mounting to the top of the tank and running a large diameter disk into the coolant surface. The disk itself is made of either plastic or stainless steel. As the disk passes through the coolant surface, oil is captured and cleaned with a set of wiper blades as the disk passes between them. The recovered oil may be stored in a container or pumped directly into a reservoir. This description can apply to the generic form of any disk skimmer, but what will be assessed are the different functionalities and flexible designs that today's oil skimmer has to offer as well as the advantages and disadvantages.

The Disk-Type oil skimmer offers flexible design options that allow versatility as well as cost efficient production options. Disk skimmers, although dependent upon the number and size of the operational discs; are most effective in medium viscosity oils. Compared to other oleophilic skimmer types, the disk skimmers are smaller, more cost efficient and have a slightly higher pick-up rate than their counterparts. Grooved disks, studies have shown, result in higher recovery rates than of disks with smoother surfaced disks. The skimmers can also be operational in a stationary setting or float within polluted waters. Some drawbacks are that the disk skimmer requires a larger operating space due to the accommodation of the disks. Also, the skimmer typically can not sustain efficient operation if debris is present. The skimmer may also require additional ancillaries to operate. These include separate power packs, hydraulic or discharge hoses and storage containment. [1] Industrial skimmers can be quite large in weight and volume due to the size and number of rotating disks. The final disadvantage is that the disk-skimmer can not handle oil that has been emulsified, or chemically broken up into small droplets.

The designs of most disk-skimmers contain a single disk or a multiplicity of disks that rotate along a common axis. The tops of the disks rotate away from the skimmer enclosure while the bottom of the disk(s) rotates towards the skimmer. Materials for these disks are usually smooth unmalleable and rigid metals or plastic and plate like structures. Some designs also include disks that have sorbent materials that provide extra efficiency to oil recovery rate. A United States patent [2] developed in 1981 incorporated fibrous bristles that can attach to the disks. The design features 32 disks with absorbent fibers attached that provide a large surface area to which oil can adhere. The bristles have a thickness of .005-.100 inches and a length of .25-2 inches. Possible bristle materials were nylon, polyesters, and polyamides. An experiment conducted through this

patent included a test of two types of oil with and without the presence of the oil absorbent bristles. Results concluded that the presence of the fibrous bristles substantially increased the oil recovery for both oil types due to the increased surface area they provided. This patent experiment expresses that simple disk design can be easily altered to increase the overall recovery efficiency of the skimmer.

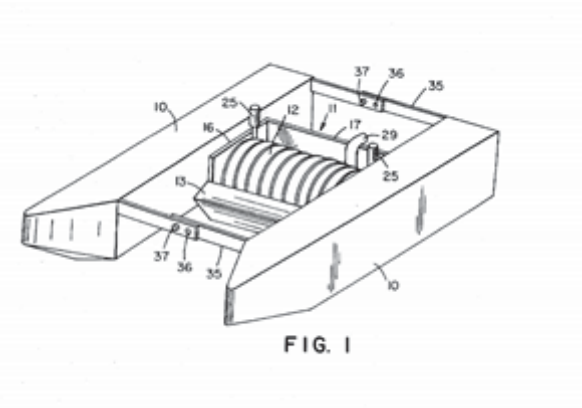


Figure 3.1 US Patent 5,685,979

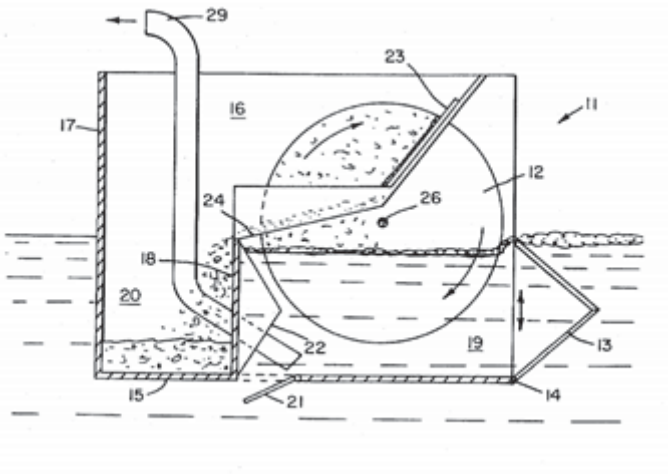


Figure 3.2 US Patent 5,685,979

Another United States Patent [3] design developed in 1997 features a detachable skimmer system that is suspended within two hulls. The open U-shaped design allows for water to flow inwards to a plurality of oleophilic disks along the same shaft. Like the previous mentioned patent, disks rotate away from the skimmer and alternatively collect oil while rubber scrapers are then used to remove the oil into a drainage area and into the hulls for storage. In many disk-designs like this one, hydraulic actuators can be used to compensate for the weight of the collected oil to maintain deployment of the skimmer device on the surface of the water. Keels and bows were also used to allow directional stability. The patent claims also express that the design was not limited to just

the two hulls included. This helps to expand the design options for future oil skimmer developments.

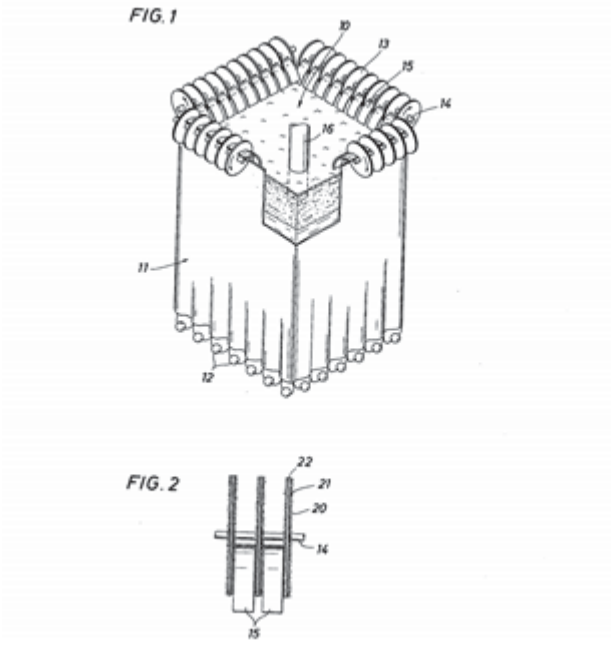


Figure 3.3 US Patent 4,264,450,

Automation within design serves as a key advantage to disk skimmers. Power packs are utilized for disk designs to allow the disk to rotate which can serve as a motor for the disk shaft. These can be hydro- electric or possibly just a standard industrial DC volt battery.

3.3.2 Belt-Type Skimmer

In this section, we will discuss an oleophilic oil skimmer which utilizes a belt system. This type of apparatus is commonly used in the oil recovery field alongside disc, drum, tube, brush, grooved disc, smooth drum, and grooved drum. A belt-type oil skimmer uses an endless belt of corrosion resistant steel or synthetic medium, which is lowered into the tank or vessel to be skimmed. The belt passes through resilient wiper blades where the oil is removed from both sides of the medium. The advantage of a belt type skimmer is that it is the most reliable and economical type of skimmer design that is able to remove various thickness of oil layers.

In the research paper “A free floating endless belt skimmer” an experiment was conducted using a free-floating endless belt skimmer. “The skimmer utilized a unique high efficiency conveyor wringer to power and wring the belt. The belt is designed to float on the water surface and responds rapidly to the shape of the waves, thereby maximizing oil-sorbent contact time”[4]. This experiment was conducted in a 60-foot diameter annular test tank and demonstrated the effectiveness of a belt type oil skimmer. The results of this experiment showed that the oil pick up rates would vary depending on the belt speed, oil slick thickness and porosities. In addition, “oil pick-up rates of 8.3 and 3.7 gpm per foot of belt width were obtained for #2 Fuel Oil and Bunker C oil respectively at a slick thickness of 0.10 inches. The recovered liquid

contained approximately 50-70% oil at 0.10-inch slick thickness."[4] This research was conducted in 1972, however it demonstrates the effectiveness of a belt type skimmer and provides experimental data and a design that can be improved upon.

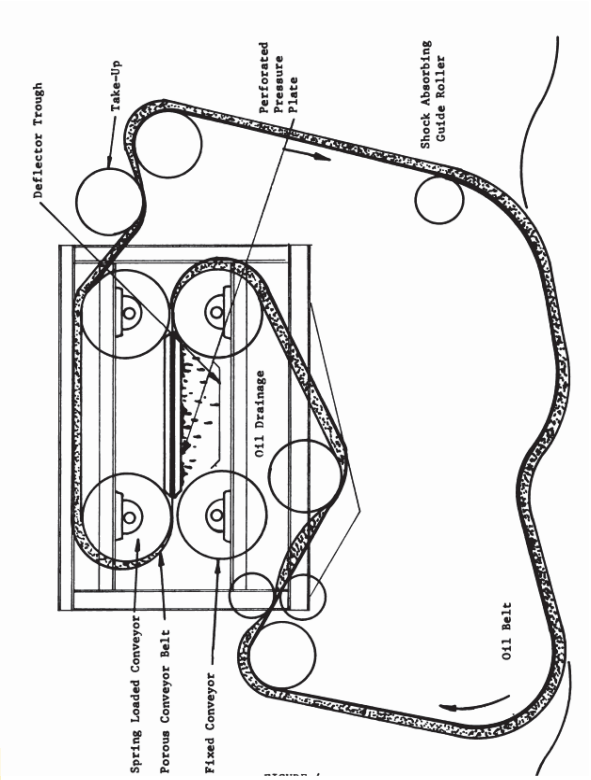
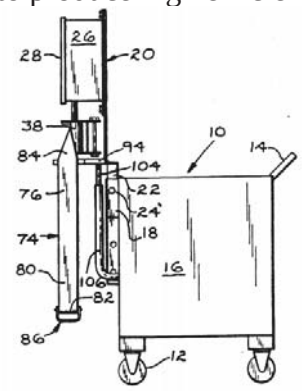


Figure 3.4 Free Floating Endless Belt Skimmer

In the patent 5,015,378, it illustrates an "apparatus for removing oil from the surface of a liquid using an endless belt partially submerged in the liquid, the belt passes over a primary roller having a vertical axis and pressure rollers squeeze the belt which flows by gravity to a collection receptacle mounted upon the frame supporting the primary roller and its driven structure. The belt twists whereby its lower portion submerged in the liquid defines a reversing loop whose configuration is maintained by a weight roller having a horizontal axis of rotation."[] Using a combination of belt and rollers, this design is able to produce high efficiency oil removal and requires minimum maintenance and servicing.



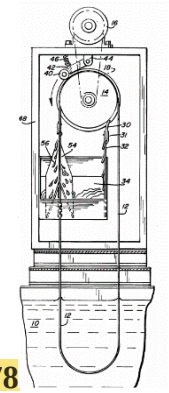


Figure 3.5 U.S Patent 5,017,378

In the patent 5,062,953, it depicts an oil skimmer where “The belt is threaded over the upper portion of a primary drive roller having a horizontal axis and pressure rollers mounted upon linkage sets are biased towards opposite sides of the primary roller in engagement with the belt to squeeze the collected oil from the belt permitting the oil to flow to a collector located below the rollers. The linkage sets include reversing rollers, and the apparatus is constructed to readily permit belt replacement.”[5] Similarly to the last patent, it uses a combination of belt and rollers in order to successfully remove oil from water. These patents exhibit similar goals and objectives, however, take various steps into achieving them.

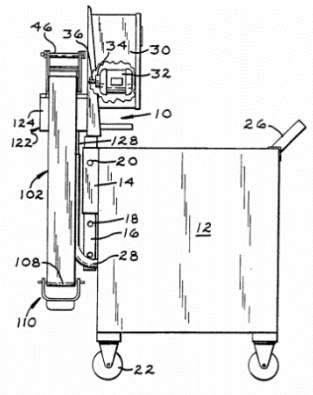


Figure 3.6 U.S Patent 4,089,784

In the patent 4,089,784 it portrays a design where “An endless belt for carrying oil is partially submerged in the basin and is driven and supported by a rotary drum. The rotary drum has an irregular surface for frictional cooperation with the belt and a spring biased roller urges the belt against the irregular surface. The oil is scraped from the belt and directed away from the belt and basin.”[6] Unlike these last two patents, this one utilizes a rotary drum in addition to a belt and roller system. The addition of a drum indicates that most oil skimmers will utilize a combination of designs in order to maximize efficiency of oil removal.

3.3.3 Drum Skimmers

The oleophilic drum skimmer was pioneered in 1990 by Elastec and was regarded as one of the most efficient oil recovery skimmers for shallow waters. This type of skimmer uses materials like aluminum, steel, or general-use plastics since these materials attract oil and repel water. This allows for oleophilic skimmers to be very efficient in not picking up substantial amounts of water even when there is little to no oil present. This is one of the most crucial elements of its design because this is what determines its rate of efficiency of oil recovery.

Figure 3.7 Elastec Drum oil Skimmer

Drum skimmers typically have one or more large drums that rotate while slightly submerged in water. The oil attaches to the surface of the drum while the drum rotates in the oil-water interface. The oil is then squeezed or scraped off the drums into the recovery tank. The oil is passed to a reservoir trough, which forms the back of the frame, through channels between the two drums and at the drum ends. The reservoir trough and the drums are sized to provide all of the buoyancy necessary to float the device and are proportioned so as to position the skimmer in an effective, oil gathering attitude.

The drum skimmer consists of three main items in the development stage, a smooth or grooved drum skimmer, a pump, and a power unit. Just as there are also many factors to consider during configuration. For starters, the location of the oil must be known in order to choose the sizing of the model. Knowing if the oil is very light, light, moderate, or heavy as well as knowing what condition the oil is in due to the weather will affect the viscosity of the oil. For example, cold weather will cause more viscous oil which will be harder to pump. The volume of the oil is a big factor as well as the timeframe. When time is a factor, skimmers with a larger trough are not ideal since the large trough skimmers are used for a more paced scenario. Lastly, being aware of the surrounding area and resources will help depict the best power source (pneumatic skimmer system, electric power pack, or a diesel hydraulic power unit).

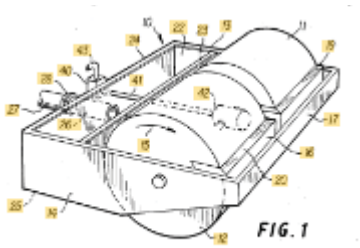


Figure 3.8 US Patent 4,957,636

The ~~figure above~~ shows a perspective view of the skimmer device of patient 4,957,636

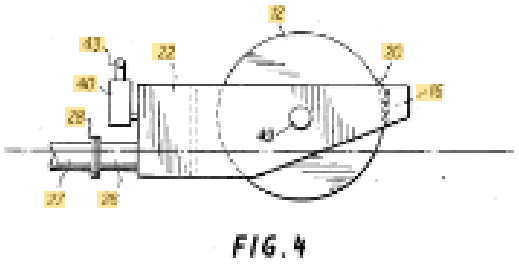


Figure 3.9 US Patent 4,957,636

The ~~figure above~~ shows a side elevational view of the skimmer device of patient 4,957,636

This patient's design features "polyolefins including polyethylene and polypropylene since they are among the preferred plastics due to the fact that they have desirable properties including light weight, oil wettability, and corrosion resistance. The collection trough is open-topped, has two rear wall portions, each adjacent to and extending along the length of one of the drums and topped with scraper or doctor blades which bear against the cylindrical wall surface of the drums respectively. The total power required to drive the drums is modest; less than 1 horsepower, so a very light weight air motor is adequate." ~~[5]~~

3.3.4 Rope Mop Skimmer

The rope mop oil skimmers or rope mop wringers are about the oldest technology out there for oil skimming or getting oil off of water. Like all hard mounted oil skimmers, the Rope Mop Oil Skimmer can be set to run continuously and run unattended. These rope mops run an endless or looped rope or belted material (looks like a squirrel tail) with oil attracting (oleophilic) fibers woven or sewn into it, out across the water or down vertically (as in a pit). The oil sticks to the outside of the fibers and the rope goes back into the wringer machine where either 2 or 3 rubber coated rollers squeeze the oil out and off of the rope and gravity drains it into a tank [6]. For higher viscosity oils, this medium tends to mat down and lose effectiveness. Generally, a decantation system must be used with these Units, as water pickup can be quite high. Also, replacement mops tend to be more expensive than its counterpart (Belt type skimmer).

3.10 Rope Mop Skimmer

Rope mop skimmer can be used in a variety of configurations and they are listed as follows. Vertical mop skimmers can be deployed down boreholes, drains, separators and sumps. Horizontal mop skimmers can be deployed across lakes and rivers, settlement bonds, balancing tanks or fat traps. They can also be Retro-fitted to existing industrial water treatment facilities. The skimmers can be powered either by an electric drive, air, hydraulic or diesel options are available if required.

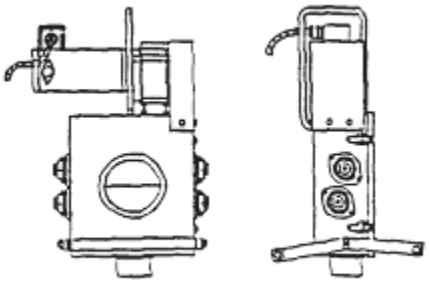


Figure 3.11

The mops are manufactured from a special polypropylene fabric which is stitched to form a continuous loop. Oilskim ropes are made from fibrillated polypropylene which has a large surface area and ensures excellent oil recovery rates. The mops are available in varying widths in black (For heavy sticky oils) and white (for light oils). They are available in lengths form 2m long to 120m long depending on the application. In addition to that, they recover up to 2000L an hour of floating oil.

The Rope Mop recovery rate is dependent on the number and velocity of the ropes, it is generally low throughput. It can be used in both medium to high oil spills, but it is most effective when used on medium spills. The design of the mop skimmer makes it operable in choppy waters, and it is also able to tolerate significant debris, ice and other obstructions.

3.4 Non-Oleophilic Skimmers

Non-oleophilic skimmers carry out the same function as other skimmers, to separate oil from water. The distinguishing component between non-oleophilic vs. oleophilic is that the latter uses oleophilic material. Oleophilic material is oil attracting, by adding oleophilic material onto the skimmer, oil adheres to the surface. In certain situations, such as hot alkaline aqueous parts washer, oleophilic material is inappropriate~~[12].~~ In such cases, non-oleophilic skimmers are necessary. Non-oleophilic techniques include weir skimmers, suction systems, and mechanical skimmers. Non-oleophilic skimmers are not as prevalent due to the many restrictions they have. They are usually only used in environments where oleophilic skimmers are inappropriate. They are not as efficient in differentiating between oil and water and aren’t as versatile in the types of water they can be used in[13].

3.4.1 Suction Skimmers

Suction skimmers include vacuum skimmers, whereby oil is recovered directly from the water surface by air suction systems. Other vacuum skimmers use a hose directly connected to a vacuum truck, which can easily be carried out in rivers. Vacuum trucks are generally self-contained with necessary power supply, pump and storage[14]. Due to the sensitivity to waves, vacuum skimmers are often restricted for use in calm waters. Furthermore, suction skimmers are ideally suited for recovery of oil on or near the shoreline[15]. Another disadvantage of suction mechanisms are the unchanging capabilities of a suction device which can result in high proportions of water being collected, and are easily clogged by large debris.

3.4.2 Belt Mop Oil Skimmer

A belt mop oil skimmer is a non-oleophilic mechanism employed to skim oil from coolant and wastewater. The belt is used in applications where an oleophilic material, such as a rope, drum, or disc, is inappropriate. The skimmer works on the difference in surface tension of oil and water allowing the rotating continuous belt to attract waste oil and reject water. Since belt mop oil skimmers are used in harsh conditions, the skimmer is generally turned off whenever there is no oil to skim to minimize the amount of water collected. It is most effective in heavy oils and is capable of removing a high volume of oil[16].

3.5 Weir Skimmers

Weir skimmers are used for effective oil recovery all around the globe. This type of skimmer uses the difference in specific gravity from the oil and water to their advantage for effective draining of spilled oil from the surface of a body of water. The skimmers are usually released using a crane from a moving vessel into an oil containment area to proceed with the recovery of the oil. The weir skimmers are either remote controlled by compressed air or by self-adjusting. [17][18][19]Moreover, according to a study of the enhanced oil spill recovery rate using the weir skimmers made by A.H. Hammoud from the Mechanical Engineering Department of the Beirut Arab University, "Weir skimmers play an important role in oil spill recovery." [20] In addition, the study emphasized that improving the performance of weir skimmers will allow spilled oil to be recovered more efficiently, which will result in the reduction of environmental harm[20]. However, weir skimmers' recovery effectiveness lies on several factors that will be discussed in detail in the following paragraphs

3.5.1 Specific gravity and operational environment

In order to start developing a fundamental understanding of how the weir skimmer works, it is necessary to understand the role that specific gravity plays in the overall effectiveness of the skimmer. According to the book "Fluid Mechanics Fundamentals and Applications," specific gravity is defined to be the ratio of the density of a liquid to the density of a standard liquid such as water at a specific temperature. Therefore, for many applications the specific gravity of a liquid is calculated based on the specific gravity of water at 4°C, 1000 kg/m3 [21]. As mentioned in the beginning of this section, the difference in specific gravity between the oil and water allows the oil to create layers on top of the surface of the water. The higher the difference in specific gravity between them, the higher chance for effective containment and recovery of the oil.

When an oil spill is experienced, one of the most important operations that leads to effective oil recovery, is the effective containment of the oil. Therefore, most of the oil recovery operations begin by using oil containment booms. Although the booms difference in size and form, what affects their effectiveness is the operational environment and the specific gravity difference between the oil and the water. These two factors go hand by hand and directly affect each other. For example, if the difference in specific gravity of the oil and the water is significant, then the oil will be more accessible in the recovery process as it will form a thick layer on top of the water surface. In addition, the thick layer of oil will be more likely to withstand higher wave pressure and increased wind. On the other hand, if the specific gravity of the oil is very close or equal to the specific gravity of the water, then the waves and higher winds are likely to easily move the oil. Harsh movement of the oil whose specific gravity is close to the water's specific gravity, causes the oil to sink under the boom and resurface around 100 ft away from where it sank. As a consequence, the weir skimmer will not be able to recover the amount of oil when it experiences that level of turbulence and buoyancy [22].

3.5.2 Weir skimming operation

Weir skimmers drain are known to be floating devices. The edges of the weir skimmers are positioned at the interface between water and the oil layer on top of it or right below the upper oil

slick surface. This allows the oil to successfully flow right over the weir edges into the containment area within the skimmer. Once the oil is recovered and placed in the containment area the Oil is then pumped into external storage tanks. The weird skimmers are the skimmers most commonly used due to their portability and easy assembly [18][19]. Conclusively, these skimmers effectiveness increases when there is effective containment of the oil by using a boom like the one shown in Figure ~~3.5.1~~ and again depending on the specific gravity of the oil over the water as stated in the specific gravity and environment subsection. In addition, weir skimming operations can be improved by developing a mechanism that will increase oil recovery rate with less amount of water recovered and becoming independent of the oil-water gravitational force effects.

Figure ~~3.5.1~~ displays an oil recovery operation by using a weir skimmer and a boom containment unit.

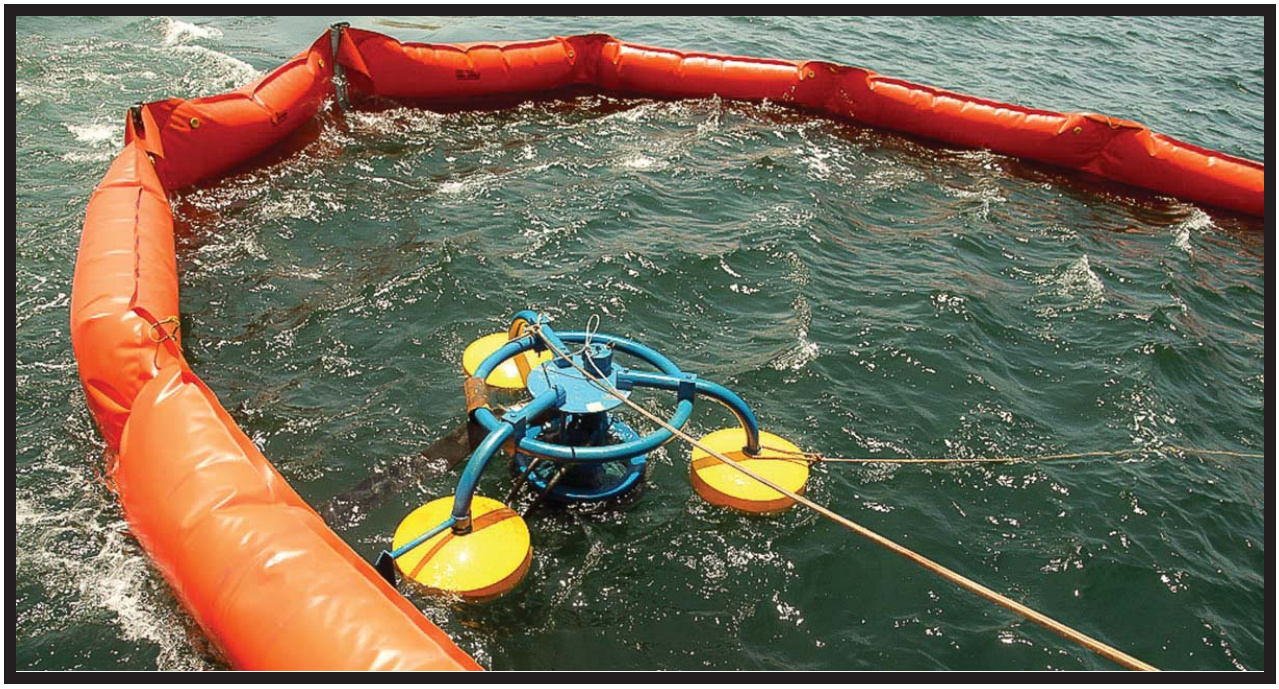


Figure 3.12 SpillPro on 1 November 2017

3.6 Operational Environment of Skimmers

Operational environment can be described as a condition that influences the behavior and efficiency of an object to do a certain function. Operational environment on booms, skimmers,

absorbent materials or any other physical oil recovery method is the primary process that affects the nature of an oil spill. Boom is a barrier used to prevent oil spill or slick from spreading, however the efficiency of this operation can heavily depend on the characteristics of the current, wind, or wave behavior[24]. When the wind or current velocity is at a certain point or the height of the wave is above 1 meters then the oil will spill underneath the barrier. This will limit the booms efficiency recovery which leads to using a skimmer as the next step of the water cleanup process. An oil skimmer is a device used to remove oil from a body of water, however an operational environment can heavily influence the productivity of this product. These negative consequences can happen as a result of weathering, which is the case of spreading, evaporating, dispersion, dissolution, and emulsification of an oil[25]. The final step of water rehabilitation is using adsorbent materials, which is the use of sorbent materials to clean oil spills.

3.6.1 Weathering

The effect of weathering on the productivity and efficiency of the oil recovering process can occur in various ways. one of the weathering aspects is spreading, which can be described as the reduction of bulk quantity of oil and increasing spatial area[24]. Thus, oil in a high current system can be less concentrated as opposed to a well contained system. Evaporation is another characteristic of weathering that can affect the recovery of an oil spill. Evaporation is the mechanism of losing the light molecules into the air which leaves the oil to be denser, heavier, and more viscous. Dispersion can be described as the action of distributing the oil into the water which can damage the skimmer or booms physical impact on oil recovering. Dispersion can be a result of having a high water turbulence. Dissolution of oil occurs when the water soluble component of oil may dissolve into the water surrounding. This type of weather characteristics is one of the primary toxic reasons of an oil spill. The process of dissolution may occur frequently when temperature rises, molecular weight decreases, salinity decreases, and when there is an increase in the dissolved concentrations of organic matter[25]. Lastly, emulsification is opposite to dispersion, it is when water dissolves and incorporates oil. This is a product of the wave behavior into the oil and water, the high energy of the wave emulsifies the oil. Heavier oil is more likely to emulsify rapidly as opposed to lighter oil. This condition is often referred to as “mousse”. Figure ~~4.1~~ showcases some of the different alteration processes that an oil spill faces on water[26].

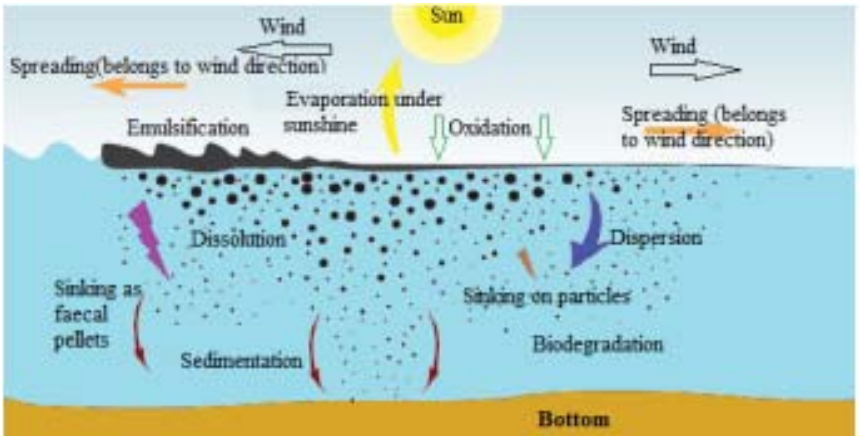


Figure 3.13: Various Weathering Conversations of Oil Spills

3.6.2 Oil Spill Classification

Oil spills unquestionably damages marine environments and causes severe impact to the water. therefore oil spills has been classified into three categories;

- First class: The following classification is for small oil spills that are related to machinery discharge of oil water mixture. It can also be a result of oberational vessels/ships in port, or bertheline[25].
- Second class: The following classification is for oil spills that are related to ship incidents such as fires, collisions, or any other damages that are associated with ships. This can result in contaminating large water areas and can result in damaging the ocean environment[25].
- Third class: The following oil spill classification is for any intentional oil spill, someone who jeopardizes the water quality and marine life just to save money. This can be classified as a criminal act[25].

3.7 Major Components

- Pump/hose: Extension of skimmer design used to extract collected oil to be relocated to an outside container source.
- Container - Used to store the collected oil from the skimmer. This prevents the oil from mixing with the water after it is collected.
- Draining system - A system designed to drain the collected oil from the container after it is separated from the water. The collected oil is then removed and stored to keep the container empty to restart the skimming process.
- Filter system - Oil and water separator that detects the density of collected liquids and also catches small particles to keep oil purified for reuse. After liquid is filtered, it is then moved to the container.
- Power supply - A power supply would be needed for skimmer mobility. Examples consist of an Electric motor, Diesel hydraulic power unit, or a DC volt battery.
- Sensor: A sensor will be needed to determine the distances the skimmer will fluctuate within. These sensors will also manage the START and STOP control for the skimmer during skimming operations. Finally, the sensor will be able to detect oil thicknesses.
- Actuators: Hydraulic actuators are components used to control the intake of a system. Since the skimmer is mechanically driven by water, the actuator can “control” how the system reacts to the environment using a control signal, usually a valve.

3.8 Relevant Analysis

- Oil and grease always on the water surface. They do not mix with water. Separation of it is based on the surface tension, specific gravity and viscosity of them
- properties determining if oil is able to skim surfaces involve floatation, viscosity and the time the oil stays on the surface of the water.

- Specific gravity can be calculated to determine if oil will float on water, if the specific gravity is lower than the surrounding water is(which depends on if it's pure or sea water) then it will float. API equation can be used to measure specific gravity of oil

$$°API = \frac{141.5}{specific\ gravity\ at\ 15.6\ °C} - 131.5 \quad \text{(Equation 3.8)}$$

- Besides specific gravity, pour point, is another method used to categorize oils. The pour point is the temperature below which an oil can no longer float[17].
- The speed of oil spreading depends on the viscosity of the oil as well as external factors like wind. Low viscosity oil spreads easily while high viscosity oils do not
- The rate of evaporation depends on the ambient temperature as well as the wind speed, but in temperate climates all hydrocarbons with a boiling point below 200°C will evaporate within 24 hours[17].
- Oil dispersions mainly occur at sea, at the location of breaking waves. Dispersion usually affects low viscosity oils as high viscosity oils are more protected of dispersion as the particles are more tightly attached to each other thus requiring more force to break the oil particles apart.
- Various factors need to be taken into account during the selection skimmers but the most important aspects to consider are the viscosity and the adhesive properties of the oil within the skimming process
- The second most important factor to assess is the skimmer's intended use and expected operational conditions.
- Recovery rate(RR): The rate at which pure oil is recovered
- Recovery efficiency(RE): The relation between recovered oil and recovered fluids (oil-water mixture)
- Throughput efficiency: The relation between encountered oil and recovered oil

3.9 Codes and Standards

This section covers some of the acts, programs, and testing regulations that are relevant to Oil skimmers and oil recovery.

~~3.9.1 Oil Pollution Regulation Programs~~

The oil pollution act was passed in 1990. This act was an amendment to the Clear Water Act in which some oil storage facilities were required to develop facility response plans for spills. The lead federal response agency EPA is the agency for oil spills occurring in inland waters. Some of EPA's top priorities are to prevent, prepare for, and respond to oil spills that occur in and around inland waters of the United States. EPA's oil spill prevention program includes the Spill Prevention, Control, and Countermeasure (SPCC) and the Facility Response Plan (FRP) rules[17].

On the other hand, the Bureau of Safety and Environmental Enforcement, the Oil Spill Preparedness Division, and the Response Research Branch manages the OSRR Program. This research program has focused on improving the spill response countermeasures. The program

opens a path that helps develop decision making strategies for oil spill responses in the offshore environment.

In addition, testing optimization from ASTM-2709-08 requires performance data to be the result of three measurements that produce results within 20% of the arithmetic mean. The skimmer optimization process requires that a skimmer should operate to provide the maximum ORR while also meeting 70%.

Discussion:

The supporting articles and references above help to establish the credibility and procurement of today's advances within the efforts of efficiently conducting oil removal from open water sources. The abundance of resources pertaining to these advances allow for comparisons of the advantages and disadvantages that the industrial oil skimmers have to offer today. By examining the many key differences between oleophilic, non-oleophilic, and weir skimmers, an analysis can be conducted to determine which design can be further altered to increase the efficiency of today's oil recovery. Key aspects of understanding the efforts of increasing the efficiency include the characterization of each skimmer type as well as their operational environments. Patterns and characteristics of oil behavior are also examined to comprehend the "oil life" during its duration on the water's surface. This guides the sense of urgency for the effectiveness of the oil removal process. All references gathered guided for a general understanding of the oil skimmer industry.

6. References should be properly cited in the literature review, and a list of references provided using the format provided in the Senior Project Manual which is available to you free on e-course.

LIST OF REFERENCES

[1] Grill, P., Linde, F., *Oil Skimming Business Potential and Strategic Options Facing a Marginalised Business Segment at Sandvik Process Systems,* EGI-2013-077MS, The Royal Institute of Technology Stockholm, 2013, pp 27-28

[2] Robert Governale, inventor; Miller Environmental Group, Inc., assignee. Oil Skimming Apparatus, United States patent US 5,685,979, 1997 Nov 11.

[3] Ray Ayers,Kenneth L. Bickham inventors; Shell Oil Company, assignee. Fibrous Disc Oil Skimmer, United States patent US 4,264,450, 1981 Apr 28.

[4] Agnew, R.W., *Free floating endless belt oil skimmer* United States Environmental and protection agency, 1972

[5] Philip C. Lewan, inventor; Camshaft Machine Company assignee. Belt Type Oil Skimmer with Horizontal Rotors, United States patent US 5,062,953, 1991 Nov 5.

[6] Gregory A. Ettelt, Alfred L. Cohen, inventor; Tenco Hydro/Aero ScienceS, Inc., assignee. Belt Type Oil Removal Unit, United States patent US 4,089,784, 1978 May 16.

[7] Philip C. Lewan, inventor; Miller Environmental Group, Inc., assignee. Belt Oil Skimmer Apparatus, United States patent US 5,015,378, 1991 May 14.

[8] INC., Elastec. “Drum Oil Skimmers: Oleophilic Skimmer.” *Elastec*, 17 Sept. 2020, www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/.

[9] Donald L. Wilson, Jerry C. Trippe, inventors; Elastec Inc., assignee. Device for skimming oil from water. United States patent US 4,957,636, 1990 Sep 18.

[10] J. S. Shum and M. Borst Mason & Hanger-Silas (*2015*) OHMSETT TESTS OF A ROPE-MOP SKIMMER IN ICE-INFESTED WATERS. International Oil Spill Conference Proceedings: February 2015, Vol. 2015, No. 1, pp. 31-34.

[11] Alves, Tiago M et al. 2015. “Modelling of Oil Spills in Confined Maritime Basins: The Case for Early Response in the Eastern Mediterranean Sea.” Environmental Pollution 206: 390–99

[12] Al-Majed et al., 2012 A.A. Al-Majed, A.R. Adebayo, E.M. Hossain A sustainable approach to controlling oil spills J. Environ. Manag., 113 (2012).

[13] Anh Tuan Hoang & Minh Quang Chau, 2018. "A Mini Review of Using Oleophilic Skimmers For Oil Spill Recovery," Journal of Mechanical Engineering Research & Developments (JMERD), Zibeline International Publishing, vol. 41(2), pages 92-96, July.

[14] ITOPF. (2012). The Fate of Marine Oil Spills. London, UK: The International Tanker Owners Pollution Federation.

[15] NOAA. (2010). Fact Sheet: Skimmers. Mobile, AL: National Oceanic and Atmospheric Administration.

[16] Ortega AE, Walker JT, Whitfield WW, Bostwick J (2011) Materials and methods for removing oil from bodies of water Google Patents.

[17] Grill, P., Linde, F., *Oil Skimming Business Potential and Strategic Options Facing a Marginalised Business Segment at Sandvik Process Systems,* EGI-2013-077MS, The Royal Institute of Technology Stockholm, 2013, pp 20-90

[18] N.O.A.A., *Fact Sheet: Skimmers*,National Oceanic and Atmospheric Administration,2010

[19] I.T.O.P.F., *The Fate of Marine Oil Spills*, International Tanker Owners Pollution Federation, 2012

[20] Hammoud, A.H. *Enhanced oil spill recovery rate using the weir skimmer* Mechanical Engineering Department, Beirut Arab University, pp 1

[21] Cengel, Y.M., Cimbala, J.M., *Fluid Mechanics: Fundamentals and Applications*, McGraw-Hill, New York, 2014, pp 39,980

[22] Kaperick, J.A., *Oil Beneath the Water Surface- and-Review of Currently Available-Literature on Group V Oils: An Annotated Bibliography Report*, HMRAD 95-8, National Oceanic and Atmospheric Administration, 1997, pp 3,9,18

[23] SpillPro: *Oil Spill Control and Management*, https://spillpro.com.au/ 2017

[24] *Northwest National Petroleum Reserve-Alaska: Draft integrated activity plan/environmental impact statement* (Vol. 2). (2003). Anchorage, AK: U.S. Dept. of the Interior, Bureau of Land Management.

[25] Hoang, A., Pham, V., & Nguyen, D. (n.d.). *A Report of Oil Spill Recovery Technologies* (Vol. 13, 0973-4562, pp. 4915-4928, Rep.). Research India Publications. Retrieved 2018.

[26] ITOPF. (2014). Effects of oil pollution on the marine environment (Technical Information Paper 13). London, UK: ITOPF Ltd.

[27] Oil Spills Prevention and Preparedness Regulations. (2020, August 05). Retrieved October 01, 2020, from https://www.epa.gov/oil-spills-prevention-and-preparedness-regulations

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

FALL 2020

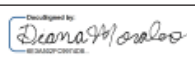
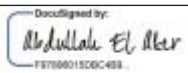
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER __3_____

Progress Report Title:____Literature Review_____

Due Date:___10/1/2020_____

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Completed introduction and table of contents. Formatted report for submission and proofread.	100	
2	Christian White 	Assigned to identify information relevant to the project as well as identify potential sources for the project.	100	
3	Fanta Kaba 	Assigned to complete the introduction and table of content. Assisted in proofreading the report.	100	
4	Abdullah EL Aker 	Assigned to identify major components and their functions. Identify relevant subject areas and general equations for the design.	100	
5	Marcelo Epam Ona 	Gathered some of the information needed to complete the literature review and work on the methods and fabrication of similar designs.	100	
6	Yemboado Yonli 	Researched and Identified designs similar to the one that is going to be used in that experiment. Provided a list of references	100	
7				
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COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
Status Report 5A on Literature Review

Assigned 09/16/20 **Due: 09/24/20**

This status report covers the information on the Literature Review chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class for the assignment #2. The report should be prepared using the chapter title." **3. LITERATURE REVIEW**". The subsections highlighted in blue fonts should be used in the status report.

3. LITERATURE REVIEW

A. Provide introductory paragraphs for this chapter that discuss the purpose of the chapter.

3.1 Identification of Information Relevant to the Project

B. **Identify and** list the types of information needed to be reviewed for a complete understanding of all aspects of the project. **Describe in detail how you identified the types of information relevant to the project as an introduction to your response to this question.**

3.2 Potential Sources of Information for Project

C. For each information type listed in item 2 above, identify the sources you will need to use to obtain the information. This will also serve as a partial reference list for your project. Refer to how to list references in the Senior Project manual for the format for this section. **Describe how you identified the sources as an introduction to the answer for this question**.

D. Plan the literature review chapter by carefully developing a Table of Content page for the subsections to be included in the literature review.

See example below

3. LITERATURE REVIEW ……..
……..13

3.1 Identification of Information Relevant to the Project …… 14
3.2 Potential Sources of Information for Project…….. 14
3.3 Major Subsection Title …… 14
3.3.1 Minor subsection title 1…….. 15
3.3.2 Minor subsection title 2 …….. 15
3.4 Major Subsection Title 4 ……. 18
3.4.1 Minor subsection title 1 …… 20
3.4.2 Minor subsection title 2 ……. 21
Etc.

E. Using the sources identified in item 2, and following your planned table of content, develop a well planned and exhaustive literature review for your project. The literature review should focus on relevant items that would help you with the design. This should include but not limited to:
    - existing similar designs and how each functions, advantages and disadvantages of each of the existing designs;
    - identifying the major components of the existing similar designs and how they function;
    - identifying subject areas that are relevant as well as the design equations in these subject areas that are relevant for the design analysis that can be used for sizing and specifying the components of the design;
    - identifying fabrication and testing methods and procedures for similar designs.
    - Identifying codes and standards applicable to the design

F. References should be properly cited in the literature review, and a list of references provided using the format provided in the Senior Project Manual which is available to you free on e-course.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheet)

Assignment for Assessing Outcome c.2

Grading Scheme for
Status Report on Literature Review

Project Group #___3___

Item	Description	Maximum Points	Your Score
1	Introduction paragraphs for chapter provided	5	
2	Description provided on how information was identified Types of information completely identified to a level that shows the group has a grasp of what they need to look for on the project	3 12	
3	Description provided on how potential sources of information were identified. For each information, sources needed are adequately identified.	3 12	
4	Literature review topics are well planned and broken down into appropriate logically sequenced Sections and sub-sections in a TOC format Content of TOC for Literature Review are related to the 5 listed objectives for literature review	15 5	
5	The literature review is detailed and focused on relevant items related to the project, include existing similar designs, components needed, relevant design analysis methods, fabrication, and testing. Relevant codes & standards Figures & Tables properly numbered, titled and cited in the report	110 10	
6	References properly cited and appropriate list of references provided	20	
7	Copy of Status request attached	5	
	Total	200	

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
Status Report 5A on Literature Review

Assigned 09/16/20 **Due: 09/24/20**

This status report covers the information on the Literature Review chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class for the assignment #2. The report should be prepared using the chapter title." **3. LITERATURE REVIEW**". The subsections highlighted in blue fonts should be used in the status report.

3. LITERATURE REVIEW

Provide introductory paragraphs for this chapter that discuss the purpose of the chapter.

The purpose of this ~~experiment~~ is to design a proper method to measure the convection transfer coefficient for nanofluids under different boundary conditions. In order to completely understand the scope of this experiment, the identification of relevant information is necessary to ensure the functionality in the measurement technique selected. Relevant sources are reviewed to establish a well-planned literature review, which focuses on examining existing similar designs and its components, relevant design analysis methods, fabrication, and testing, as well as, relevant codes and standards.

3.1 Identification of Information Relevant to the Project

Identify and list the types of information needed to be reviewed for a complete understanding of all aspects of the project. **Describe in detail how you identified the types of information relevant to the project as an introduction to your response to this question.**

These specific resources were determined through intense study and research to better understand the scope of our specific project. This project is a design of a system that will efficiently measure heat transfer coefficient and effective thermal conductivity in nanofluids under different boundary conditions. Knowing that, it was determined that the best way to approach this project was by first researching other experiments conducted by professionals who have studied the different types of nanofluids, as well as respective measuring techniques. It was also determined that research on the concentration of nanoparticles, controlled parameters, and hybrid nanofluids will help to gain an understanding for the design of this project.

The types of information to be reviewed to understand the **systematic approach** for measuring the heat transfer coefficient and **effective thermal conductivity in nanofluids** consists of past experimental projects, **research documents that highlight the study of nanofluids** under different boundary conditions, studies stating the effects of temperature and nanoparticles concentration, documents that describe multiple measuring techniques regarding a nanofluids heat transfer coefficient, documents that determine efficient measurement techniques for the measuring of thermal conductivity, a **review on the control parameters** of natural convection, and lastly, the **review of past experiments** for the determination of viscosity of water-based

magnetite nanofluid in heating and cooling systems. Determination of viscosity of water-based magnetite nanofluid in heating and cooling systems.

3.2 Potential Sources of Information for Project

For each information type listed in item 2 above, identify the sources you will need to use to obtain the information. This will also serve as a partial reference list for your project. Refer to how to list references in the Senior Project manual for the format for this section. **Describe how you identified the sources as an introduction to the answer for this question**.

These references were identified by the group to state that the following resources are the best options to efficiently understand the system for this project. The reference list contains articles which were written by professionals who have studied different measuring techniques as well as nanoparticles related to various boundary conditions.

- Masoud, M.E., *"Experimental study on thermal conductivity of water-based Fe3O4 nanofluid: Development of a new correlation and modeled by artificial neural network"* Islamic Azad University, Najafabad, Iran pp 262-269

- Masoud, M.E., *"Effects of temperature and nanoparticles concentration on rheological behavior of Fe3O4–Ag/EG hybrid nanofluid: An experimental study"*Islamic Azad University, Najafabad, Iran pp 38-44

- Colmanetti, P.O., *"Heat transfer coefficient: a review of measurement techniques"*Heat Transfer Research Group, Department of Mechanical Engineering, Sao Carlos School of Engineering, University of São Paulo pp 264

A. Plan the literature review chapter by carefully developing a Table of Content page for the subsections to be included in the literature review.

See example below

3. LITERATURE REVIEW …….. 4

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3.2 Potential Sources of Information for Project……...….. 5

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3.4 Codes & Standards Applied to Design ……...…..…… 12

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3.6.1 Sizing the Thermal Fluid Heater…….…….. 14
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3.6.3 Heat Losses to the Environment…..……...….. 15
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3.7 Identifying Fabrications, Testing Methods & Procedures for Similar Designs …… 17
3.7.1 Identifying Testing Methods…..…….. 17
3.7.2 Direct Method and Fabrication ……..…….. 17
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3.7.4 Procedures Taken for the Direct Method Technique …….. 23
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3.8 ~~Codes & Standards Applied to Design~~ ……. 24

B. Using the sources identified in item 2, and following your planned table of content, develop a well-planned and exhaustive literature review for your project. The literature review should focus on relevant items that would help you with the design. This should include but not limited to:
    - existing similar designs and how each functions, advantages and disadvantages of each of the existing designs.
    - identifying the major components of the existing similar designs and how they function;
    - identifying subject areas that are relevant as well as the design equations in these subject areas that are relevant for the design analysis that can be used for sizing and specifying the components of the design;
    - identifying fabrication and testing methods and procedures for similar designs.
    - Identifying codes and standards applicable to the design

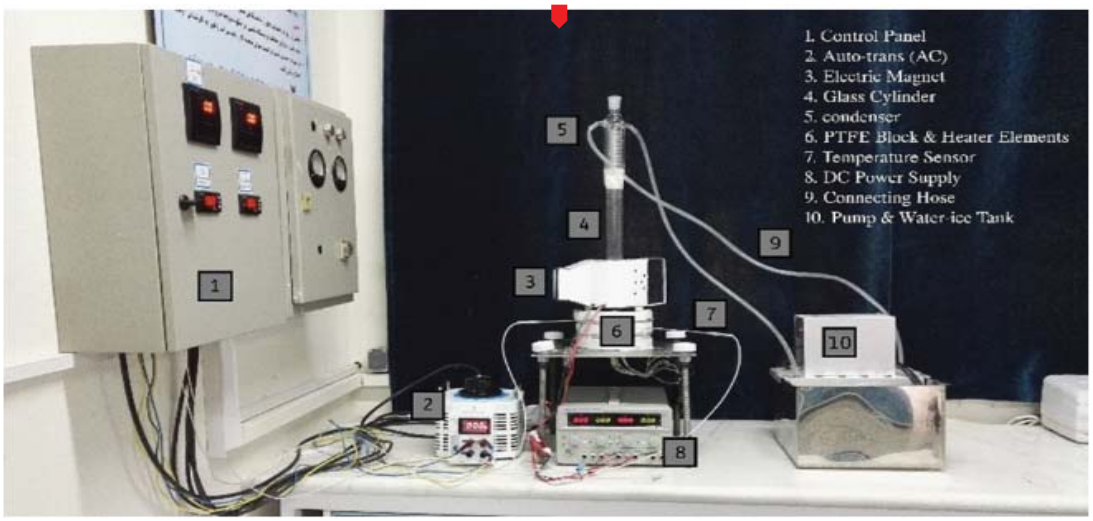
- Existing similar designs and how each functions, advantages and disadvantages of each of the existing designs; **Bryan**

~~Existing Similar Designs & Functions~~

In the process of learning more about measuring the heat transfer coefficient of nanofluid (h), a few devices capable of doing so were discovered. Each Design brings with it a lot of advantages but also some disadvantages. Care has been put into finding devices that were used in experiment with conditions as similar as the one this group is aiming to perform. For that matter two designs were identified.

~~Design 1~~

An interesting device was the one used by ~~[1]~~S. Rostami, E. Raki, A. Abdollahi, A. S. Goldanlou which is represented by Fig. 1.



~~Fig.1~~ An overview of the device used by ~~[1]~~S. Rostami, E. Raki , A. Abdollahi , A. S. Goldanlou

According to Fig. 1, the pool boiling device with the specified components was utilized to calculate the heat transfer in the pool boiling. The components of the device, in accordance with the performed numbering, include the control panel, DC power supply, temperature sensors, electric magnet, boiling glass cylinder condenser, cooling water pipes, pump, cold water tank, Teflon body (insulated), autotrans, and heat elements.

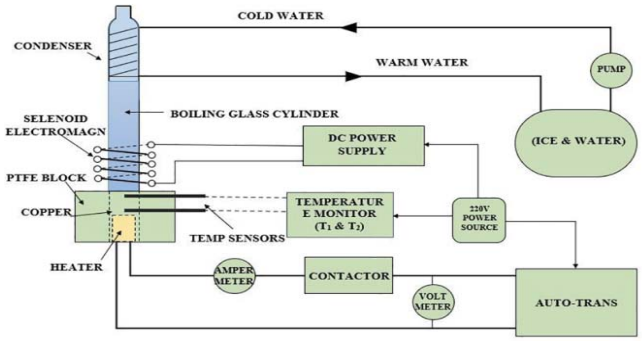


Fig. 2 The operational diagram of the device

According to Figs. 1 and 2, the application of the introduced components includes: the control panel has a monitoring system for the ampere, the input voltage (Autonics TC4Y) to the heat elements, and the temperature of the resistance temperature detector (RTD) sensors embedded in the copper block. The copper block is cylindrical with high purity, with a diameter of 40 mm and a length of 90 mm. The thermal conductivity coefficient of the high purity copper was measured using a KD2 Pro device manufactured by the Decagon Company (401 W/m.K). The whole copper wall is completely threaded. The length of the thread pitches is 2 mm. Four steel elements (electric heaters) with a diameter of 6 mm and a length of 40 mm, with 200 W power each, are embedded inside the copper cylindrical block from below. The copper cylindrical block is heated by these four elements. The Teflon cylinder has a height of 90 mm and a diameter of 150 mm. The Teflon around the copper is polytetrafluoroethylene (PTFE), where its thermal conductivity coefficient is measured using the KD2 Pro device (0.25 W/m.K). Due to the insulation effect of PTFE Teflon around the copper block, the radial heat transfer is ignored. The copper cylinder is Teflon-wrapped and fastened in the hole using the threads on its exterior wall. PTFE tapes, produced by the Sitco Company with ISO9001 standard, were also used on the threads of the copper wall to prevent the fluid leakage. The positions of the sensors, the heat elements, and the copper block are shown in Fig. 3. The sensors are passed through a hole with a diameter of 3 mm and placed in the center of the copper block. The upper surface of the copper block is in touch with the fluid, and the glass cylinder into which the fluid is poured is installed on top of it using holding clips. The height of the glass is 350 mm, its external diameter is 40 mm, and the thickness of the wall is 3 mm. An electromagnet, which is generated using a solenoid and a tubular core is installed around the glass cylinder (Fig. 4). This magnet has a variable magnetic field intensity that changes by changing the input ampere of the magnet. The intensity of the magnetic field was examined and measured using a magnetometer (Lutron MG-3003SD) in several steps and for various amperes. By generating magnetic fields with a maximum capacity of 1000 gauss in the wall of the metal core and 300 gauss in the central core, this device is designed and produced for a maximum amperage of 10 A DC and is set up using a DC power supply. Its contour and field direction are shown in Fig. 5. The condenser, which is connected to the pump and the cold-water tank using two flexible hoses, is installed on top of the glass

cylinder. The cold water is pumped to the condenser using the pump, and this circulation leads to the cooling of the condenser and conversion of the vapor produced through boiling to the fluid and returning to the initial volume of the fluid. This causes the fluid volume to be constant. According to Fig. 6, the top surface of the condenser is open, which causes the boiling pressure to be equal to the environment pressure. Due to the effect of the roughness of the boiling copper surface on the heat transfer, a 600-grit sandpaper was used to achieve a constant roughness for all of the experiments.

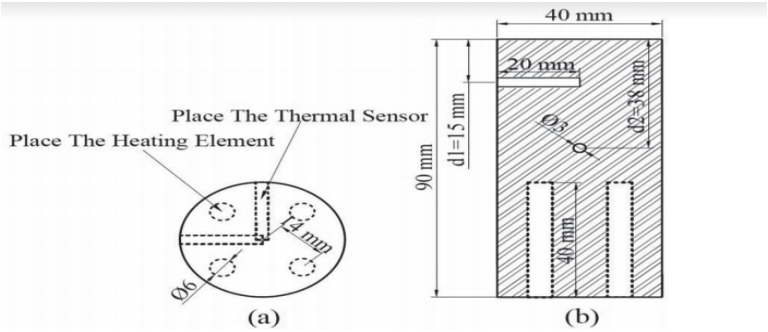


Fig. 3 Schematic view of the position of the sensors, heat elements inside the copper block (a) from the top and (b) from the side

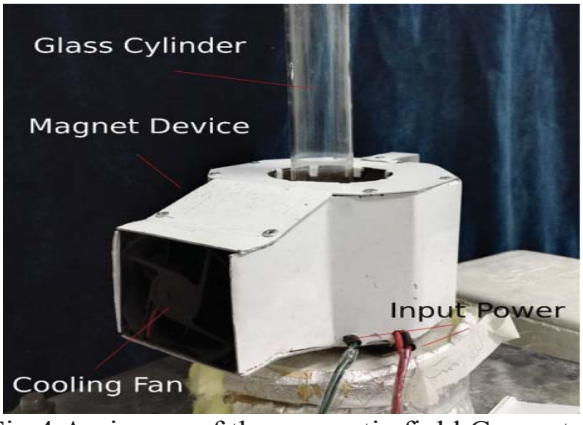
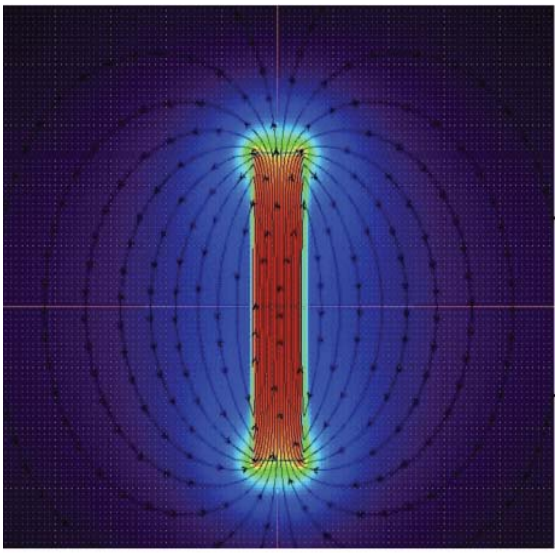
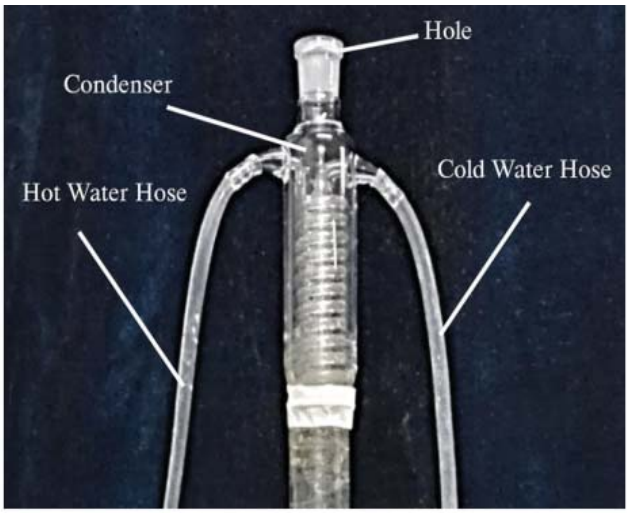


Fig 4 An image of the magnetic field Generator



~~Fig. 5~~ Magnetic field contours (electromagnet with tube cores)



A view of the condenser used to cool the vapor down

Advantages of Design 1

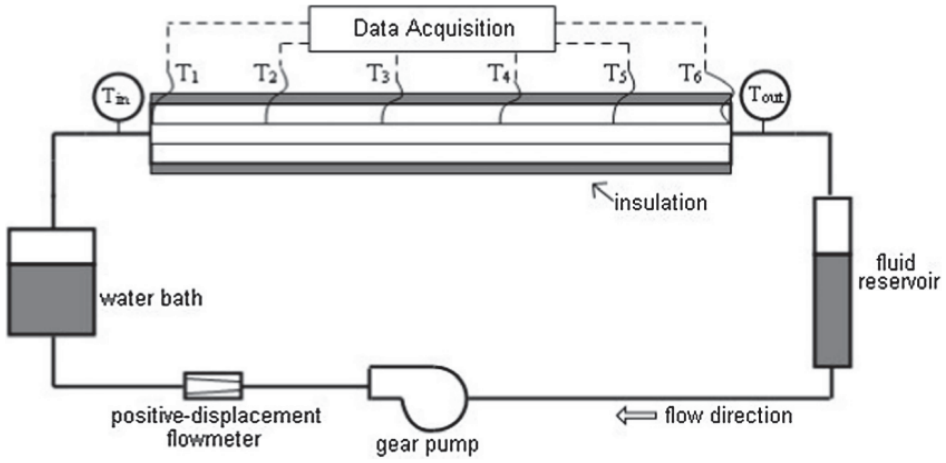
The most important advantage of that device is the condition in which it has been used. ~~the~~ magnetic field has been changed many times, affecting then the heat transfer coefficient of the nanofluids used during the experiment. This is a major change in boundary conditions in the experiment which goes along with the kind of apparatus that would be beneficial for the current project. This also suggests that the magnetic field does not affect the material used to fabricate the experimental set up which is a huge advantage for that experiment. the insulation around the copper block also allows the heat transfer coefficient to be measured as a one-dimensional parameter which is also a good advantage

Disadvantage of Design 1

The device was used in that experiment to measure the boiling heat transfer coefficient of the nanofluid. For the experiment that group number 3 wants to practice the heat transfer coefficient does not have to be measured only at boiling point. So, the device might have to be adapted to the situation. Another problem is that the only change in boundary condition applied was the change in magnetic field. The device used by group 3 for the experiment must be able to sustain other changes in boundary conditions. Also, the device does not measure directly the temperature. ~~the~~ temperature must be manually calculated.

~~Design 2~~

Another design that looked interesting and could fit the project was the one used by ~~[2]~~ M. Ahmadi & G. Willing represented in Fig. ~~8~~. The heat transfer coefficients of prepared base and nanofluids were measured using a lab-built test rig. The entire system is made from 1⁄4 in stock copper tubing and fittings. The fluid flows from the reservoir with 1.5 l capacity through a variable speed gear pump (Grainger 6NY97). Flow rates are measured using an inline flow meter connected into an electronic readout. From here the fluid flows through a copper coil held in a hot water bath which can maintain the test fluid at any temperature from room temperature up to 96C. The fluid then enters the heat exchange section. There are two thermocouples placed in the fluid at both the inlet and outlet of this section. The section itself is formed from high thermal conductivity copper refrigerator tubing that is 1.095 m length and 0.0048 m inner diameter. Six type-T thermocouples are attached equidistant along the exterior of the copper tube in this section. The entire heat exchange section is wrapped in heat tape that provides a constant heat flux to the fluid. Two layers of insulation are wrapped around the heating tape to ensure low heat loses within the heat exchange section. Temperatures are monitored in real time using a Labview program designed for the system. The heat transfer coefficient enhancement ratio at an inlet fluid temperature of 70 C and different CuO concentrations were calculated from experimental measurements.



~~Fig. 8~~ Schematic of heat transfer Test rig used by M. Ahmadi, G. Willing

Advantages of Design 2

The design is simple which makes it more understandable and potentially easier to build and easier to improve. This design has a flowmeter that allows to read directly the flow of fluid going through the apparatus. The thermocouples also allow the temperature to be directly measured.

Disadvantages of Design 2

~~this~~ device has been used in steady state boundary condition. the device might have to be revised in order to be able to apply boundary conditions that will only affect the fluid.

- Identifying codes and standards applicable to the design **Bryan**

~~Codes and Standards applied to Design~~

Any engineering design generated must be submitted to certain codes and standards in order to make sure that the safety of the one using it is taken into account. This is not only about safety but also about usability, cost and quality and also the innovation that is brought through the design. In the United States the ASME (American Society of Mechanical Engineers) is the one to set the standards. For this experiment the heat transfer coefficient of nanofluid is to be measured. It is to assume then that the ASME Boilers and Pressure vessel codes will be used. The code has been taken the code fully detailed will be listed below:

1. Section I, Power Boilers.
2. Section II, Material Specifications.
3. Section III, Rules for Construction of Nuclear Power Plant Components.
    - Division 1, Nuclear Power Plant Components.
    - Division 2, Concrete Reactor Vessel and Containments.
    - Division 3, Containment Systems and Transport Packaging for Spent Nuclear Fuel and High-Level Radioactive Waste.
4. Section IV, Heating Boilers.
5. Section V, Nondestructive Examination.
6. Section VI, Recommended Rules for Care and Operation of Heating Boilers.
7. Section VIÏ, Recommended Rules for Care of Power Boilers. Section VIII, Pressure Vessels
    - Division 1, Pressure Vessels.
    - Division 2, Pressure Vessels (Alternative Rules).
    - Division 3, Alternative Rules for Construction of High- Pressure Vessels.
8. Section IX, Welding and Brazing Qualifications. Section X, Fiber-Reinforced Plastic Pressure Vessels.
9. Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components.
10. Section XII, Rules for Construction and Continued Service of Transport Tanks.

11. Code Cases: Boilers and Pressure Vessels. Code Cases: Nuclear Components.

For more detail on each section the 2017 edition of the Process Piping **Design** Handbook [3]can be visited.

As the design is supported a lot by pipes, we will try to use the ASTM codes and standards.

A typical American Standard for Testing Materials covers, among many things, the following:

- Scope.
- Referenced documents.
- Ordering information.
- Chemical composition.
- Mechanical requirements—tensile strength, yield strength^ elongation.
- Dimension, mass, and permissible variations
- Length
- Heat treatment.
- Workmanship, finish, and appearance. Additional supplementary requirements.
- End Finish
- Test
- Retest
- Safety
- Certification
- Product making

- Identifying the major components of the existing similar designs and how they function; **Abdul**

Major Components & Functions

The first design shown in Figure 1 by S. Rostami , E. Raki , A. Abdollahi , A. S. Goldanlou has major components of control panel, DC power., supply, temperature sensors, electric magnet, boiling glass cylinder condenser, cooling water pipes, pump, cold water tank, Teflonbody (insulated), autotrans, and heat elements. The **control panel** manages the peripheral devices and communicates between the host computer and the peripheral devices. The control panels have the following functions: Consolidation of all connections to peripheral devices. Provision of power, as needed, to peripheral devices. In other words it connects the module with a computer and maintains the power and input between the two. it also can be used as the command center of the module/design. The **DC power** converts direct current coming from the power source (a battery) from one voltage level to another depending on the point-in-time needs of the device being supplied. ... Just like with AC power supplies, DC-DC power supplies may use regulators to smooth out the signal and eliminate ripple voltage. It can be summed to the control center of the power going in and out of the device to the module. The **temperature sensors** convert thermal energy sent from an object in a wavelength range of 0.7 to 20 um into an electrical signal that converts the signal for display in units of temperature after compensating for any ambient temperature. These sensors are used to measure temperature when: Thermocouples or probes cannot be used. Another program can be used with correlation of the data collected from the

sensors to shut down the module if the temperature is going above or below the safe limit. The electromagnet can be used to generate electricity with adding a coil of wire or moving it around one. It pushes the electrons in the wires and creates an electrical current, it will then convert kinetic energy into electrical energy (power). The **Condenser** condenses incoming refrigerant vapor into liquid, a compressor to raise the pressure of the refrigerant and move it along, and a fan for blowing outside air through the heat exchanger section to cool the refrigerant inside. The amount of cooling will depend on the temperature sensors. The condenser must have access to a low temperature reservoir (cold water tank), and will be moved inside pipes. The **Teflonbody** is used to coat the parts to insulate any heat or energy loss. The **Storage** is where the energy is being conserved.

Another design used by M. Ahmadi & G. Willing in Figure 8 has some similarity in the major components. The **pump** moves thermal energy in the opposite direction of spontaneous heat transfer, by absorbing heat from a cold reservoir and releasing it to a warmer one. It works similar to the condenser as they are both used to cool the device using a cold source and release it into the environment or a hot reservoir.

- identifying subject areas that are relevant as well as the design equations in these subject areas that are relevant for the design analysis that can be used for sizing and specifying the components of the design;~~**Abdul**~~

Relevant Subject Areas & General Equations

Most of the subject areas used in our project falls under the big umbrella of Thermodynamics, Fluids mechanics and Heat transfer. We will always start with the basic energy balance equation Etot=Ein - Eout + EStorage and derive based on the needs.

Sizing the Thermal Fluid Heater

The heater needs to be sized for the maximum BTU/hr requirements of the system during peak load. If the customer plans on expanding in the future, the future BTU/hr requirements also should be considered. In most cases, the customer knows what size heater is required. Otherwise, the heat required must be calculated by using the following equation:

$$Q=M \times Cp \times \Delta T$$

where
Q is the heat required.
M is the quantity of material being heated.
CP is the ~~specific heat of material~~
ΔT is the difference between final temperature and initial temperature.

This calculation must include the product being heated as well as the vessel containing the product and any piping that carries the hot fluid to the product. Remember that the vessel must heat up in order to heat its contents. Heat losses also must be taken into consideration, and proper engineering practices must be followed to determine an appropriate safety factor.

Determining the Required Flow Rate

When flow rates have to be calculated, it is important to revert back to the equation to determine how much flow is required to remove the appropriate amount of heat from the thermal

fluid flow stream. However, for this calculation, we must rearrange the equation to solve for flow rate. It looks like this:

$$M=Q / (Cp \times \Delta T)$$

where
Q is the heat being transferred to the user from the thermal fluid.
M is the required flow rate of the thermal fluid
CP is the specific heat of the thermal fluid
ΔT is an allowable temperature drop for the thermal fluid across the inlet and outlet of the user.

Heat Losses to the Environment

Conduction Losses:

These occur when a hot object is in touching contact with a cooler object and heat energy passes from the hot object to the cool one. It can be calculated using the following equation:

LConduction = Thermal Conductivity of Material Accepting Heat x Area of Contact x ΔT x 1 Hour Per Thickness of Material Accepting Heat

Convection Losses:

Heat losses due to convection are more difficult to calculate because there are many ways for heat to be removed from an object through a surrounding medium. The main challenge, among others, is due to the fact that the convection medium can be motionless or flowing, referred to as natural convection or forced convection. Convection rates also are affected by the orientation of the object in the medium due to the effects of convection boundary layers in the medium. It can be calculated using the following equation:

LConvection= Surface Loss (W/in2) x Area x 1 hr

Radiation Losses:

Losses due to radiation usually are insignificant at low temperatures, but they can be a large contributor of heat loss at temperatures above 500oF and should be considered when calculating wattage requirements.

LRadiation= Radiation Loss (W/in2) x Area x Emissivity x 1 hr

Resistance Temperature Detectors (Sensors)

RTDs are used to measure temperature by correlating the resistance of the RTD with temperature. This correlation between the resistance and temperature of the RTD is described by the **Callendar-Van Dusen** equation:

For Temperature: $-200^{\circ}C \leq t \leq 0^{\circ}C$,
$RT=Ro[1 + AT + BT2 + (t-100)CT3]$

Where,
RT= Resistance at Temperature, T
Ro= Resistance at 00C
T = Temperature in °C

For Temperature: $0^{\circ}C \leq t \leq 661^{\circ}C$
$RT=Ro(1+AT+BT2)$

A, B and C are known as the Callendar-Van Dusen constants, defined by the following equations:

$$A=\alpha + (\alpha\delta)/100$$
$$B= -(\alpha\delta)/1002$$
$$C= -(\alpha\beta)/1004$$

α= (R100-Ro)/(100+Ro)
β= constant if t < 0 °C, else zero

δ= (Ro[1+α(260)]-R200)/(4.16 Roα)

Heat Loads and Condensers

Total heat load can be calculated using the following equation:

$$h = c_p \rho q dt$$

where,

h = heat load (Btu/h)

c_p = 1 (Btu/lb_m ^oF) for water

ρ = 8.33 (lb_m/gal) for water

q = water volume flow rate (gal/min)

dt = temperature difference (^oF)

***Evaporator water flow rate** can be expressed as:*

$$qevap=24\ hevap/dt$$

where

qevap = evaporator water flow rate (gallons per minute - gpm)

hevap = air condition load

***Condenser water flow rate** can be expressed as:*

$$qcond=30\ hcond/dt$$

where

qcond = condenser water flow rate (gallons per minute - gpm)

hcond = air condition load

IDENTIFYING FABRICATIONS, TESTING METHODS AND PROCEDURE FOR SIMILAR DESIGNS

IDENTIFYING TESTING METHODS

Based on an article published by the Journal of the Brazilian Society of Mechanical Sciences and Engineering on May 27 2019, there are five experimental methods used for the measurement of heat transfer coefficient, which were classified into five major groups: (1) direct method, (2) transient method, (3) Wilson method, (4) heat/momentum/mass transfer analogy method and (5) boundary layer thickness method. However, this chapter will mainly be focused on two direct and transient methods since these seem to be so closer to the group project. To analyze these methods, it should be considered the constraints and accuracy reported by the improvement in the temperature and heat flux measurements techniques.

DIRECT METHOD AND FABRICATION

The direct method is based on the application of the heat transfer definition that is given by Newton's cooling law, where all the variables that are found in this equation are measured. These variables are (1) fluid bulk temperature T_{∞}, (2) wall surface temperature T, (3) heat flux on the wall surface q'':

$$h = \frac{q''}{T_s - T_\infty} \quad \frac{q''}{T_s - T_\infty}$$

This technique has been widely employed in research involving single-phase convection, boiling and condensation. Now, the temperature and heat flux are measured using methods such as mechanical, electrical and optical. Mechanical measurement techniques, in which liquid column expansion thermometer is one of the most widespread temperature measurement techniques, the principle involved in this method is the thermal expansion of liquid due to changes in the surrounding temperature bulb. Mercury, the most widely fluid employed due to its low vapor pressure, wide temperature range (-30 to 300 °C) and high accuracy (<0.1 °C). Electrical measurements techniques, which are defined by the use of sensing elements that produce an electrical output signal when temperature is changed. These electrical output signals are voltage, current and electrical resistance. Optical measurement techniques, which are a set of emerging techniques that maximize new applications hardly solved by mechanical or electrical temperature sensors. Their main advantages are non contact measurements, which are easy integration for obtaining high-resolution 2D temperature techniques. These techniques are chosen based on their respective application's restrictions.

The ~~table above~~ shows recent experiments that used this technique, describing the used temperature and heat flux measurement methods, the convection mode, application and reported uncertainties. More than 12 distinct direct-mode techniques are included in this table.

Table 3.1 Application and reported uncertainties

Convection mode	References	Temperature/heat flux technique	Application	Reported HTC uncertainty (%)
Gas free convection	[70,71,72]	Thermocouple/interferometry	Vertical flat plate, air	9
		Thermocouple/heat flux sensor	Building wall, air	
Gas forced convection	[54, 73]	Thermocouples/boundary layer temperature profile	Flame heat transfer	7.5
		Thermocouples/enthalpy		8–45
Liquid free convection	[74,75,76]	Thermocouple/interferometry	Supercooled water, flat plate	–
		Thermocouple/Joule effect	Horizontal gap water	–
		Platinum wire self-temperature and heating by Joule effect	Horizontal platinum wire, water	21
Liquid forced convection	[77, 78]	Thermocouple/Joule effect—direct tube heating	Water-based nanofluid	4.5
Nucleated boiling	[80, 81]	Thermocouple/Joule effect—cartridge resistance	Cylindrical surfaces with R123, R22, R134a	1.3–20 > 1
		Infrared/Joule effect	Flat horizontal surface, water	
Convective boiling	[82, 83]	Thermocouple/Joule effect—tape resistance	Horizontal copper tubes, R22, R134a, R404a	17
		Thermocouple/enthalpy profile (water)	Horizontal flat tubes, R22, R404a	6
Microchannel flow boiling	[84]	Infrared thermocouple/direct tube Joule effect	Ethanol/water flow boiling	15
	[29]	Liquid crystal/Joule effect	Vertical rectangular	16.45

			microchannel, R123 and R11	
	[42, 85, 86]	Thermocouple/direct tube Joule effect	Single microchannel, R134a, R245fa	< 30
	[87]	Infrared RTD/Joule effect	Flow boiling multi-microchannel	15
	[88]	Thermocouple/enthalpy profile	Flow boiling inside a single microchannel, R134a and R32	8
	[41]	Infrared-TSP-thermocouple/direct tube Joule effect	Flow boiling, HF7100	–
In-tube condensation	[89]	PT100/enthalpy	Smooth and microfin tube	23
Microchannel condensation	[90]	Thermocouple/Joule effect similarity	Single channel, R134a	19.9
	[43]	Thermocouple/Peltier heat flux sensor	Parallel microchannels, R134a	5–70
Film condensation	[91]	Thermocouple/enthalpy	Steam condensation of hydrophobic surface	11.1

TRANSIENT METHOD AND FABRICATION

The transient technique is used when unsteady boundary conditions or non-equilibrium initial conditions in convective problems can be applied. First, a mathematical model of the system describing the transient response in terms of the heat transfer coefficient must be produced. With this model, the problem resumes to minimize the error between the mathematical transient model and the experimental transient data. The value of the heat transfer coefficient of the mathematical model that minimizes the error between a chosen parameter of the model and the experiment is assumed as the heat transfer coefficient value for the experiment. The main benefit of the transient method is the simplification of experiment procedure since temperature becomes the only variable needed to be considered for a long time. The transient thermal mathematical model can be of any complexity, from single lumped parameter to multidimensional transient system solved by finite-element techniques. The boundary conditions used in the experiment are bulk fluid temperature step change, plug flow and square-wave or sine wave heat flux boundary condition. Parameters used for the minimization between the mathematical model and the experimental data are maximum slope temperature derivatives, system thermal time constant, system thermal phase lag, system gain, frequency response and temperature derivatives, frequency response and temperature curve fitting usually by least square methods.

The ~~table above~~ shows some studies of HTC measurements that used the transient technique. The table provides a description of the mathematical models used the boundary condition or initial conditions, type of convection problem, application, time and spatial resolution obtained for the HTC and experimental uncertainty ranges.

Table 3.2 application, time and spatial resolution obtained for the HTC and experimental uncertainty ranges.

Transient mathematical model type/boundary conditions	References	Convection mode/application	HTC temporal/spatial resolution	Reported HTC uncertainty
1D axial conduction solid porous matrix/convection fluid bulk temperature step change	[92]	Liquid forced convection/packed bed	Time and space average	–
1D axial conduction solid porous matrix/convection fluid bulk temperature step change	[93]	Gas forced convection/bed of solids	Time and space average	–
1D conduction solid porous matrix/convection fluid bulk temperature step change	[94]	Heat exchanger surfaces/plate-fin type	Time and space average	7.5–15% (Colburn factor)

1D conduction solid porous matrix/convection fluid bulk temperature step change	[95]	Gas forced convection/heat exchanger surfaces/plate-fin type	Time and space average	< 4.32%
1D conduction, Fourier analyses/oscillating fluid temperature	[96]	Liquid forced convection water	Time and space average	< 27% (Colburn factor)
1D Fourier analyses/oscillating fluid temperature	[97]	Plate heat exchangers|	Time and space average	2.9%
1D and lumped model transfer function between fluid and solid, frequency response analysis/plug flow temperature changes	[98]	Plate heat exchangers|	Time and space average	5%
1D conduction sphere/bulk temperature step change in the convection boundary	[99]	Natural convection/food HTC	Instantaneous/space average	–
2D conduction, phase delay/square-wave radiant laser heat input	[100]	Spray cooling	Time-average/2D spatial resolution	< 20.8%
Lumped conduction/non-equilibrium initial condition in solid temperature	[101]	Natural convection/food HTC	Instantaneous/space average	–
2D conduction/square wave radiant laser heat input	[102]	Plate heat exchangers| IR measurement	Time -average/2D spatial resolution	11%
1D radial conduction/convection fluid bulk temperature step change	[103]	Air jet impingement. IR measurement	Time-average/1D radial resolution	–
Lumped conduction/bulk	[104, 105]	Boiling, single-phase convection/quenching	Instantaneous/space average	–

temperature step change in the convection boundary				
1D radial conduction/sinusoidal oscillation wall heat flux (Joule heating)	[106]	Tube internal liquid forced convection. IR measurement	Time and space average	11%
2D cylindrical coordinates heat conduction FEM inverse method/bulk temperature step input in the convection boundary	[107]	Boiling, single-phase convection/quenching	Instantaneous/space average	<8%
Lumped conduction/bulk temperature step change in the convection boundary	[108]	Natural convection/container	Time and space average	10%
1D axial conduction/sinusoidal oscillation wall heat flux (Joule heating)	[109]	Air water multiport internal liquid forced convection. IR measurement	Time and space average	13.2%
1D conduction/convection fluid bulk temperature step change	[110]	Gas forced convection/plate	Time and space average	< 10%
1D conduction/convection fluid bulk temperature step change, maximum slope method	[111]	Gas forced convection/compact heat exchanger air	Time and space average	12%

The simplest mathematical models used in transient experiments are mostly focused on single lumped models for low Biot numbers ($Bi \ll 1$). Biot numbers smaller than 0.1 provide 5% maximum temperature different among all the existing points inside the boundary of the system and lumped models can be modeled by the following equation:

$$h \times As(T-T\infty)=m \times c\frac{dTdT}{dt\,dt}$$

With the initial condition given by $T(t=0) = Ti$. The instantaneous heat transfer coefficient can be obtained by solving for the heat transfer coefficient "h", which remains constant

over time. The only variable that does not remain constant over time is the temperature "T" considering that T∞ also remains constant, which shows simple this method is. If the heat transfer coefficient remains constant over time, the time constant of the system can also determine the time-average heat transfer coefficient as:

$$h = \frac{m \times c}{As \times T} = \frac{m \times c}{As \times T}$$

When Biot number becomes close to or higher than the unity multidimensional transient does conduction models are necessary.

PROCEDURES TAKEN FOR THE DIRECT METHOD TECHNIQUE

Here are some example of the direct methods used to measure the heat transfer coefficient, where it can be also shown the different procedures and approaches taken by his main protagonist:

Naylor and Duarte measured the free convection heat transfer coefficient over a vertical flat plate for air using interferometry technique. The surface and fluid bulk temperatures were measured by thermocouples, and the heat flux was measured by interferometry. Electrical strip heaters impose the heat flux on the back surface of the plate. Interferometry enabled the measurement of one-dimensional heat transfer coefficient over the entire vertical plate profile. Yoon applied a similar technique for water as the fluid. Water has higher Prandtl than air making the boundary layer thinner, which makes the optical reading of the isothermal strips obtained from interferometric readings more difficult.Yang used thermocouples to measure wall and fluid bulk temperature in free convection over a building wall. Heat flux sensors measured the wall heat flux, and they were able to measure both convective and radiant heat transfers. The advantage of the technique is that no external heat flux was imposed on the wall for the heat flux determination. Problems, however, are related to the intrusiveness of the heat flux sensor, which can add a thermal resistance layer and disrupt surface heat transfer characteristics near the wall. Han and Goldstein measured the HTC of air flowing over the surface of the turbine endwall. They used a thermocouple probe to measure the temperature profile inside the fluid boundary layer using a five-axis measurement unit (four axial and one rotational degrees of freedom). The thermocouple junction had 76 μm diameter, and the measurement unit had a 5 μm position resolution. The heat flux was determined.

PROCEDURES TAKEN FOR THE TRANSIENT METHOD TECHNIQUE

Here are some example conducted by this method:

Schumann was the first to solve the transient one-dimensional problem systematically for HTC measurements. He demonstrated a solid porous matrix with internal flow as a one-dimensional transient conduction problem subject to fluid bulk step alteration initial condition. This technique is also known as single-blow transient technique and characterized by a fluid stream flowing steadily in the test matrix up to an instance where a transient perturbation of the fluid temperature is forced. The variation in the test matrix temperature enables the heat transfer coefficient determination. Furnas, Pucci, Heggs and Burns adapted the method to different conditions, as a bed of solids and heat exchangers. Becker and Fricke utilized an one-dimensional transient conduction model of a sphere to analyze the heat transfer coefficient of food during a cooling process. Krishnakumar reviewed the single-blow method for transient heat transfer coefficient measurements.

Freund developed a spray cooling system measuring the two-dimensional HTC distribution on the wall. The spray cooled one side of the wall, and the backside was heated by a 0.25-Hz-pulsed laser source. An infrared camera with 0.4 mm spatial resolution and 30 Hz acquisition rate measured the temperature field in the back wall. A two-dimensional mathematical model of the system was developed and solved by a finite-difference method in order to transform the measured temperature field into the equivalent heat transfer coefficient of the spray side. Freund and Kabelac applied a similar technique to study a plate heat exchanger.

CODES AND STANDARDS

Any engineering design generated has to be submitted to certain codes and standards in order to make sure that the safety of the one using it is taken into account. This is not only about safety but also about usability, cost and quality and also the innovation that is brought through the design. In the United States the ASME (American Society of Mechanical Engineers) is the one to set the standards. For this experiment the heat transfer coefficient of nanofluid is to be measured. It is to assume then that the ASME Boilers and Pressure vessel codes will be used. The code fully detailed will be listed below:

1. Section I, Power Boilers.

2. Section II, Material Specifications.

3. Section III, Rules for Construction of Nuclear Power Plant Components.

    - Division 1, Nuclear Power Plant Components.
    - Division 2, Concrete Reactor Vessel and Containments.
    - Division 3, Containment Systems and Transport Packaging for Spent Nuclear Fuel and High-Level Radioactive Waste.

4. Section IV, Heating Boilers.

5. Section V, Nondestructive Examination.

6. Section VI, Recommended Rules for Care and Operation of Heating Boilers.

7. Section VII, Recommended Rules for Care of Power Boilers. Section VIII, Pressure Vessels

    - Division 1, Pressure Vessels.
    - Division 2, Pressure Vessels (Alternative Rules).
    - Division 3, Alternative Rules for Construction of High- Pressure Vessels.

8. Section IX, Welding and Brazing Qualifications. Section X, Fiber-Reinforced Plastic Pressure Vessels.

9. Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components.

10. Section XII, Rules for Construction and Continued Service of Transport Tanks.

11. Code Cases: Boilers and Pressure Vessels. Code Cases: Nuclear Components.

For more detail on each section the 2017 edition of the Process Piping **Design** Handbook can be visited.

As the design is supported a lot by pipes, we will try to use the ASTM codes and standards.

A typical American Standard for Testing Materials covers, among many things, the following:

- Scope.
- Referenced documents.
- Ordering information.
- Chemical composition.
- Mechanical requirements—tensile strength, yield strength^ elongation.
- Dimension, Mass and permissible variations
- Length
- Heat treatment.
- Workmanship, finish, and appearance. Additional supplementary requirements.
- End Finish
- Test
- Retest
- Safety
- Certification
- Product making

C. References should be properly cited in the literature review, and a list of references provided using the format provided in the Senior Project Manual which is available to you free on e-course.

References

- S. Rostami, E. Raki , A. Abdollahi , A. S. Goldanlou, Effects of different magnetic fields on the boiling heat transfer coefficient of the NiO/deionized water nanofluid, an experimental investigation 399 (2020) (Yemboado Yonli)
- M. Ahmadi, G. Willing, Heat transfer measurement in water based nanofluids 42 (2017),(Yemboado Yonli)
- Process Piping **Design** Handbook: The Fundamentals of Piping **Design**: Drafting & **Design** Methods for Process Applications; 2007, p1-48, 48p, 1 Black and White Photograph (PVAMU online library) (4,37)(Yemboado Yonli)
- Reviewed September 26, 2020 from Tiago Augusto Moreira, Alex Roger Almeida Colmanetti & Cristiano Bigonha Tibiriçá, "Heat transfer coefficient: a review of measurement techniques", Journal of the Brazilian Society of Mechanical Sciences and Engineering. 2019 Article number: 264 https://link.springer.com/article/10.1007/s40430-019-1763-2 (Marcelo Epam Ona)

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheet)

Assignment for Assessing Outcome c.2

Grading Scheme for
Status Report on Literature Review

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Introduction paragraphs for chapter provided	5	
2	Description provided on how information was identified Types of information completely identified to a level that shows the group has a grasp of what they need to look for on the project	3 12	
3	Description provided on how potential sources of information were identified. For each information, sources needed are adequately identified.	3 12	
4	Literature review topics are well planned and broken down into appropriate logically sequenced Sections and sub-sections in a TOC format Content of TOC for Literature Review are related to the 5 listed objectives for literature review	15 5	
5	The literature review is detailed and focused on relevant items related to the project, include existing similar designs, components needed, relevant design analysis methods, fabrication, and testing. Relevant codes & standards Figures & Tables properly numbered, titled and cited in the report	110 10	
6	References properly cited and appropriate list of references provided	20	
7	Copy of Status request attached	5	
	Total	200	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 5 Literature Review

Due Date: 10/1/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Completed section 3.5 over steering and section 3.6.3 over machine design equations	~~14.3~~	
2	Jonathan Horta Jonathon Horta	Complete section 3.3 by including references and an image that elaborates on general information on the vehicle	~~14.3~~	
3	Todd Maxwell Todd Maxwell	Complere Section 3.6.1 and 3.6.2 over the finite element and kinematic design calculations regarding the suspension.	~~14.3~~	
4	Michael Samuel Michael Samuel	Completed Section 3.4.2 Suspension components	~~14.3~~	
5	Aramis King Aramis King	Completed sections 3.4.1 and 3.4.2 Suspension Components	~~14.3~~	
6	Daniel Ward Daniel C. Ward	Completed section on audience and clients and formatting sources	~~14.3~~	

7	**Titus Woodard** *Titus Woodard*	**Completed section on safety**	~~**14.3**~~	

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
Status Report 5A on Literature Review

Assigned 09/16/20 **Due: 10/1/20**

This status report covers the information on the Literature Review chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class for the assignment #2. The report should be prepared using the chapter title. " **3. LITERATURE REVIEW**". The subsections highlighted in blue fonts should be used in the status report.

3. LITERATURE REVIEW

1. Provide introductory paragraphs for this chapter that discuss the purpose of the chapter.

3.1 Identification of Information Relevant to the Project

2. **Identify and** list the types of information needed to be reviewed for a complete understanding of all aspects of the project. **Describe in detail how you identified the types of information relevant to the project as an introduction to your response to this question.**

3.2 Potential Sources of Information for Project

3. For each information type listed in item 2 above, identify the sources you will need to use to obtain the information. This will also serve as a partial reference list for your project. Refer to how to list references in the Senior Project manual for the format for this section. **Describe how you identified the sources as an introduction to the answer for this question**.

4. Plan the literature review chapter by carefully developing a Table of Content page for the subsections to be included in the literature review.

See example below

3. LITERATURE REVIEW …….. 13

3.1 Identification of Information Relevant to the Project …… 14
3.2 Potential Sources of Information for Project…….. 14
3.3 Major Subsection Title 3 …… 14
3.3.1 Minor subsection title 1…….. 15
3.3.2 Minor subsection title 2 …….. 15
3.4 Suspension Systems ……..……. 18
3.4.1 Types of Suspension …… 20
3.4.2 Components that make up a suspension ……. 21
Etc.

5. Using the sources identified in item 2, and following your planned table of content, develop a well planned and exhaustive literature review for your project. The literature review

should focus on relevant items that would help you with the design. This should include but not limited to:

- existing similar designs and how each functions, advantages and disadvantages of each of the existing designs;
- identifying the major components of the existing similar designs and how they function;
- identifying subject areas that are relevant as well as the design equations in these subject areas that are relevant for the design analysis that can be used for sizing and specifying the components of the design;
- identifying fabrication and testing methods and procedure for similar designs.
- Identifying codes and standards applicable to the design

6. References should be properly cited in the literature review, and a list of references provided using the format provided in the Senior Project Manual which is available to you free on e-course.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheet)

Assignment for Assessing Outcome c.2

Grading Scheme for
Status Report on Literature Review

Project Group #_8__

Item	Description	Maximum Points	Your Score
1	Introduction paragraphs for chapter provided	5	
2	Description provided on how information was identified Types of information completely identified to a level that shows the group has a grasp of what they need to look for on the project	3 12	
3	Description provided on how potential sources of information were identified. For each information, sources needed are adequately identified.	3 12	
4	Literature review topics are well planned and broken down into appropriate logically sequenced Sections and sub-sections in a TOC format Content of TOC for Literature Review are related to the 5 listed objectives for literature review	15 5	
5	The literature review is detailed and focused on relevant items related to the project, include existing similar designs, components needed, relevant design analysis methods, fabrication, and testing. Relevant codes & standards Figures & Tables properly numbered, titled and cited in the report	110 10	
6	References properly cited and appropriate list of references provided	20	
7	Copy of Status request attached	5	
	Total	200	

Literature review

This chapter discusses all of the information needed to understand this project. ~~We~~ will discuss topics such as the baja car for which this steering and suspension system will be a part of. The descriptive functions of these systems as well as different designs that are available for each system with their pros and cons. After that ~~we~~ will show the relevant equations for each system that will need to be solved to come up with a design later on. Then ~~we~~ will talk about the clients that this project is relevant to along with the safety factors we are considering throughout this project.

3.1 Identification of Information Relevant to the Project

For the information relevant to this project, the group had a meeting to talk about what would need to be researched to give a complete overview of this project. During this time, we began to break down the project as a whole to see what was included. We came up with a list to start out with and if any more topics came up as we began research it, bring it to the group to discuss if we should create a new section for that topic. We assigned at least one person to each topic to cover every section to give a complete overview of this project. The list of topics that we concluded are:

- General information over baja car
- Suspension system
- Steering system
- Math equations involved
- Safety Considerations
- Audience/ Clients

3.2 Potential Sources of Information for Project

As mentioned in the section above, every member was assigned to a different section to pull sources that would help provide more information for the overall of this project. The sources were pulled from several different articles, reports, textbooks, and detailed videos on each individual topic. The list of sources include:

LIST OF SOURCES

3.3 General Information on baja vehicle

This section will be covering general information as far as focussing on the overall expected performance of the vehicle, and the performance specifically on the suspension. Although most of the general information is suggested based on experiences with previous designs, some of the information is required by the competition hosts expecting the vehicle.

3.3.1 Overall Performance

There will be ~~[1]~~ a total of 12 tests on the vehicle. The performance side focuses on the vehicle's ~~[1]~~ instant reactions based on different terrains. A report on the ~~[1]~~ vehicle's design and marketing cost is required by the audience. The most expensive areas on the kart would be the [3] suspensions and the differential/axles. Reverse direction tread on the vehicle's tires are one of the things that helps ~~[3]~~ for medium to dry surfaces and soft or muddy surfaces.

Table 3.1 Description of Formula SAE Competition Trials [1]

Events	Points	Description
Preliminary tests	**0**	**Pre-competition safety tests.**
Technical inspection	-	General check of car by judges.
Tilt	-	Car inclination up to 60º checking its stability and that no type of liquid is leaking.
Brakes	-	Simultaneous blocking of all four wheels after a brief acceleration.
Noise	-	Check to ensure vehicle emits less than 110 dB under certain acceleration conditions.
Static	**325 in total**	**Presentations and oral defence in front of the judges of technical solutions adopted.**
Design	150	Technical defence of vehicle design and solutions proposed.
Presentation	75	Marketing presentation, convincing the judges to choose their car compared to the others.
Costs	100	Written report detailing cost of each part and component of the unit built.
Dynamic	**675 in total**	**Different on-track trials with the single-seater.**
Acceleration	75	Cover 75 m on a straight run in the shortest possible time
Manoeuvrability (Skidpad)	50	Manoeuvrability to run a 9 metre circle in both directions.
Sprint	150	Quick lap of the circuit.
Endurance	350	Overall vehicle performance and reliability in 22 laps of a circuit.
Fuel	50	Minimum consumption in endurance trial
Total	**1000**	

Table 3.1 presents the specifics on how the performance on the vehicle will be graded. Each event is associated with points and has a description of what results the judges are looking for in a vehicle.

3.3.2 Suspension Performance

The vehicle will have ~~[3]~~ higher net weight towards the back of the vehicle. The rear suspension should be ~~[3]~~ lightweight, but remain strong. Rear suspension could be ~~[3]~~ adjustable to assist in traveling through different terrains. A minimum of ~~[2]~~ 11in. clearance of the suspension has been used in measurement in the past. Weight, cost, and functionality ~~[2]~~ are the main factors of a rear suspension. The upper arm ~~[2]~~ should be slightly shorter than the lower arm. As the vehicle's suspension system compresses, ~~[2]~~ the roll center typically moves upward. Having an axis of motion in ~~[2]~~ vertical direction helps the suspension react in horizontal and vertical direction as a result of impacts.

3.4 Suspension system

In this section the various types of suspension systems and components involved with the designs are discussed and compared. There are various types of systems and component combinations can be used and some are more suitable for off-road vehicles than others.

3.4.1 Types of Suspension

There are two types of suspension systems. They are classified as dependent and independent. The dependent system is a beam connecting two wheels which transmits a load or movement to both wheels. It is a rigid system and there is a lack of adjustability. Independent systems allow more flexibility needed for off-road driving.~~[4]~~ The types of various independent systems and their pros and cons are described below.

The Double Wishbone (Double A-Arm) is a suspension system setup that uses two control arms and a shock assembly.~~[4]~~ The two control arms are connected to the chassis and the wheels of the vehicle. The system can be used in the front or rear of the vehicle. There are two different types of wishbone systems. The first is equal length. With an equal length setup, both the top and bottom control arms are the same length. The second double wishbone setup in an unequal length setup. With this set up the upper control arm is shorter than the bottom control arm. Below are the pros and cons related to choosing the Double Wishbone system.

Pros: Resistive to high loads, load handling abilities, easy to adjust

Cons: Weight, high cost, complex components, takes up a lot of space

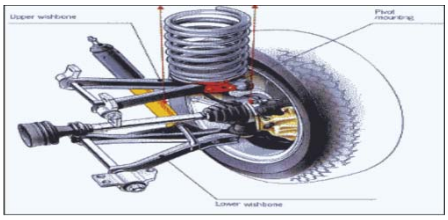


Figure 3.1: Double Wishbone System [4]

The Macpherson system (A-Arm) is also known as the single control arm system. ~~[4]~~ The design consists of one control arm, a wheel hub, and shock or strut assembly. The strut and control arm connects directly to the chassis of the vehicle. The other side of the control arm connects to the bottom of the wheel hub to get connection to the wheels. The strut or shock assembly connects at the top of the hub assembly. The pros and cons of the Macpherson system are as follows.

Pros: Simple setup, low cost, light weight, does not take up a lot of space

Cons: Increased ride height, more difficult to turn

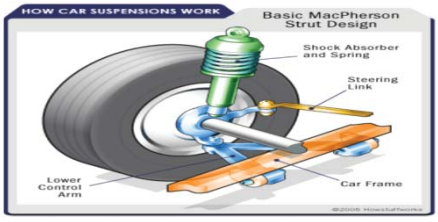


Figure 3.2: Macpherson System [4]

The semi-trailing and trailing arm systems use pivoting arms that are attached to the vehicle. These two systems are only used for the rear of the vehicle. The arms are also located in the front of the wheel which creates a trailing effect. The difference between the semi-trailing and trailing arm lies in the position of the pivot points. Semi-trailing arms are positioned at an angle to the centerline and trailing arms are positioned perpendicular to the centerline.

Pros: Rigid design, simple, not many mechanical components

Cons: Can only be used in rear of vehicle, weight, high cost

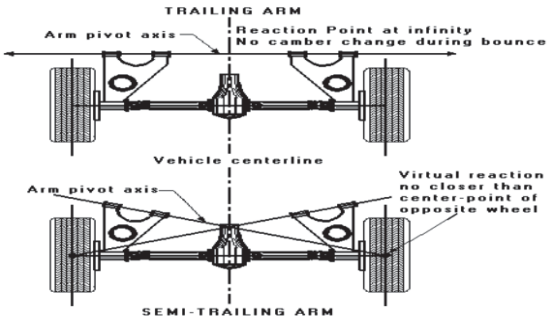


Figure 3.3: Trailing/Sem-Trailing System [4]

The Swingaxle suspension is a very old system that provides independent shock absorption. It isn't used much today due to weakness of the system and does not have good handling.

Pros: Independent shock absorption

Cons: Difficult handling, weak system, old system

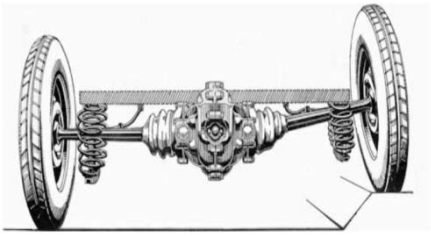


Figure 3.4: Swing axle suspension [5]

The Leaf Spring suspension system is made up of a stack of arc shaped pieces of steel that are bolted together. All the pieces of steel are different sizes with the longest on top and decreases in

size with each bottom piece. It is then attached to the rear axle of the vehicle. There are also more advanced leaf spring systems such as the transverse leaf spring suspension but uses very high cost composite materials.

Pros: light weight, added support

Cons: Not flexible, high cost

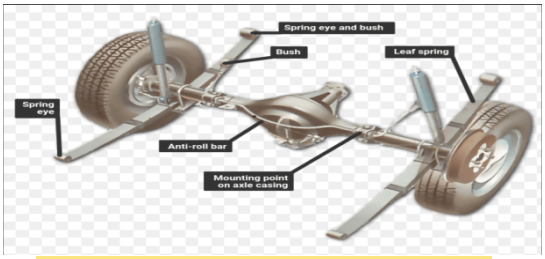


Figure 3.5: Leaf Spring System [6]

3.4.2 Components that make up a suspension

Shocks- Keeps the vehicle from bouncing.

Pros: Good for off road vehicle

Cons: High Cost, can be difficult to tune

Coil springs- The function of coil springs is to support the vehicle at its desired height, to maintain proper alignment angles and to absorb road shock transmitted through the tires and shock absorbers.

Pros:Performance and Off-Road Capability, Customizable, flexible and comfortable

Cons:Not For Heavy Vehicles, can be expensive

Control Arms- (lower & Upper)- control arms connect the suspension to the actual vehicle frame. They are connected to the frame through a component called bushings, while they attach to the suspension through the ball joint. That allows the vehicle to turn its wheel and pivot, connecting the tire to the car's suspension.~~[9]~~

Pros: allow you to set the camber to your desired setting.

Cons:you will spend hours messing with it and trying to decide the right angles

Ball joints- Ball joints consist of a ball and socket similar to the hip joint of the human body. Ball
joints of your front suspension provide pivoting movement between the steering knuckles and control arms to provide a safe, smooth ride and allow you to precisely control your vehicle.~~[10]~~

Pros: Allows free movement in two directions at the same time, including rotating

Cons: Dry ball joints increases frictions and can cause steering stiffness

Sway bar (if needed)- a bar that torsionally couples the right and left front-wheel suspensions of an automobile to reduce roll and sway.~~[11]~~

Pros: Allows less body roll

Cons:High cost

Steering box / system - The steering gearbox contains the gears that transmit the driver's steering inputs to the steering linkage that turns the wheels, and it multiplies the driver's steering changes so that the front wheels move more than the steering wheel.[9]

Pros: simple construction

Cons: Sensitive to impact

Tire- A tire is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface over which the wheel travels.

Pros:Improves traction

Cons:High cost

3.5 Steering System

The steering system is a complex system which integrates between several other systems in a vehicle. The steering is composed of linkages that move side to side based on the way the steering wheel is turned to turn the vehicle. The way that those linkages are placed will determine the turning radius of the vehicle. The geometry will also determine the movement of the tires when approaching and during the turns. The placement of the system is crucial due to the drivetrain and suspension being inches away from each other. The geometry and design will have to be considered based on the pros and cons of each geometry and design as well as the room available in the chassis. There are three steering geometries that a vehicle can have. The three geometries are Ackerman, parallel, or reverse Ackerman steering. These geometries are used for different types of scenarios such as desired turn radiuses and speeds at turns. Along with these geometries there are different designs that can be considered. A steering box can be used to steer the car or a rack and pinion can be used to achieve steering to our desirability. This section will discuss the pros and cons of each geometry and designs for the steering system.

3.5.1 Steering Geometries

The three steering geometries used today are the ackerman, parallel and reverse ackerman. These geometries are used for different applications that one is looking for.

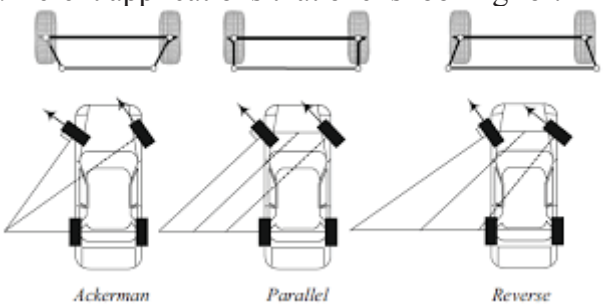


Figure 3.6: This image above shows the difference between the three geometries [12].

Ackerman steering

The first type of steering geometry and most commonly used for off-road vehicles is the Ackerman geometry. The theory of ackerman is having the inside tire of the vehicle to turn more than the outside tire allowing for a greater turn radius. By having a greater turn radius, the

vehicle will have to approach the turn at lesser speeds. A higher tire angle is achieved on the inside tire. Slip angle is the angle between the direction the tire is pointing and the direction the car is actually moving. A low slip angle is desired when it comes to turning a common vehicle to reduce drag and to prevent an increase in temperature in the front tires. A higher slip angle causes more drag for the inside tire and higher temperature of that tire. This is important in a competitive setting. Figure 3.6 has a visual of the linkage that is needed to achieve ackerman geometry. When using the Ackerman geometry the joint connected to the wheel needs to be aligned with one end of the steering rod all the way to the center of the rear axle. Figure 3.7 shows the imaginary lines that connect the tire connection, steering rod joint and the center of the rear axle.

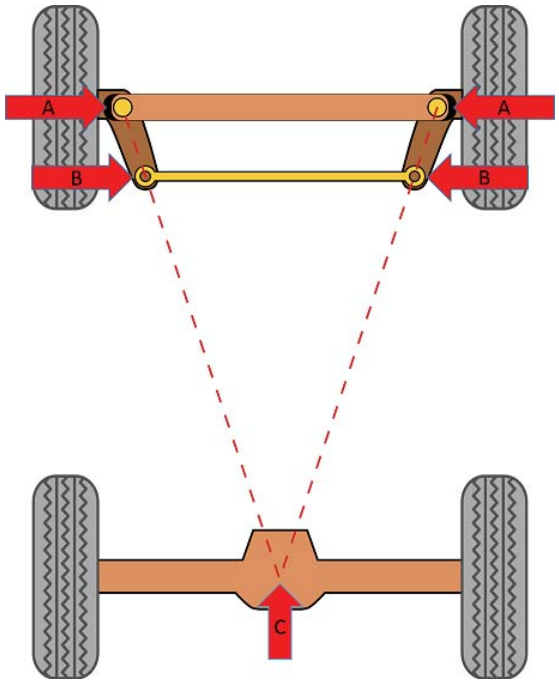


Figure 3.7: The picture above shows the Ackerman geometry [13].

The list below will show the pros and cons on using the Ackerman geometry.

Pros

- Sharper turns
- Easy to fabricate
- Avoids front tire slippage
- Simple geometry
- Lower slip angle at lower speeds

Cons

- Lower speeds at turns
- Not ideal on flat surfaces
- Increased drag on inside tire causing increase in temperature on that tire

Parallel steering

When the front tires are turned at the same angle when the steering wheel is turned is called parallel steering. This steering geometry is commonly used for racing cars. This geometry puts

lower slip angles for the front tires. With the front tires moving at the same angle, there is less drag on the inside tire which means there is no increase in temperature for the tire not slowing the vehicle down.

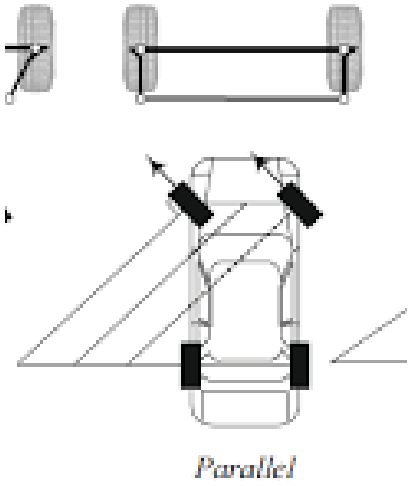


Figure 3.8: The picture above is to show the front tires turning at the same angle.

The list below will show the pros and cons for the parallel steering geometry.

Pros

- Less drag on the tires
- Can approach turns at higher speeds
- Less increase in tire temperature
- Good static turning radius

Cons

- Not ideal for off-road surfaces
- Limited turn radius
- Understeering may occur

Reverse Ackerman

The steering geometry where the outside front tire turns more than the inside tire is called reverse Ackerman. This geometry is ideal for indie and formula cars. This geometry is for very high speeds and wider turns. The tires achieve the best grip when it is taking a wider turn. Since this car is traveling very fast and approaching turns at higher speeds it is noticeable that the cars using this geometry are low to the ground to prevent the car from tumbling on a turn.

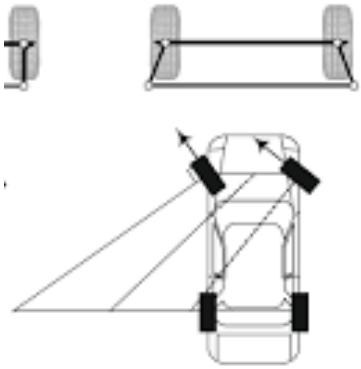


Figure 3.9: The picture above is to show how the outside front tire turns more than the front inside tire during a turn.

The list below will show the pros and cons of the reverse ackerman steering geometry.

Pros

- Better grip on tires on wider turns
- Approach turns at higher speeds
- Ideal for flat surfaces

Cons

- Wider turns
- Need lower center of gravity
- Drag on outside tire slowing down vehicle
- Not practical for off-road setting

3.5.2 Steering Designs

There are several designs when it comes to steering systems. Since our design will be intended for off-road vehicles and need to have four wheel drive we are choosing a basic steering design. These designs are easier to fabricate because these designs are less complex. The main steering designs are rack and pinion, worm and sector, and recirculating ball ~~[14]~~. This section will dive deeper into the pros and cons of these steering designs.

Rack and Pinion

The rack and pinion steering design consists of the fewest moving parts compared to the others ~~[15]~~. The main object for rack and pinion is designing the gearset to our best interest. With the gears continually grinding against each other, there is no repair available. The only option is to replace the gears and steering rod. The driver would turn the steering wheel therefore turning the pinion which would move the rack side to side turning the tires to their desired location. The gearbox needs to consider making the pinion bigger or smaller with certain parameters of each. If the pinion is smaller then the steering wheel would be easier to turn but more revolutions of the wheel would be necessary to make a tighter turn. If the pinion is bigger then it would be harder to turn but the driver would barely need to move the steering wheel. This type of steering design is very precise compared to the others.

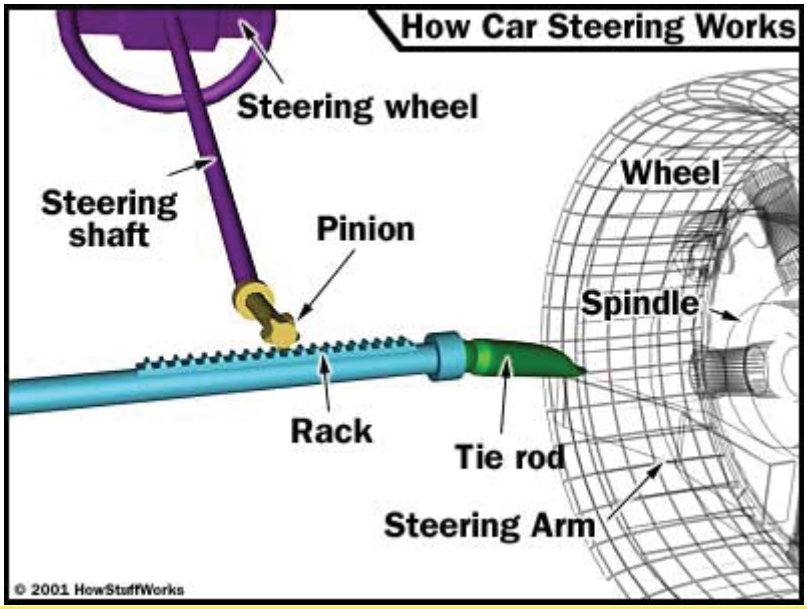


Figure 3.10:The illustration above shows all parts of a rack and pinion design [~~16~~].

Worm and sector

The worm and sector design is more complex than the rack and pinion design. This steering design does have more moving parts and is more difficult to assemble correctly. With more moving parts in this design, there is more room for loss of motion. When there is a lot of loss of motion, the car will not move appropriately. This design is easier for new drivers but with more moving parts, this design has a lot of areas where parts can lock up and will not allow any steering for the vehicle. Also, with many bumps and rocks in the road there is an increased chance that joints can lock up during unexpected forces from the environment. This design is not ideal for off-road environments.

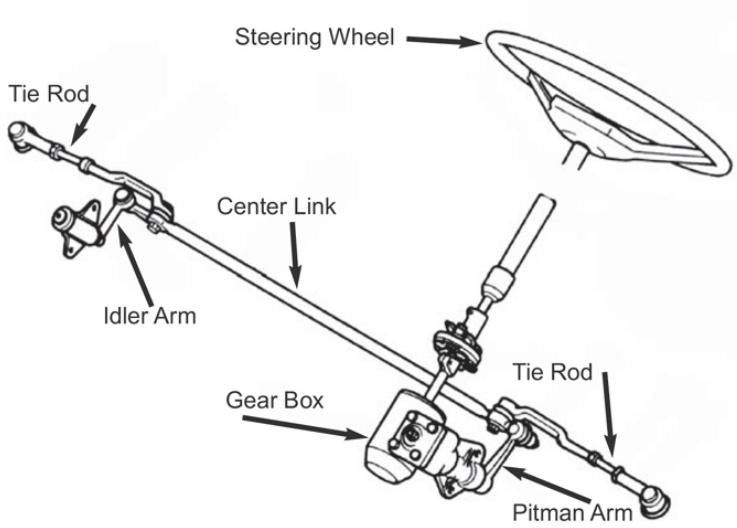


Figure 3.11: The diagram above shows the parts of a worm and sector steering design [~~17~~].

Recirculating Ball

The most complex of these three designs is the recirculating ball steering design. This design is similar to a rack and pinion with several tiny spheres in the middle of the gears contact points. These tiny spheres help slow down the wear in the gears providing a longer life to the steering system as a whole. The spheres also help reduce slop in the gear. Slop is the feeling when you change direction in the gears and it wheels loose when turning the steering wheel ~~[18]~~. With more components in the steering system, there is more room for loss of motion and the cost of this system will be significantly higher than the others. This system works more like levers pushing and pulling the tires side by side.

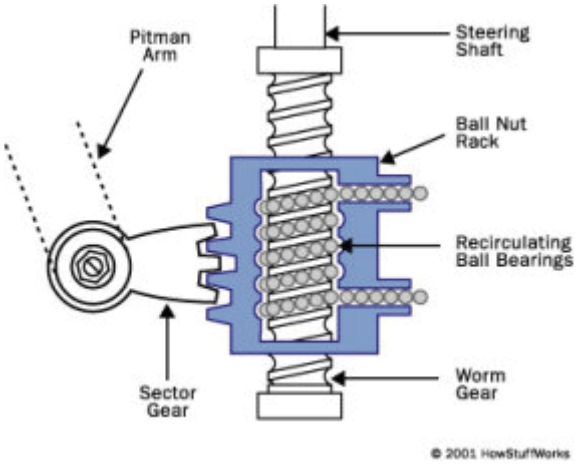


Figure 3.12: The picture above shows the tiny spheres within the grooves ~~[18]~~.

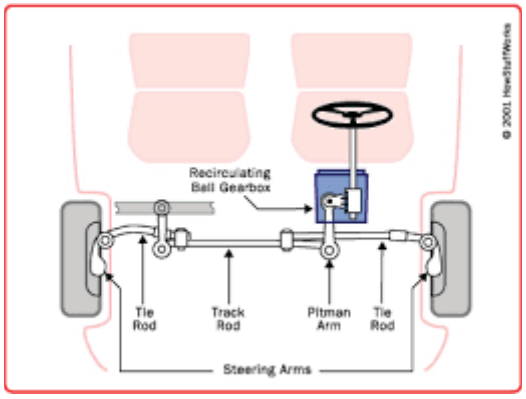


Figure 3.13: This diagram shows the whole recirculating ball steering design ~~[18]~~.

3.6 Math Equations involved

This section of the literature review will include the equations that will be used throughout this entire project. This section is split between three categories which are finite element, kinematic, and machine design equations.

3.6.1 Finite Element

Finite elements is a commonly used tool in engineering systems, as you can calculate solutions for vibrating systems. This was measured by the FEA to better understand the behavior of a structure that is placed in boundary conditions and loads. This strategy is used by breaking the systems into different sections in order to understand the displacement the system is facing. The calculations are represented by

nodes and the collaboration of the Finite Elements to determine the mesh of programs which determine the effect of the loads. The system most commonly used is the quarter of the suspension system.

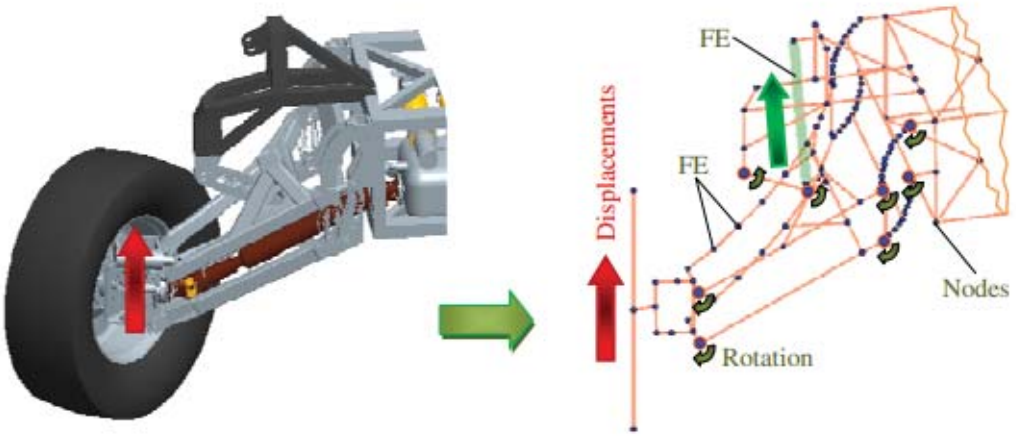
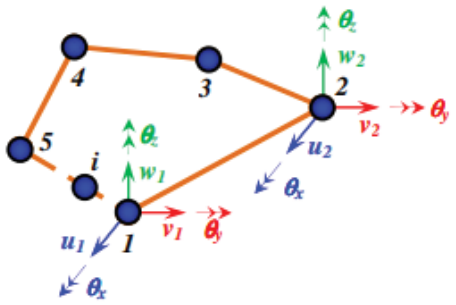


Figure #: This diagram shows quarter of the suspension system

$$[k]\cdot\{u\}=\{f\}, \tag{3.1}$$

where $[k]$ denotes the global stiffness matrix of a structure, $\{u\}$ is the global nodal vectors displacement, $\{f\}$ introduces the global nodal vectors of the applied forces, u_i, v_i, w_i are the termed vectors displacement of nodes i^{th}, θ_x, θ_y, θ_y define the rotational vectors of nodes i^{th} in the axes x, y and z and $i = 1, 2, \ldots, n$ are the presented nodes.



Node **1** ⇒ { Three dispacement (u_1, v_1, w_1) ; Three rotations $(\theta_x, \theta_y, \theta_z)$

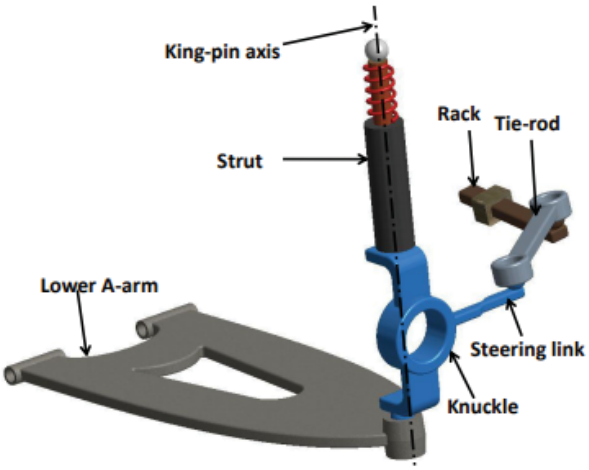
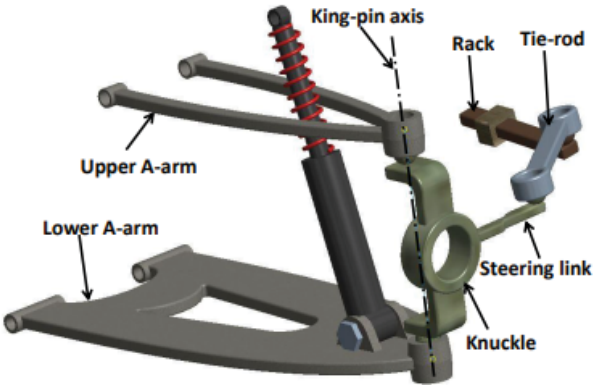
Node **2** ⇒ { Three dispacement (u_2, v_2, w_2) ; Three rotations $(\theta_x, \theta_y, \theta_z)$

$\{u\}$ = {global displacement vector} =

$= \{u_1\ v_1\ w_1\ u_2\ v_2\ w_2 \ldots\ u_i\ v_i\ w_i\ \theta_x\ \theta_y\ \theta_z\}^T$

3.6.2 Kinematics

Kinematic Design Analysis is used to calculate motion of a machine during movement while being able to calculate the geometry of motion in the system.Kinematics is being used to measure the dynamic movement of the suspension and steering system.

Macpherson	Double wishbone
 Figure 3.14: Solid model of the MacPherson system	 Figure 3.15: Solid model of the DWS

The MacPherson system removes the top a-arm from the previous system and instead connects the damper directly to the knuckle through a struct.
Pros: compact and complex, independent: flexible structure, stable
Cons: costly

The double wishbone system (DWS), requires two a-arms connected to a knuckle that connects to the tires through a steering link, while the damper system is placed on the bottom a-arm and connects to the car while both a-arms connect to the chassis

Pros: Strong against front impact, Easy to manufacture, Lightweight

Cons:Weaker in loading

Double wishbone:

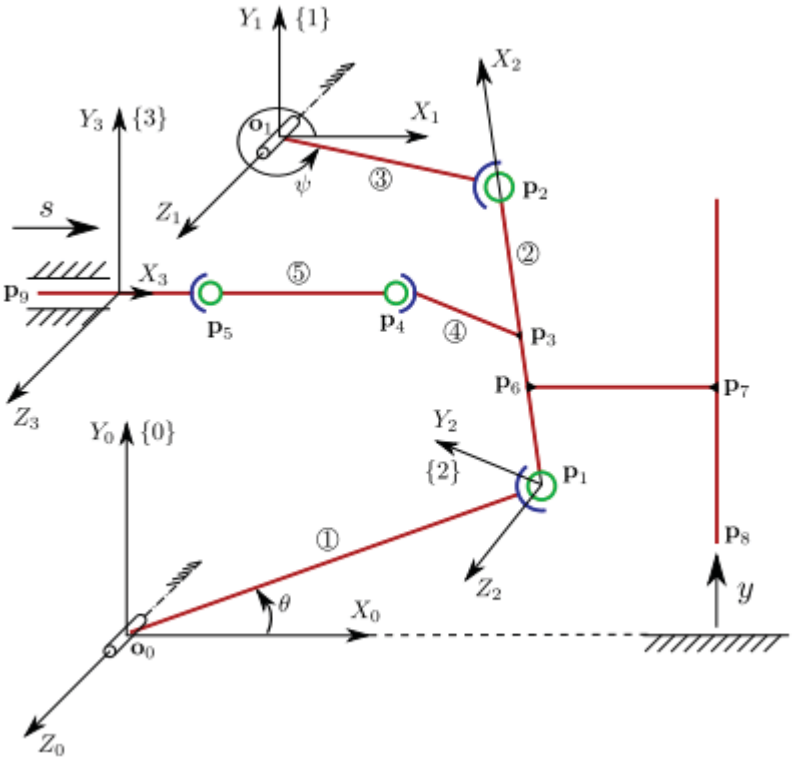
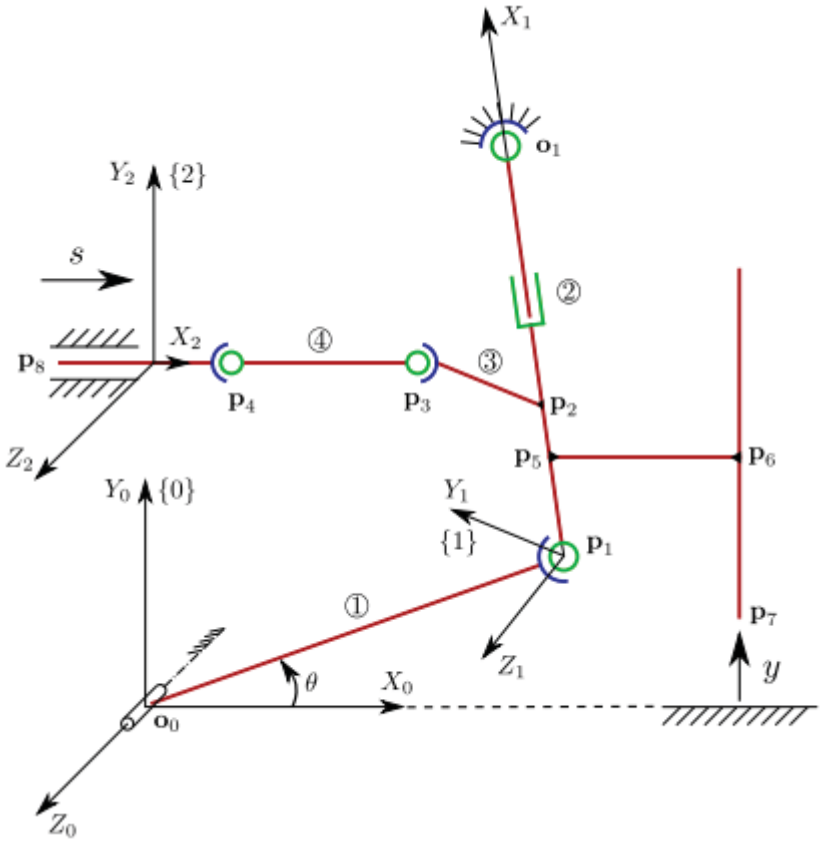


Figure 3.17: Schematic of the DWS

$$\begin{aligned}
\eta_{1x} =& -l_2\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - c_\Delta l_1 \cos\theta + c_\Delta l_3 \cos\alpha_2(\cos\alpha_3\cos\psi - \sin\alpha_3\sin\psi) \\
&+ c_\Delta o_{1x}, \\
\eta_{1y} =& -2l_2(c_1c_2 + c_3) + c_\Delta l_3(\cos\psi(\sin\alpha_1\sin\alpha_2\cos\alpha_3 + \cos\alpha_1\sin\alpha_3) \\
&+ \sin\psi(\cos\alpha_1\cos\alpha_3 - \sin\alpha_1\sin\alpha_2\sin\alpha_3)) - c_\Delta l_1\sin\theta + c_\Delta o_{1y}, \\
\eta_{1z} =& -2l_2(c_1c_3 - c_2) + c_\Delta l_3(\cos\psi(\sin\alpha_1\sin\alpha_3 - \cos\alpha_1\sin\alpha_2\cos\alpha_3) \\
&+ \sin\psi(\cos\alpha_1\sin\alpha_2\sin\alpha_3 + \sin\alpha_1\cos\alpha_3)) + c_\Delta o_{1z},
\end{aligned}$$

$$(\boldsymbol{p}_5 - \boldsymbol{p}_4)\cdot(\boldsymbol{p}_5 - \boldsymbol{p}_4) - l_5^2 = 0.$$

$$
\begin{aligned}
\eta_{3x} =& -l_2\rho\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - l_{6x}\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - 2l_{6y}(c_1c_2 - c_3) \\
& - 2l_{6z}(c_1c_3 + c_2) + c_\Delta\left(-l_1\cos\theta + p_{8x} + x\right), \\
\eta_{3y} =& -2l_2\rho(c_1c_2 + c_3) - 2l_{6x}(c_1c_2 + c_3) - l_{6y}\left(-c_1^2 + c_2^2 - c_3^2 + 1\right) \\
& - 2l_{6z}(c_2c_3 - c_1) + c_\Delta\left(-l_1\sin\theta + p_{8y} + y\right), \\
\eta_{3z} =& -2l_2\rho(c_1c_3 - c_2) - 2l_{6x}(c_1c_3 - c_2) - 2l_{6y}(c_1 + c_2c_3) \\
& - l_{6z}\left(-c_1^2 - c_2^2 + c_3^2 + 1\right) + c_\Delta\left(p_{8z} + z\right).
\end{aligned}
$$



Macpherson:

Figure 3.18: Schematic of MacPherson system

$$
\begin{aligned}
\eta_{1x} =& -l_2\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - c_\Delta l_1\cos\theta + c_\Delta o_{1x}, \\
\eta_{1y} =& -2l_2(c_1c_2 + c_3) - c_\Delta l_1\sin\theta + c_\Delta o_{1y}, \\
\eta_{1z} =& -2l_2(c_1c_3 - c_2) + c_\Delta o_{1z}.
\end{aligned}
$$

$$(\boldsymbol{p}_4 - \boldsymbol{p}_3) \cdot (\boldsymbol{p}_4 - \boldsymbol{p}_3) - l_4^2 = 0.$$

$$\begin{aligned}
\eta_{3x} = &- l_{5x}\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - 2l_{5y}(c_1c_2 - c_3) - 2l_{5z}(c_1c_3 + c_2) \\
&- r_2\left(c_1^2 - c_2^2 - c_3^2 + 1\right) - c_\Delta l_1 \cos\theta + c_\Delta p_{7x} + c_\Delta x, \\
\eta_{3y} = &- 2l_{5x}(c_1c_2 + c_3) - l_{5y}\left(-c_1^2 + c_2^2 - c_3^2 + 1\right) - 2l_{5z}(c_2c_3 - c_1) \\
&- 2r_2(c_1c_2 + c_3) - c_\Delta l_1 \sin\theta + c_\Delta p_{7y} + c_\Delta y, \\
\eta_{3z} = &- l_{5z}\left(-c_1^2 - c_2^2 + c_3^2 + 1\right) - 2l_{5x}(c_1c_3 - c_2) \\
&- 2l_{5y}(c_1 + c_2c_3) - 2r_2(c_1c_3 - c_2) + c_\Delta p_{7z} + c_\Delta z.
\end{aligned}$$

3.6.3 Machine design

For the machine design math equations involved are centered toward creating a gearbox for certain steering designs. These equations range from generating the gearbox ratio to stress equations on each tooth. These equations are being pulled from the textbook "SHIGLEY'S MECHANICAL ENGINEERING DESIGN, TENTH EDITION". This textbook contains all equations for creating gearboxes from start to finish. The list of equations below show equations to arrive at important parameters of each gear [19].

$$P = \frac{N}{d}$$

$$m = \frac{d}{N}$$

$$p = \frac{\pi d}{N} = \pi m$$

$$pP = \pi$$

where P = diametral pitch, teeth per inch
N = number of teeth
d = pitch diameter, in or mm
m = module, mm
p = circular pitch, in or mm

$$V = \pi dn/12$$

where V = pitch-line velocity, ft/min
d = gear diameter, in
n = gear speed, rev/min

$$W_t = 33\,000\frac{H}{V}$$

where W_t = transmitted load, lbf
H = power, hp
V = pitch-line velocity, ft/min

The next two equations are used to find the transmitted load on the gear that is needed to move the rack that will then move the tires in the direction that is desirable. If necessary, equations for all transmitted forces are provided below.

$$W_r = W \sin \phi_n$$

$$W_t = W \cos \phi_n \cos \psi$$

$$W_a = W \cos \phi_n \sin \psi$$

where W = total force
W_r = radial component
W_t = tangential component, also called the transmitted load
W_a = axial component, also called the thrust load

When designing this gearbox, the material will be an important fact as far as life for the system. Also, a goal is to make a gearbox with the highest efficiency possible to prevent any failures while the vehicle is in motion.

3.7 Safety considerations

Safety is the most integral part of any designing process of machinery. Without hours of testing and errors, vehicles would not be able to legally operate under any circumstances. Off road vehicle safety has some the same standard rules as regular vehicles, but adding safety designs to your off road vehicle according to ~~[23]~~.

3.7.1 Driver Safety

Driver Safety is very important when operating any moving mechanism. In order to understand the danger of operating a vehicle, especially an off road vehicle, one must follow all safety guidelines to limit incidents. Based on research through ~~[24]~~, here is a list of recommended off-road Driver Safety.

- Operator must be 18yrs or older.
- Operator must NOT be more than 250lbs.
- Protective headgear/eye and gloves are recommended.
- Operator must wear a Harness/seatbelt
- Neck collar is recommended
  (Optional for the driver, but reduces uncontrolled neck movements.)
- Operator must wear long sleeve bottoms/tops and No synthetic materials.

Figure 3.19: shows all necessary safety gear

3.7.2 Design Safety

Design safety limits any danger to potential consumers. Our design process includes the safest practices to prevent harm to driver. The safety approach to building our vehicle will allow for our design to withstand rigid terrains, harsh conditions and competition success.
With devoted research from ~~[25]~~
we found these safe ways to create a proper design.

- Deep treaded tires
  - This allows safe traction for off road driving.
- Ground clearance
  - with proper clearance it allows the underbelly to not scrape ground when operating on rocky terrains or bumps.
- Roll cage
  -this protects the driver during off road challenges, also prevents structural integrity
- Harness
  -the strap restraint to hold the driver in place.
- Kill switch
  -this stops electrical flow from the ignition system if any accident/danger occurs.
- Fire wall

-machined metal separating the driver from the engine compartment.

- Fire Extinguisher

  - in case of any fire

Daily/weekly inspections are also recommended to maintain upkeep of every component of the vehicle.

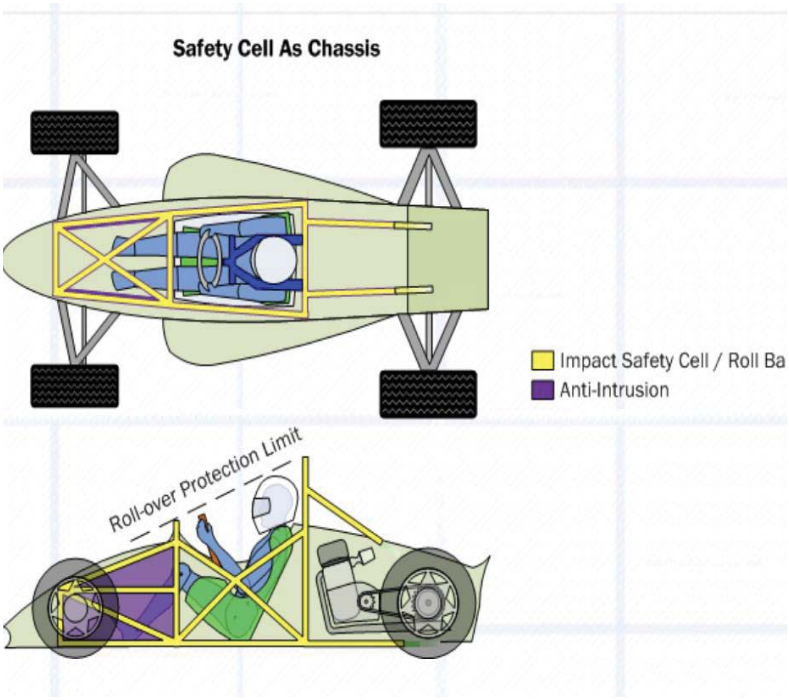


Figure 3.20: shows Roll Bar/Roll Cage

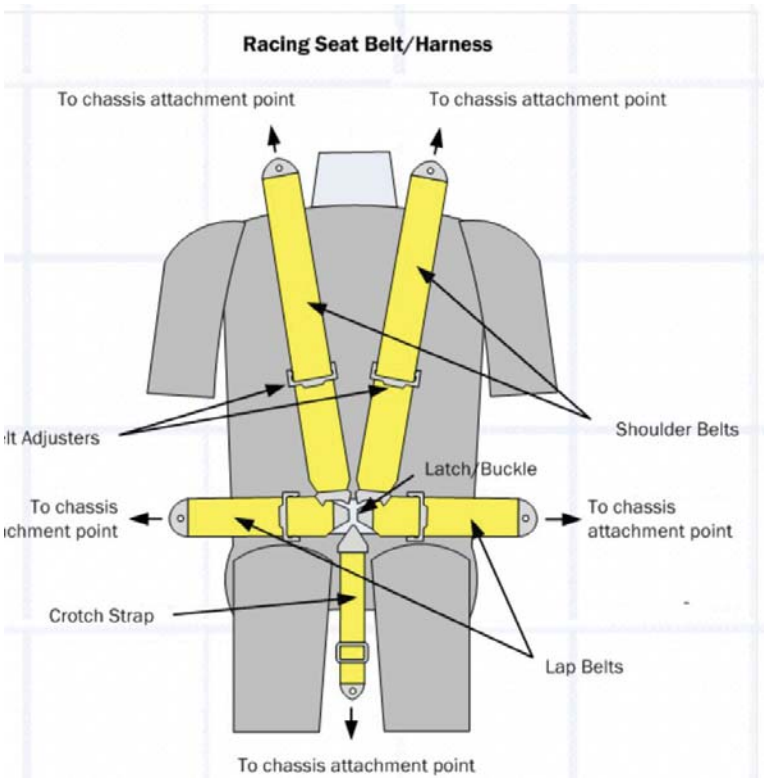


Figure 3.21: illustrates a proper harness/seatbelt

3.8 Audience & Clients

This section entails the potential audience and clients in whom the off-road vehicle could be a useful for. Though the main focus of this specified project is the suspension and steering system, there are many applications where the team's overall collection of designs and calculations can be utilized on an even broader spectrum.

3.8.1 Domestic Use

The PV Baja team's off-road vehicle will be showcased in the SAE Baja competition [25] as a contestant. SAE calls for bright minded students to produce various vehicles to compete and prove their skills in a tedious competition style format based on engineering, science and overall knowledge of automobiles. Under these circumstances, SAE is the team's main audience but there are still plenty of other consumers who could possibly take interest in the vehicle design.

Prairie View A&M is only one of many schools who participate in the annual Baja competition. It is definitely plausible for other institutions [26] to take interest in the team's project if it proves to be a great design satisfactory for competition. Other students will be able to be influenced by the PV Baja team for future builds and design specs.

Aside from student based programs, the vehicle may appeal to those who may want to utilize it for personal use [27]. Whether it be hunting, recreational off-roading or sports, this design may also be used for these purposes as an all-weather, all-terrain resource.

3.8.2 Commercial Use

Other than competition and the possibility of domestic use, there may be a plausible case for the vehicle to be utilized in industry on a much larger scale. The team has partnered with Toyota who is known for their very own off-road vehicle and baja programs [28]. It wouldn't be a surprise if the Japanese powerhouse were to reach out to the team for design implementations to use for their own competitive means. To piggyback, it may also be appealing for other manufacturers and car companies to bear interest in the vehicle to compete amongst their industry.

The possibility of this vehicle to be used in the fields of aerospace and defense are remarkably high as well. NASA is well known for its space exploration projects [29] and taking on outer space missions to the moon and even Mars. Most have heard about NASA's space exploration vehicle; the Rover program is used to track various terrains and withstand a differentiation of unknown elements. Based on this, it is very likely that the government would be interested in seeking an outside contractor, as they do already through companies such as Raytheon Technologies and Lockheed Martin, to provide a concept vehicle for extra-terrestrial purposes and planetary exploration. Northrop Grumman may also be a contender for a project such as this, as this company is looking to be 'number one in space' [30] in the next few years. Such a vehicle would allow them to assist or even compete with NASA for certain contracts and expand their opportunities in the industry.

Outside of space systems, the military may also have some use for this type of vehicle [31] for mission systems. The military is known to use a great deal of vehicles by means of combat and transportation. Most of these vehicles are plated with armor, specialized equipment and tailored for off-road capabilities for combat and even non-combat situations.

Figure 3.22: NASA Rover on Mars mission

Figure 3.23: Heavily armored and fully equipped military grade buggy

List of references

[1]
Francisco J. Sánchez-Alejo, Miguel A. Álvarez, Francisco Aparicio and José M. López (2011). Analysis Approach of How University Automotive Competitions Help Students to Accelerate their Automotive Engineer Profile, New Trends and Developments in Automotive System Engineering, pp 653-654 .

[2]
Jason Bracco, Coleman DeAnda, Jaime Deschenes, Tara Olson, Austin Sabbagha, *Baja Front Suspension*, Mechanical Engineering Laboratory The George Washington University School of Engineering and Applied Sciences, 2018, pp 2-9 .

[3]
Nick Brockman, *Baja SAE Rear Suspension Design*, College of Engineering and Applied Science at University of Cincinnati, 2013, pp 3-6.

[4]
Burgess, Allan, et al. "Design and Optimization of a Baja SAE Vehicle ." *Design and Optimization of Baja Vehicle*, 2015, web.wpi.edu/Pubs/E-project/Available/E-project-042815-121714/unrestricted/Design_and_Optimization_of_an_SAE_Baja_Vehicle.pdf.

[5]
"Swing Axle." *Motor Car*, 2020, motor-car.net/suspension-types/item/14776-swing-axle.

[6]
"Cleaning and Checking Leaf Springs." *How a Car Works*, How a Car Works, www.howacarworks.com/suspension/cleaning-and-checking-leaf-springs.

[7]
Cross, Zane, et al. *SAE Mini BAJA: Suspension and Steering*, 2014, ceias.nau.edu/capstone/projects/ME/2015/SAE-MiniBaja/suspension/suspension_report%20_2.pdf.

[8]
SAE, CCYN. "Suspension - CCNY SAE." *Google Sites*, 2014, sites.google.com/site/ccnysae/past-competitions/2012-baja/component-redesigns/suspension.

[9]
WD, 4. (2012). Choosing the Right Shock Absorbers for Your Truck. Retrieved October 02, 2020, from https://www.4wd.com/article/content.jsp?childEventId=jeep-parts-choosing-shock-absorbers

[10]
Wan, M. (2000). Suspension Geometry (Cont'l). AutoZine Technical School. Retrieved October 2, 2014, from http://www.autozine.org/technical_school/suspension/tech_suspension21.htm

[11]

Wood, K. (2014, February 3). Composite leaf springs: Saving weight in production suspension systems : CompositesWorld. Composite leaf springs: Saving weight in production suspension systems: CompositesWorld. Retrieved October 5, 2014, from http://www.compositesworld.com/articles/composite-leaf-springs-saving-weight-inproduction-suspension-systems

[12]
Colgrove, Dallin. *Steering System for SAE Baja*. 15 Mar. 2019, scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=1063&context=studentpub_uht.

[13]
Google Search, Google, www.google.com/search?q=ackerman+geometry.

[14]
"Steering." *Wikipedia*, Wikimedia Foundation, 30 Aug. 2020, en.wikipedia.org/wiki/Steering.

[15]
Suryavanshi, Omkar, et al. "(PDF) DESIGNING OF THE RACK AND PINION GEARBOX FOR ALL TERRAIN VEHICLE FOR THE COMPETITION BAJA SAE INDIA AND ENDURO STUDENT INDIA." *ResearchGate*, ESAT Publishing House, 15 Sept. 2017, www.researchgate.net/publication/319874670_DESIGNING_OF_THE_RACK_AND_PINION_GEARBOX_FOR_ALL_TERRAIN_VEHICLE_FOR_THE_COMPETITION_BAJA_SAE_INDIA_AND_ENDURO_STUDENT_INDIA.

[16]
Google Search, Google, www.google.com/search?q=rack+and+pinion+steering.

[17]
Lazarowich, Orest. "Looking Backward but Moving Forward Series." *Google Search*, Google, 2016, www.google.com/search?q=worm+and+sector+steering+design.

[18]
Nice, Karim. "How Car Steering Works." *HowStuffWorks*, HowStuffWorks, 31 May 2001, auto.howstuffworks.com/steering3.htm.

[19]

Budynas, Richard G., et al. *Shigley's Mechanical Engineering Design*. McGraw-Hill Education, 2015.

[20]
Norton, Robert L. Design of Machinery. McGraw-Hill Higher Education, 2012.

[21]
Scoggins, Michael. Design Baseline Document: Mini Baja Frame . May 2015.

[22]
Rischar, Zachary, et al. Steering & Front Suspension Design. 2017, www.ceias.nau.edu/capstone/projects/ME/2018/SAEBaja/documents/frontendprelim.pdf.

[23]
Shpetim, M. *Https://Core.ac.uk/Download/Pdf/67565218.Pdf*. Mar. 2013, core.ac.uk/download/pdf/67565218.pdf.

[24]
University , Lehigh. On and off the Road. Lehigh University , 2020, https://www1.lehigh.edu, www1.lehigh.edu/baja-sae-off-road-racing-team#follow-along-next-year.

[25]
“Build Your Own Race Car: Sports Car: Off-Road Truck!” Build Your Own Race Car!, 2020, www.buildyourownracecar.com/.

[26]
2018, Collegiate Design Series Baja SAE Rules, Bajasae.net

[27]
Himpsel, Peter. *SAE Baja*, University of Colorado Boulder, www.colorado.edu/saebaja/.

[28]
CSF. “Off Highway Vehicles (OHV).” *Off Highway Vehicles*, Congressional Sportsman Foundation, 2020, congressionalsportsmen.org/policies/state/off-highway-vehicles-ohvs.

[29]
Racing, Toyota. “Toyota Racing Development.” *TRD*, Toyota Motor Sales, 2020, www.trdusa.com/baja1000.html.

[30]
NASA. “Mars 2020 Perseverance Rover.” *Mars 2020 Mission*, NASA, 2020, mars.nasa.gov/mars2020/.

[31]
Grumman, Northrop. *Space Logistics Services*, Northrop Grumman Corporation, 2020, www.northropgrumman.com/space/space-logistics-services/.

[32]
Military.com. “Articles Tagged: Military Vehicles.” *Military.com*, Military Advantage, 2020, www.military.com/equipment/military-vehicles.

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

STATUS REPORT 6

TOPICS COVERED IN STATUS REPORT 6

Functional Decomposition

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Functional Decomposition

Assigned 09/23/2020 **Due:10/08/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the chapter title.

[Please avoid discussing the sticky note portion of the questions with other group members because they should be done independently]

" 4. PRELIMINARY DESIGN" . The subsections highlighted in blue fonts should be used in the status report. Study the sections on functional decomposition and concepts generation and functional analysis discussed in class/provided in the PowerPoint slides and in the web link provided in the slides and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example.

4.1 Functional Decomposition

1. Using electronic sticky note sheets **each member** should provide 3 to 4 suggestions for the overall function. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example. The group should analyze this input from members to determine the overall function that needs to be accomplished by the design and using the identified overall function, create the black box for your project showing the overall function, inputs, and outputs. (The format for answering this question should be similar to that shown in Figure 2 for the splashguard example). **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

2. Using electronic sticky note sheets **each member** should decompose the overall function into simple **level 1 sub-function** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. (The format for answering this question should be similar to that shown in Figure 3 for the splashguard example). From the suggestions on the sticky notes, the group should discuss, combine or eliminate to arrive at suitable level 1 sub-functions for the project similar to that shown in Figure 4 for the Splash guard. Identify the inputs and the outputs for each sub-function. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

3. Using electronic sticky note sheets each member should decompose **EACH** of the level 1 sub-functions into simple **level 2 sub-functions** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. From the suggestions on the sticky notes for **EACH** level 1 sub-function collected from the members, the group should discuss, combine or eliminate to arrive at suitable level 2 sub-functions for **EACH** level 1 sub-function for the project similar to that shown in Figure 5 for the Splash guard. Identify the inputs and the outputs for each level 2 sub-function. NOTE: This section should be repeated for each level 1 subfunction in order to break each level 1 subfunction into level 2 subfunctions. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

4. For the level 2 sub-functions that can be further broken down, repeat step 3 to break them down to level 3 sub-functions and repeat this process until the final sub-functions cannot be decomposed any further.

Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.

5. Using your Level 1, Level 2, Level 3 and any additional level sub-functions, create a Table similar to Table 1 (shown in the next page) in which all items to the left of the red vertical line should be provided and the right side of that line left blank. This Table is similar to Table 2 Morphology for the Splashguard in the PowerPoint notes, but with the concepts columns blank. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
	VNM-1	VNM-1.1	VNM-1.1.1								
			VNM-1.1.2								
			VNM-1.1.2								
		VNM-1.2	VNM-1.2.1								
			VNM-1.2.2								
		VNM-1.3 (No level 3 subfunctions)									
	VNM-2	VNM-2.1	VNM-2.1.1								
			VNM-2.1.2								
			VNM-2.1.2								
		VNM-2.2 (No level 3 subfunctions)									
		VNM-2.3	VNM-2.3.1								
			VNM-2.3.2								
	VNM-3	VNM-3.1	VNM-1.1.1								
			VNM-1.1.2								
			VNM-1.1.2								
		VNM-3.2 (No level 3 subfunctions)									
		VNM-3.3	VNM-1.3.1								
			[illegible]								
	VNM-4	VNM-4.1 (No level 3 subfunctions)									
		VNM-4.2	VNM-2.2.1								
			VNM-2.2.2								
		VNM-4.3	VNM-2.3.1								
			VNM-2.3.2								
	VNM-5	VNM-5.1 (No level 3 subfunctions)									
		VNM-5.2	VNM-5.2.1								
			VNM-5.2.2								
		VNM-5.3									

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier E.g. Protect-Rider-From Dirt

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Grading Scheme
Homework #6 Group
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Overall function to be performed by the device properly provided.	8	
2a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 1 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 1 sub-functions.	30	
2b	Reasonableness and relevancy of level 1 sub-functions to the project.	10	
3a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 2 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 2 sub-functions.	20	
3b	Reasonableness and relevancy of Level 2 sub-functions to their level 1 sub-functions and the project.	10	
4a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 3 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 3 sub-functions.	5	
4b	Reasonableness and relevancy of Level 3 sub-functions to their level 2 sub-functions and the project.	5	
8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Functional Decomposition

GROUP NUMBER: 7

Progress Report Title: Status Report VI

Due Date: 10/10/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan** DocuSigned by: D752FAC3D5EC429...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Splashguard and tree generation **Attendance:** attend meetings. **Participation:** participate in meetings.	**84%**	
2	**David Trevino** DocuSigned by: David Trevino 70629F9F1296489...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Splashguard and tree generation **Attendance:** attend meetings. **Participation:** participate in meetings.	**98%**	
3	**Amna Ansari** DocuSigned by: Amna Ansari E25E51620421451...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Splashguard and tree generation **Minutes:** Record meeting minutes for each meeting and record of attendance. **Attendance:** attend meetings. **Participation:** participate in meetings.	**99%**	
4	**Demetrious Sandford** DocuSigned by: Demetrious Sandford C7D32FE84B0A419...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Splashguard and tree generation **Proofreading:** Full report **Formatting:** indenting sections, font type and size consistency. **Meeting:** Organize meeting times. **Attendance:** attend meetings. **Participation:** participate in meetings.	**94%**	
5	**Caleb Riggins** DocuSigned by: Caleb Riggins 41AFA23858EE4BC...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Report writing, Splashguard, and tree generation **Technical writing review:** Full report **Formatting:** indenting sections, font type and size consistency. **Attendance:** attend meetings. **Participation:** participate in meetings.	**99%**	
6	**Ximena Cifuentes** DocuSigned by: Ximena Cifuentes BD1F416D20884F6...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Report writing, Splashguard. and tree generation **Formatting:** Cover page, empty report sheet, indenting sections, font consistency. **Communication:** Send report to Dr. Park for feedback, assign tasks. **Attendance:** attend meetings. **Participation:** participate in meetings.	**99%**	
7	**Aamna Jangda** DocuSigned by: Aamna Jangda 781C4B4D2C9D46D...	**Section work:** Overall Function Individual Level 0, level 1, level 2, level 3 Group Analysis of Level 0, level 1, level 2, level 3 Splashguard and tree generation **Formatting:** Font consistency within certain parts **Attendance:** Attend meetings **Participation:** Participate in meetings	**99%**	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Functional Decomposition

Assigned 09/24/2020 **Due:10/08/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the chapter title.

[Please avoid discussing the sticky note portion of the questions with other group members because they should be done independently]

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Project Group #_____

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8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

4. PRELIMINARY DESIGN

This chapter discusses the process in which the skimmer main functions were identified. Throughout the chapter descriptions and images related to the functional decomposition of prospective skimmer design can be found. Note that as some of the figures in the chapters are perceived as repetitive it is important to observe closely and effectively real the descriptions to better understand the process.

4.1 Functional Decomposition

In this section, the team worked both individually and in conjunction to come up with the best overall skimmer function for the prospective design. In addition, the team further decomposed the overall function in level 1, level 2, and level 3 sub-functions. This section allowed each team member to freely express their individual ideas and it encouraged each team member to research and get familiar with existing skimmer designs.

1. Using electronic sticky note sheets **each member** should provide 3 to 4 suggestions for the overall function. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example. The group should analyze this input from members to determine the overall function that needs to be accomplished by the design and using the identified overall function, create the black box for your project showing the overall function, inputs, and outputs. (The format for answering this question should be similar to that shown in Figure 2 for the splashguard example). **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

Identifying the most important function that the prospective skimmer design should achieve, was not an easy task. The process of narrowing down from the many functions available for skimmers to one overall function was found to be interesting and it will be considered for future project assignments.

To begin the identification of the overall function, each team member individually came up with 3 main functionalities that the prospective design should be able to perform. Once each member was ready to share their ideas, a sticky note splashguard was made available on a Google slides document. Team members were given approximately 4 minutes to input their ideas on the google sticky note splashguard as shown in Figure 4.1. After all the team members' ideas were posted, the team joined a Zoom meeting to discuss each one of the functionalities provided by the team and make an effective decision on an overall function. As shown in Figure 4.2, it was determined that the overall function of the prospective skimmer design was identified to be the ability to recover at least 25~50% of oil in 1-inch oil slick. In addition, the Figure 4.2 indicates the appropriate inputs related to the overall function and its expected outcomes.

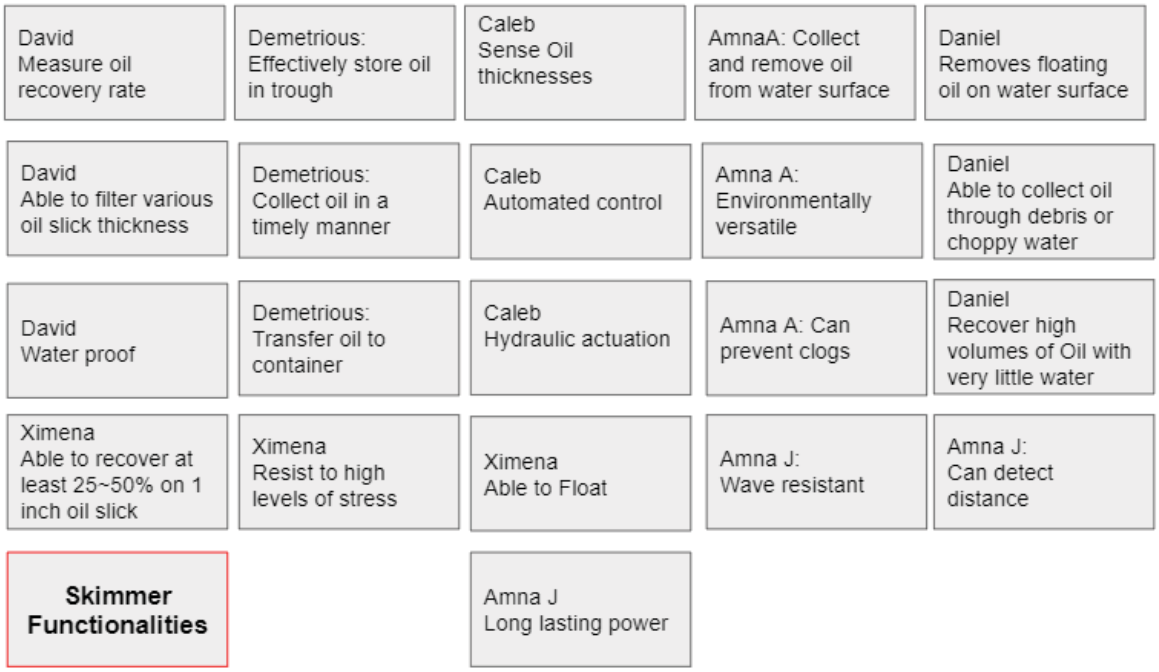


Figure 4.1 Skimmer Function ~~Splashguard~~ - Level 0

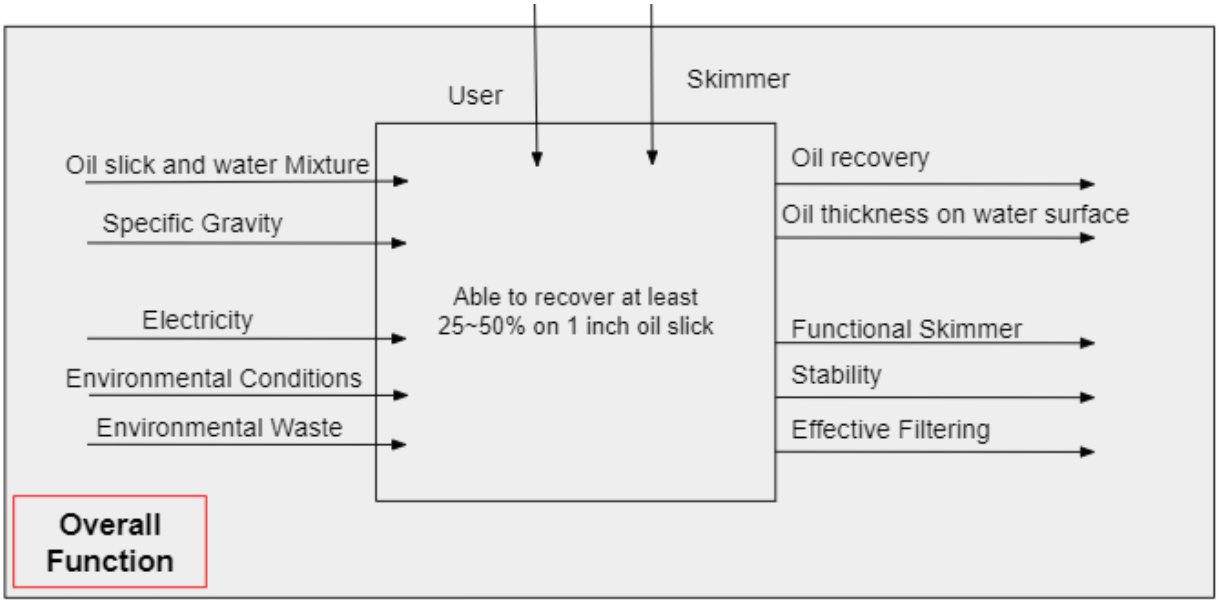


Figure 4.2 Overall Function Inputs and Outputs

2. Using electronic sticky note sheets **each member** should decompose the overall function into simple **level 1 sub-function** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky note should be represented with an overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. (The format for answering this question should be similar to that shown in Figure 3 for the splashguard example). From the suggestions on the sticky notes, the group should discuss, combine or eliminate to arrive

at suitable level 1 sub-functions for the project similar to that shown in Figure 4 for the Splash guard. Identify the inputs and the outputs for each sub-function. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

In this section, each team member was asked to come up with three different level 1 sub-functions based on the identified overall function of the prospective skimmer. Once each Team member was ready to share their level 1 sub-function ideas, a sticky note splashguard was made available to each member on another Google slides document. Then, each team member was given another 4 minutes to input their ideas on the new google sticky note splashguard as shown on Figure 4.3. After all the group members shared their ideas, the team joined a Zoom meeting to further discuss each sub-function. Subsequently to the analysis, the team selected five main level one sub-functions. As expressed in Figure 4.4, the team concluded that in order for the prospective skimmer design to be able to recover at least 25~50% of oil in 1 inch oil slick, the skimmer should be able to measure oil recovery rate, filter various oil slick thickness, separate oil from water, collect oil through debris or choppy water, and limit water intake.

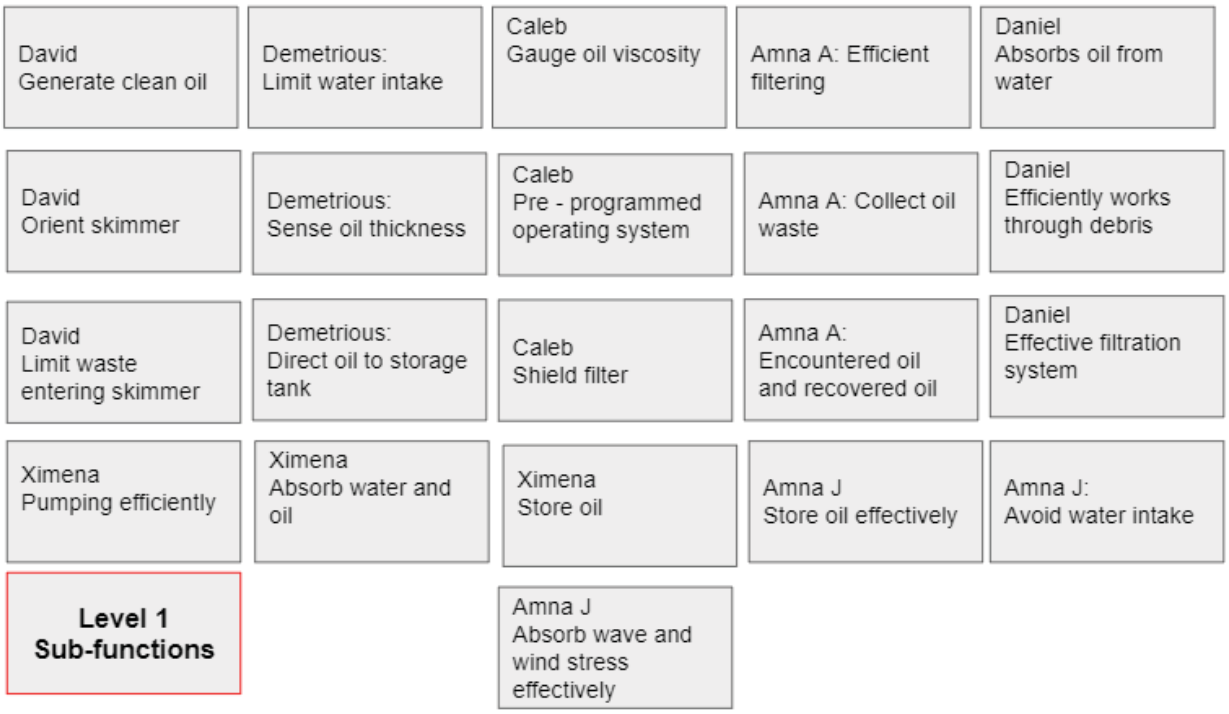


Figure 4.3 Skimmer Idea ~~Splash Guard~~ - Level 1 Sub-functions

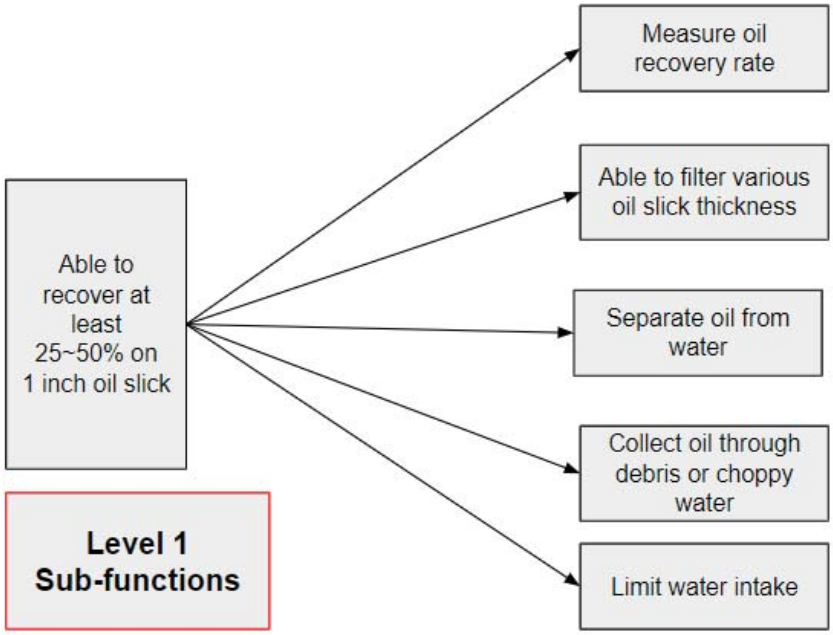


Figure 4.4 Level 1 Sub-functions Tree

3. Using electronic sticky note sheets each member should decompose **EACH** of the level 1 sub-functions into simple **level 2 sub-functions** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky note should be represented with an overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. From the suggestions on the sticky notes for **EACH** level 1 sub-function collected from the members, the group should discuss, combine or eliminate to arrive at suitable level 2 sub-functions for **EACH** level 1 sub-function for the project similar to that shown in Figure 5 for the Splash guard. Identify the inputs and the outputs for each level 2 sub-function. NOTE: This section should be repeated for each level 1 subfunction in order to break each level 1 subfunction into level 2 subfunctions. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

In this section, each team member was asked to generate three different level 2 sub-functions for each one of the five level 1 sub-functions selected in the previous section. Once each team member was ready to share their 15 level 2 sub-function ideas, a sticky note splashguard was made available to each member for each one of the level 1 subfunctions.
Then, each team member was given 12 minutes to input their ideas on the google sticky note splashguards as shown on Figures 4.5 - 4.9. After all the group members shared their ideas, the team joined another Zoom meeting to further discuss each level 2 sub-function. Next, the team selected 15 out of 105 level 2 sub-function ideas provided based on the level 1 sub-functions. In figure 4.10 a display of the 15 level 2 sub-functions selected was made available.

During the analysis of the level 2 functions, the team concluded that for the prospective skimmer design to be able to measure oil recovery rate, the skimmer should be able to sense the amount of

oil recovered per second, effectively detect change in recovery of oil, and efficiently control the rate of recovery. It was also concluded that for the skimmer to be able to filter various oil slick thickness, the skimmer must be able to distinguish between viscosities, detect type of oil, and self-adjust to different types of oil. In addition, the team decided that to successfully separate the oil from the water, the prospective skimmer must be able to filter water out of the oil, to contain the oil, and limit the intake of water. Moreover, it was determined that for the skimmer to be able to collect oil through debris or choppy water, the design must successfully shield debris from the filter, avoid debris collection, and conduct waste separation from fluid. Finally, the team agreed that to limit the water intake, the skimmer design should be able to maintain stability, release the water it takes in and control water intake with the help of actuators.

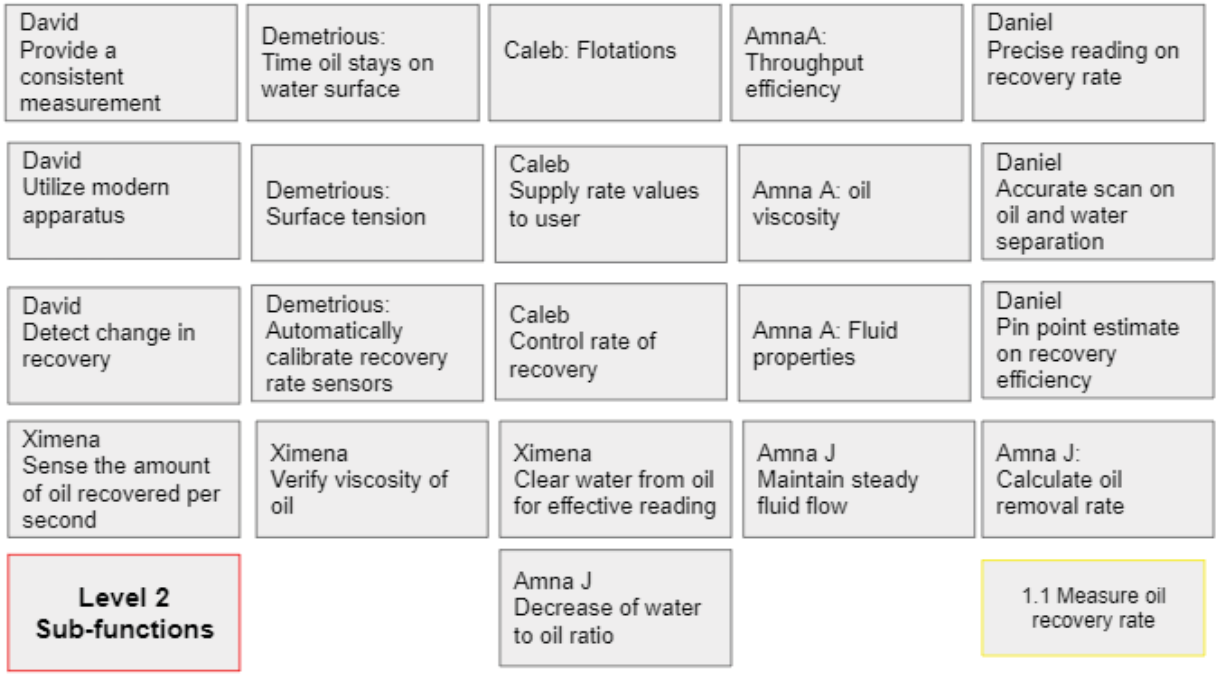


Figure 4.5 Measure Oil Recovery Rate - Level 2 Sub-functions ~~Splashguard~~

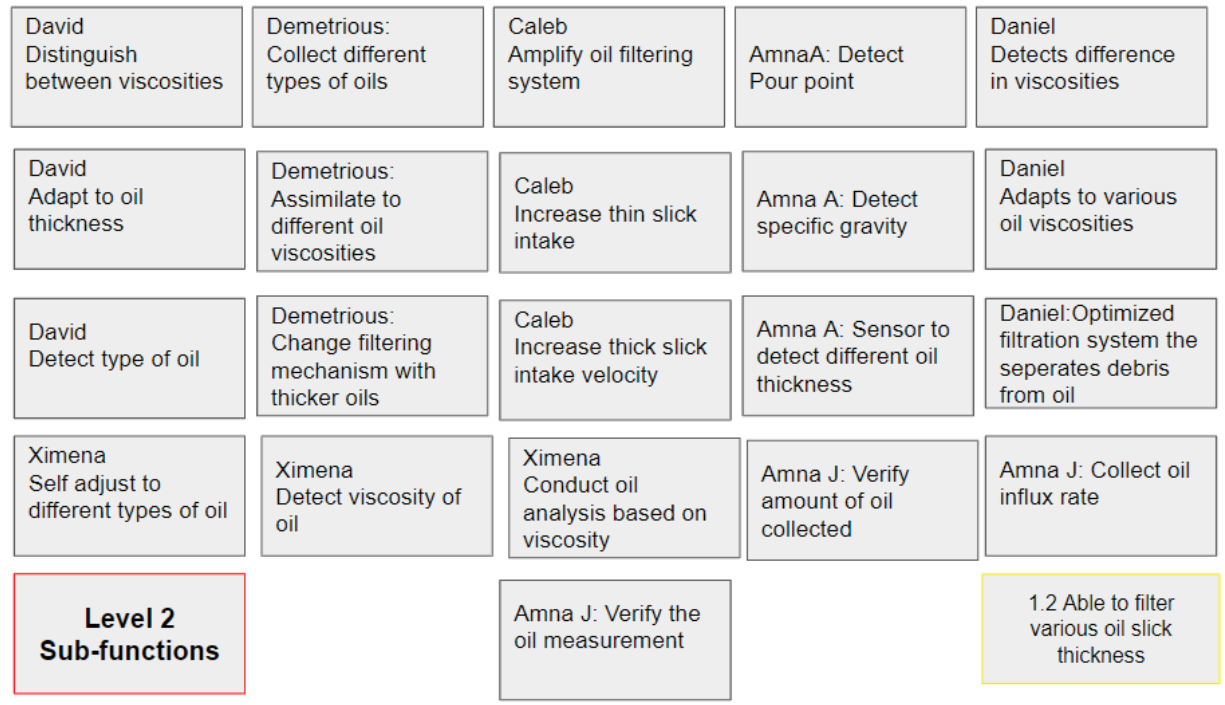


Figure 4.6 Filter various oil slick thickness - Level 2 Sub-functions Splashguard

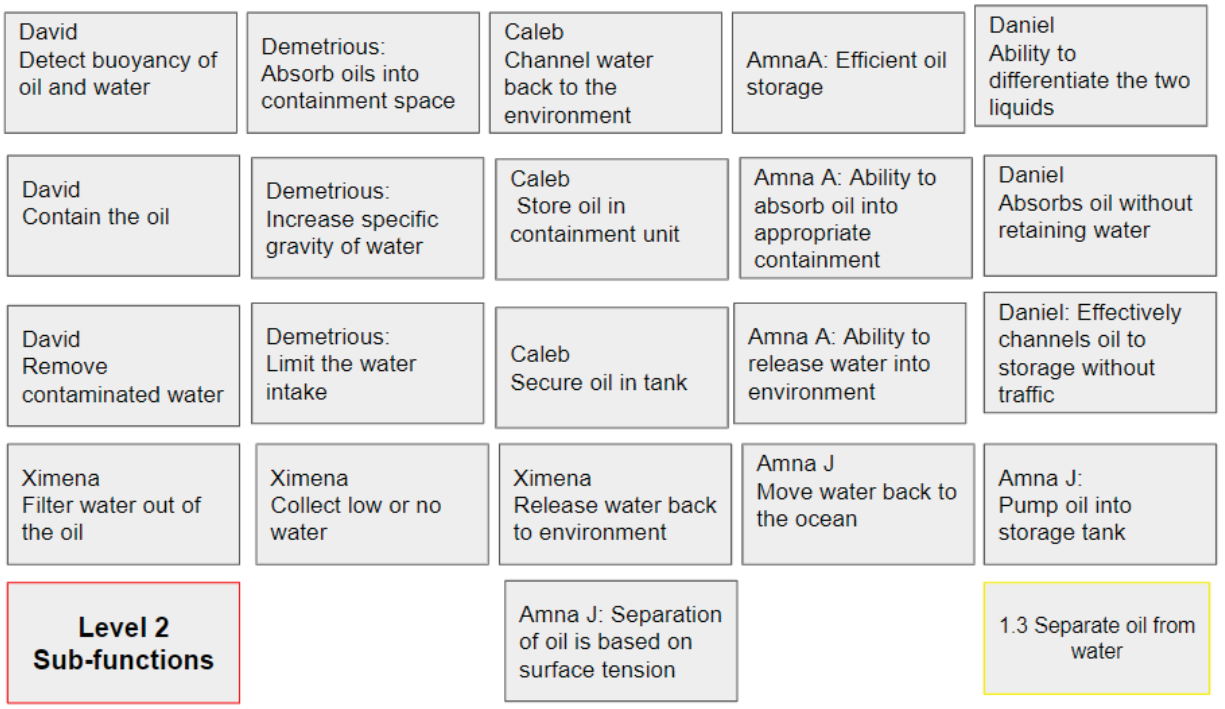


Figure 4.7 Separate Oil From Water - Level 2 Sub-functions Splashguard

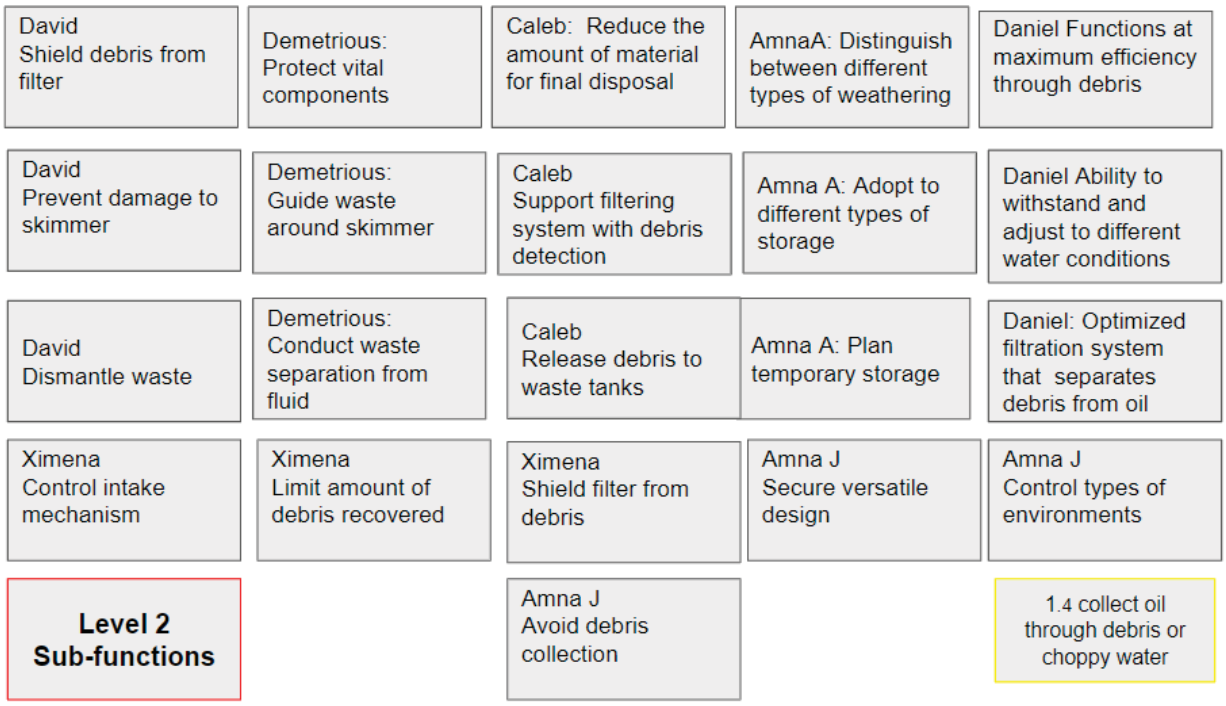


Figure 4.8 Collect Oil Through Debris or Choppy Water - Level 2 Sub-functions Splashguard

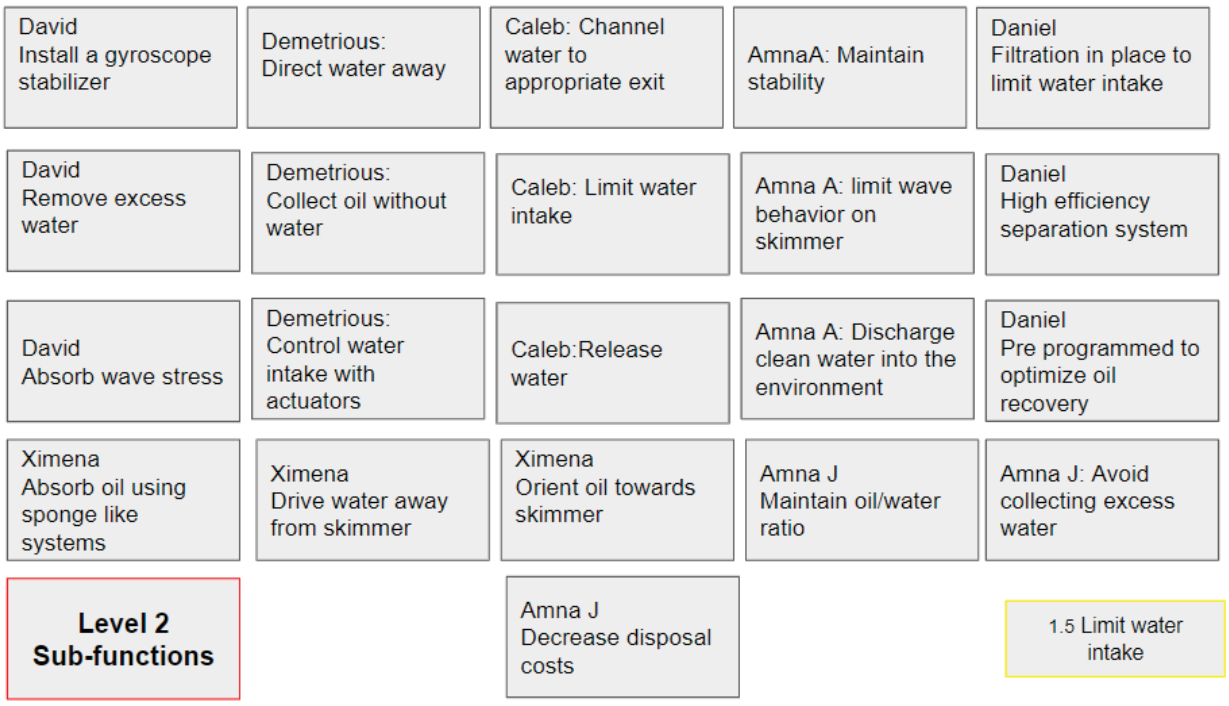


Figure 4.9 Limit Water Intake - Level 2 Sub- functions ~~Splashguard~~

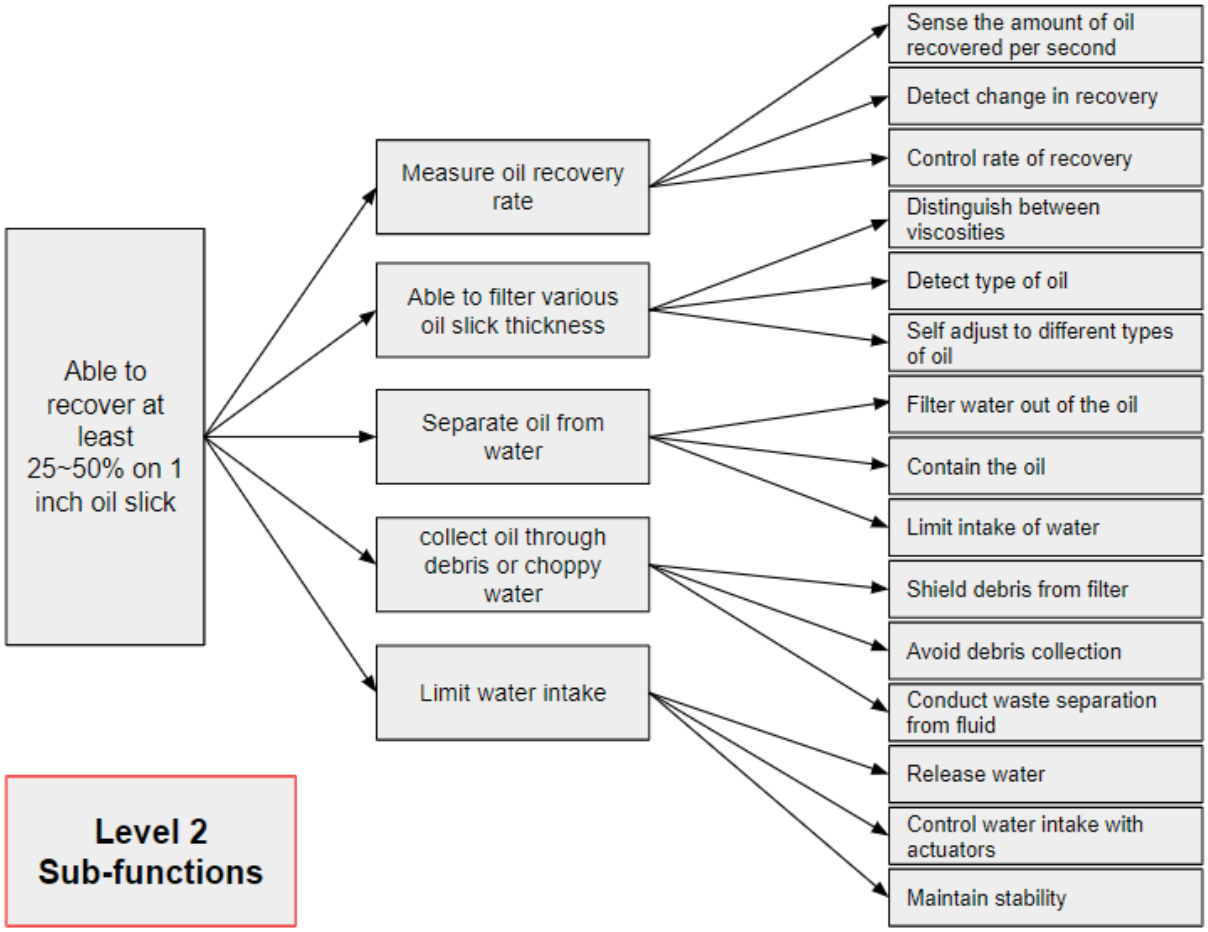


Figure 4.10 Level 2 Sub-functions Tree

4. For the level 2 sub-functions that can be further broken down, repeat step 3 to break them down to level 3 sub-functions and repeat this process until the final sub-functions cannot be decomposed any further. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

In this section, everyone generated three different level 3 sub-functions for five of the level 2 sub-functions selected in the previous section. Once each team member was ready to share their 15 level 3 sub-function ideas, a sticky note splashguard was made available to each member for each one of the level 2 subfunctions to repeat the same process done in the previous sections. At that point, each team member was given around 12 minutes to input their ideas on the google sticky note splashguards as shown on Figures 4.11 - 4.15. Next, all the group members were able to discuss the level 3 sub-functions in a Zoom meeting. Subsequently, the team selected 15 out of 105 level 3 sub-function ideas based on the level 2 sub-functions identified in the previous section. In figure 4.16 the full functionality decomposition for the prospective skimmer design is displayed.

Through the analysis of the level 3 functions, it was concluded that for the design to be able to sense the amount of oil recovered per second, the skimmer should be able to transform rate readings, calculate amount of oil intake, and accurately detect through sensors. It was also concluded that for the skimmer to be able to distinguish between viscosities, the design must be able to verify oil thickness, measure oil resistance to flow, and detect surface tension. In

addition, the team decided that to successfully filter water out of the oil, the prospective skimmer must be able to dissipate excess water, increase filtration rate, and avoid water contamination. Furthermore, it was determined that for the skimmer to be able to avoid debris collection, the design must successfully limit debris entering skimmer, divert debris using its filtration system, and remove debris through aversion technology Finally, the team decided that to control the water intake with actuators, the skimmer design should be able use specific gravity differential to limit water intake, perform floatation stabilization, collect optimal level of oil.

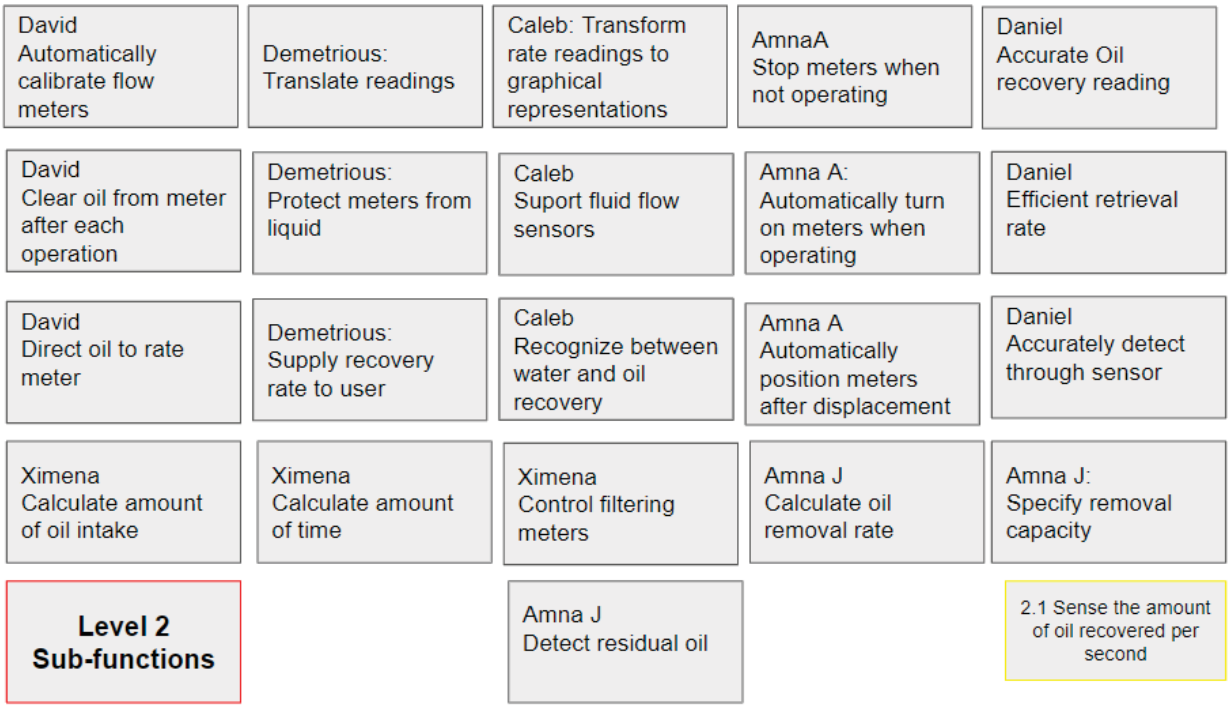


Figure 4.11 Sense the Amount of Oil Recovered /Second - Level 3 Sub-functions ~~Splashguard~~

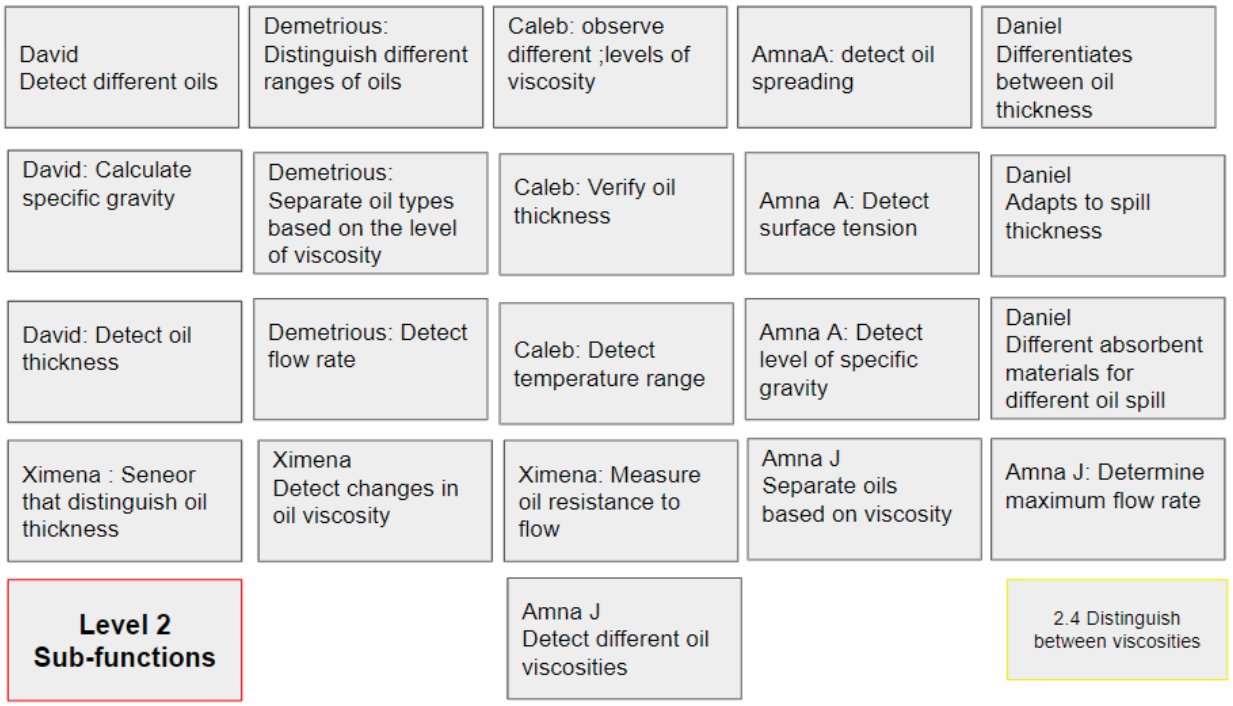


Figure 4.12 Distinguish Between Viscosities - Level 3 Sub-functions ~~Splashguard~~

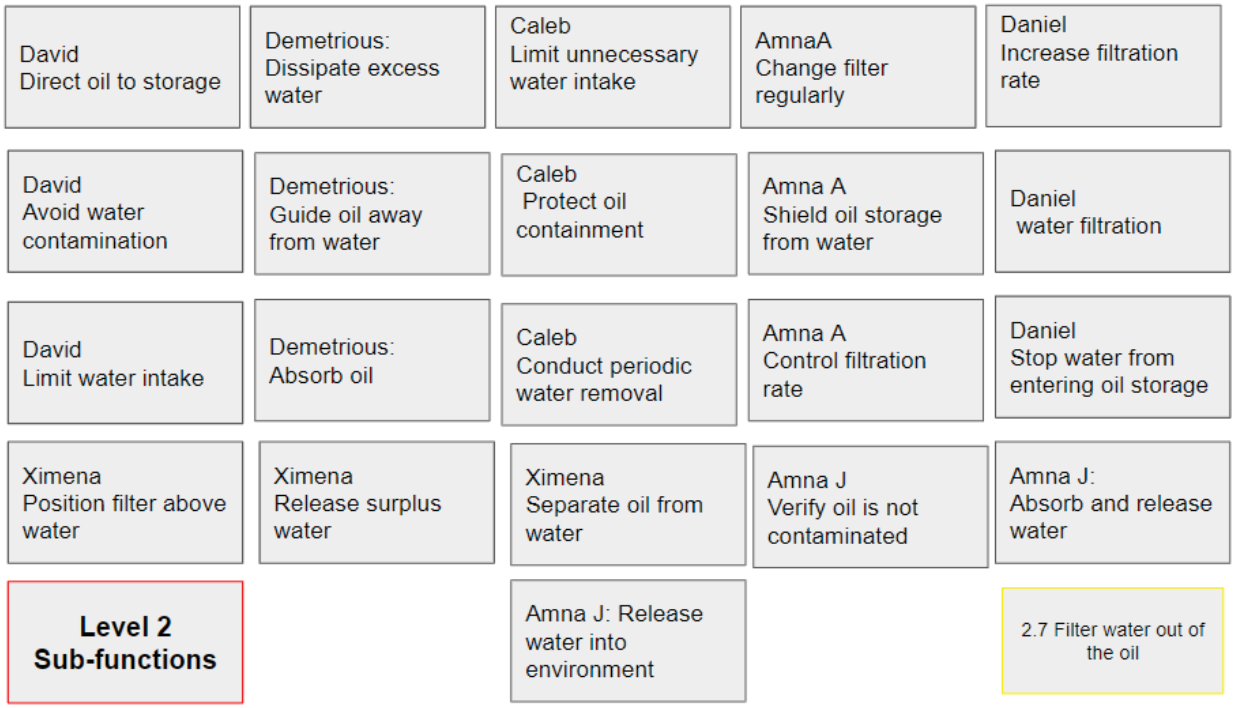


Figure 4.13 Filter Water Out of Oil - Level 3 Sub-functions ~~Splashguard~~

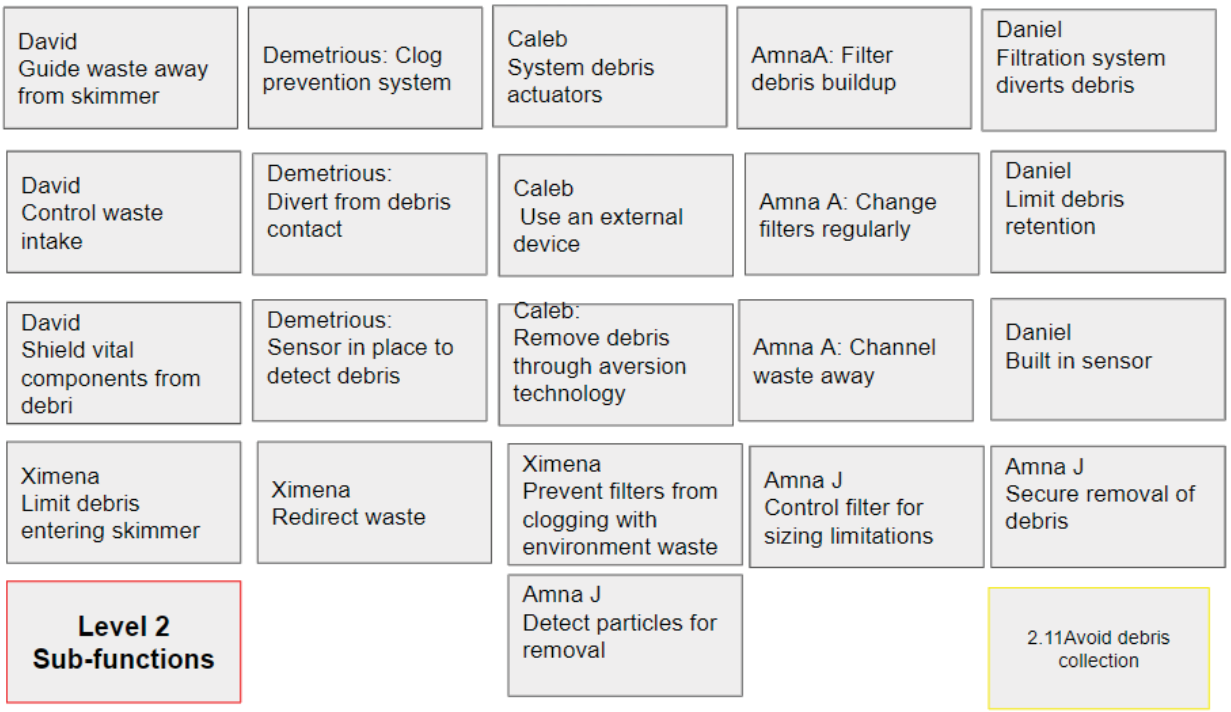


Figure 4.14 Avoid Debris Collection - Level 3 Sub-functions ~~Splashguard~~

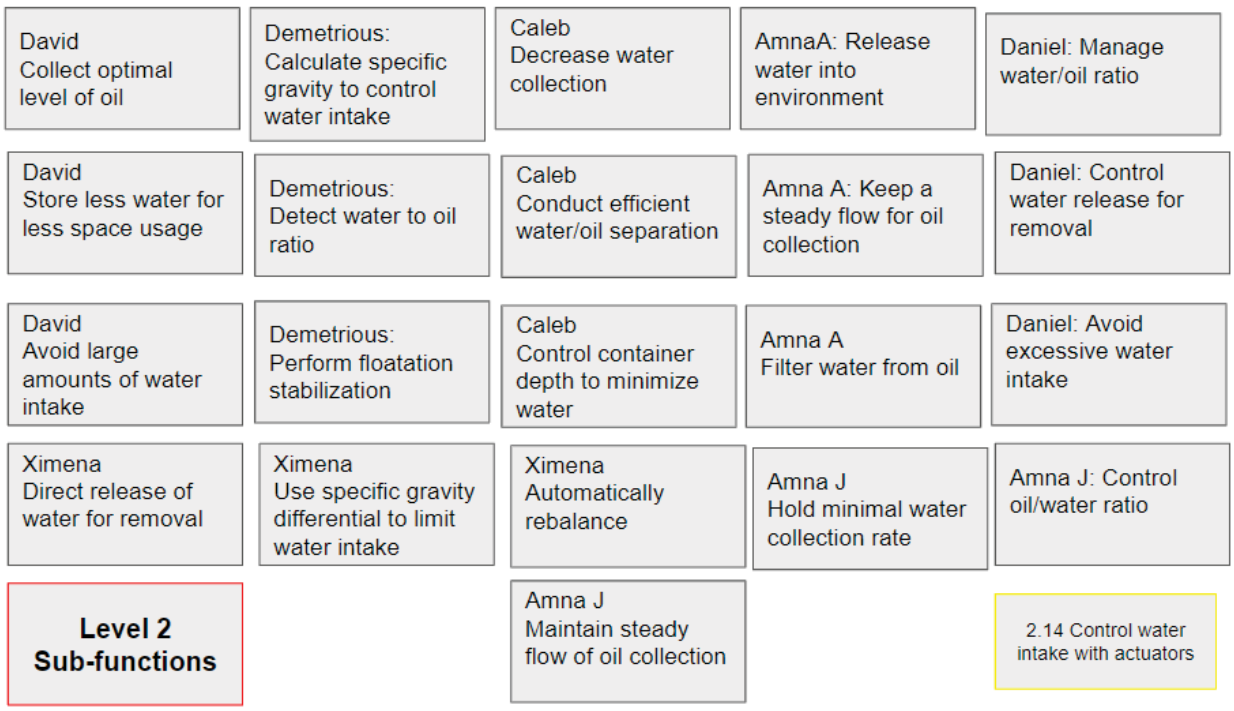


Figure 4.15 Control Water Intake with Actuators - Level 3 Sub-functions ~~Splash Guard~~

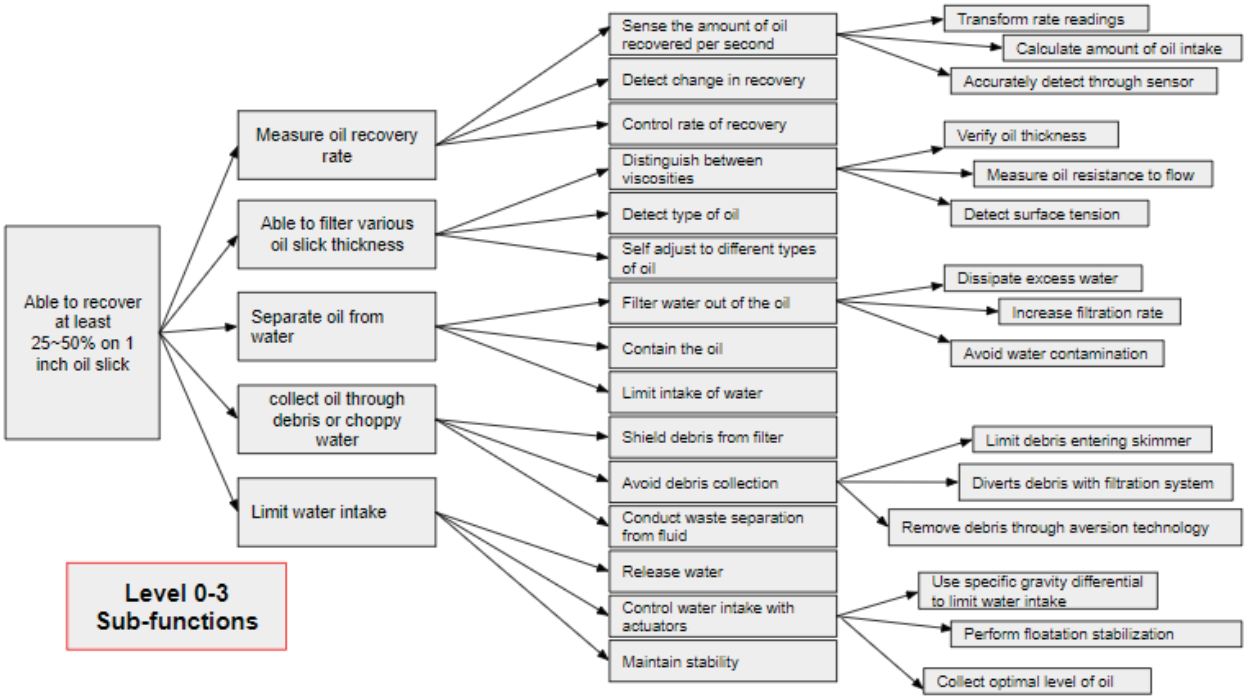


Figure 4.16 Level 3 Sub-functions Tree

5. Using your Level 1, Level 2, Level 3 and any additional level sub-functions, create a Table similar to Table 1 (shown in the next page) in which all items to the left of the red vertical line should be provided and the right side of that line left blank. This Table is similar to Table 2 Morphology for the Splashguard in the PowerPoint notes, but with the concept's columns blank. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

Table 4.2, given below, is a morphology table that represents the current status of the generated sub-functions levels 1-3 created through adaptations of the overall function of the skimmer being able to recover at least 25~50% on 1 inch oil slick. The table is organized in levels of sequential order from sub-function 1 to 2 to 3. As shown below, some of sub-level 2 functions do break down into a third sublevel. These breaks help to express which sub-functions were further chosen to be expanded based upon their vitality and functionality.

Table 4.2 Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
Recover at least 25~50% on 1-inch oil slick	Measure oil recovery rate	Sense the amount of oil recovered per second	Transform rate readings								
			Calculate amount of oil intake								
			Accurately detect through sensor								
		Detect change in recovery									
		Control rate of recovery									
	Able to filter various oil slick thickness	Distinguish between oil viscosities	Verify oil thickness								
			Measure oil resistance to flow								
			Detect surface tension								
		Detect type of oil									
		Self-adjust to different types of oil									
	Separate oil from water	Filter water out of the oil	Dissipate excess water								
			Increase filtration rate								
			Avoid water contamination								
		Contain the oil									
		Limit the intake of water									
	Collect oil through debris or choppy water	Shield debris from filter									
		Avoid debris collection	Limit debris entering skimmer								
			Filtration system diverts that debris								
			Remove debris ~~through aversion technology~~								
		Conduct waste separation from fluid									
	Limit water intake	Release water									
		Control water intake with actuators	~~Use specific gravity differential to~~ limit water intake								
			Perform floatation stabilization								
			Collect optimal level of oil								
		Maintain stability									

Grading Scheme
Homework #6 Group
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Overall function to be performed by the device properly provided.	8	
2a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 1 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 1 sub-functions.	30	
2b	Reasonableness and relevancy of level 1 sub-functions to the project.	10	
3a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 2 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 2 sub-functions.	20	
3b	Reasonableness and relevancy of Level 2 sub-functions to their level 1 sub-functions and the project.	10	
4a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 3 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 3 sub-functions.	5	
4b	Reasonableness and relevancy of Level 3 sub-functions to their level 2 sub-functions and the project.	5	
8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 6 Functional Decomposition

Due Date: 10/10/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Completed 4.1 function decomposition Provided black boxes for each sub-functions	100	
2	Jonathan Horta Jonathon Horta	Provided black boxes for sub-functions	100	
3	Todd Maxwell Todd Maxwell	Provided black boxes for sub-functions	100	
4	Michael Samuel Michael Samuel	Provided black boxes for sub-functions	100	
5	Aramis King Aramis King	Provided black boxes for sub-functions and sectionalized sticky notes	100	
6	Daniel Ward Daniel C. Ward	Provided black boxes for sub-functions and sectionalized sticky notes	100	
7	Titus Woodard Titus Woodard	Provided black boxes for sub-functions	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Functional Decomposition

Assigned 09/24/2020 **Due:10/08/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the chapter title.

[Please avoid discussing the sticky note portion of the questions with other group members because they should be done independently]

" 4. PRELIMINARY DESIGN" . The subsections highlighted in blue fonts should be used in the status report. Study the sections on functional decomposition and concepts generation and functional analysis discussed in class/provided in the PowerPoint slides and in the web, link provided in the slides and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example.

4.1 Functional Decomposition

1. Using electronic sticky note sheets **each member** should provide 3 to 4 suggestions for the overall function. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example. The group should analyze this input from members to determine the overall function that needs to be accomplished by the design and using the identified overall function, create the black box for your project showing the overall function, inputs, and outputs. (The format for answering this question should be similar to that shown in Figure 2 for the splashguard example). **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

2. Using electronic sticky note sheets **each member** should decompose the overall function into simple **level 1 sub-function** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. (The format for answering this question should be similar to that shown in Figure 3 for the splashguard example). From the suggestions on the sticky notes, the group should discuss, combine or eliminate to arrive at suitable level 1 sub-functions for the project similar to that shown in Figure 4 for the Splash guard. Identify the inputs and the outputs for each sub-function. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

3. Using electronic sticky note sheets each member should decompose **EACH** of the level 1 sub-functions into simple **level 2 sub-functions** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. From the suggestions on the sticky notes for **EACH** level 1 sub-function collected from the members, the group should discuss, combine or eliminate to arrive at suitable level 2 sub-functions for **EACH** level 1 sub-function for the project similar to that shown in Figure 5 for the Splash guard. Identify the inputs and the outputs for each level 2 sub-function. NOTE: This section should be repeated for each level 1 subfunction in order to break each level 1 subfunction into level 2 subfunctions. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

4. For the level 2 sub-functions that can be further broken down, repeat step 3 to break them down to level 3 sub-functions and repeat this process until the final sub-functions cannot be decomposed any further. **Provide**

a detailed description of the process used for this section and cite and completely describe all figures related to this section.

5. Using your Level 1, Level 2, Level 3 and any additional level sub-functions, create a Table similar to Table 1 (shown in the next page) in which all items to the left of the red vertical line should be provided and the right side of that line left blank. This Table is similar to Table 2 Morphology for the Splashguard in the PowerPoint notes, but with the concept's columns blank. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
	VNM-1	VNM-1.1	VNM-1.1.1								
			VNM-1.1.2								
			VNM-1.1.2								
		VNM-1.2	VNM-1.2.1								
			VNM-1.2.2								
		VNM-1.3 (No level 3 subfunctions)									
	VNM-2	VNM-2.1	VNM-2.1.1								
			VNM-2.1.2								
			VNM-2.1.2								
		VNM-2.2 (No level 3 subfunctions)									
		VNM-2.3	VNM-2.3.1								
			VNM-2.3.2								
	VNM-3	VNM-3.1	VNM-1.1.1								
			VNM-1.1.2								
			VNM-1.1.2								
		VNM-3.2 (No level 3 subfunctions)									
		VNM-3.3	VNM-1.3.1								
			VNM-1.3.2								
	VNM-4	VNM-4.1 (No level 3 subfunctions)									
		VNM-4.2	VNM-2.2.1								
			VNM-2.2.2								
		VNM-4.3	VNM-2.3.1								
			VNM-2.3.2								

	VNM-5	VNM-5.1 (No level 3 subfunctions)									
		VNM-5.2	VNM-5.2.1								
			VNM-5.2.2								
		VNM-5.3									

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier E.g. Protect-Rider-From Dirt

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Grading Scheme
Homework #6 Group
Project Group #__8____

Item	Description	Maximum Points	Your Score
1	Overall function to be performed by the device properly provided.	8	
2a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 1 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 1 sub-functions.	30	
2b	Reasonableness and relevancy of level 1 sub-functions to the project.	10	
3a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 2 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 2 sub-functions.	20	
3b	Reasonableness and relevancy of Level 2 sub-functions to their level 1 sub-functions and the project.	10	
4a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 3 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 3 sub-functions.	5	
4b	Reasonableness and relevancy of Level 3 sub-functions to their level 2 sub-functions and the project.	5	
8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

4. Preliminary Design

This chapter will show the breaking down of this project from an overall most important function. The group decided to break this project into two different sections. One for the suspension system and one for the steering system. By separating the two systems, the group will be able to optimize the performance of each system. Each student will bring forward their idea for a function and sub function. The group will collaborate and determine the next level subfunction. By breaking down the overall function, the group will be able to develop sketches and designs.

4.1 Functional Decomposition

This section will dive deeper in the process that the group took to come up with the overall function of each system and break them down all the way to level 3 sub-functions. For this project, there are two different systems that the group will design, analyze, and fabricate. To optimize each system the group decided to use the functional decomposition method on each system.

The overall most important function of each system was generated from using the sticky note system. This system involves each student to come up with at least three black boxes for each function and sub-function. When every student generated three black boxes, the group gathered them all together and collaborated to create the most important overall function. Figure 4.1 will demonstrate the first process of using the sticky note system for the suspension system. Figure 4.2 will show the overall most important function and all of the variables going in and out of the suspension system. Figure 4.3 demonstrates the sticky note system that was used to come up with the overall function of the steering system. Figure 4.4 shows the overall function of the steering system that was decided by the group.

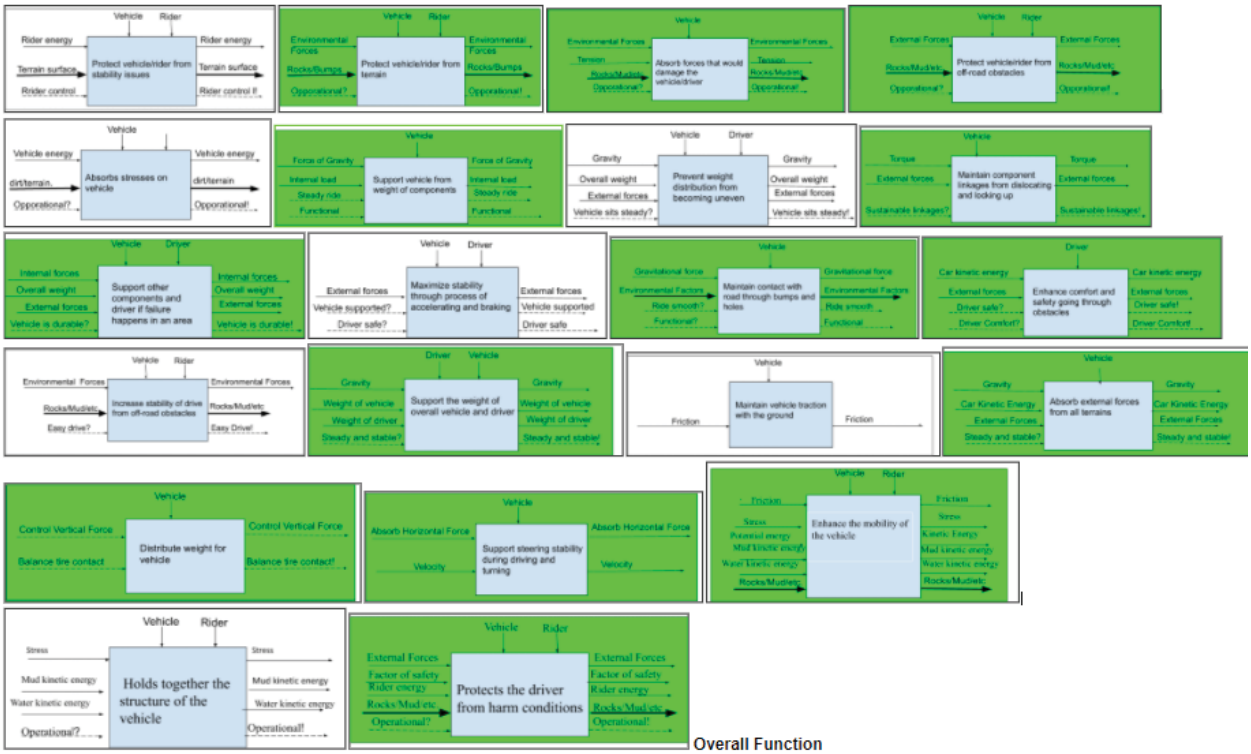


Figure 4.1 The sticky note system for the overall function of the suspension system

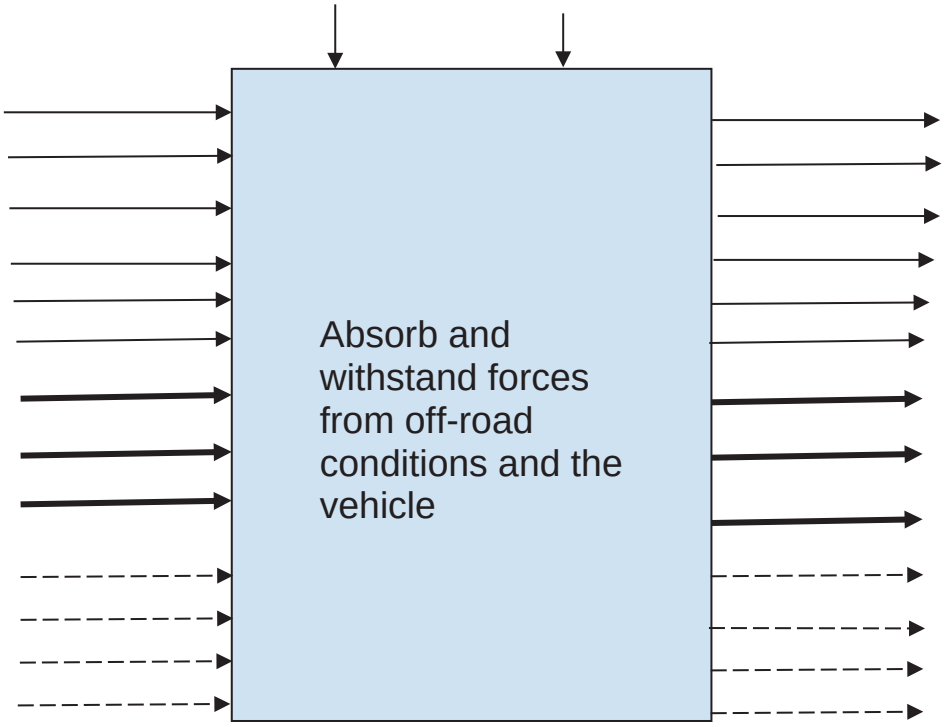


Figure 4.2 The overall most important function for the suspension system

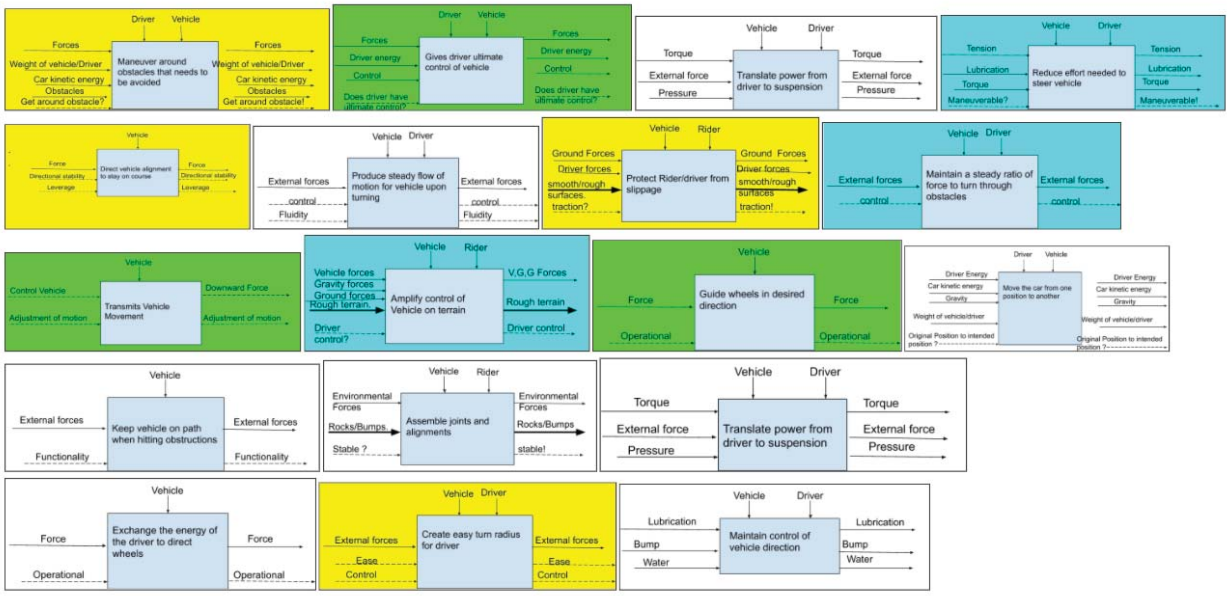


Figure 4.3 Sticky note system for the overall function for the steering system

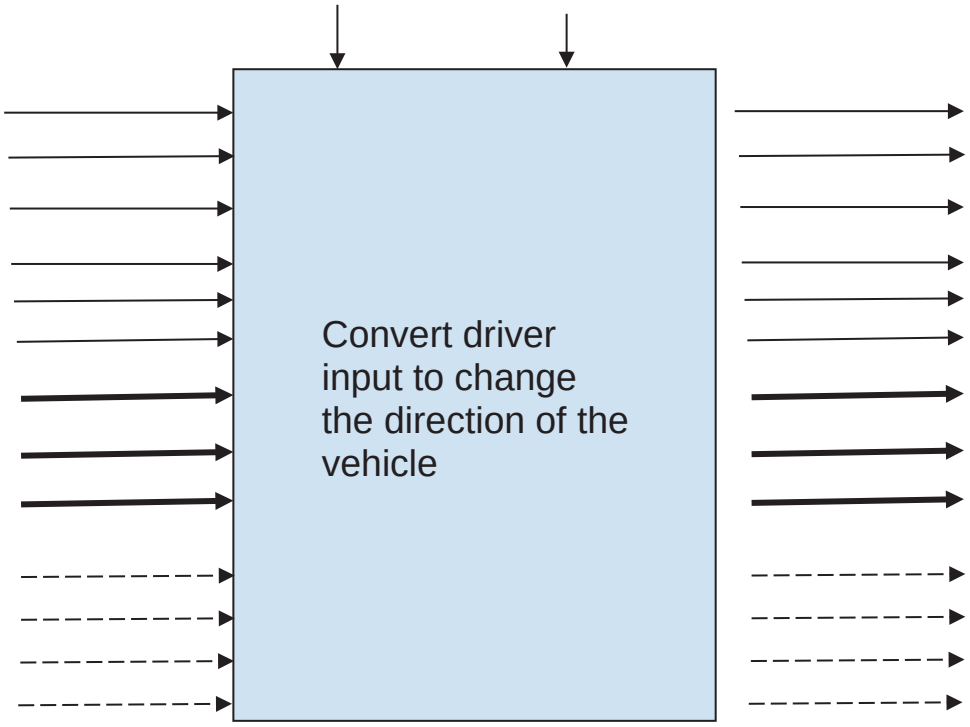


Figure 4.4 The overall most important function for the steering system

Once the overall function for each system was decided, the group had to generate more black boxes to break the overall function into level one sub functions. Each student had to come up with at least three level one sub-functions and bring them to the group. When all the students brought their black boxes together, the group began to work together to gather similar black boxes and created a level one sub-function. The perk of the sticky note system was the group was able to see other students' ideas together as the group discussed what should be a level one sub-function. The group tried to generate as many level one sub functions as possible to make sure the overall function was covered in every aspect. When all of the level one sub-functions were generated, the overall function black box was updated with all the level one sub-functions included. Figure 4.5 shows the sticky note system used to create the level one sub-functions for the suspension system. Figure 4.6 shows the updated overall function black box for the suspension system. Figure 4.7 shows the sticky note system used to create the level one sub-functions for the steering system. Figure 4.8 shows the updated overall function black box for the steering system.

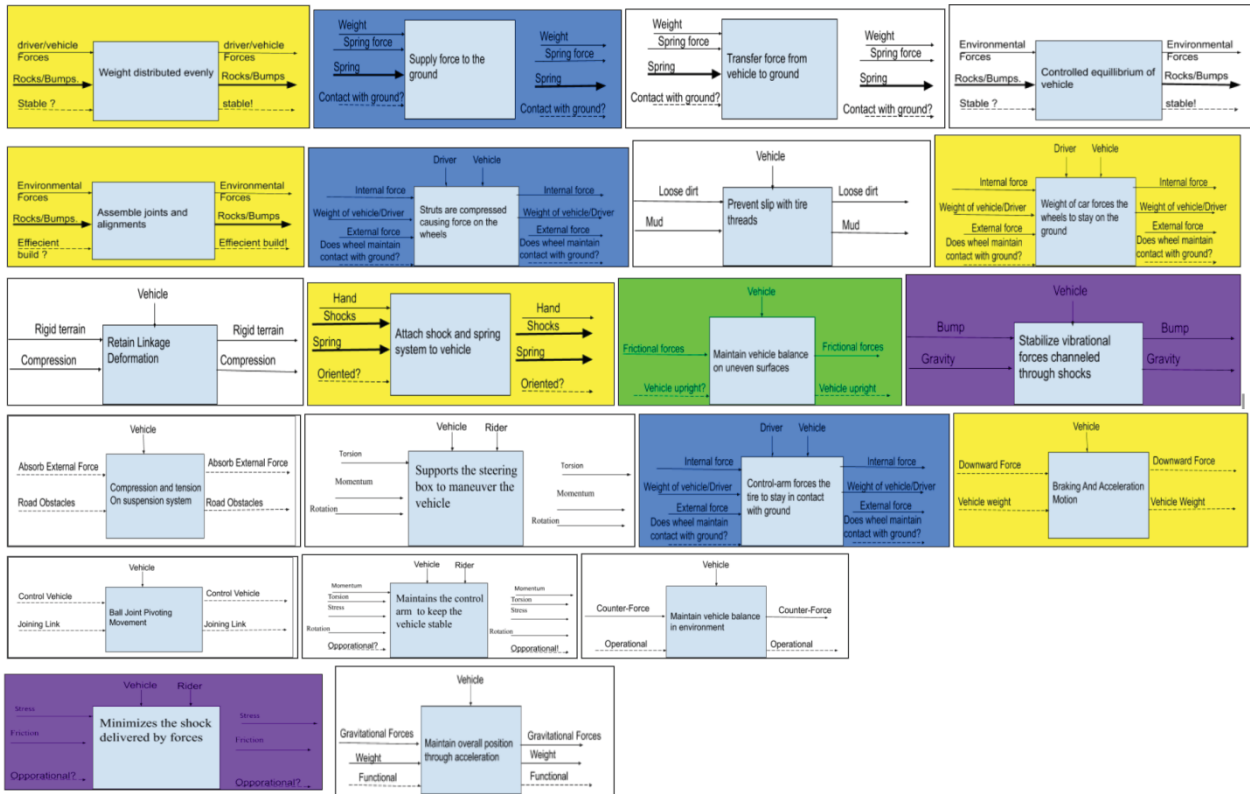


Figure 4.5 The sticky note system of the level one sub-function for the suspension system

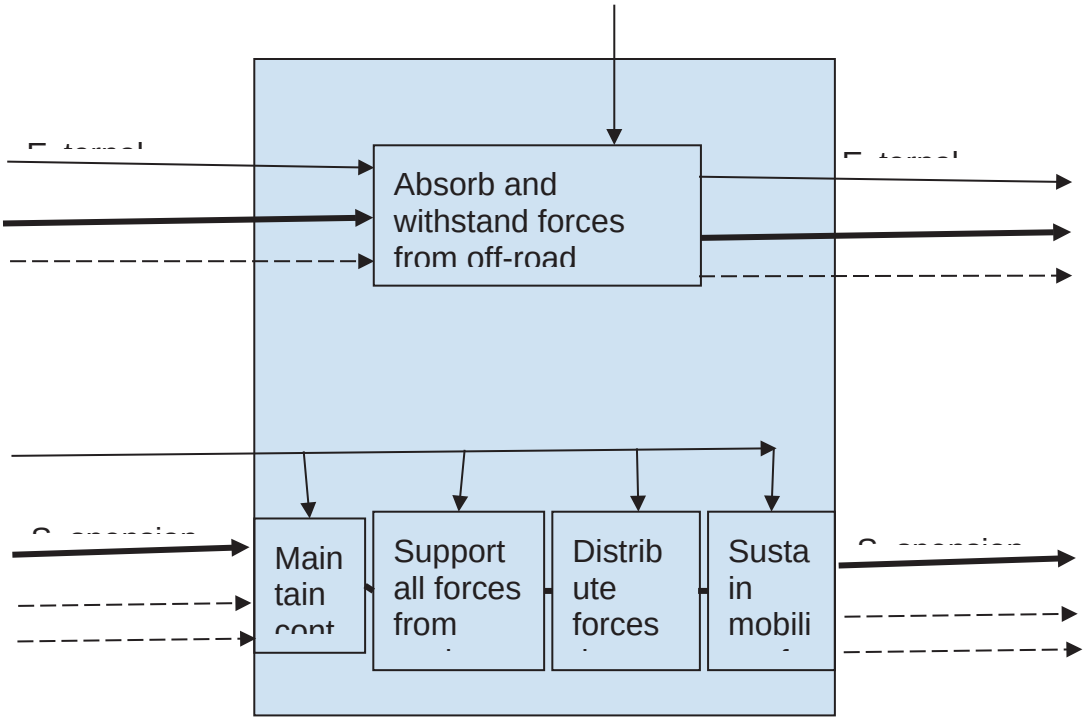


Figure 4.6 The overall function and the level one sub-function for the suspension system

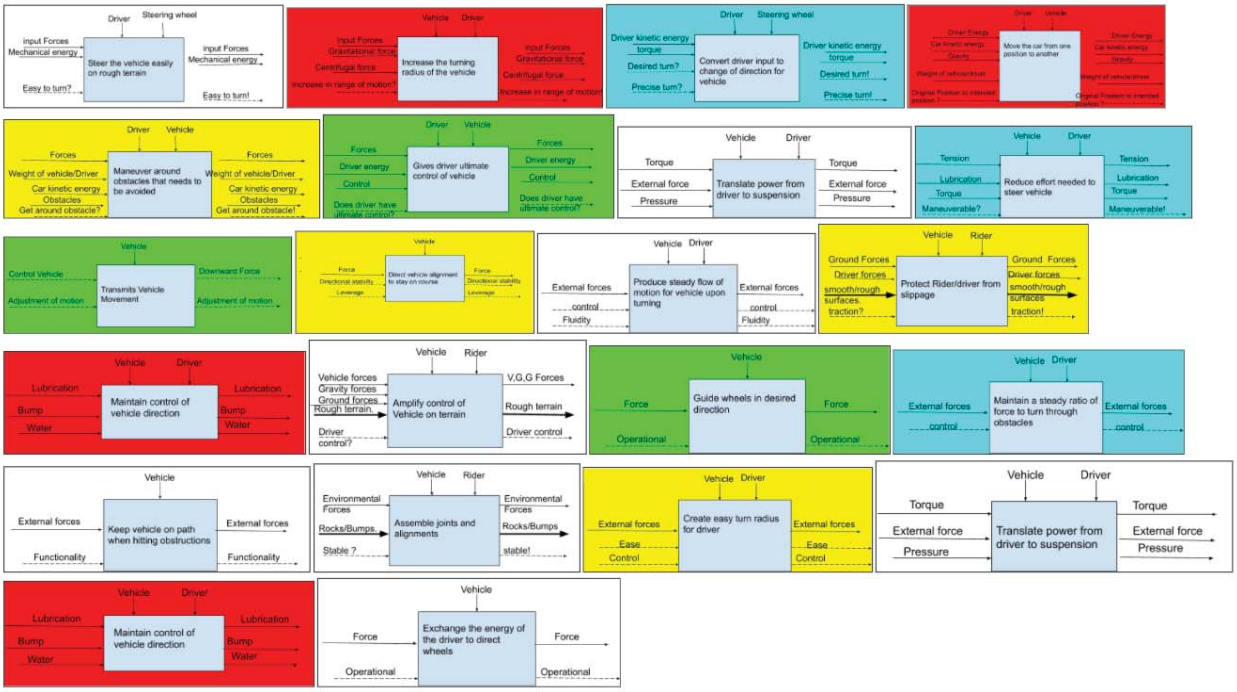


Figure 4.7 The sticky note system that was used for the level one sub-function of the steering system

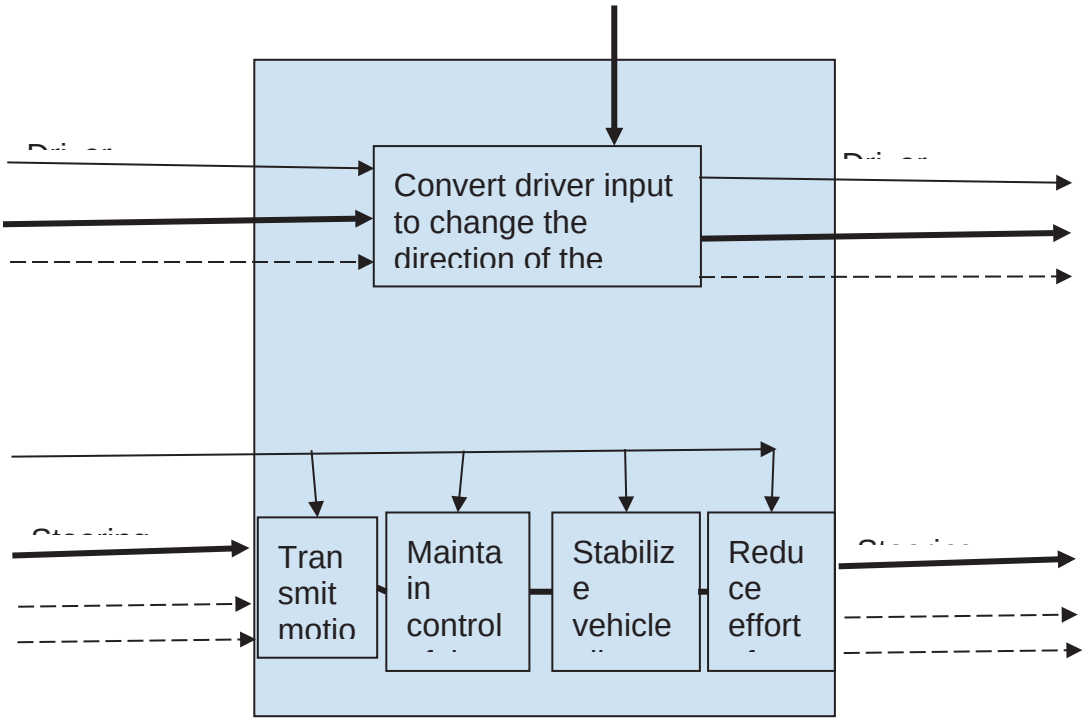


Figure 4.8 The overall function and level one sub-functions of the steering system

After the level one sub-functions were created, the group repeated the process of the sticky note system. This time the group had to come up with their own ideas for the level two sub-

functions for each level one sub-function. Once the group all had their own ideas, all of the ideas were combined and the group decided on what the level two sub functions are for each system. After the level two sub-functions were agreed upon, a new diagram was created for each level one sub-function. Figure 4.9 shows the sticky note system for the level two sub-functions for maintaining contact with the ground for the suspension system. Figure 4.10 shows the new diagram for maintaining contact with the ground. Figure 4.11 shows the sticky note system for the level two sub-function for sustaining the mobility of moving parts of the suspension system. Figure 4.12 shows the new diagram for sustaining mobility of moving parts. Figure 4.13 shows the level two sub-functions for distributing forces throughout the suspension system. Figure 4.14 shows the new diagram for distributing forces throughout the suspension system. Figure 4.15 shows the sticky note system used to come up with the level two sub-functions for supporting internal and external forces from vehicle conditions. Figure 4.16 shows the new diagram for supporting all forces from vehicle conditions. Figure 4.17 shows the sticky note system for the level two sub-functions for maintaining control of the vehicle for the steering system. Figure 4.18 shows the new diagram for maintaining control of the vehicle. Figure 4.19 shows the sticky note system for the level two sub-function for transmitting motion of the vehicle of the steering system. Figure 4.20 shows the new diagram for transmitting motion of the vehicle. Figure 4.21 shows the level two sub-functions for stabilizing the vehicle alignment to stay on course for the steering system. Figure 4.22 shows the new diagram for stabilizing the vehicle alignment to stay on course. Figure 4.23 shows the sticky note system used to come up with the level two sub-functions for reducing effort of the driver of the steering system. Figure 4.24 shows the new diagram for reducing effort of the driver.

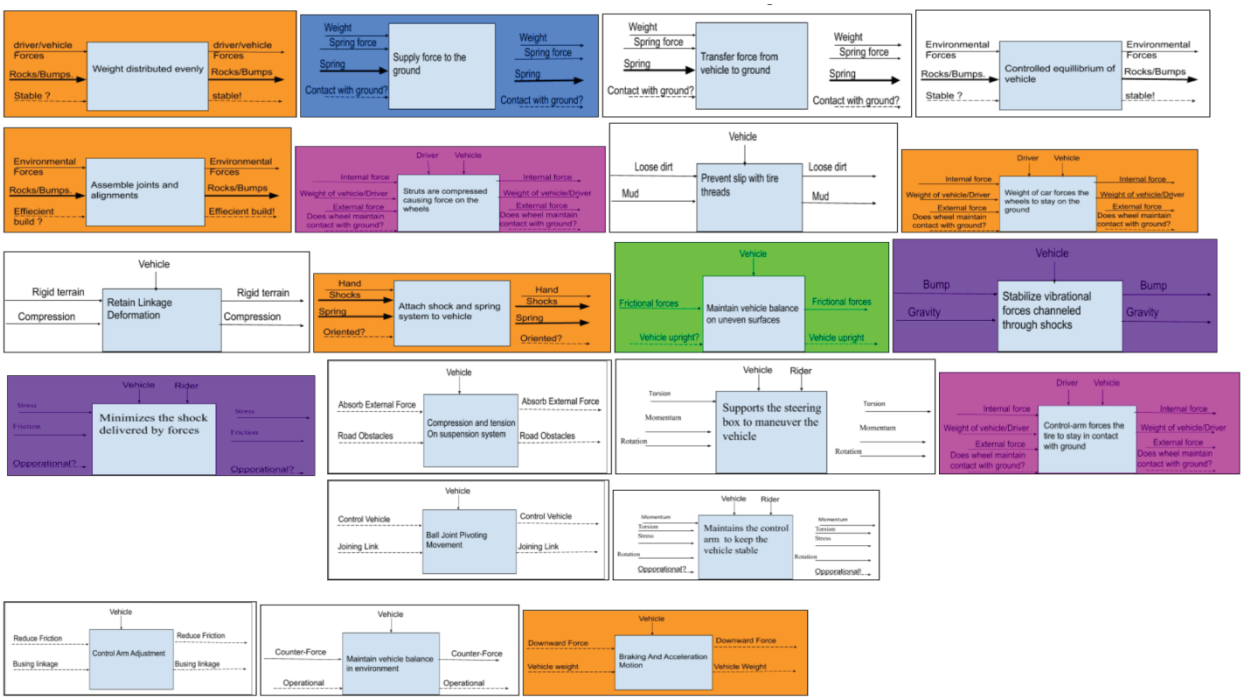


Figure 4.9 Sticky note system for level 2 sub function maintaining contact with ground

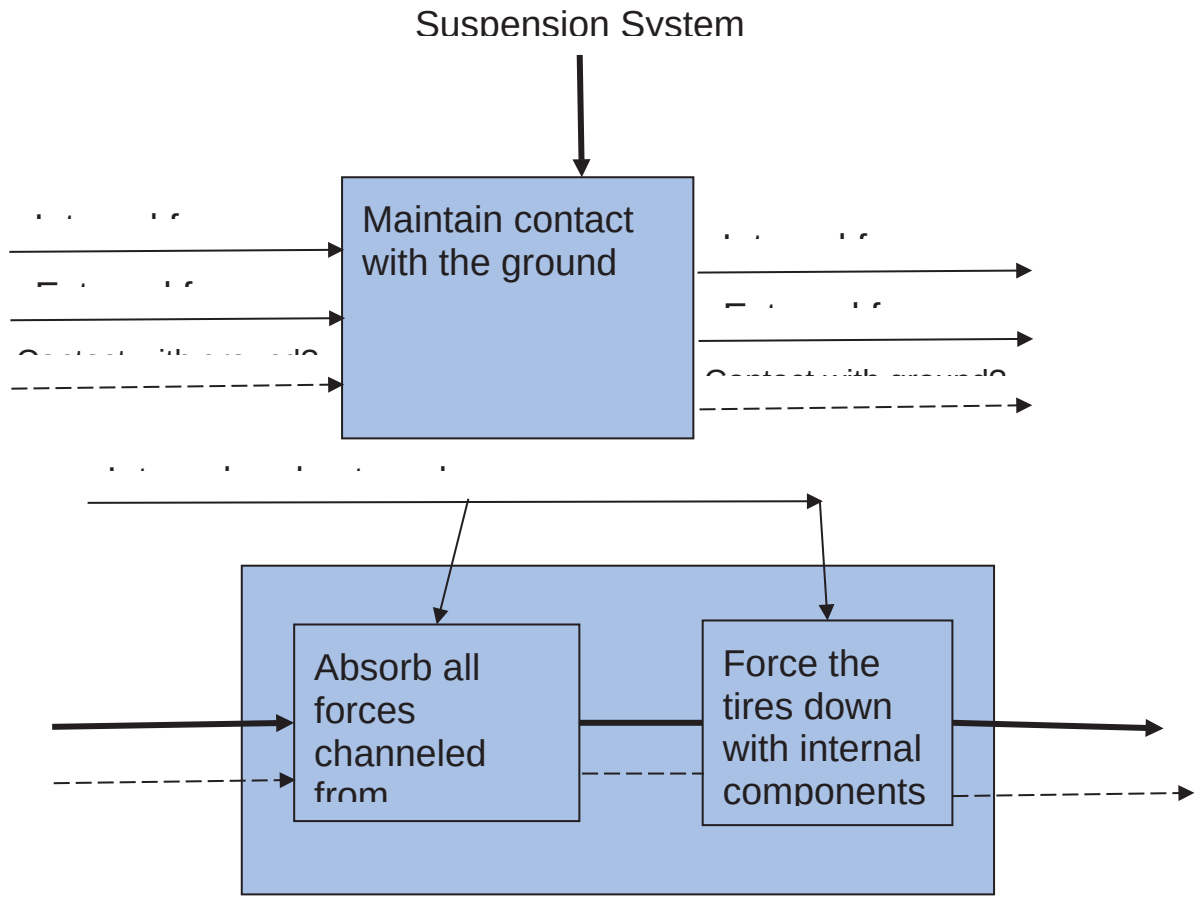


Figure 4.10 Diagrams breaking down of level one sub-function maintaining contact with the ground

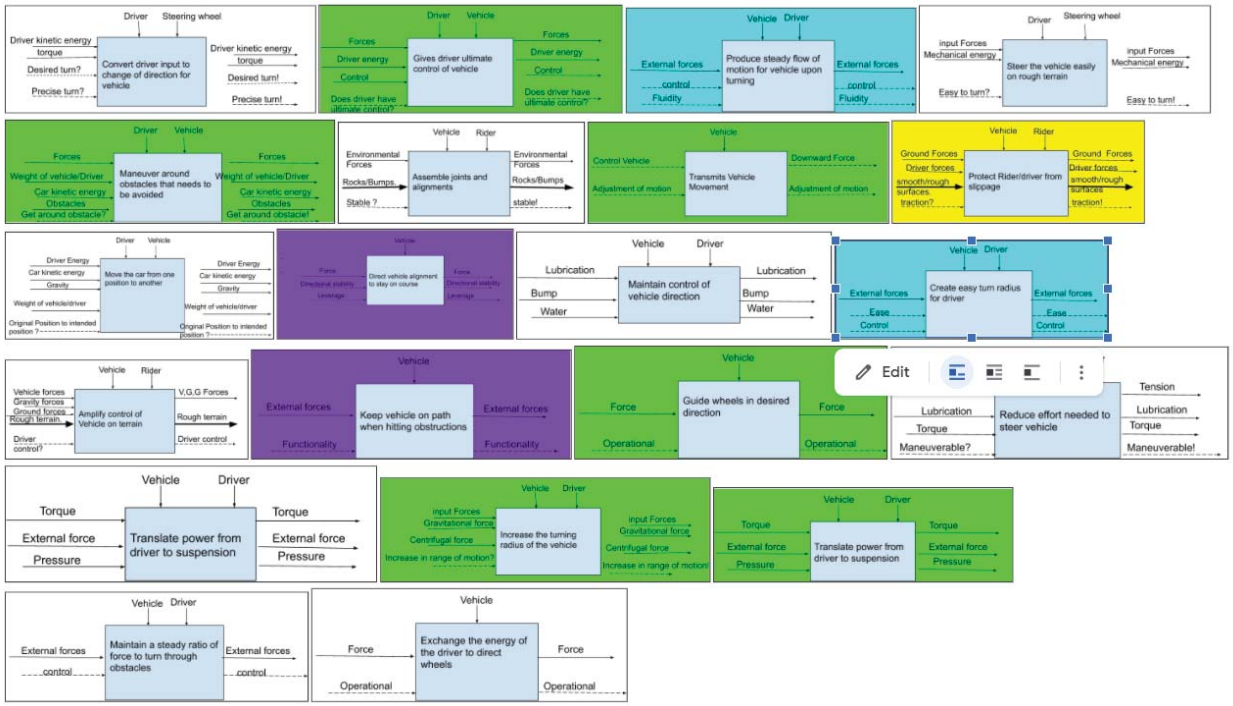


Figure 4.11 shows the sticky note system for the level two sub-function for sustaining the mobility of moving parts of the suspension system

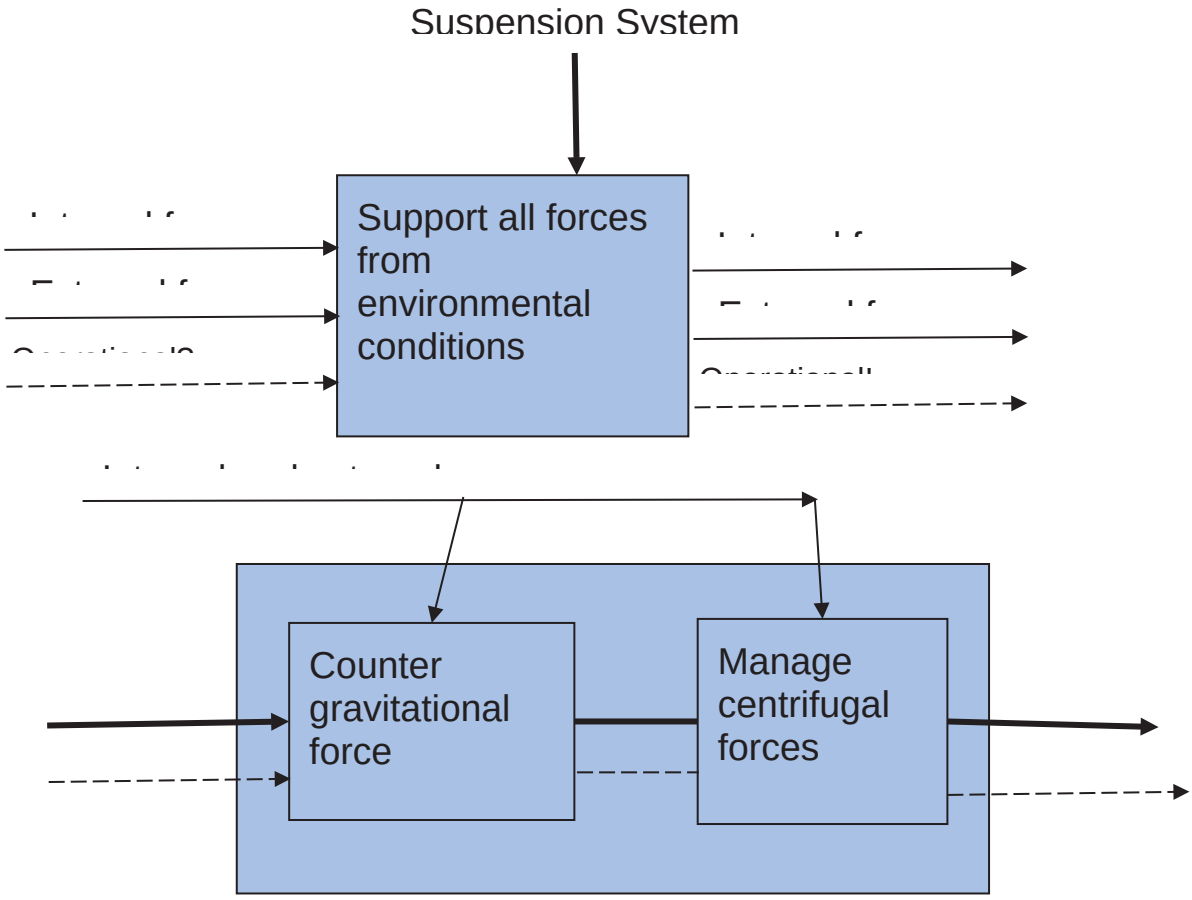


Figure 4.12 Diagrams breaking down of level one sub-function supporting all forces from environmental conditions

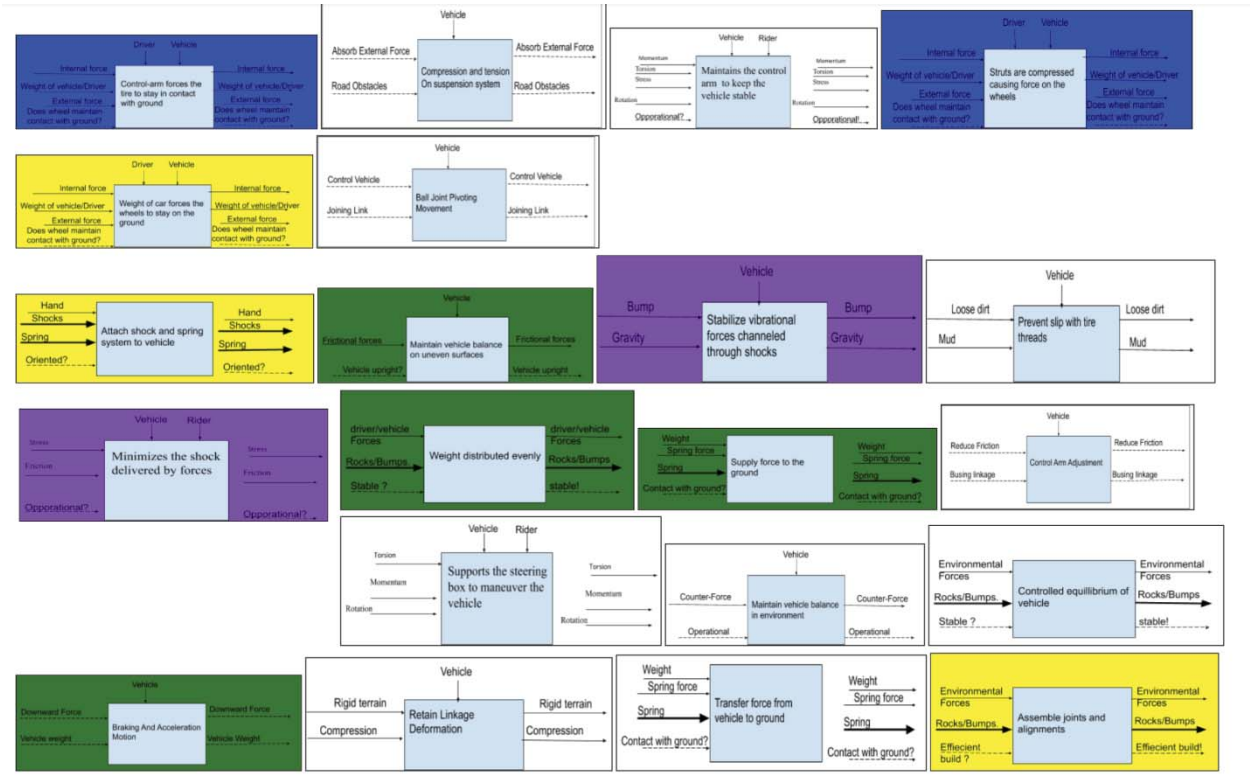


Figure 4.13 Sticky note system for level 2 subfunction distributing forces throughout suspension

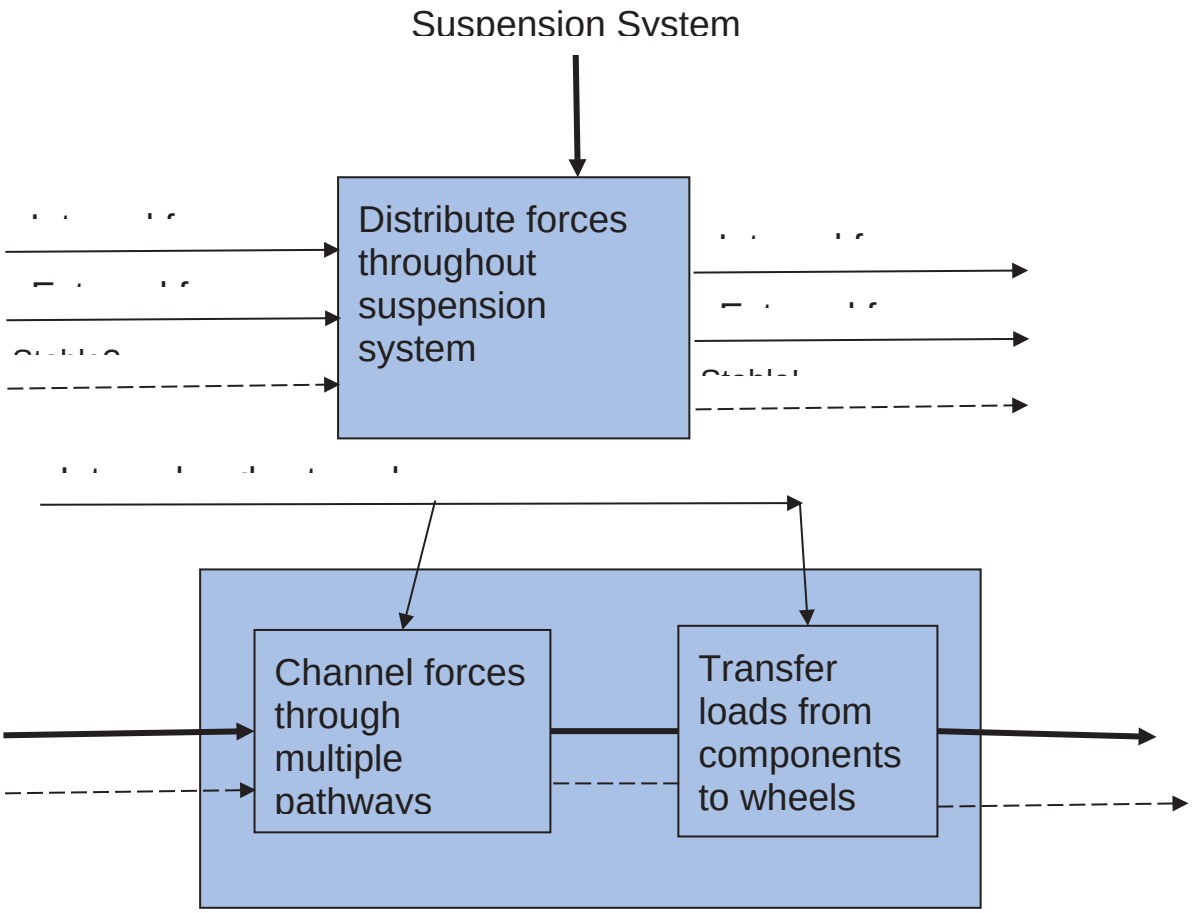


Figure 4.14 Diagrams breaking down of level one sub-function distributing forces throughout the suspension

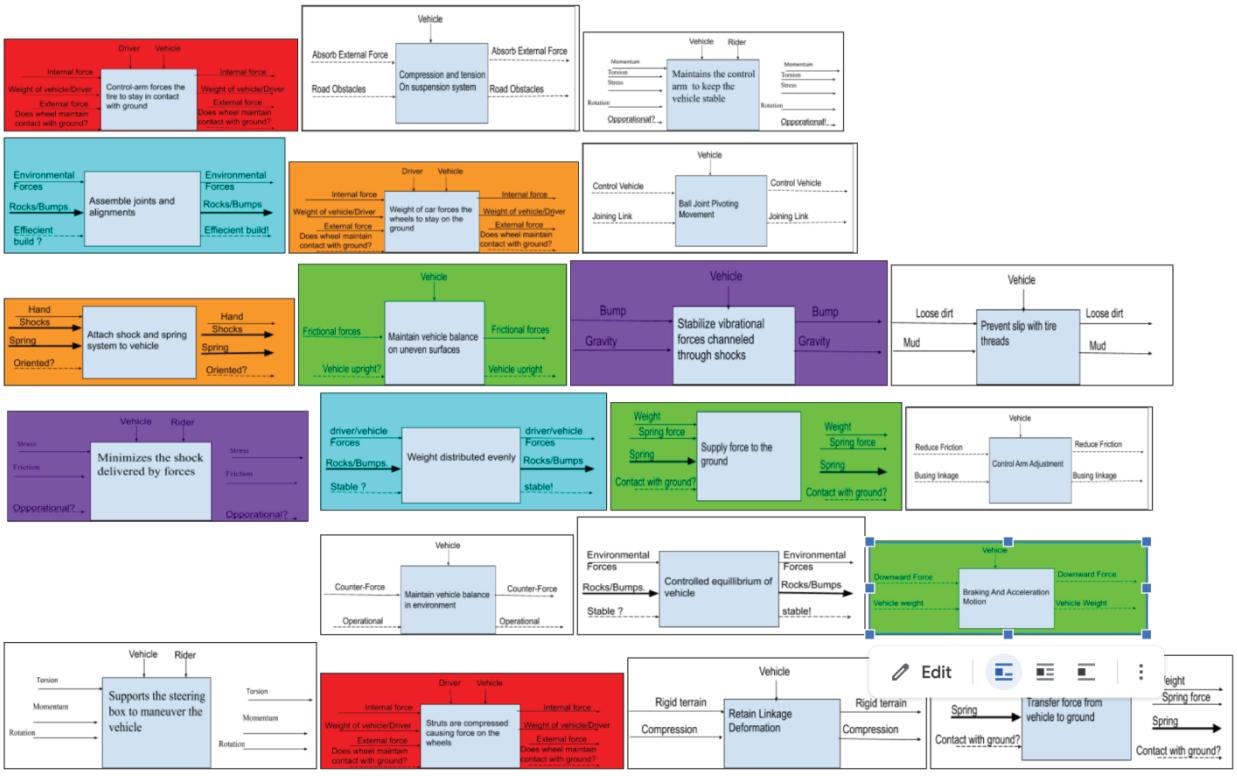


Figure 4.15 Sticky Note System for suspension sublevel 2 supporting internal and external loads

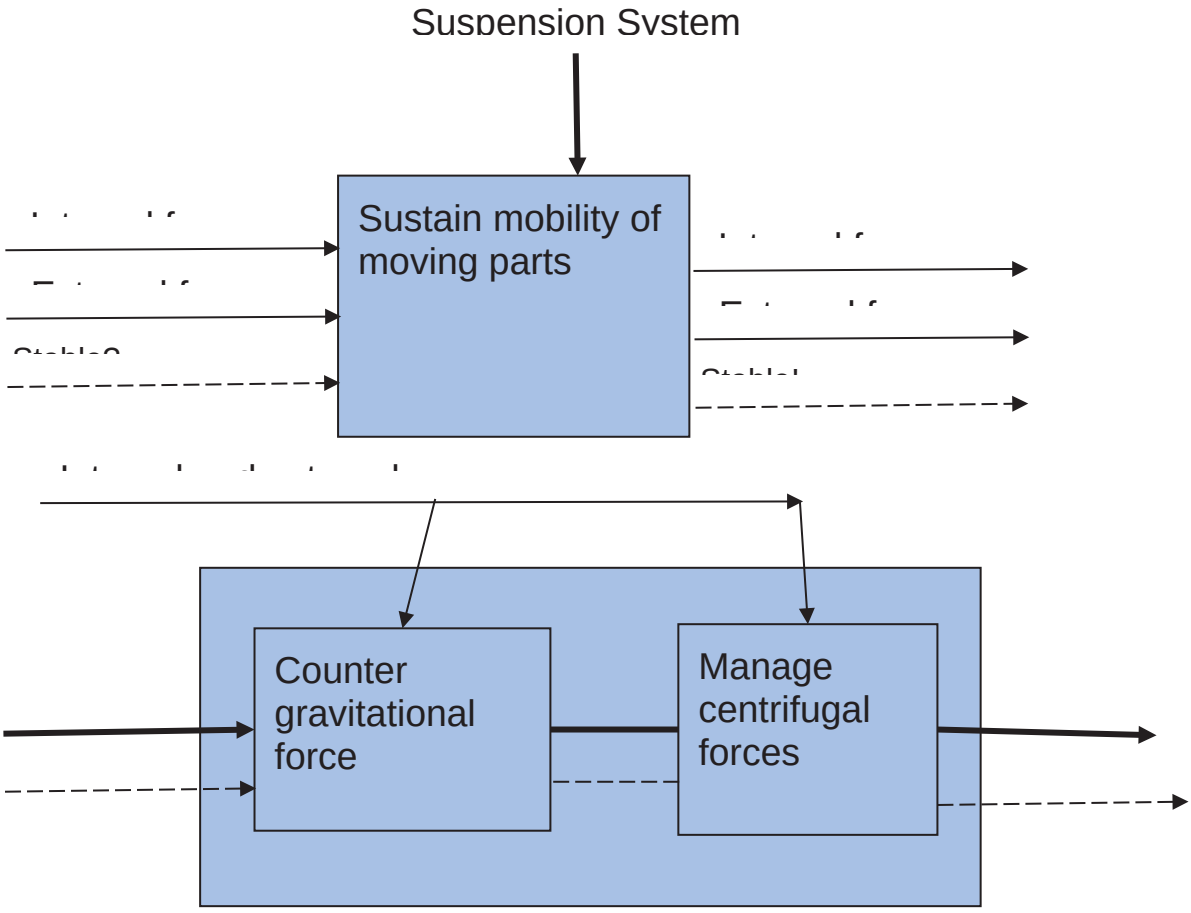


Figure 4.16 Diagrams breaking down of level one sub-function sustaining mobility of moving parts

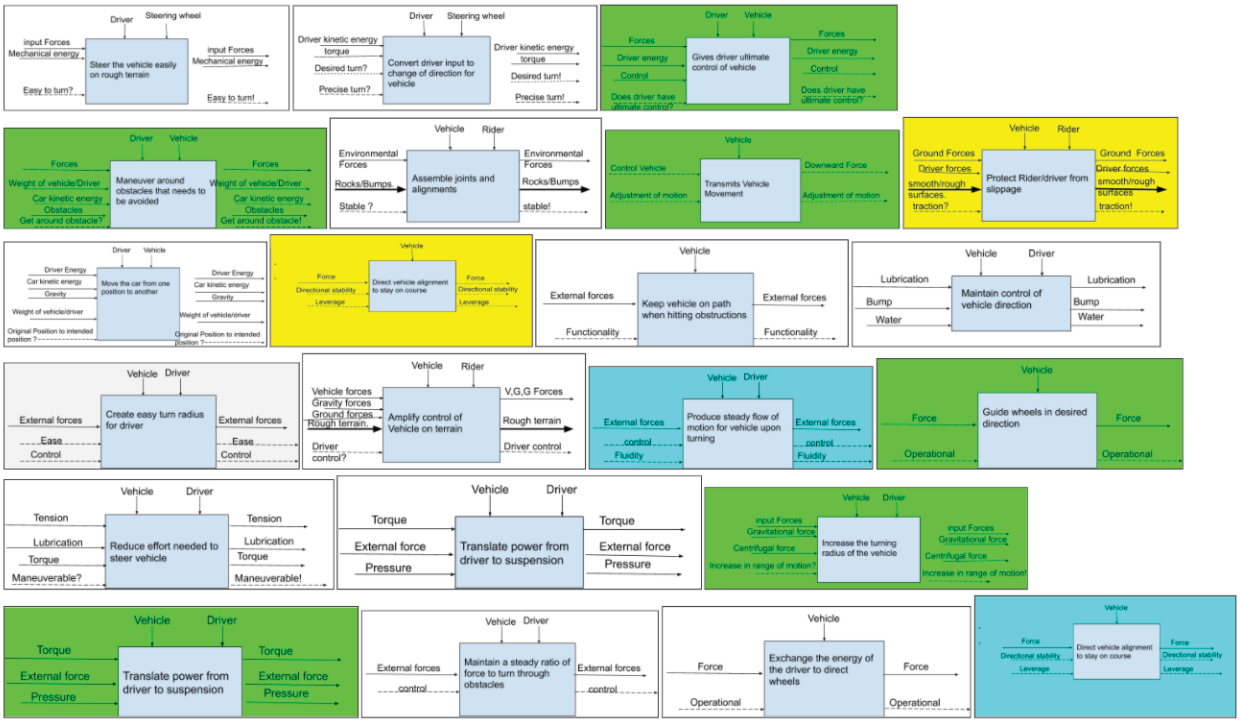


Figure 4.17: Sticky Note System for Steering Level 2 Subfunctions for Maintaining Control

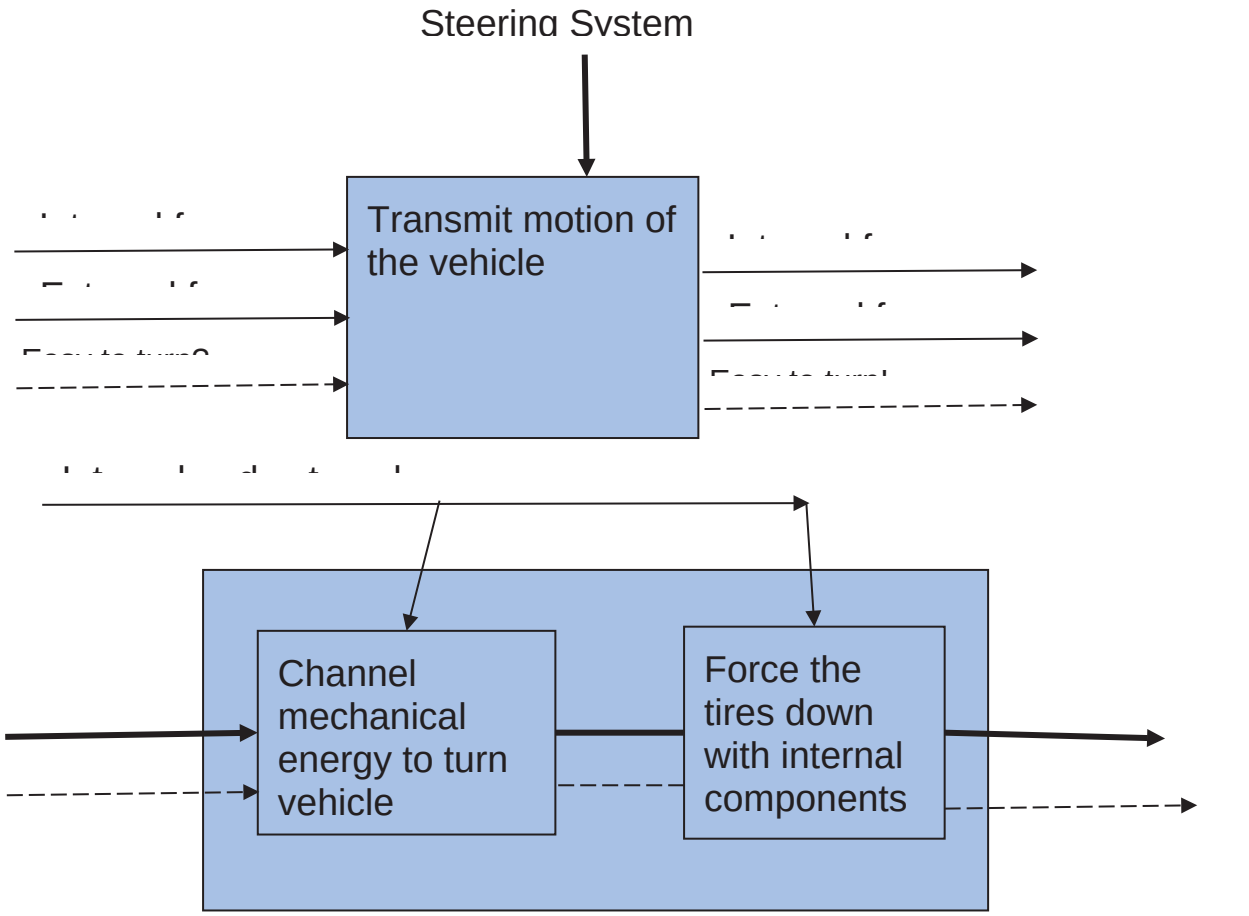


Figure 4.18 Diagrams breaking down of level one sub-function transmitting motion of the vehicle

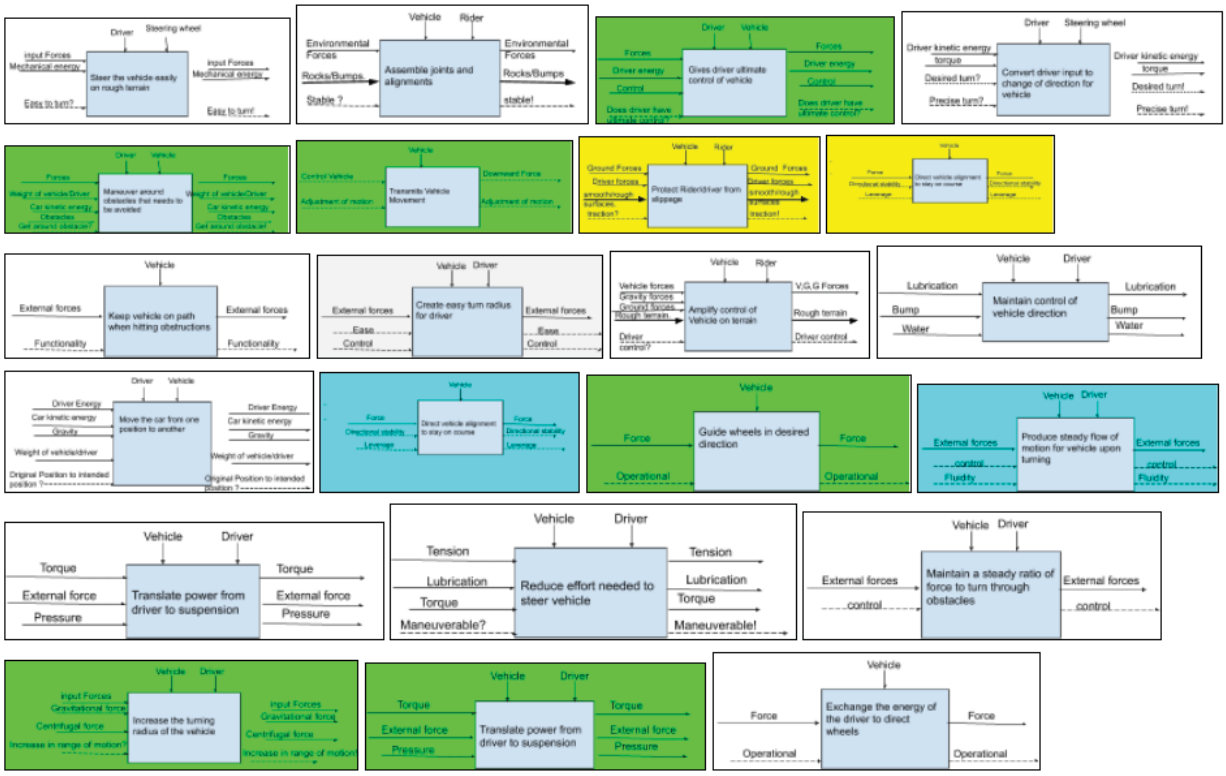


Figure 4.19: Sticky Note System for Steering Level 2 Subfunctions for Transmitting Motion

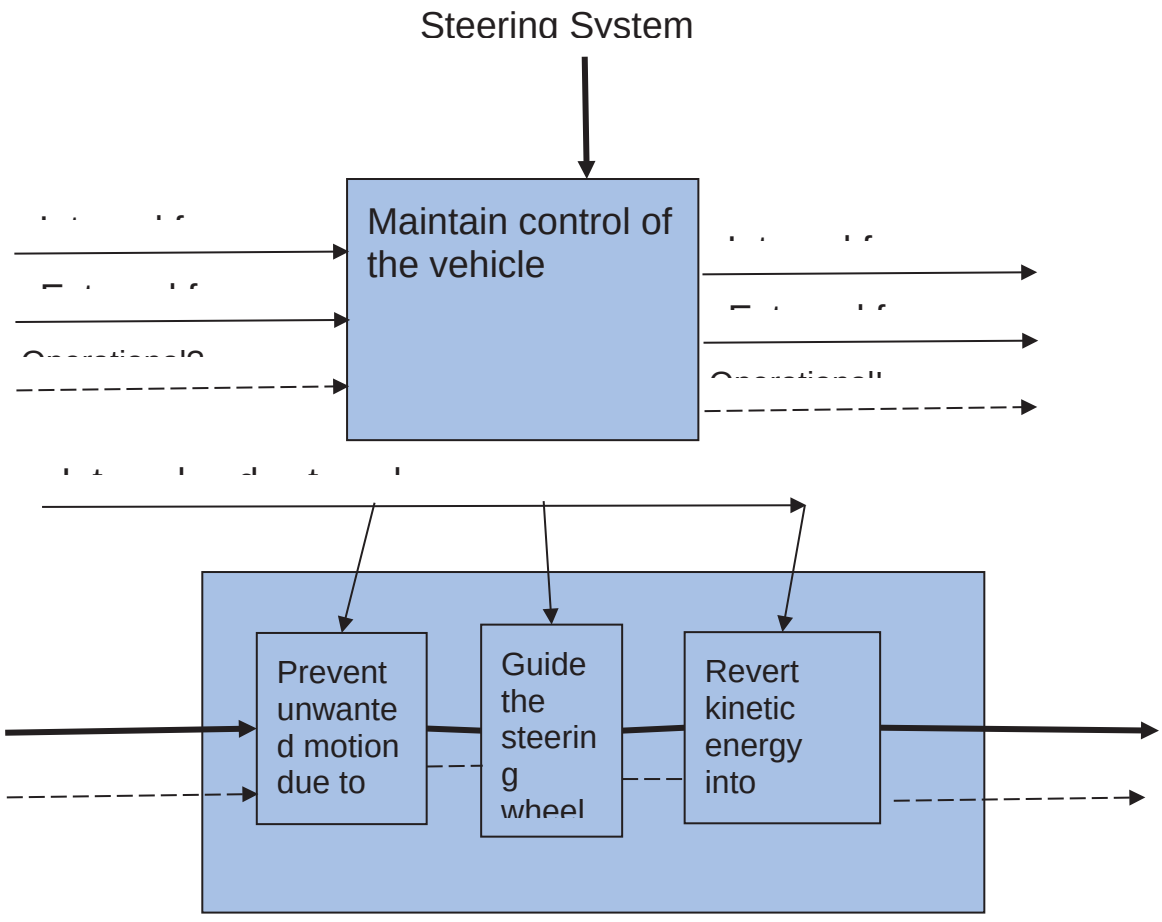


Figure 4.20 Diagrams breaking down of level one sub-function maintaining control of the vehicle

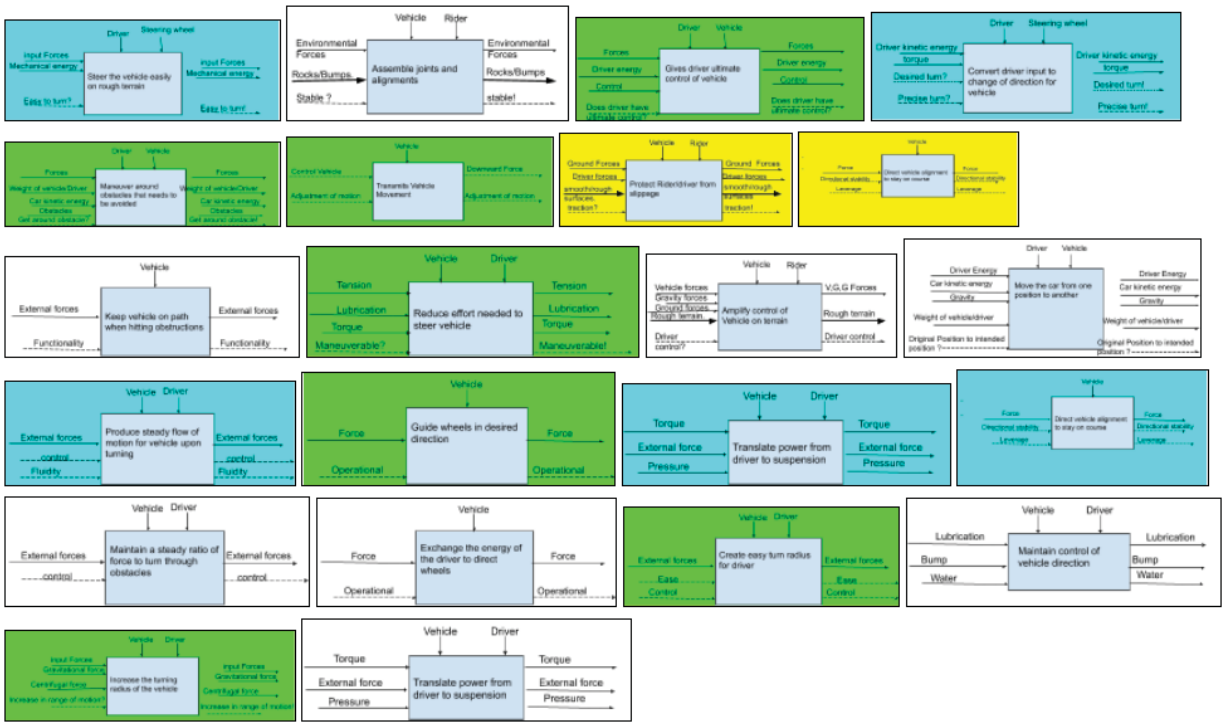


Figure 4.21: Sticky Note System for Steering Level 2 Subfunctions for Stabilization

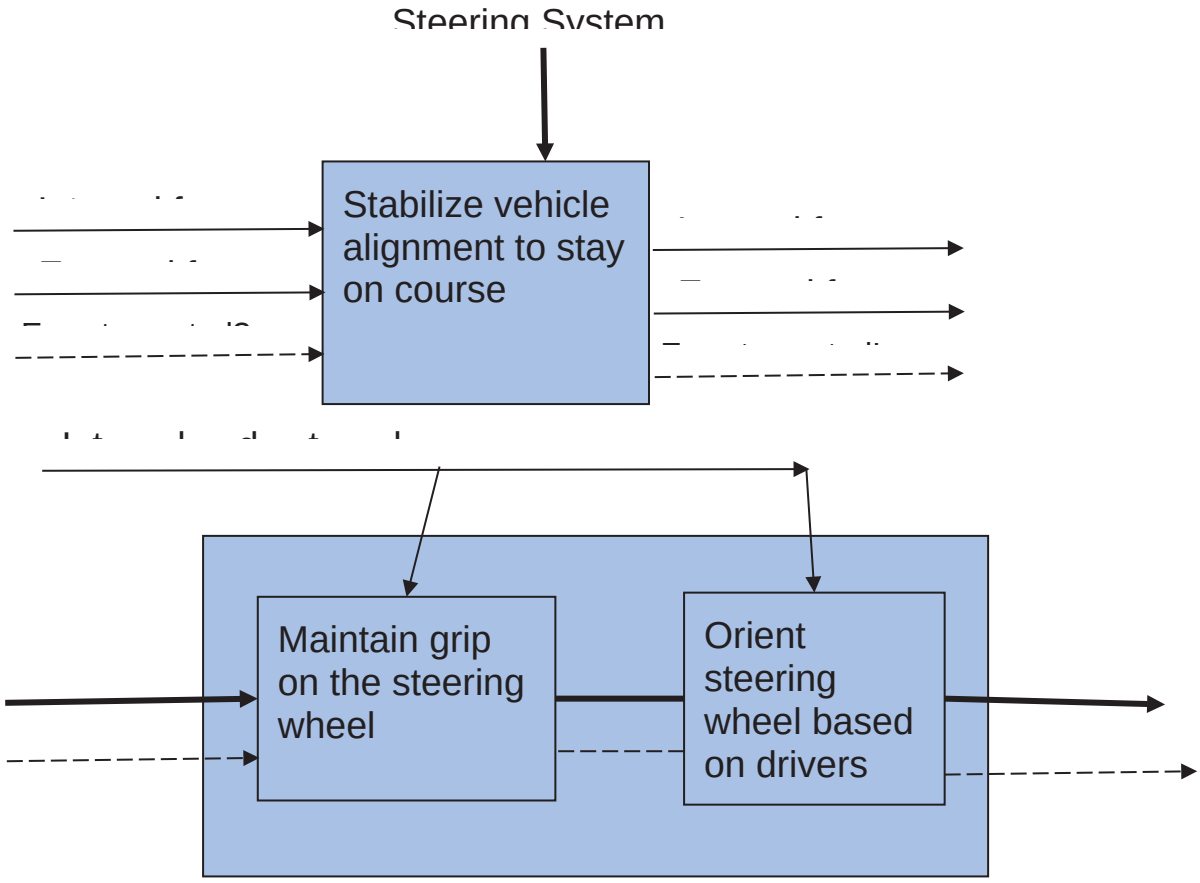


Figure 4.22 Diagrams breaking down of level one sub-function stabilize vehicle alignment to stay on course

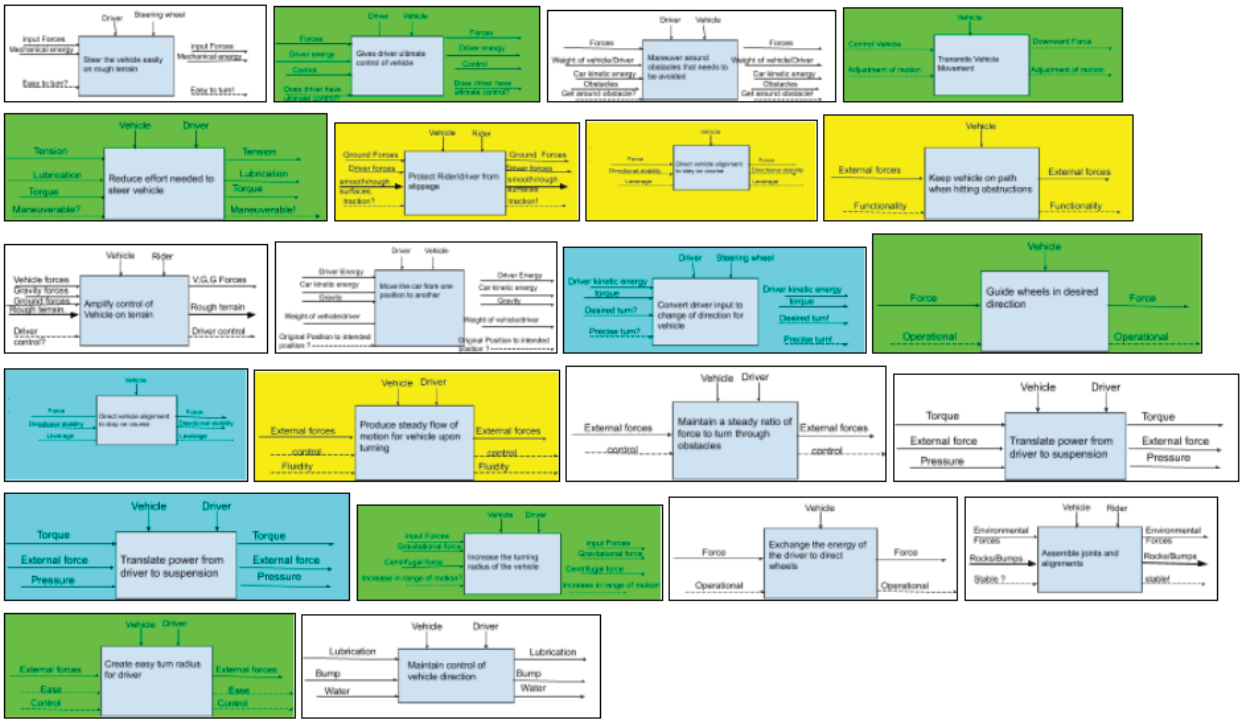


Figure 4.23: Sticky Note System for Steering Level 2 Subfunctions for Reducing Effort

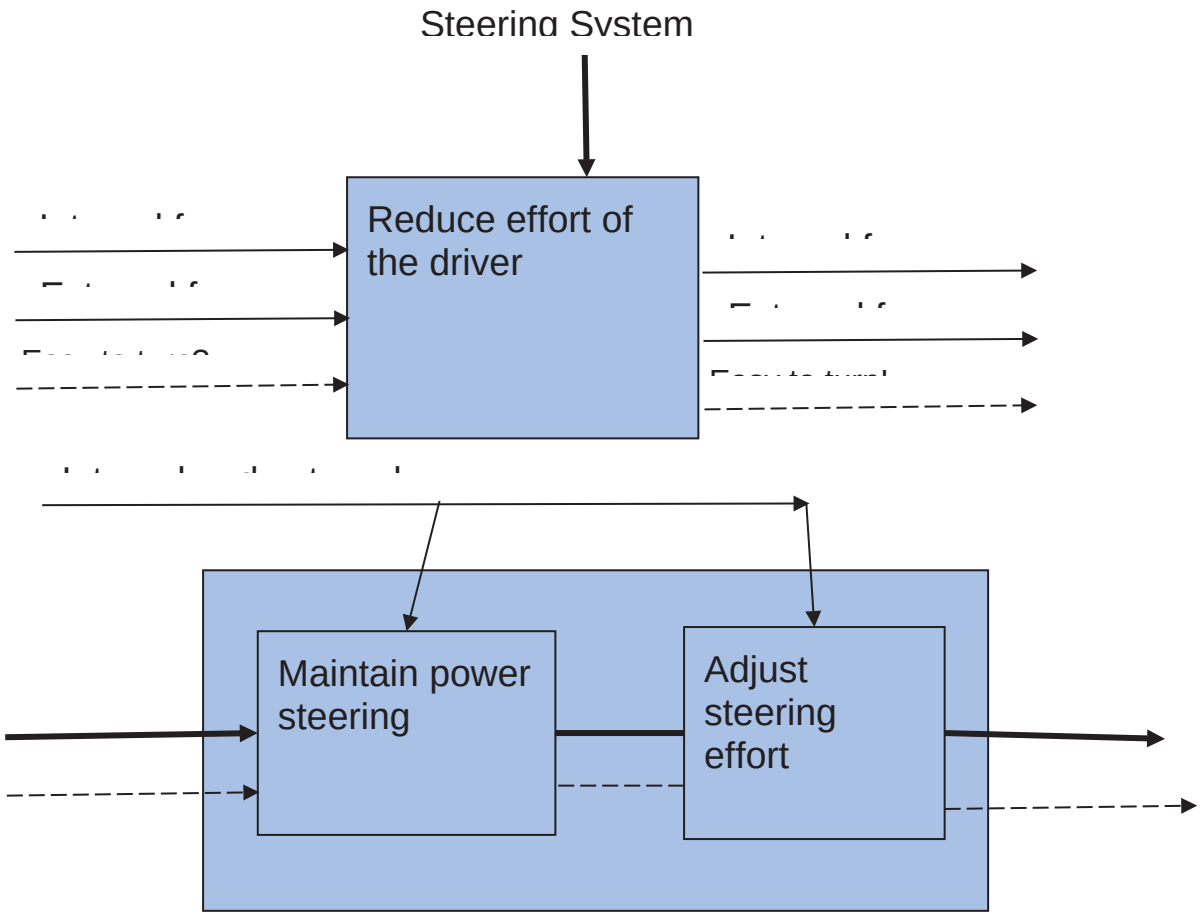


Figure 4.24 Diagrams breaking down of level one sub-function reducing effort of the driver

After all of the students created the level two sub functions, the group did not use the sticky note system to come up with the level three sub-function. The group instead had a meeting to discuss them verbally. This was sped of the process to generate the level three sub-functions. To organize everything, a morphology table was created for each suspension and steering system.

Table 4.1 shows all of the functions and sub-functions for the suspension system.

Table 4.1 Morphology Table for Suspension System

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions
Absorb and withstand forces from off-road conditions and the vehicle	Maintain contact with the ground	Force tires down with internal components	Release force from coils to the ground
			Release energy from shocks to the tires
		Absorb All forces channeled from environment	Compress the springs from the external forces
			Compress the shocks from external forces
			Rotate the control arms to decrease force intake
	Sustain mobility of moving parts	Allow freedom of suspension components	Rotating of control arms to absorb excess forces
			Rotating of ball joints to absorb excess forces
			Compressing of shocks and springs from external forces
		Stabilize movement of vehicle	Absorb forces with shocks and springs
			Move control arms based off environment
			Rotate ball joints from contact of force
	Distribute forces throughout suspension system	Channel forces through multiple pathways	Collect force through the shocks
			Collect force through coils
			Transfer force through ball joint
		Transfers loads from components to wheels	Transfer load from control arms
			Transfer load from coils
			Transfer load from shocks
	Support external and internal forces from vehicle conditions	Counter Gravitational Force	Release force from spring to the ground
			Release force from shock to ground
		Manage centrifugal forces	Transfer vehicle load through shocks while turning
			Transfer vehicle load through coils while turning
			Rotate control arms while turning

Table 4.2 shows all of the functions and sub-functions for the steering system.

Table 4.2 Morphology Table for Steering System

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions
Convert driver input to change the direction of the vehicle	Maintain control of vehicle	Prevent unwanted motion due to external factors	Allow forces to be absorbed
			Rotate gears only from steering wheel
		Guide the steering wheel in direction desired	Hold the steering wheel firmly
			Turn the steering wheel when adjusting to external forces
			Allow horizontal motion with steering rod
		Revert kinetic energy into another direction	Allow gears to move in both directions
			Allow steering rod to move horizontally in both directions
	Transmit motion of the vehicle	Channel mechanical energy to turn vehicle	Transfer energy from steering wheel to Steering shaft
			Translate motion from gears to steering rod
			Move tires side to side from steering rod
		Grasp the steering wheel firmly	Contact the steering wheel tactfully
			Hold the steering wheel with hand
	Stabilize vehicle alignment to stay on course	Maintain grip on the steering wheel	Contact the steering wheel firmly
			Hold the steering wheel until leaving the vehicle
		Orient steering wheel based on drivers view	Avoid extreme conditions of the course
			Drive along calmer environmental conditions
	Reduce effort of driver	Maintain Power Steering	Apply pressure to reduce force input
			Absorb external force to reduce driver control
			Reduce the turn of the steering wheel to perform a sharp maneuver
		adjusting steering effort	Allow easy motion of gears
			Allow easy motion of steering rod
			Allow easy motion of steering wheel

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

FALL 2020

PROJECT PROGRESS REPORT COVER SHEET

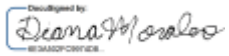
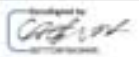
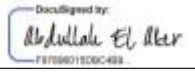
PROJECT TITLE:__ Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER ___3_____

Progress Report Title:__ **PRELIMINARY DESIGN: Functional Decomposition**_____

Due Date:___10-8-2020_____

_____

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Came up with ideas for function and subfunction with the team. Proofread and help prepare the report before submission.	100	
2	Christian White 	Created ideas for overall functions and sub-functions. Wrote detailed descriptive for sections 3-5 on report 6	100	
3	Fanta Kaba 	Created ideas for functions and different subfunctions. Help proofread the finalized report.	100	
4	Yemboado Yonli 	Created a full set of functions Put functions together Created sticky notes for functional decomposition	100	
5	Abdullah EL Aker 	Linked all levels of sub functions sticky notes with the input and output. Contributed to the morphology table.	100	
6	Marcelo Epam Ona 	Worked on creating sticky notes for the functional decomposition Worked on creating level 0, 1, 2 and 3 functions. Wrote paragraphs explaining how the function have been chosen	100	
7				
8				

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Functional Decomposition

Assigned 09/24/2020 **Due:10/08/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the chapter title.

[Please avoid discussing the sticky note portion of the questions with other group members because they should be done independently]

" 4. PRELIMINARY DESIGN" . The subsections highlighted in blue fonts should be used in the status report. Study the sections on functional decomposition and concepts generation and functional analysis discussed in class/provided in the PowerPoint slides and in the web, link provided in the slides and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example.

4.1 Functional Decomposition

1. Using electronic sticky note sheets **each member** should provide 3 to 4 suggestions for the overall function. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example. The group should analyze this input from members to determine the overall function that needs to be accomplished by the design and using the identified overall function, create the black box for your project showing the overall function, inputs, and outputs. (The format for answering this question should be similar to that shown in Figure 2 for the splashguard example). **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

2. Using electronic sticky note sheets **each member** should decompose the overall function into simple **level 1 sub-function** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. (The format for answering this question should be similar to that shown in Figure 3 for the splashguard example). From the suggestions on the sticky notes, the group should discuss, combine or eliminate to arrive at suitable level 1 sub-functions for the project similar to that shown in Figure 4 for the Splash guard. Identify the inputs and the outputs for each sub-function. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

3. Using electronic sticky note sheets each member should decompose **EACH** of the level 1 sub-functions into simple **level 2 sub-functions** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. From the suggestions on the sticky notes for **EACH** level 1 sub-function collected from the members, the group should discuss, combine or eliminate to arrive at suitable level 2 sub-functions for **EACH**

level 1 sub-function for the project similar to that shown in Figure 5 for the Splash guard. Identify the inputs and the outputs for each level 2 sub-function. NOTE: This section should be repeated for each level 1 subfunction in order to break each level 1 subfunction into level 2 subfunctions. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

4. For the level 2 sub-functions that can be further broken down, repeat step 3 to break them down to level 3 sub-functions and repeat this process until the final sub-functions cannot be decomposed any further. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

5. Using your Level 1, Level 2, Level 3 and any additional level sub-functions, create a Table similar to Table 1 (shown in the next page) in which all items to the left of the red vertical line should be provided and the right side of that line left blank. This Table is similar to Table 2 Morphology for the Splashguard in the PowerPoint notes, but with the concept's columns blank. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3	
				Description	Sketch	Description	Sketch	Description	Sket
	VNM-1	VNM-1.1	VNM-1.1.1						
			VNM-1.1.2						
			VNM-1.1.2						
		VNM-1.2	VNM-1.2.1						
			VNM-1.2.2						
		VNM-1.3 (No level 3 subfunctions)							
	VNM-2	VNM-2.1	VNM-2.1.1						
			VNM-2.1.2						
			VNM-2.1.2						
		VNM-2.2 (No level 3 subfunctions)							
		VNM-2.3	VNM-2.3.1						
			VNM-2.3.2						
	VNM-3	VNM-3.1	VNM-1.1.1						
			VNM-1.1.2						
			VNM-1.1.2						
		VNM-3.2 (No level 3 subfunctions)							
		VNM-3.3	VNM-1.3.1						
			VNM-1.3.2						
	VNM-4	VNM-4.1 (No level 3 subfunctions)							
		VNM-4.2	VNM-2.2.1						
			VNM-2.2.2						
		VNM-4.3	VNM-2.3.1						
			VNM-2.3.2						
	VNM-5	VNM-5.1 (No level 3 subfunctions)							
		VNM-5.2	VNM-5.2.1						
			VNM-5.2.2						
		VNM-5.3							

dCp) Vax7 6FurE(VNEy(uVa Nax7 rt 6Fur(o E(VMEi m=ax S-o- vxEuaFuVf ri axVgxEl c nxu

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Grading Scheme
Homework #6 Group
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Overall function to be performed by the device properly provided.	8	
2a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 1 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 1 sub-functions.	30	
2b	Reasonableness and relevancy of level 1 sub-functions to the project.	10	
3a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 2 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 2 sub-functions.	20	
3b	Reasonableness and relevancy of Level 2 sub-functions to their level 1 sub-functions and the project.	10	
4a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 3 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 3 sub-functions.	5	
4b	Reasonableness and relevancy of Level 3 sub-functions to their level 2 sub-functions and the project.	5	
8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Functional Decomposition

Assigned 09/23/2020 **Due:10/08/2020**

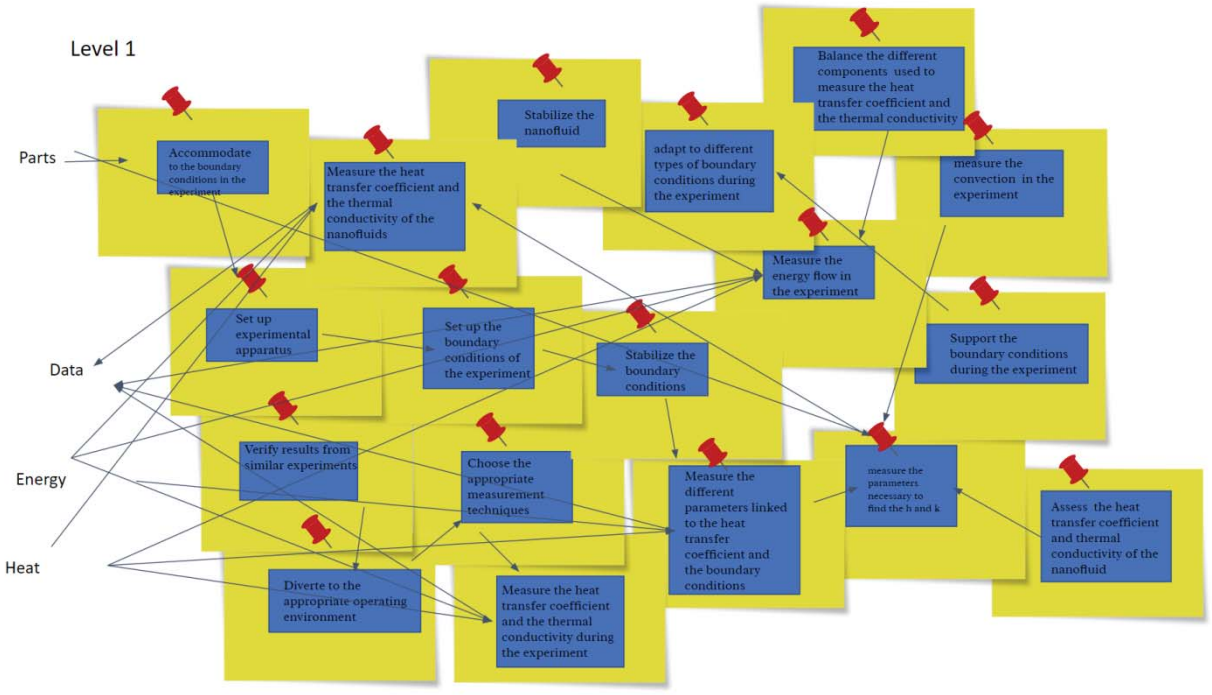
This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the chapter title.

[Please avoid discussing the sticky note portion of the questions with other group members because they should be done independently]

" 4. PRELIMINARY DESIGN" . The subsections highlighted in blue fonts should be used in the status report. Study the sections on functional decomposition and concepts generation and functional analysis discussed in class/provided in the PowerPoint slides and in the web link provided in the slides and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example.

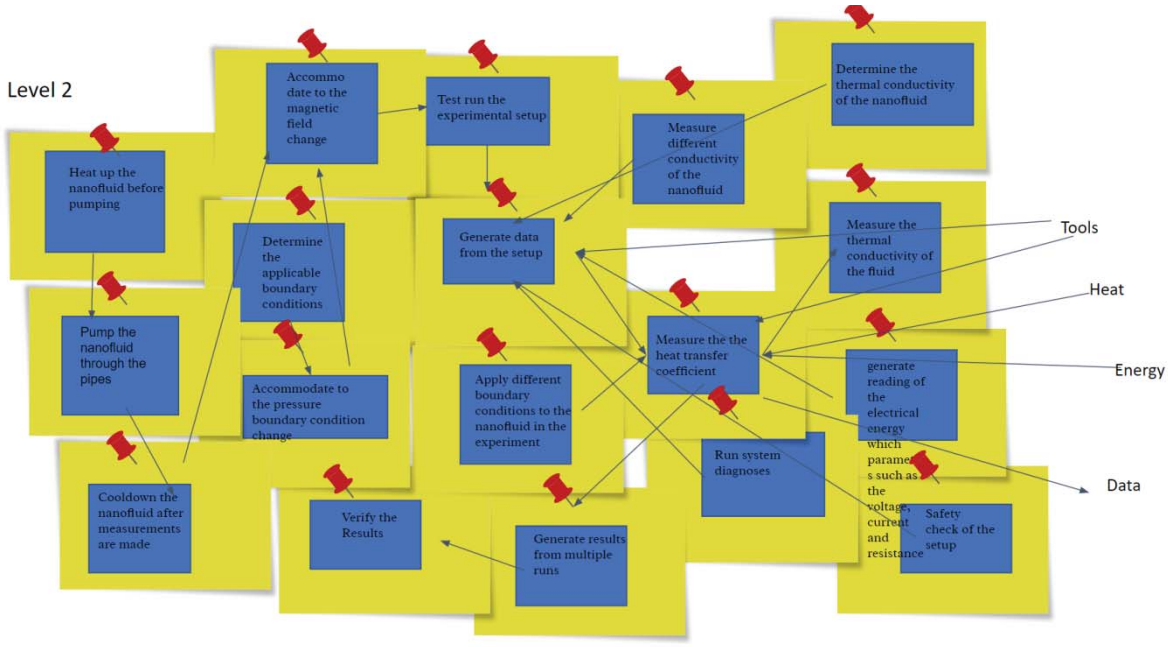
4.1 Functional Decomposition

1. Using electronic sticky note sheets **each member** should provide 3 to 4 suggestions for the overall function. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example. The group should analyze this input from members to determine the overall function that needs to be accomplished by the design and using the identified overall function, create the black box for your project showing the overall function, inputs, and outputs. (The format for answering this question should be similar to that shown in Figure 2 for the splashguard example). **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

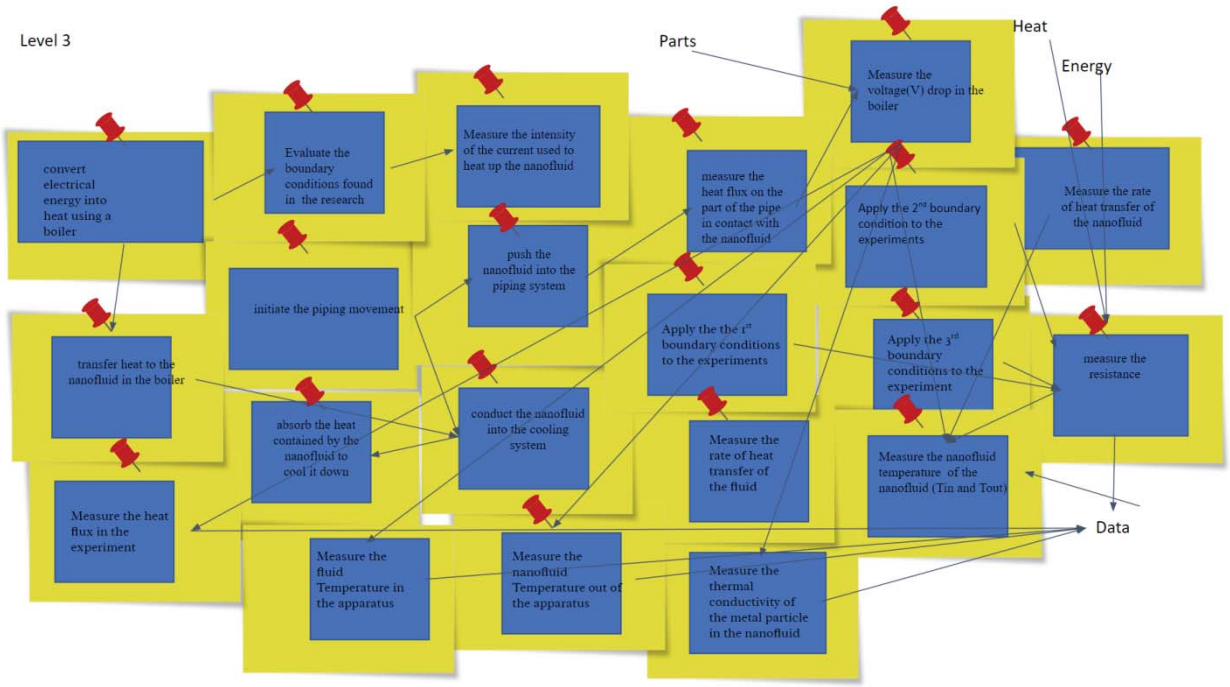


2. Using electronic sticky note sheets **each member** should decompose the overall function into simple **level 1 sub-function** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your

engineering major in addition to any other action verbs relevant to your project. (The format for answering this question should be similar to that shown in Figure 3 for the splashguard example). From the suggestions on the sticky notes, the group should discuss, combine or eliminate to arrive at suitable level 1 sub-functions for the project similar to that shown in Figure 4 for the Splash guard. Identify the inputs and the outputs for each sub-function. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**



3. Using electronic sticky note sheets each member should decompose **EACH** of the level 1 sub-functions into simple **level 2 sub-functions** descriptions using the guidelines provided in the PowerPoint notes on Canvas. The sticky notes from each group member should be collected and pasted on a page to produce a figure similar to Figure 3 in the splash guard example (in the status report, each sticky not should be represented with overlapping text box containing the information on the sticky note). Members can use the action verbs in Table 1 or that may be applicable to your engineering major in addition to any other action verbs relevant to your project. From the suggestions on the sticky notes for **EACH** level 1 sub-function collected from the members, the group should discuss, combine or eliminate to arrive at suitable level 2 sub-functions for **EACH** level 1 sub-function for the project similar to that shown in Figure 5 for the Splash guard. Identify the inputs and the outputs for each level 2 sub-function. NOTE: This section should be repeated for each level 1 subfunction in order to break each level 1 subfunction into level 2 subfunctions. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**



4. For the level 2 sub-functions that can be further broken down, repeat step 3 to break them down to level 3 sub-functions and repeat this process until the final sub-functions cannot be decomposed any further. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

5. Using your Level 1, Level 2, Level 3 and any additional level sub-functions, create a Table similar to Table 1 (shown in the next page) in which all items to the left of the red vertical line should be provided and the right side of that line left blank. This Table is similar to Table 2 Morphology for the Splashguard in the PowerPoint notes, but with the concepts columns blank. **Provide a detailed description of the process used for this section and cite and completely describe all figures related to this section.**

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Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3	
				Description	Sketch	Description	Sketch	Description	Ske
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	make t the nanofluid during the experiment	Heat up the nanofluid before pumping	convert electrical energy into heat using a boiler						
			transfer heat to the nanofluid in the boiler						
		Pump the nanofluid Through the pipes	initiate the piping movement						
			push the nanofluid into the piping system						
		cool down the nanofluid after the measurements are made	conduct the nanofluid into the cooling system						
			absorb the heat contained by the nanofluid to cool it down						
	accommodate to different type of boundary conditions for the experiment	Accomodate to the magnetic field change	~~Find different types of boundary conditions for the experiment~~						
			~~Evaluate the boundary conditions found in the research~~						
		Accomodate to the pressure boundary condition change							
		Accommodate the boundary layer change of the nanofluid							
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler						
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)						

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			Measure the intensity of the current used to heat up the nanofluid						
		Measure the thermal conductivity of the nanofluid in the experiment	measure the heat flux on the part of the pipe in contact with the nanofluid						
			measure the nanofluid temperature						
			Measure the rate of heat transfer of the nanofluid						
		generate reading of the electrical energy which parameters such as the voltage, current and resistance	be able to read the voltage						
			To analyze the current flowing on device						
			measure the resistance						

dCp) Vax7 6FunE(VNEy(uMa Nax7 nt 6Fun(o E(VMEi n=max S-o- vxEuaFuMf ni axVgxEl c nxu

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

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Grading Scheme
Homework #6 Group
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Overall function to be performed by the device properly provided.	8	
2a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 1 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 1 sub-functions.	30	
2b	Reasonableness and relevancy of level 1 sub-functions to the project.	10	
3a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 2 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 2 sub-functions.	20	
3b	Reasonableness and relevancy of Level 2 sub-functions to their level 1 sub-functions and the project.	10	
4a	Demonstration of the use of sticky notes or text box representation of sticky notes from members in determining Level 3 sub-functions and demonstration of the group's evaluation of sticky notes from members to finalize level 3 sub-functions.	5	
4b	Reasonableness and relevancy of Level 3 sub-functions to their level 2 sub-functions and the project.	5	
8	Comprehensive morphology Table for project containing final versions of functions at each level,	10	
	Status report cover page & a copy of assignment sheet attached	2	
	Total for Group Portion	100	

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SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

STATUS REPORT 6b

TOPICS COVERED IN STATUS REPORT 6b

Concepts Generation

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

3. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:
Concept 1 for the function " Heat the biomass"
Figure 1.1 shows the concept for this function. Then provide a brief description of the concept and how it works to execute the function.

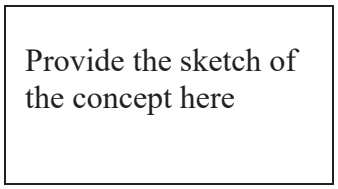


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***
Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	
4	Status report assignment sheet attached	5	
	Total for Individual Report	100	

Group Grading Scheme
Homework #7b
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

Table 1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
	VNM-1	VNM-1.1	VNM-1.1.1	Member 1	Member 2	Member 3	Member 4
			VNM-1.1.2	Member 5	Member 6	Member 7	Member 1
			VNM-1.1.3	Member 2	Member 3	Member 4	Member 5
		VNM-1.2	VNM-1.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-1.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-1.3 (No level 3 subfunctions)		Member 7	Member 1	Member 2	Member 3
	VNM-2	VNM-2.1	VNM-2.1.1	Member 4	Member 5	Member 6	Member 7
			VNM-2.1.2	Member 1	Member 2	Member 3	Member 4
			VNM-2.1.3	Member 5	Member 6	Member 7	Member 1
		VNM-2.2 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-2.3	VNM-2.3.1	Member 6	Member 7	Member 1	Member 2
			VNM-2.3.2	Member 3	Member 4	Member 5	Member 6
	VNM-3	VNM-3.1	VNM-3.1.1	Member 7	Member 1	Member 2	Member 3
			VNM 3.1.2	Member 4	Member 5	Member 6	Member 7
			VNM-3.1.3	Member 1	Member 2	Member 3	Member 4
		VNM-3.2 (No level 3 subfunctions)		Member 5	Member 6	Member 7	Member 1
		VNM-3.3	VNM-3.3.1	Member 2	Member 3	Member 4	Member 5
			VNM-3.3.2	Member 6	Member 7	Member 1	Member 2
	VNM-4	VNM-4.1 (No level 3 subfunctions)		Member 3	Member 4	Member 5	Member 6
		VNM-4.2	VNM-4.2.1	Member 7	Member 1	Member 2	Member 3
			VNM-4.2.2	Member 4	Member 5	Member 6	Member 7
		VNM-4.3	VNM-4.3.1	Member 1	Member 2	Member 3	Member 4
			VNM-4.3.2	Member 5	Member 6	Member 7	Member 1
	VNM-5	VNM-5.1 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-5.2	VNM-5.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-5.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-5.3		Member 7	Member 1	Member 2	Member 3

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt.

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
	VNM-1	VNM-1.1	VNM-1.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-1.2	VNM-1.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-1.3 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
	VNM-2	VNM-2.1	VNM-2.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-2.2 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-2.3	VNM-2.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-3	VNM-3.1	VNM-3.1.1		Figure #		Figure #		Figure #		Figure #
			VNM 3.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-3.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-3.2 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-3.3	VNM-3.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-3.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-4	VNM-4.1 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-4.2	VNM-4.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-4.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-4.3	VNM-4.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-4.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-5	VNM-5.1 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-5.2	VNM-5.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-5.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-5.3			Figure #		Figure #		Figure #		Figure #

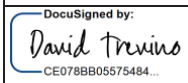
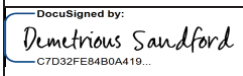
VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Concepts Generation
GROUP NUMBER: 7
Progress Report Title: Status Report VII
Due Date: 10/25/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan**	-Generate concepts for: Transform rate readings, Accurately detect through sensor, Control rate recovery, Detect surface tension, Self-adjust to different types of oil, Dissipate Excess Water, Limit the intake of water, Shield debris form filter', Filtration system that diverts debris, Perform flotation stabilization. -Compile individual reports -Contribute with group report -Attend meetings -Conduct team evaluations	49%	
2	**David Trevino** 	-Generate concepts for:Calculate amount of oil intake, Detect change in recover, Detect type of oil, Self-adjust to different types of oils, Avoid contaminating water, Contain the oil, Limit intake of water, Limit debris entering skimmer, Conduct waste separation from fluid, Differentiate between specific gravities and Collect optimal level of oil. -Compile individual reports -Contribute with group report -Attend meetings -Conduct team evaluations	96%	
3	**Amna Ansari**	-Generate concepts for: Accurately detect through sensor, Control rate of recovery, Verify oil thickness, Self-adjust to different type of oil, Avoid contaminating water, Contain the oil, Shield debris from filter, Filtration system diverts that debris, Conduct waste separation from fluid, Release water, Maintain stability. -Create individual reports -Contribute with group report -Attend meetings -Conduct team evaluations - Create meeting minutes	96%	
4	**Demetrious Sandford** 	-Generated concepts for: Transform Rate Reading, Detect Change in Recovery, Verify Oil Thickness, Measure Oil Resistance to Flow, Detect Surface Tension, Dissipate Excess Water, Increase Filtration Rate, Limit Debris Entering Skimmer, Remove Debris, Release Water, Collect Optimal Level of Oil. -Compile individual reports -Contribute with group report -Attend meetings -Conduct team evaluations	94%	
5	**Caleb Riggins**	-Generate concepts for: Detect Change in Recovery, Differentiate between Specific gravities, Collect Optimal level of oil, Calculate the amount of oil intake, Remove Debris, Dissipate excess water, Detect type of oil, .Shield debris for skimmer, Increase Filtration rate, Limit debris entering skimmer. -Compile individual reports -Contribute with group report -Attend meetings -Conduct team evaluations	100%	

6	**Ximena Cifuentes** DocuSigned by: Ximena Cifuentes BD1F416D20884F6...	-Generate concepts for: Perform floatation stabilization, separate debris from fluids taken by skimmer, calculate the amount of oil intake, control rate of recovery, measure oil resistance to flow, detect surface tension, dissipate excess water. -Format references -Cite references -Name figures -Cite figures Name figures -Combine individual reports	98%	
7	**Aamna Jangda** DocuSigned by: Aamna Jangda 781C4B4D2C9D46D...	Generated concepts for:Transform Rate Readings, Accurately Detect Through Sensor, Verify Oil Thickness, Measure oil resistance to flow, Detect type of oil, Avoid contaminating water, Contain the oil, Remove debris, Differentiate between specific gravities, Perform floatation stabilization. -Compile individual reports -Contribute with group report -Attend meetings -Conduct team evaluations	95%	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

3. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:

Concept 1 for the function " Heat the biomass"

Figure 1.1 shows the concept for this function.
Then provide a brief description of the concept and how it works to execute the function.

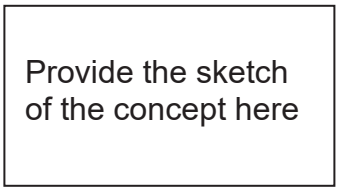


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	
4	Status report assignment sheet attached	5	
	Total for Individual Report	100	

Group Grading Scheme
Homework #7b
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
	VNM-1	VNM-1.1	VNM-1.1.1	Member 1	Member 2	Member 3	Member 4
			VNM-1.1.2	Member 5	Member 6	Member 7	Member 1
			VNM-1.1.3	Member 2	Member 3	Member 4	Member 5
		VNM-1.2	VNM-1.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-1.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-1.3 (No level 3 subfunctions)		Member 7	Member 1	Member 2	Member 3
	VNM-2	VNM-2.1	VNM-2.1.1	Member 4	Member 5	Member 6	Member 7
			VNM-2.1.2	Member 1	Member 2	Member 3	Member 4
			VNM-2.1.3	Member 5	Member 6	Member 7	Member 1
		VNM-2.2 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-2.3	VNM-2.3.1	Member 6	Member 7	Member 1	Member 2
			VNM-2.3.2	Member 3	Member 4	Member 5	Member 6
	VNM-3	VNM-3.1	VNM-3.1.1	Member 7	Member 1	Member 2	Member 3
			VNM 3.1.2	Member 4	Member 5	Member 6	Member 7
			VNM-3.1.3	Member 1	Member 2	Member 3	Member 4
		VNM-3.2 (No level 3 subfunctions)		Member 5	Member 6	Member 7	Member 1
		VNM-3.3	VNM-3.3.1	Member 2	Member 3	Member 4	Member 5
			VNM-3.3.2	Member 6	Member 7	Member 1	Member 2
	VNM-4	VNM-4.1 (No level 3 subfunctions)		Member 3	Member 4	Member 5	Member 6
		VNM-4.2	VNM-4.2.1	Member 7	Member 1	Member 2	Member 3
			VNM-4.2.2	Member 4	Member 5	Member 6	Member 7
		VNM-4.3	VNM-4.3.1	Member 1	Member 2	Member 3	Member 4
			VNM-4.3.2	Member 5	Member 6	Member 7	Member 1
	VNM-5	VNM-5.1 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-5.2	VNM-5.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-5.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-5.3		Member 7	Member 1	Member 2	Member 3

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt.

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
	VNM-1	VNM-1.1	VNM-1.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-1.2	VNM-1.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-1.3 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
	VNM-2	VNM-2.1	VNM-2.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-2.2 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-2.3	VNM-2.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-3	VNM-3.1	VNM-3.1.1		Figure #		Figure #		Figure #		Figure #
			VNM 3.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-3.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-3.2 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-3.3	VNM-3.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-3.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-4	VNM-4.1 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-4.2	VNM-4.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-4.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-4.3	VNM-4.3.1		Figure #		Figure #		Figure #		Figure #

			VNM-4.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-5	VNM-5.1 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-5.2	VNM-5.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-5.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-5.3			Figure #		Figure #		Figure #		Figure #

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

3. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:

Concept 1 for the function " Heat the biomass"

Figure 1.1 shows the concept for this function.
Then provide a brief description of the concept and how it works to execute the function.

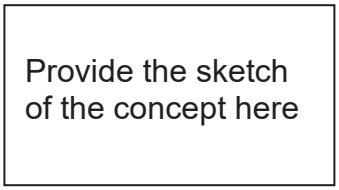


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	
4	Status report assignment sheet attached	5	
	Total for Individual Report	100	

Group Grading Scheme
Homework #7b
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

~~4.1~~ Concept Generation

In this section, the team developed and executed a plan to effectively generate concepts for the level 2 and level 3 functions identified during the functional decomposition stage. Members were designated to generate 4 concepts for each of 10 to 11 functions that were assigned per member. During this stage each team member developed an individual report that displayed around 44 concepts. Then, the team worked together to generate a group report where a total of 100 concepts out of the 300 concepts were selected. In Table 4.1 the level 0,1,2,3 functions can be found. In addition, the table shows the functions assigned to the student for the concept generation stage. The student will be required to develop 4 concepts per function assigned. Once the student generates the concepts, the student will be required to use Table ~~2~~ to list the figure numbers for each concept generated and a brief description of the figure.

Table 4.1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name
Recover at least 25~50% on 1-inch oil slick	Skimmer Mobility	Mobilize the skimmer	Perform Floatation Stabilization	Aamna J	Ximena	Daniel
	Collect oil through debris or choppy water	Avoid debris collection	Limit debris entering skimmer	Demetrious	David	Caleb
			Separate debris from fluids taken by skimmer	Ximena	Daniel	Amna A
			contain debris	Aamna J	Caleb	Demetrious
	Measure oil recovery rate	Measure the amount of oil recovered per second	Transform rate readings	Demetrious	Aamna J	Daniel
			Calculate amount of oil intake	Ximena	David	Caleb
			Accurately detect flow rate	Aamna J	Daniel	Amna A
		Control rate of recovery		Daniel	Amna A	Ximena
	Able to filter various oil slick thickness	Distinguish between oil viscosities	Maintain oil/water ratio	Demetrious	Aamna J	Amna A
			Measure oil resistance to flow	Ximena	Aamna J	Demetrious
			Detect surface tension	Demetrious	Daniel	Ximena
		Detect type of oil		David	Caleb	Aamna J
		Self-adjust separation method to different types of oil		Daniel	Amna A	David
	Limit water intake	Control water intake	Differentiate specific gravities of fluids	Amna J	David	Caleb
			Collect optimal level of fluids	David	Caleb	Demetrious

	Separate oil from water	Filter water out of the oil	Separate oil from water	Demetrious	Caleb	Ximena
			Dissipate excess water	Daniel	Demetrio us	Caleb
			contain contaminated water	Aamna J	David	Amna A
		Contain the oil(filter water out of the oil)		David	Aamna J	Amna A

Table 4. 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concepts 6		Concept 7	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
Recover at least 25 ~50% on 1-inch oil slick	Skimmer Mobility	Mobilize the Skimmer	Perform Floatation Stabilization	Floatation foam container	Figure 4.1 (A)	Foam Filled Buoys	Figure 4.1 (B)	Buoyant Body	Figure 4.1 (C)	Foam filled modular chain buoys	Figure 4.1 (D)	Tri-float skimmer	Figure 4.1 (E)	Floating Drum Skimmer	Figure 4.1(F)	Skimmer material	Figure 4.1(G)
	Collect oil through debris or choppy water	Avoid debris collection	Limit debris entering skimmer	Monitoring sensor	Figure 4.2 (A)	Debris Net	Figure 4.2 (B)	Perimeter appendage	Figure 4.2 (C)	Repeller Grate	Figure 4.2 (D)	Debris shield	Figure 4.2(E)	Skimmer guard	Figure 4.2(F)	Flow Transmitter	Figure 4.2(G)
			Separate debris from fluid taken by skimmer	Debris protection net	Figure 4.3(A)	Floating Skimmer Fence	Figure 4.3(B)	Self Filtration	Figure 4.3(C)	Commercial Screened Shield	Figure 4.3 (D)	Filters	Figure 4.3(E)				
			Contain debris	Return-line filter	Figure 4.4(A)	Waste Basket	Figure 4.4(B)	Hydraulic system	Figure 4.4(C)	Bandalong Litter Trap	Figure 4.4 (D)	boom system	Figure 4.4(E)	bag float	Figure 4.4(F)		
	Measure Oil Recovery Rate	Measure the amount of oil recovered per second	Calculate amount of oil intake	Flow meter	Figure 4.5 (A)	Flow Monitor	Figure 4.5 (B)	Signa Magmeter	Figure 4.5 (C)	Electromagnetic Flow Meter	Figure 4.5 (D)	Flow switch	Figure 4.5(E)	Flow meter	Figure 4.5(F)	Ultrasonic clamp meter	
			Transform rate readings	Digital Transmitter	Figure 4.6 (A)	Detector Array	Figure 4.6 (B)	Control panel	Figure 4.6 (C)	Electrical panel	FIgure 4.6 (D)	Oil Monitor	Figure 4.6(E)	Flow Meter	Figure 4.6(F)		
			Accurately detect flow rate	Oil/Water Separator	Figure 4.7 (A)	Pressure Transducer	Figure 4.7 (B)	Oil smart alarm system	Figure 4.7 (C)	Waterproof 24-hr timer	FIgure 4.7 (D)	frequency transceiver	Figure 4.7(E)	Sensor	Figure 4.7(F)		
		Control rate of recovery		Fixed orifice model	Figure 4.8 (A)	Flow Monitor	Figure 4.8 (B)	Pressure Switch	Figure 4.8 (C)	DataFlo Remote controller	FIgure 4.8 (D)	oil traffic controller	Figure 4.8(E)	Actuator	Figure 4.8(F)		
	Able to filter various oil slick thickness	Distinguish between oil viscosities	Maintain oil/water ratio	Microwave signal generator	Figure 4.9 (A)	DMS Thickness Gauge	Figure 4.9 (B)	Ultrasonic thickness gauge	Figure 4.9 (C)	Ultrasound Ultrasonic Testing	Figure 4.9 (D)	Line transducer	Figure 4.9 (E)	Flow transmitter	Figure 4.9 (F)	Digital flow meter	Figure 4.9 (G)
			Measure oil resistance to flow	Viscometer fork	Figure 4.10 (A)	Oval Gear Flow Meter	Figure 4.10 (B	Flow meter	Figure 4.10 (C)	Flow Meter DulcoFlow	Figure 4.10 (D)	Hand viscosity meter	Figure 4.10(E)		Figure 4.10(F)		Figure 4.10(G)
			Detect surface tension	Surface tension meter	Figure 4.11(A)	Tension Meter	Figure4 4.11(B)	Grease Grabber	Figure 4.11(C)	Portable Tensiometer	Figure 4.11(D)	Surface tension detector	Figure 4.11(E)	Tensiometer	Figure 4.11 (F)		Figure 4.11 (G)
		Detect type of oil		Digital viscometer	Figure 4.12(A)	Viscometer	Figure 4.12(B)	Compact density meter	Figure 4.12(C)	Viscosities and Densities	Figure 4.12(D)	Viscosity tester	Figure 4.12(E)	Detection system	Figure 4.12 (F)		Figure 4.12 (G)

										Detector							
		Self-adjust separation method to different types of oil		Viscometer	Figure 4.13(A)	Compact Density Meter	Figure 4.13(B)	Flow gauge	Figure 4.13(C)	Vibration Viscometer	Figure 4.13(D)	Mass flow meter	Figure 4.13 (E)	Density meter	Figure 4.13 (F)	Analog recorder	Figure 4.12 (G)
	Limit water intake	Control water intake	Differentiate between specific gravities	Hydrometer	Figure 4.14(A)	Liquid Level Transmitter	FIgure 4.14(B)	Point level sensor	FIgure 4.14(C)	TriSKimmer (TSK) weir skimmer	Figure 4.14(D)	Oil grabber	Figure 4.14(E)		Figure 4.14 (F)		Figure 4.14 (G)
			Collect optimal level of fluids	Grooved disk	Figure 4.15(A)	Groove Formation	Figure 4.15(B)	Ultrasonic transmissions	Figure 4.15(C)	Druck 180	Figure4 4.15(D)	Grooved disk	Figure 4.15 (E)	Filtration Plate	Figure 4.15(F)	Level transmitter	Figure 4.15 (G)
	Separate oil from water	Filter water out of the oil	Separate oil from water	Grooved disk	Figure 4.16(A)	Grooved Disk	Figure 4.16(B)	Oil Water Filter	Figure 4.16(C)	Mini Polypropylene T-Strainer	Figure 4.16(D)	Increased width of canal fingers	Figure 4.16(E)	Oil filter	Figure 4.16 (F)		
			Dissipate excess water	Transmitter	Figure 4.17(A)	Liquid Level Sensor	Figure 4.17(B)	Oil Water Separator	Figure 4.17(C)	Frothy	Figure 4.17(D)		Figure 4.17(E)		Figure 4.17 (F)		Figure 4.19(G)
			Contain contaminated water	Filter cart	Figure 4.18(A)	Oil Separator System	Figure 4.18B	Filtration system	Figure 4.18(C)	Fluid Separator	Figure 4.18(D)	Flow regulating valve	Figure 4.18 (E)	Ball Valve	Figure 4.18 (F)	Flow switch	Figure 4.18 (G)
		Contain the oil		Storage tank	Figure 4.19(A)	Oil Retainer	Figure 4.19(B)	Oil Container	Figure 4.19(C)	Floating Boom sock	Figure 4.19(D)	oil containment tank	Figure 4.19(E)	Oil skimmer tan	Figure 4.19 (F)		Figure 4.19 (G)

Individual Concepts Generation

1. Concepts for the function "Perform floatation stabilization"

In Figure 4.1 the concepts generated for the function "Perform flotation stabilization" can be observed. Figure 4.1A includes an image of a flotation foam container. This material can be applied under the skimmer bottom surface to increase the skimmer flotation [1]. Figure 4.1B displays spherical foam filled buoys that can be installed on the outside of the skimmer to improve skimmer flotation [2]. Another concept, Figure 4.1C includes a buoyant body for floating on the water surface having a front and rear portion. A debris collecting channel passes between the front and rear portions, the skimmer device also including a propulsion system for moving the buoyant body through the body of water in the direction of the front portion [3]. Figure 4.1D contains a display of several foam filled modular chain buoys that can help maintain flotation and stabilization of the skimmer device [4]. Figure 4.1E is a Tri-float skimmer. All 3 sides have flotation devices within them. All 4 concepts could assist in the floatation stabilization of skimmer. Another concept is Figure 4.1F Floating Drum Skimmer (FDS) they float on the surface, and sealed flotation makes them unsinkable [5]. Finally, Figure 4.1G is a device that floats on the water surface. It is made of corrosion-resistant glass fiber reinforced plastics, stainless steel or marine grade aluminum alloy [6]. It can be used for recovery of spilled oil on the surface of seawater or fresh water and its robust and durable structure is best suited for applications on open seas were rough sea state may occur [7].

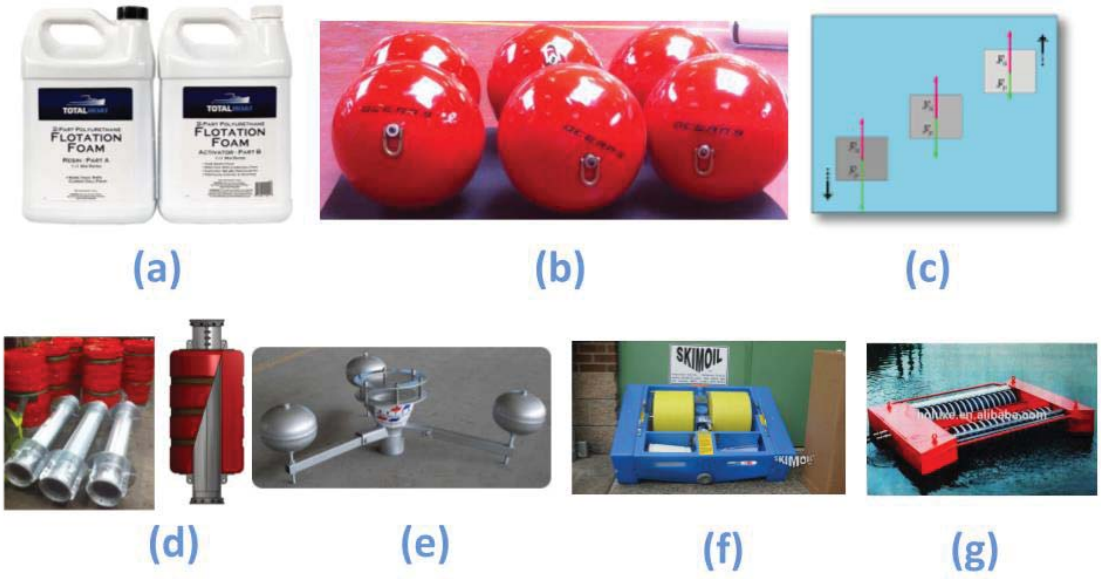


Figure 4.1 Concept Sketches for "Perform flotation stabilization"

2. Concepts for the function “Limit debris entering skimmer”

In Figure 4.2 the concepts generated for the function “Limit debris entering skimmer” can be observed. Figure 4.2A is a Condition Monitoring Sensor that provides continuous real-time monitoring for cases of large particle build-up preventing unexpected downtime in the process [8]. Figure 4.2B is an InCord enviroNet is a debris net that offers total containment of both solid and liquid contaminants. Developed for use under bridges spanning sensitive waterways, enviroNet has the debris containment power of our RocBloc family of nets, with the added benefit of liquid and fine particle control [9]. Figure 4.2C The bracket could be used to swipe debris away from the skimmer as a perimeter appendage [10]. Finally Figure 4.2D contains the Repeller Grate inhibits the accumulation of weeds and debris on the intake grate, which may interfere with the performance of the watercraft. Commonly used on jet skis, the design can be modified to fit an oil skimmer and prevent debris from entering the skimmer [11]. Figure 4.2E is a debris shield that can be used as a perimeter appendage to block out entering debris during skimmer movement. The concept could be incorporated around the entire skimmer to increase debris limitation [12]. Additionally, Figure 4.2F is a standard skimmer guard used in modern day swimming pools. The guard concept could also be imagined within the skimmer design as another way to block out unwanted debris [13]. Finally, Figure 4.2G displays a RT-30 Flow Transmitter provides protection from moisture and debris from environmental factors [14].

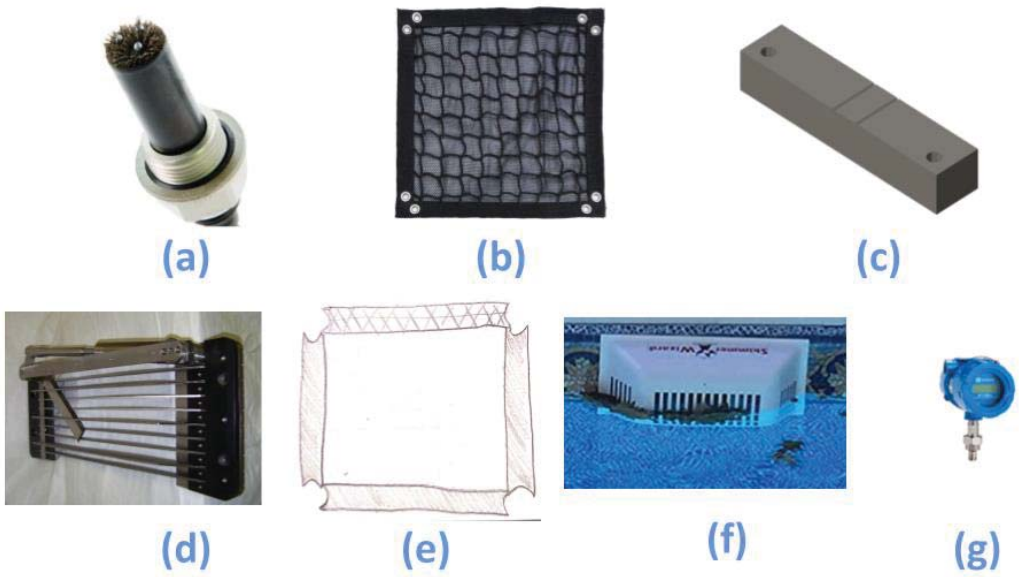


Figure 4.2 Concept Sketches for “Limit debris entering skimmer”

3. Concepts for the function "Separate debris from fluids taken by the skimmer”

In Figure 4.3 the concepts generated for the function “Filtration system diverts that debris” can be observed. Figure 4.3A shows an enclosed debris protection net that contains anchors at the bottom end. The anchors will allow the bottom of the net to sink. On the other hand, the net will be fixed to the skimmer outer fence to prevent debris from entering the skimming area [15]. Figure 4.3B includes a sketch of an outer floating skimmer fence that contains pores on its surface. This allows water and oil to flow through the pores and prevent debris from reaching the skimming area [16]. Figure 4.3C is a self-filtration debris filter that can divert any unwanted material out of the system [17]. Figure 4.3D displays a Commercial screened Shield heads prevent leaves and debris from blocking downspouts and entering your skimmer tank. Shield heads are ideally installed on each downpipe as they protect the skimmer and improve your tank's water quality [18]. Finally, Figure 4.3E filters have rigid and durable V-SLOT filter cartridges, with uniform surface crack width, single large filter area, precision filtration features, and high reliability features. It applies to the filtration of dirty water containing oil sludge type impurities, soft and viscous impurities, high content impurities, small amount of hairs and fibers [19].

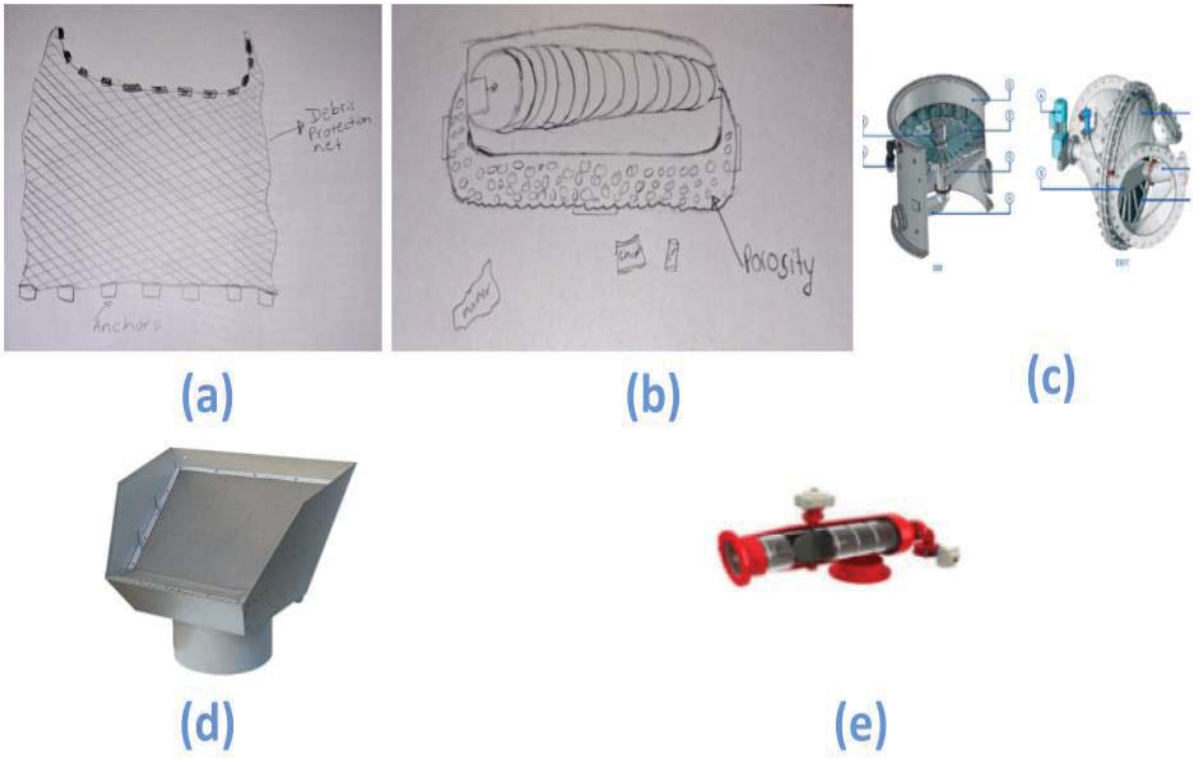


Figure 4.3 Concept Sketches for “Separate debris from fluids taken by the skimmer”

4. Concepts for the function “Contain debris”

In figure 4.4 the concepts generated for the function “Remove debris” can be observed. Figure 4.4A displays a return-line hydraulic filter, also known as a spin-on filter, which is used to clean hydraulic oil or fluid in pressurized hydraulic systems [20]. This filter has multiple openings for debris filtration. In-line hydraulic filters are installed on the low-pressure, return line side of a hydraulic system to clean the fluid before it returns to the reservoir. Figure 4.4B shows a waste basket that’s used for collecting larger amounts of debris that can be removed when full [21]. This filter allows for debris accumulation that can be easily cleaned once max debris is collected. On the other side, Figure 4.4C is a single-head filter assembly for return lines on hydraulic systems that clean hydraulic fluid by passing it through one filter before returning it to the reservoir [22]. Finally Figure 4.4D contains a Bandalong litter trap designed to float in waterways in order to capture litter before it flows farther downstream by using the current to guide debris into the trap [23]. Additionally, Figure 4.4E is the Bandalong Boom Systems, which act as a barrier to collect or deflect debris. The floating boom sections are coupled together and spanned across a weir, waterway or dam to capture litter and prevent it from floating farther downstream [24]. Finally, Figure 4.4F displays a Hayward TVX6009EA where this bag float is used to pick up the debris [25].

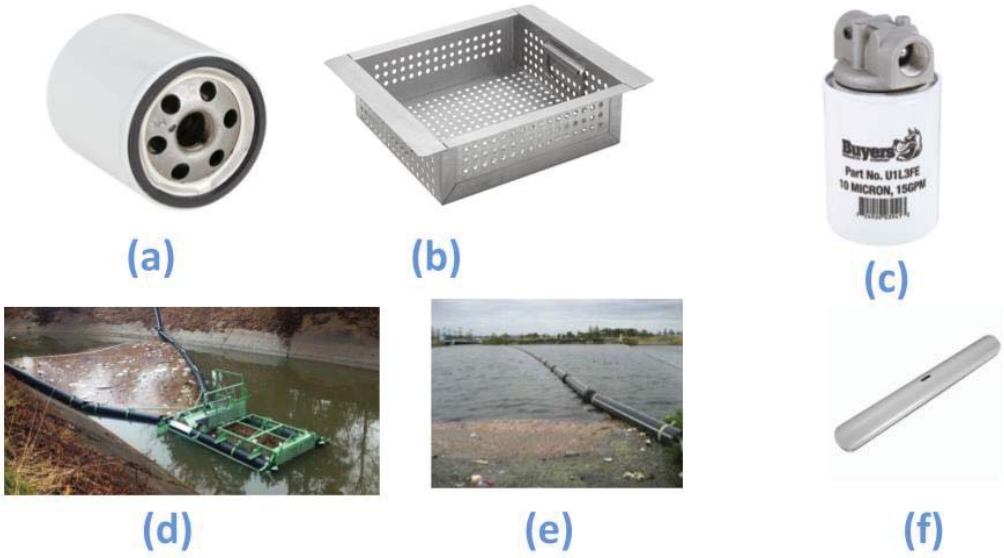


Figure 4.4 Concept Sketches for “Contain Debris”

5. Concepts for the function “Calculate amount of oil intake”

In figure 4.5 the concepts generated for the function “Calculate amount of oil intake” can be observed. Figure 4.5A shows a mass flow meter is a large diameter developed to meet the demanding custody transfer requirements of the oil and gas industry. The high performance of the OPTIMASS 2000 also makes it a suitable flow meter for the bulk measurement of petroleum and oil as well as products like syrup, molasses, and raw chemicals [26]. Figure 4.5B Greyline Instruments SLT 5.0 Level and Flow monitor [27]. This device can be used to monitor flow levels and totalize a quantity within a channel of flow. This can be incorporated to help calculate the total amount of oil collected in GPM.on the other side, Figure 4.5C is a GF Signet 2551 Magmeter that is corrosion resistant with digital readings of liquid flow within a channel [28]. The corrosive resistance would allow for increased lifespan as well as optimal calculation of oil intake for the oil skimmer. Figure 4.5D contains a Badger Meter M2000 Electromagnetic Flow Meter. Electromagnetic flow meters have inherent advantages over other flow technologies and can accurately meter liquids that are highly corrosive, very viscous, contain a moderate number of solids or require special handling [29]. This device can be used in most industries and can be incorporated in wastewater management. Another concept, Figure 4.5E includes a series flow switch that can be utilized to amplify the flow rates of the skimmer [30]. Figure 4.6F demonstrates a durable lightweight flow meter that is able to measure flow rates from 1-10 GPM to 60-600 GPM. With a basic accuracy of ±3%, the TM Series is well suited for sub-metering facility water usage and small wastewater treatment equipment [31]. Finally, the last concept is Figure 4.5G, which contains an ultrasonic clamp flow meter that can also be used to measure the flow rate with water entering the system. The clamp flow meter can be conveniently installed as it easily clamps on the skimmer [32].

Figure 4.5 Concept Sketches for “Calculate amount of oil intake”

6. Concepts for the function “Transform Rate Readings”

In figure 4.6 the concepts generated for the function “Transform rate readings” can be observed. Figure 4.6A Digital moisture transmitter designed for transforming rate readings and measuring water content in oil [33]. Figure 4.6B utilizes the “SmartCell" Detector Array Technology, the OCM analyses all three oil types simultaneously without the need for recalibration [34]. On the other side, Figure 4.6C is Control panel that will show all the rate readings and will have the switches and controls for the skimmer [35]. Figure 4.6D contains an electrical panel. This enclosure contains the brains and it runs and monitors all the components continuously, it transforms the data collected into readable values for data analysis [36]. Figure 4.6E is a device for real time sampling and measuring the oil content in a moving stream of water [37]. Finally, Figure 4.6F is a Compact Orifice Flow Meter that is ideal for volumetric measurement of relatively clean liquids. Meaning it can transform the readings of the clean water [38].

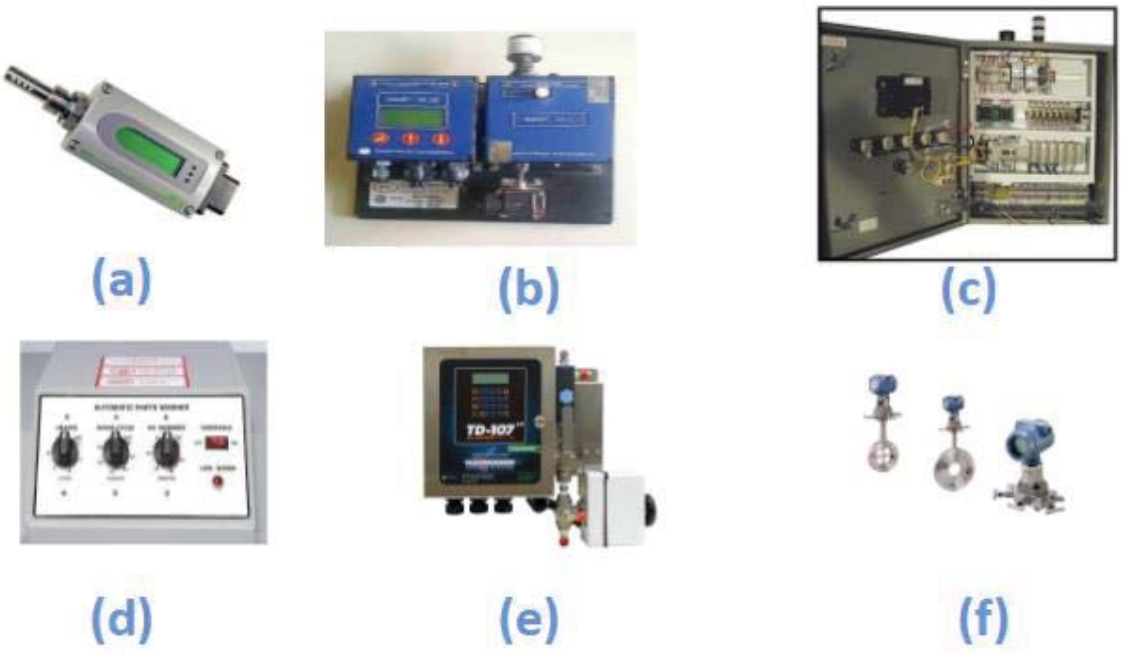


Figure 4.6 Concept Sketches for “Transform rate readings”

7. Concepts for the function “Accurately detect flow rate”

In figure 3 the concepts generated for the function “Accurately detect through sensor” can be observed. Figure 4.7A is an Oil Water Separator High/Low Level Alarm, Rings when accumulated oil would reach a predetermined level. Signals when maintenance is needed [39]. Figure 4.7B is a Core Sensors CS80, a versatile pressure transducer that is designed to operate under the harshest conditions [40]. On the other side, Figure 4.7C is a Oil Smart Alarm System, a plug and play alarm that differentiates between oil and water, it will activate with the detection of any liquid and will identify if oil or water is present [41]. Figure 4.7D contains a Waterproof 24-hr timer, 110V easy to set up, and high efficiency [42]. Figure 4.7E is GE Leakwise ID-227, which is a high frequency transceiver with two antenna elements. One antenna is located at the water interface and the other is located underwater [43]. Finally, Figure 4.7F is the Leakwise ID-225 sensor measures the thickness and monitors the buildup of hydrocarbons in water. Many petroleum and power companies use it for monitoring and control of oil layers in remediation control and skim tanks [44].

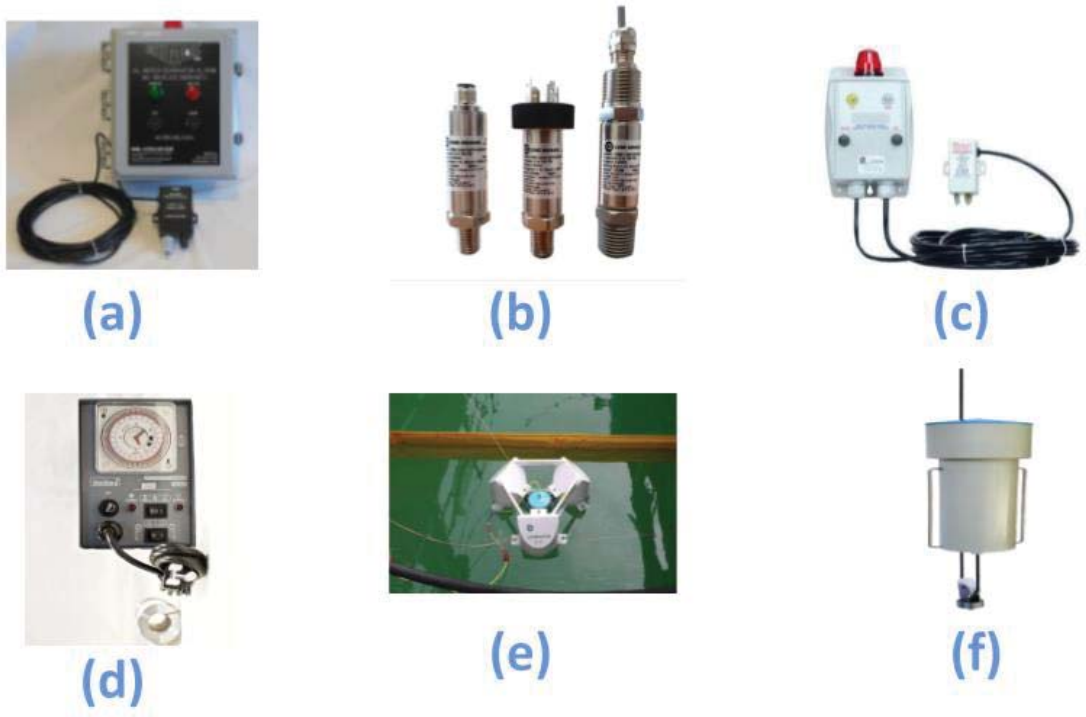


Figure 4.7 Concept Sketches for “Accurately detect flow rate”

8. Concepts for the function “Control rate of recovery”

In figure 4.8 the concepts generated for the function “Control rate of recovery” can be observed. Figure 4.8A is a Sketch of a fixed orifice within a system. The fixed orifice is one of the most elemental methods for controlling flow and can help maintain steady recovery flow rate within the skimmer [45]. Figure 4.8B Blancett B2900 Flow Monitor, a flow meter that calculates flow rate and total flow simultaneously with 10-point linearization for improved accuracy[46].On the other side, Figure 4.8C Ashcroft B400 Series Pressure Switch, a pressure switch that can control the oil rate recovery[47]. Figure 4.8D contains a DataFlo Remote controller that can help control the rate of oil recovery within the skimmer [48]. Figure 4.8E is an oil traffic controller that is used with skimmer to reduce skimmings to oil only and save coolant. When the oil is removed from the tank, the coolant removed by your skimmer will be returned right back to the tank [49]. Finally, Figure 4.8F is an actuator that controls the intake of oil being recovered and automatically shuts down or recalibrates if debris was picked up [50].

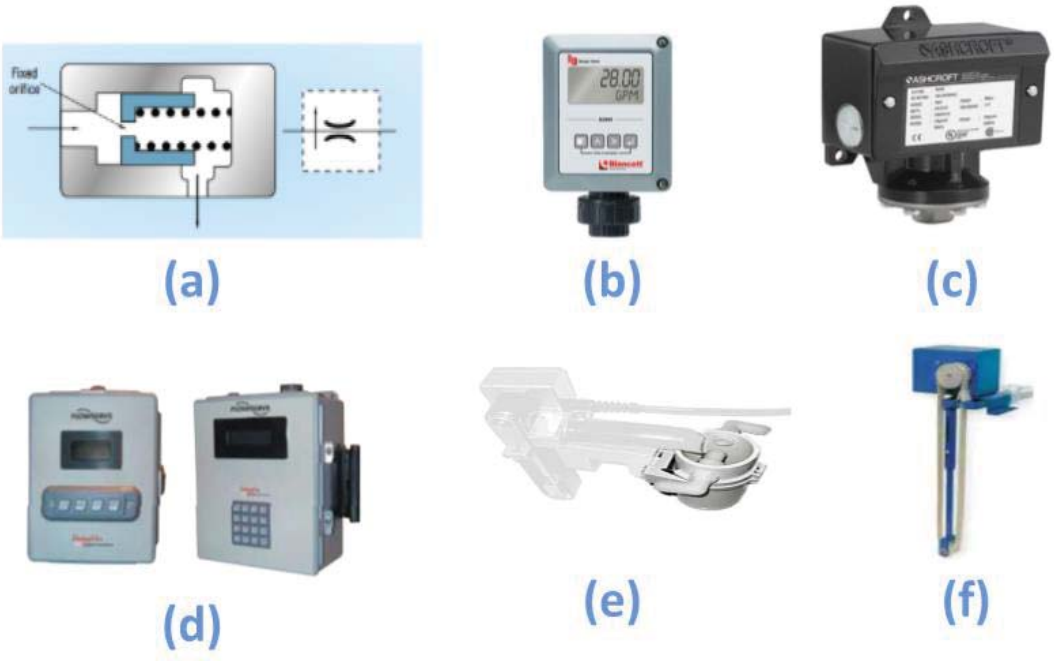


Figure 4.8 Concept Sketches for “Control rate of recovery”

9. Concepts for the function “Maintain Oil/Water Ratio”

In figure 4.9 the concepts generated for the function “Verify oil thickness” can be observed. Figure 4.9A is a Berkeley Nucleonics' Model 845 RF Microwave Signal Generator, a low-noise and fast-switching microwave signal generator. The natural microwave radiation encountering this oil layer causes its surface brightness to increase as a function of the oil layer thickness [51]. Figure 4.9B is a BDMS Go+ Thickness Gauge that has the ability to provide accurate, reliable and comprehensive thickness inspection data [52]. On the other side, Figure 4.9C also presents an ultrasonic thickness gage that is called CL5 Ultrasonic Thickness Gauge [53]. Figure 4.9D contains an Ultrasound Ultrasonic Testing which can measure thick oil slicks on water. Workers in the oil spill field have also used this technique from below the water surface. This is possible because there are sonic reflections from the oil–water interface and from the air–oil interface. All these can be used to detect oil thickness in water [54]. Figure 4.9E displays a Delay Line Transducer that incorporates a short delay between the element and the test piece [55]. Additionally, 4.9F is a Ultrasonic Flow Transmitter which utilizes a state-of-the-art flow measurement capability with a low-cost transmitter package [56]. Finally, Figure 4.9G is a Parametric DigitalFlow, which is an ultrasonic flow meter that can measure oil thickness by calculating other parameters such as velocity, volumetric and energy flow rates using transit time technology [57].

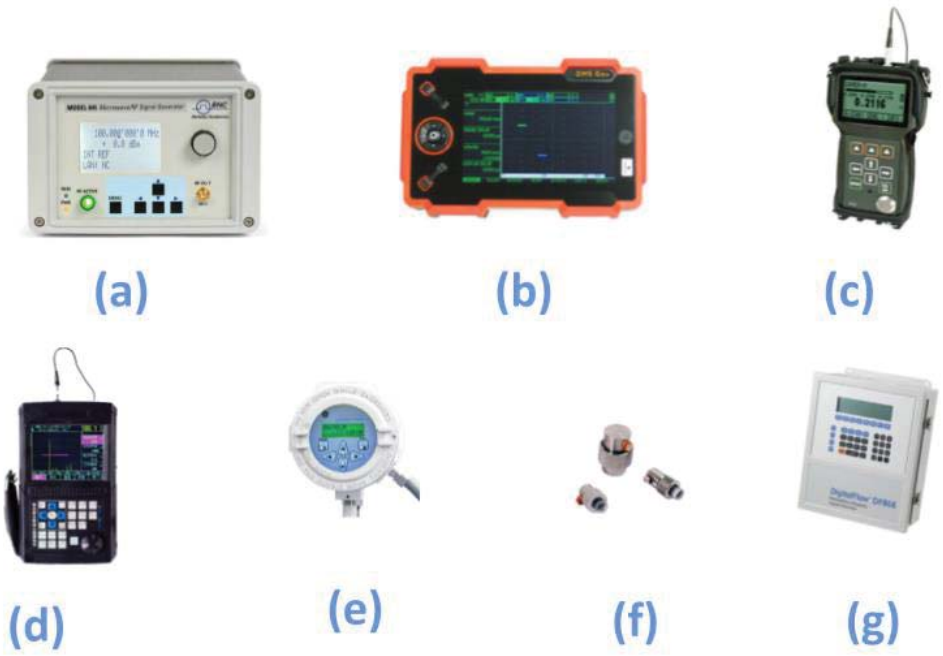


Figure 4.9 Concept Sketches for “Maintain Oil/Water Ratio”

10. Concepts for the function “Measure oil resistance to flow”

In figure 4.10 the concepts generated for the function “Measure oil resistance to flow” can be observed. Figure 4.10A is a device featuring a level of 1% of reading, a tuning fork vibration viscometer delivers a high level of accuracy [58]. This measures viscosity by detecting the driving electric current needed to resonate two sensor plates at a constant frequency. Figure 4.10B is an Oval Gear Flow Meter which measures the low flow rate of highly viscous oils, a tool that can measure oil resistance to flow [59]. On the other side, Figure 4.10C is a E+H Proline Promass I 300 Coriolis Flow Meter that Provides an in-line viscosity measurement in addition to mass flow, density and temperature measurement and utilizes one side access, remote display and improved connectivity options [60]. Figure 4.10D contains the Flow Meter DulcoFlow, this device works on the ultrasound measuring principle. It was developed specifically for measuring small pulsating volumetric flows. All liquids that conduct ultrasound waves can be measured [61]. All these measurement tools can be used to measure oil resistance flow. Finally, Figure 4.10E displays a hand viscosity meter that can be installed in the skimmer prototype to measure the viscosity level of the oil to be recovered [62].

Figure 4.10 Concept Sketches for “Measure oil resistance to flow”

11. Concepts for the function “Detect surface tension”

In figure 4.11 the concepts generated for the function “Detect surface tension” can be observed. Figure 4.11A is a Sensodyne fluid surface tension meter that can be used to measure the static and dynamic surface tension of the fluid recovered with the skimmer [63]. Figure 4.11B is a Tension meter that is cost effective for various force measurements [64]. On the other side, Figure 4.11C is a Grease grabber is able to tell the difference in surface tension between oil and water, making an efficient skimmer, with little to no water recovery [65]. Figure 4.11D contains a portable tensiometer that can be installed in the skimmer for accurate surface tension measurements [66]. Another concept, Figure 4.11E is a device that performs high-precision, automatic and reliable measurements of surface tension and Interfacial tension, CMC and contact angle on solids, fibers and powders. With high-quality components and a uniquely wide range of methods, the instrument carries out many tasks in the field of surfactant analysis and wetting measurement for your quality assurance or research [67]. Finally, Figure 4.11F displays a Tensiometer Classic that is used to measure suction tension [68].

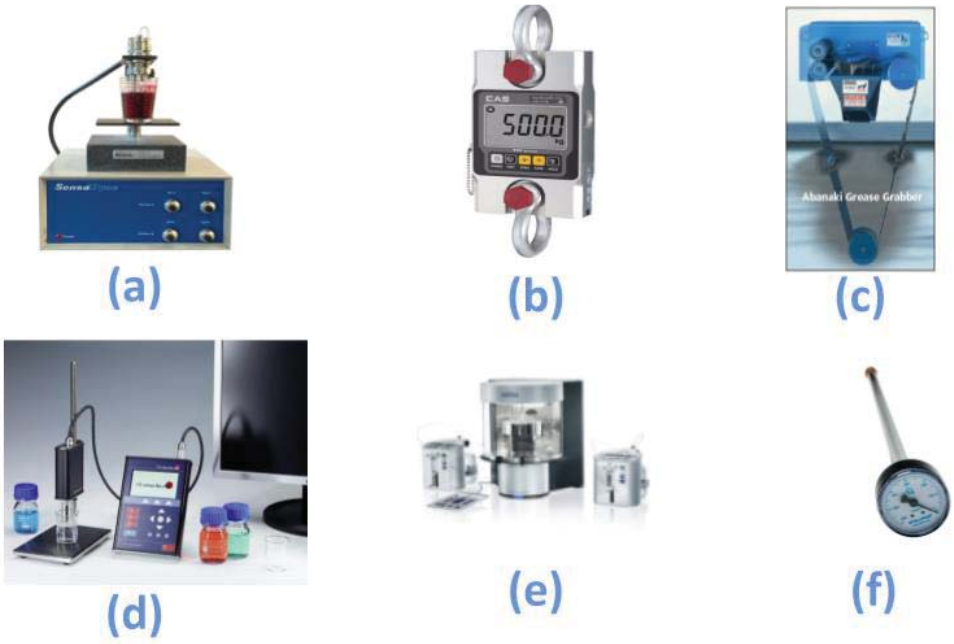


Figure 4.11 Concept Sketches for “Detect surface tension”

12. Concepts for the function “Detect type of oil”

In Figure 4.12 the concepts generated for the function “Detect type of oil” can be observed. Figure 4.12A is a Digital Viscometer 15~100,000 mPa.s, a rotary viscosity meter. The screen can directly display the viscosity, rotation speed, rotor number, percentage torque and other information. It can detect the type of oil by means of viscosity [69]. Figure 4.12B is a concept in which a viscometer can be mounted onto the skimmer much like in a tank to detect viscous properties of the oil to determine the type presented [70]. On the other side Figure 4.12C The Micro Motion CDM100 compact density meter uses dual curved-tube meter technology to measure density and Coriolis to indicate (velocity/volume) flow rate. This device can be used to distinguish between different types of oils through the use of density [71]. Figure 4.12D contains different oils containing different viscosities and densities. Within a storage tank, the oil can be detected by visualization of the way it floats on the water. There are 5 types of oil groups which include gasoline products (group 1), Diesel-Like Products/Light Crude Oils (group 2), Medium Crude Oils/Intermediate Products (group 3), Heavy Crude Oils/Residual Products (group 4) and Non-floating Oils (group 5) [72]. Figure 4.12E is a viscosity test, this test is a measurement of a lubricant's resistance to flow at a specific temperature. The single most important property of a lubricant is its viscosity [73]. Finally, Figure 4.12F is a concept sketch that serves as a mountable detection system. A probe is inserted into the oil slick and through the meniscus effect is absorbed through a pipette and into a detection tube that can then display onto a digital reading [74].

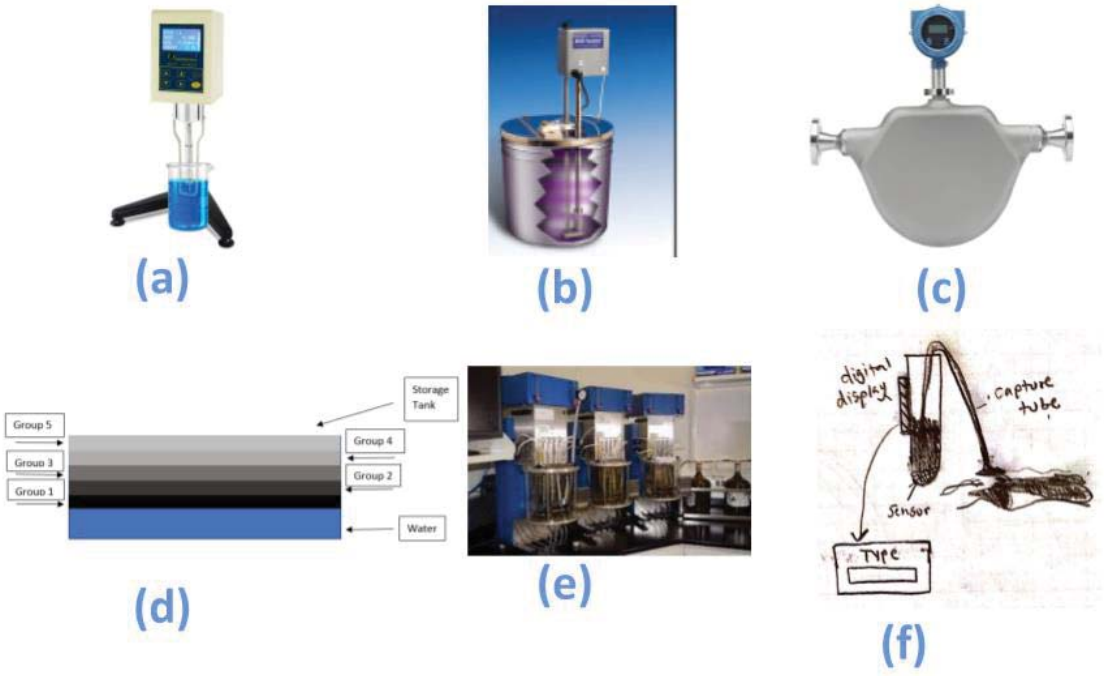


Figure 4.12 Concept Sketches for “Detect type of oil”

13. Concepts for the function “Self-adjust Separation method to different types of oil”

In Figure 4.13 the concepts generated for the function “Self-adjust to different types of oil” can be observed. Figure 4.13A evaluates fluidity and thickness of various fluid materials. This viscometer has microcomputer control technology and comes with a LED screen to evaluate your readings instantly [75]. Figure 4.13B demonstrates a compact density meter that uses dual curved-tube meter technology to measure density Coriolis to indicate velocity and volume flow rate. This device can be used to distinguish between different types of oils through the use of density [76]. On the other side, Figure 4.13C displays a series flow switch that is adjustable to an infinite number of flow settings at pressures up to 1000 psig [77]. Figure 4.13D contains a device features a level of 1% of reading, a tuning fork vibration viscometer delivers a high level of accuracy. This measures viscosity by detecting the driving electric current needed to resonate two sensor plates at a constant frequency [78]. Another concept, Figure 4.13E KROHNE OPTIMASS 1000 Coriolis Mass Flow Meter that can measure volume, temperature, volume concentration or solid content [79]. Another concept is Figure 4.13F is a handheld density meter that can adjust to different types of oil [80]. The last concept is Figure 4.13G, which is a device with multiple uses for both industry and the research field. The PAR 99X-MA analog recorder can be connected to different sensors via the 4-20 mA inputs. The PAR 99X-MA analog recorder can identify individually diverse oils with their viscosity, and they can also be digitally scaled. Therefore, the PAR 99X-MA analog recorder is able to be used in small and medium measurement/adjustment systems, as well as it allows to register simultaneously 8 signal processes. [81].

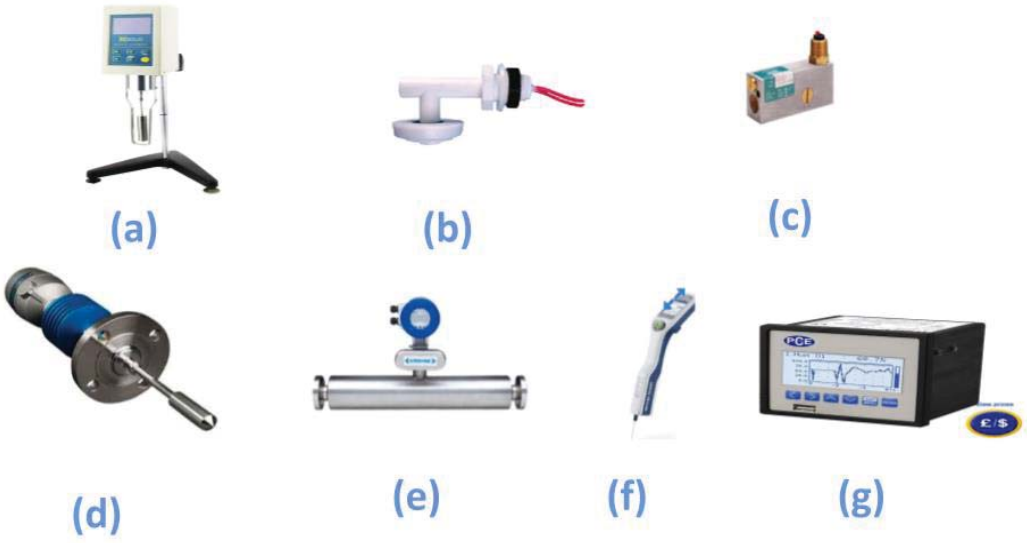


Figure 4.13 Concept Sketches for “Self-adjust Separation method to different types of oil”

14. Concepts for the function “Differentiate between specific gravities”

In Figure 4.14 the concepts generated for the function “Differentiate between specific gravities” can be observed. Figure 4.14A is simple hydrometer that is the most standard form of a hydrometer that can easily be incorporated into the skimmer design to help specify specific gravities of the oil or water [82]. Figure 4.14B is a Rosemount 2051L Liquid Level Transmitter that is a more modern type of instrument that can be flange mounted to any device to measure specific gravities up to 300psi [83]. Similarly, Figure 4.14C is a LMT110 point level sensor. Its compact sensor tip allows integration even in small pipes [84]. The factory setting to different fluid types eliminates the need for an adjustment and is automatic. The sensor allows for measurement of specific gravity based upon point level detection and is optimal for uses in storage tanks. Figure 4.14D is a TriSKimmer (TSK) weir skimmer that uses specifically the gravity differential between water and oil to effectively recover the oil [85]. Figure 4.14E is The Abanaki Model 8 Oil Grabber the belt skimmer allows to attract oil and other hydrocarbon liquids from the surface of the fluid. The Model 8 can be used in tanks with depths as shallow as one foot, or as deep as 100 feet [86]. Figure 4.14F is the PetroXtractor Skimmer, which makes use of the differences in specific gravity and surface tension between oil and water. These physical characteristics allow the unit’s continuous belt to attract floating oil in the well. After picking up the oil, the belt travels over the head pulley on the drive unit and through tandem wiper blades. All these concepts exist today to differentiate between specific gravities [87]. Finally, Figure 4.14G demonstrates a tuning fork density meter that allows accurate reading of specific gravity and density within a pipe while being placed on the outside of the pipe [88].

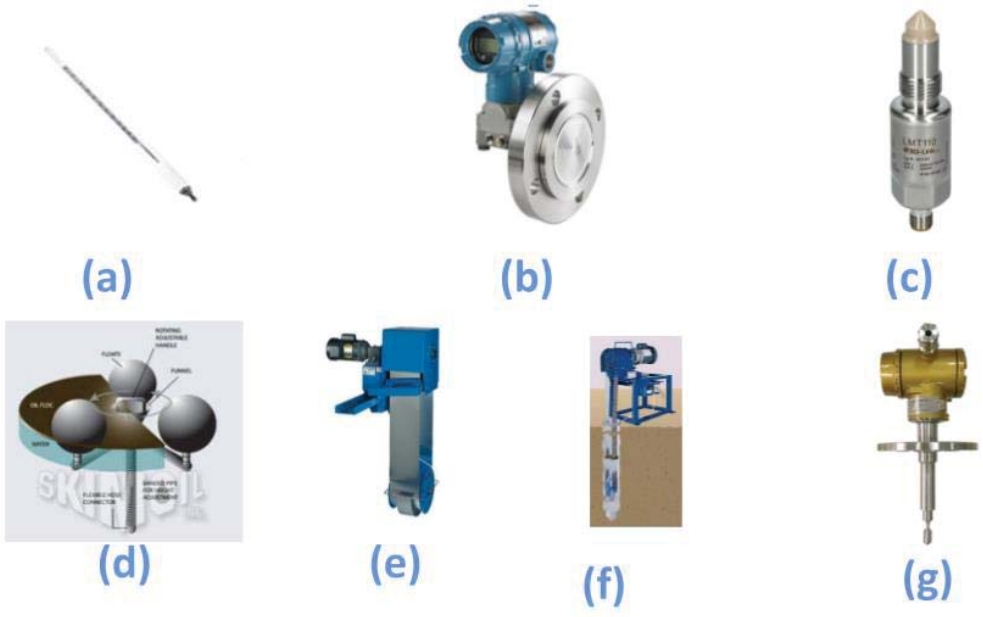


Figure 4.14 Concept Sketches for “Differentiate between specific gravities”

15. Concepts for the function “Collect optimal level of fluids”

In figure 4.15 the concepts generated for the function “Collect optimal level of oil” can be observed. Figure 4.15A presents a disk used in order to improve oil recovery, the disk is put into an offset angle [89]. The change of orientation will cause the disk to filtrate a greater amount of oil. The orientation can be manually controlled by an actuator to adjust to various oil thickness. Figure 4.15B shows how the amount grooves can be increased or decreased depending on the oil thickness that is being filtered. Additionally, an oleophilic coating can be applied to ensure that oils are successfully extracted through the grooves [90]. On the other side, Figure 4.15C is a polycarbonate design that offers measurement of liquids based on ultrasonic transmissions [91]. If utilized in this design, this concept would allow for accurate measurement of oil intake.Figure 4.15D contains Druck 180 series submersible pressure transmitters [92]. These transmitters are fully submersible and can detect hydrostatic liquid levels. This concept could be used within the storage tank. Figure 4.15E displays a Spinning Grooved Disks that pulls the oily water upward, where metal skimmers strain the oil away, separating the oil from the water and leaving the water to fall back down [93]. Figure 4.15F shows the filtration plate with the grooves evenly placed out. The distance between the grooves can be increased or decreased to accommodate the oil thickness that is being filtered. Similarly, to the last figure, an oleophilic coating can be applied to the grooves to increase the rate of oil collected [94].Finally, Figure 4.15G displays a Keller Acculevel Submersible Level Transmitter that incorporates microprocessor-controlled signal conditioning for providing outstanding accuracy in the monitoring of oil collection [95].

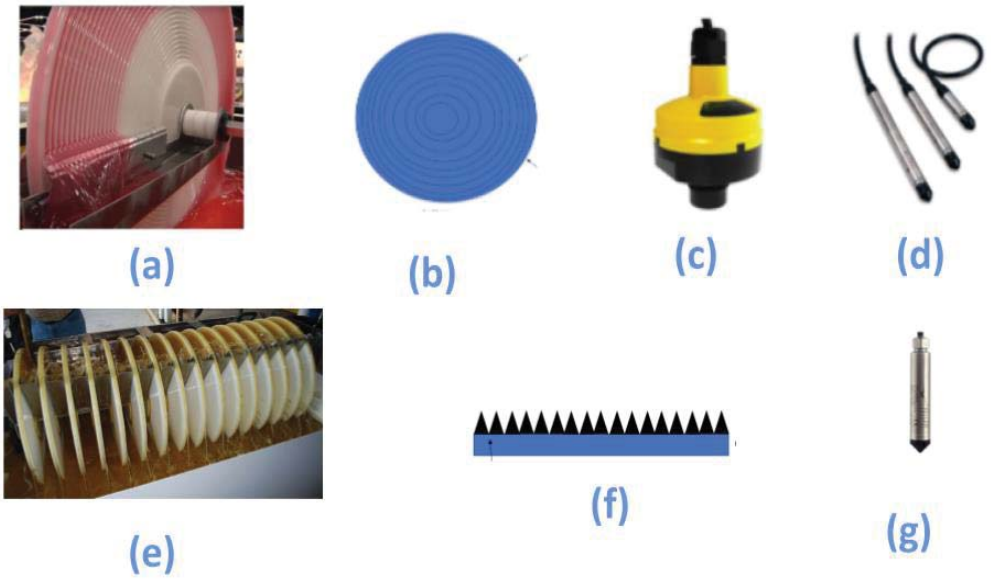


Figure 4.15 Concept Sketches for “Collect optimal level of fluids”

16. Concepts for the function “Separate oil from water”

In Figure 4.16 the concepts generated for the function “~~Increase filtration rate~~” can be observed. Figure 4.16A is a Grooved Drum, the grooved surface of this drum skimmer is designed so that it is more efficient in oil collection [96]. When scraping off the oil, the plate has the same grooved pattern so that the oil can be scraped off the drum surface and between the grooves. The greater the width of the grooves the greater the amount of oil picked up by the skimmer. Figure 4.16B displays a grooved disk that will increase the oil filtration rate as the oil sticks in the oleophilic material as the excess water drops before making it to the recovery canal. The disk displayed has an increased groove width and depth which will provide more contact surface area for the oil to stick [97]. Figure 4.16C is an oil and water separator that filters and separates oil and water during the filtration process [98]. This is vital to this function because the need for the collection of the oil is based upon the filtering of oil of water molecules to be returned to the water source. Figure 4.16D contains a Mini Polypropylene T-Strainer w/ Clear Bowl [99] that has an advantage in material due to the properties of the device. It also would help to improve filtration rate through separation of oil and water separation. Figure 4.16E displays the increased width of the recovery canal fingers. This allows the recovery canal to match the increased thickness of the disk grooves [100]. Finally, Figure 4.16F includes a Diesel Bypass Oil Filter that draws approximately 10 percent of the oil pump's capacity at any one time [101].

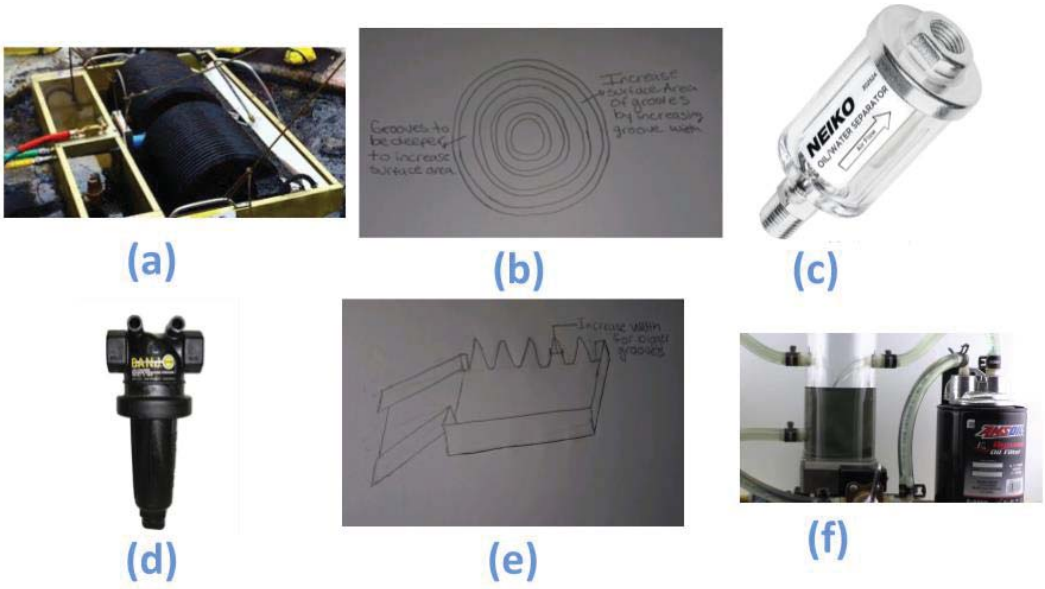


Figure 4.16 Concept Sketches for “Separate oil from water”

17. Concepts for the function “Dissipate excess water”

In Figure 4.17 the concepts generated for the function “Dissipate excess water” can be observed. Figure 4.17A is a HUMICAP ® Moisture and Temperature Transmitter series [102] that enables fast and reliable detection of moisture/water in oil. This would allow for fast detection of excess water within the oil source to be extracted. Figure 4.17B is a FS20 High Pressure Liquid Level Sensor [103], it is a stainless steel, buoyant and vertical oriented sensor that operates in high pressure environments but allows functionality in open and closed systems [104]. On the other side, Figure 4.17C is an Oil Water (Baffle) Separation, Oil water separators are based on gravity and since the specific gravity of oil is less than that of water, it floats to the water’s surface. As the oil rises the cleaned water passes through to the next container until you are left with just the cleaned water [105]. Figure 4.17D contains the skimmed oil is frothy, such as that found in machine tool coolant, cold rolling mill coolant, or parts washing solutions The decanter gives any water collected a chance to further separate from the removed oil and be returned to the solution reservoir. This helps to conserve solution loss, decreasing the need for new solution purchases [106]. Another concept, Figure 4.17E the Oilsmart Pump Switch, when combined with a non-auto pump, will allow excess water to be pumped without the risk of pumping oil out of the system [107]. Figure 4.17F is a device that is attached to a 1/2" air diaphragm pump by a 3/4" hose, the suction from the pump and floating skimmer pulls the oil/water mixture into the intake of the skimmer, then to a Oil/Water Separator where the oil is removed from the wastewater and stored for recycling [108]. The water is sent back to the storage tank or sent directly to the Sewer. Finally, Figure 4.17G displays a Flange-Mounted Rosemount 2051L Liquid Level Transmitter that provides precise level and specific gravity measurement [109].

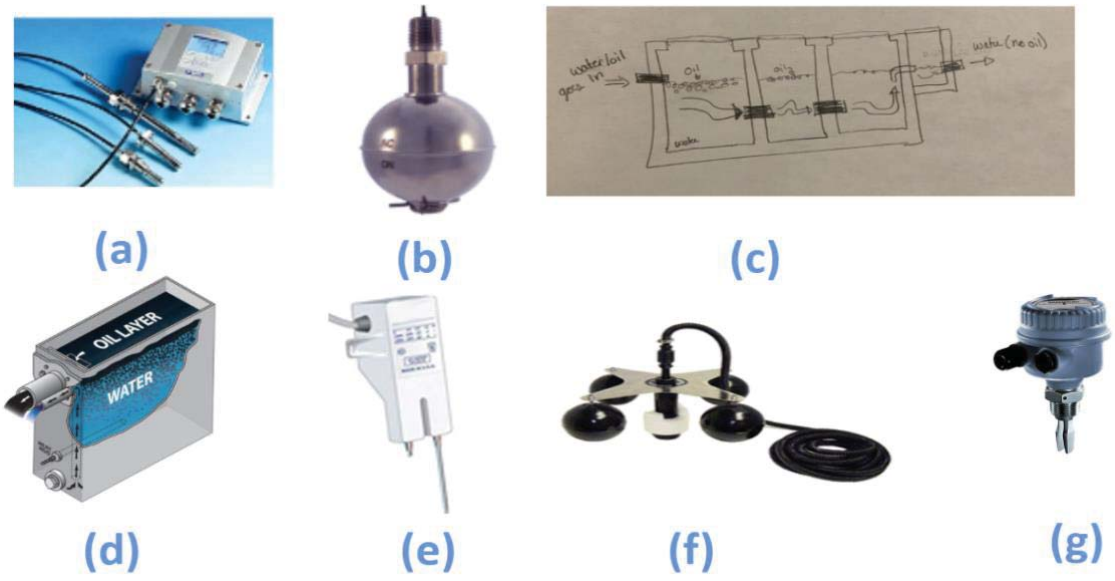


Figure 4.17 Concept Sketches for “Dissipate excess water”

18. Concepts for the function “Contain contaminated water”

In Figure 4.18 the concepts generated for the function “Avoid contaminating water” can be observed. Figure 4.18A is the Contaminant Removal Filter Cart is a portable oil filter cart. These carts use multi-pass filtration to remove water and contaminants from the liquids [110]. Figure 4.18B is the SmartSkim Oil Separator System that sets the industry standard for skimming and separating floating oil and solids from industrial fluids [111]. Figure 4.18C is the Kidney Loop Filtration System, an oil filtration system feature BETA 1000 Absolute rated micro-glass filter elements or adsorptive cellulose media filters in a variety of micron retention ratings to meet the target ISO 4406 Cleanliness Code requirements for any industrial system [112]. Figure 4.18D demonstrates a fluid separator that automatically separates the water and oil through the use of a sensor that detects density of the fluid to their respective storage tank [113]. Figure 4.18E contains an automatic flow regulating valve that keeps the flow constant by decreasing the cross-section of an orifice proportionally as the pressure increases [114]. Additionally, figure 14.18F exhibits a type 127 ball valve allowing the separation of water and oil through an open and close operation [115]. Figure 4.18G is a Gems FS-400 Series Flow Switch, which is a switch that can be used to separate the oil [116]. Finally Figure 4.18H present Moisture in Oil Transmitter, it offers highly accurate measurement of water activity and temperature; it uses those values to calculate the absolute water content [117].

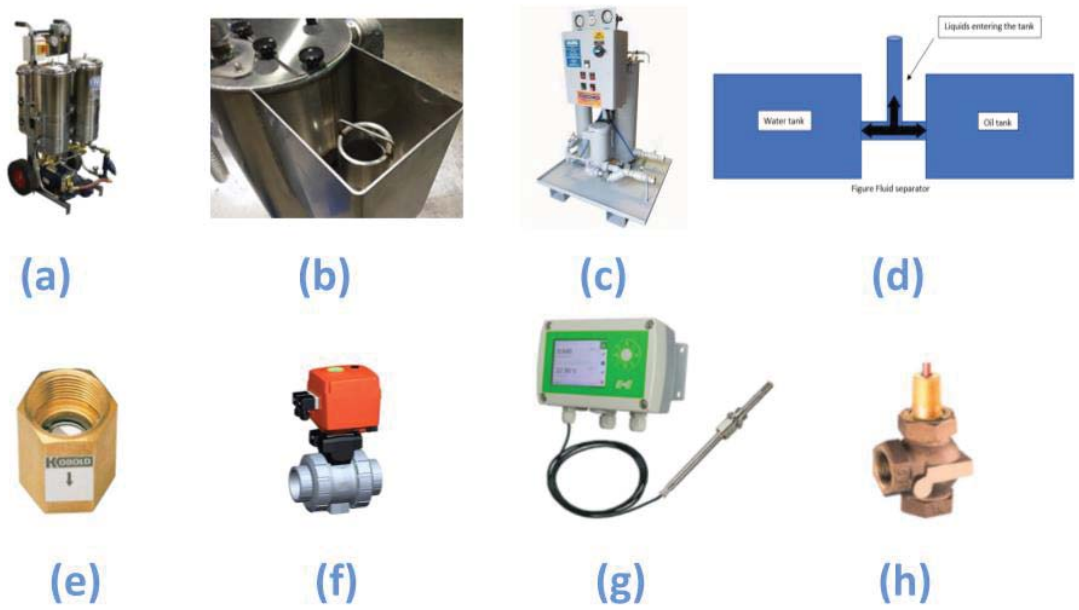


Figure 4.18 Concept Sketches for “Contain contaminated water”

19. Concepts for the function “Contain the oil”

In Figure 4.19 the concepts generated for the function “Contain the oil” can be observed.
Figure 4.19A is an Oil Storage Tank, the oil spill is drawn into the vacuum storage tank through the opening of the oil head. After the oil-water separation tank is filled with oily sewage, the liquid level controller automatically cuts off the vacuum pump current, and the vacuum pump stops pumping the oil spill on the water surface [118]. Figure 4.19B is the Oil Retainer, where Oil is wiped off and discharged into a collection container in a manner similar to belt oil skimmers [119]. Figure 4.19C is an Oil Container for an oil skimmer which serves as a designated oil reservoir from the collection process [120]. Figure 4.19D shows a floating boom sock that is able to contain and absorb oil spills on the surface of water [121]. Figure 4.19E illustrates an oil containment tank where only successfully extracted oil is sent and ensures that the oil stored in the tank is water free [121]. Finally, Figure 4.19F presents the reader can observe that an Oil skimmer tank is presented, this tank can be used to contain the oil [122].

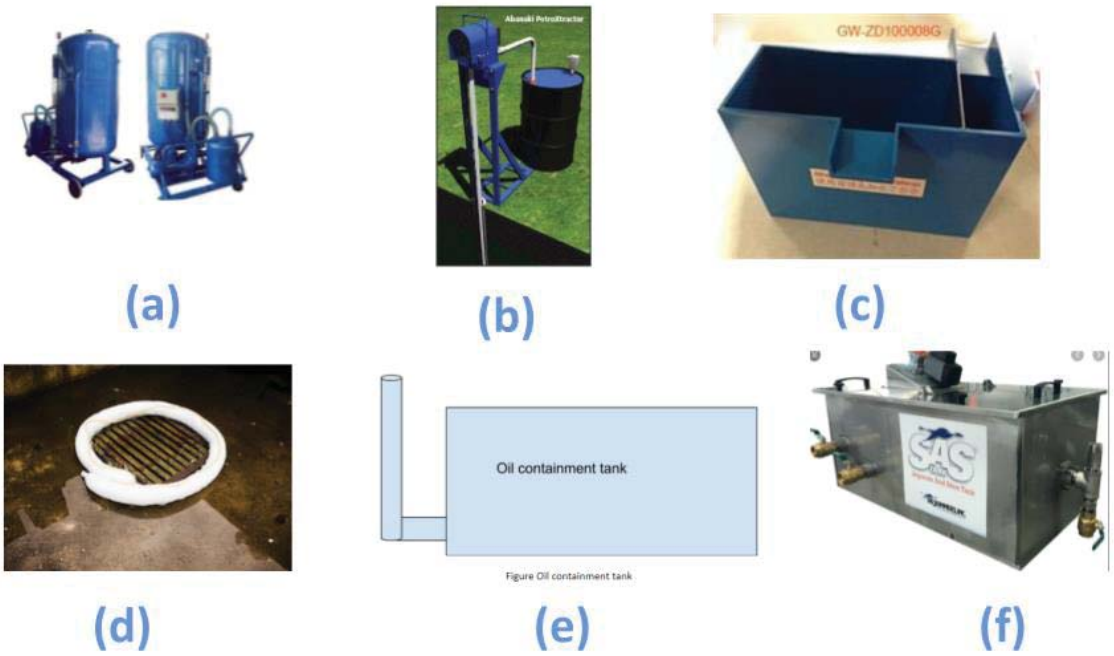


Figure 4.19 Concept Sketches for “Contain the oil”

References

[1] Total Boat, 2-Part Polyurethane Flotation Foam, Flotation equipment Brochure, Total Boat, Bristol, 2020.

[2] Ocean 3 Fendering & Floating Solutions, *Foam Filled Sphered Buoyancies*, Typology of Foam Filled Buoys and Floats, Ocean 3 Fendering & Floating Solutions, Linselles, 2015.

[3] "Neutral Buoyancy." *Wikipedia*, Wikimedia Foundation, 19 Apr. 2020, en.wikipedia.org/wiki/Neutral_buoyancy.

[4] Ocean 3 Fendering & Floating Solutions, *Foam Filled Modular Chain Buoys*, Typology of Foam Filled Buoys and Floats, Ocean 3 Fendering & Floating Solutions, Linselles, 2015.

[5] "Tri Float Oil Skimmer " ATECO TANK." *ATECO TANK*, www.atecotank.com/floating-suction-lines/tri-float-oil-skimmer/.

[6] "Floating Drum Skimmer: Heavy Duty Industrial Skimmer: Skimoil, Inc." *SKIMOIL*, www.skimoil.com/floating-drum-oil-skimmer.html.

[7] "Drum Oil Skimmers: Oleophilic Skimmer." *Elastec*, 1 Oct. 2020, www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/.

[8] Corp., Everight Position Technologies. *Oil Debris Sensor Prevents Particle Build-up by Everight Position Technologies Corp.*, MotionControl.com, 24 Mar. 2017, www.motioncontrol.com/products/oil-debris-sensor-prevents-unscheduled-downtime-by-detecting-particle-build-up/

[9] *Roc-Bloc 2K Debris Net with WS70 1/8" Debris Liner - 20' x 25'*. www.uscargocontrol.com/Roc-Bloc-2K-Debris-Net-with-WS70-1-8-Debris-Liner-20-x-25.

[10] | Cummins®, "Debris Shield. n.d. Source One Parts Center." https://s1partscenter.com/brands/cummins/shield/ (October 23, 2020)

[11] "Designed for Jet Drive Watercraft." *The Repeller Grate*, repellergrate.com/.

[12] Riggins, Caleb. Special netting. 17 Oct. 2020

[13] "Pool Supplies, "Skimmer Wizard - Skimmer Guard - Keep Leaves." Critters and Debris Out of Skimmer Basket, https://www.poolsupplies.com/product/... (October 18, 2020)

[14] "Search for RT-30 Flow Transmitter." Instrumart, www.instrumart.com/search?query=+RT-30+Flow+Transmitter.

[15] Cifuentes, Ximena, Debris Collection Net Sketches, October 16, 2020

[16] Cifuentes, Ximena, Debris Collection Fence Sketches, October 16, 2020

[17] Instrumentation Forum, "Self-Flushing Debris filter", https://instrumentationforum.com/t/self-flushing-debris-filter/48731 (October 19, 2020)

[18] "Elevator Oil Pump Switch: Oilsmart Alarm Systems: Skimoil, Inc." SKIMOIL, 2018, www.skimoil.com/oilsmart-systems.html.

[19] MSC Industrial Supply - Metalworking Tools and MRO Supplies, 2015, www.mscdirect.com/browse/Lubricants-Coolants-Fluids/Oil-Skimmers-Filters-Aerators?navid=12107395.

[20] Grainger, "Paper Hydraulic Filter Element, 10 Micron Rating, Primary Filter Removes Particles."

[21] Websturaunt Store ,"Advance Tabco A-17 3" Deep Perforated Sink Basket for 9 1/2 x 11 1/2" x 6" Bowls." https://www.webstaurantstore.com/advance-tabco-a-17-3-deep-perforated-sink-basket-for-9-1-2-x-11-1-2-x-6-bowls/109A17.html?utm_source=google&utm_me (October 19, 2020)

[22] Grainger ,"Paper Hydraulic Spin-on Filter, 10 Micron Rating, 3/4 in NPT Inlet Port Thread Size, 10 Micron Rating, Primary Filter Removes Particles." https://www.grainger.com/product/GRAINGER-APPROVED-Paper-Hydraulic-Spin-on-Filter-3KML8 (October 18, 2020)

[23] Storm Water Systems, "Bandalong Litter Trap." https://stormwatersystems.com/trash-traps/ (16 October 2020)

[24] Storm Waters Systems, "Bandalong Boom Systems." https://stormwatersystems.com/bandalong-boom-systems/(16 October 2020)

[25] "Hayward Debris Bag Float TVX6009EA." *Sunplay*, sunplay.com/products/hayward-debris-bag-float-tvx6009ea.

[26] "KROHNE OPTIMASS 2000 Coriolis Mass Flow Meter." *Instrumart*, www.instrumart.com/products/40473/krohne-optimass-2000-coriolis-mass-flow-meter.

[27] Instrusmart ,"Greyline Instruments SLT 5.0 Level & Flow Monitor." **https://www.instrumart.com/products/41663/greyline-instruments-slt-50-level-flow-monitor (October** 19, 2020)

[28] Instrumart, "GF Signet 2551 Magmeter." **https://www.instrumart.com/products/18714/gf-signet-2551-magmeter** (October 16, 2020)

[29] Badge Meter, *M1000 Electromagnetic Flow Meter*, Flow Instrumentation Brochure, Badge Meter, Milwaukee, 2020.

[30] Gems Sensors & Controls, *FS-480 Series Flow Switch,* Flow Switches and Sensors Brochure, Gems Sensors & Controls, Plainville, 2020.

[31]*GPI TM Series Water Meter with 09 Display*. www.instrumart.com/products/22926/gpi-tm-series-water-meter-with-09-display.

[32] Premier Control Technologies, *Dynasonics TFX 5000 Transit Time Flow Meter*, Ultrasonic Flow Meter Brochure, Wymondham, 2020.

[33] E+E EE381 Moisture Transmitter." *Instrumart*, www.instrumart.com/products/42930/ee-ee381-moisture-transmitter.

[34] Dhar, Nibir K., et al. "Advances in Infrared Detector Array Technology." *IntechOpen*, IntechOpen, 16 Jan. 2013, www.intechopen.com/books/optoelectronics-advanced-materials-and-devices/advances-in-infrared-detector-array-technology.

[35] "SPI Model SDC12B Duplex Control Panel." Septic Solutions - Buy Septic System Parts and Supplies Online!, 2010, www.septicsolutions.com/septic-parts/control-panels/duplex-control-panels/.

[36] Zebraskimmers, "Electrical Panel." http://www.zebraskimmers.com/oil_skimmer_products/fill_station_fluid_delivery_old.html (16 October 2020)

[37] "Oil Content Monitor: 15PPM Monitor: THP." Separator Systems, 2012, www.separatorsystems.com/oil-content-monitor.html.

[38] "Rosemount 3051SFC Compact Orifice Flow Meter." *Instrumart*, www.instrumart.com/products/28975/rosemount-3051sfc-compact-orifice-flow-meter.

[39]Separator Systems, "Separator Systems." http://www.separatorsystems.com (16 October 2020)

[40] "Core Sensors CS80 Intrinsically Safe Pressure Transducer."*Instrumart,* https://www.instrumart.com/products/47753/core-sensors-cs80-intrinsically-safe-pressure-transducer (October 17,2020)

[41] See Water Inc, "Oil Smart Systems." https://www.seewaterinc.com/product/oil-smart-high-liquid-alarm-osa-05 (16 October 2020)

[42] 1000Bulbs, "Timers." https://blog.1000bulbs.com/home/what-kinds-of-timers-can-i-use-with-my-lights (17 October 2020)

[43] Johnson, G. (2016, June 29). *Development of Smart Skimming Technologies* (Rep.). Retrieved October 17, 2020, from U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement website:https://www.bsee.gov/sites/bsee.gov/files/oil-spill-response-research-osrr/1037aa.pdf

[44] "ID-225 Oil Thickness Sensor for Wet Sumps." *Leakwise*, 2014, www.leakwise.com/ID-225-Oil-Thickness-Sensor-for-wet-sumps.html.

[45] Foukner, Jiri, "Engineering Essentials: Flow-Control Valves", January 1, 2012, https://www.hydraulicspneumatics.com/technologies/hydraulic-valves/article/21885085/engin eering-essentials-flowcontrol-valves (October 16, 2020)

[46]"Blancett B2900 Flow Monitor."*Instrumart,*
Source: https://www.instrumart.com/products/43082/blancett-b2900-flow-monitor(October 18,2020)

[47]"Ashcroft B Series Pressure Switch."*Instrumart,*
https://www.instrumart.com/products/37159/ashcroft-b-series-pressure-switch(October 18, 2020)

[48] Flowserve, *Customized Control for Severe Throttling Services,* Worcester Controls CPT Characterized Seat Control Valve, Flowserve, Irvin, 2007.

[49]"Skimpy Accessories and Replacement Belts." *Skimpy Accessories and Replacement Belts | Coolant Consultants, Inc.*, www.coolantconsultants.com/skimpy-accessories-and-replacement-belts.

[50] Corporation, Ready-Market Online. "Oil Skimmer." *SEHO INDUSTRY CO., LTD.*, www.sehoworld.com/en/product/Oil-Skimmer_disc_actuator_type.html.

[51] "Model 845: 100 KHz to 12, 20, 26.5 GHzMicrowave / RF Signal Generator." *Microwave/RF Signal Generator, 9 KHz to 26.5 GHz | Berkeley Nucleonics*, www.berkeleynucleonics.com/microwave-signal-generators.

[52] "Waygate Technologies DMS Go+ Thickness Gauge." *instrumart,*
https://www.instrumart.com/products/38960/waygate-technologies-dms-go-thickness-gauge (October 18,2020)

[53] "Waygate Technologies CL5 Ultrasonic Thickness Gauge."*Instrumart,*
https://www.instrumart.com/products/36262/waygate-technologies-cl5-ultrasonic-thickness-gauge
(October 18,2020)

[54]Berg Engineering & Sales Company, INC, "Ultrasonic Testing."
https://www.bergeng.com/blog/ultrasonic-testing-experts-discuss-nondestructive-testing/ (17 October 2020)

[55] "Panametrics XMT868i Ultrasonic Flow Transmitter." *Instrumart*, www.instrumart.com/products/38781/panametrics-xmt868i-ultrasonic-flow-transmitter.

[56] "Waygate Technologies Delay Line Transducers." *Instrumart*, www.instrumart.com/products/39739/waygate-technologies-delay-line-transducers.

[57]"Panametrics DigitalFlow DF868 Ultrasonic Flow Meter." *Instrumart* https://www.instrumart.com/products/16987/panametrics-digitalflow-df868-ultrasonic-flow-meter (October 18, 2020)

[58] "Home." *Cole*, 2017, www.coleparmer.com/p/tuning-fork-vibration-viscometer-43751/43751.

[59] Badger Meter, "Industrial Gear Flow Meters solutions." https://www.badgermeter.com/technologies/industrial-oval-gear-flow-meters/ (17 October 2020)

[60] "E+H Proline Promass I 300 Coriolis Flow Meter." *Instrumart*, www.instrumart.com/products/47445/eh-proline-promass-i-300-coriolis-flow-meter.

[61] ProMinent, "Flow Meter DulcoFlow." https://www.prominent.com/en/Products/Products/Measuring-Control-and-Sensor-Technology/Measuring-and-Test-Systems/p-dulcoflow.html (17 October 2020)

[62] PCE Instruments, *Hand Viscosity meter (Viscolite)*, Measuring Instruments Brochures, PCE Instruments, Southampton, 2015.

[63] Cornell Scientific, *Surface Tension & Foam Analysis,* Teclis Tensiometer Brochure, Cornell Scientific, New Delhi, 2013.

[64] *CAS TM-10K Tension Meter WITH Shackles 10000 x 10 Lb* , www.scalesgalore.com/product/CAS-TM10K-Tension-Meter-with-shackles-10000-x-10-lb-px39222.cfm?campaign_id=13.

[65] "Oil Skimmer." *StingRay Parts Washer | Oil Skimmer*, 2016, www.stingraypartswasher.com/parts-washer-option-oil-skimmer.html.

[66] GARDCO, *Sensadyne Fluid Surface Tensionmeter,* Surface Tensiometer brochure, GARDCO, Pompano, 2020.

[67] "Spinning Drop Tensiometer." *KRÜSS - Advancing Your Surface Science*, 3 Apr. 2018, www.kruss-scientific.com/services/education-theory/glossary/spinning-drop-tensiometer/.

[68] "Tensiometer Classic." *English*, pronova.de/en/products/agricultural-measuring/moisture-analysis/1116/tensiometer-classic.

[69] “Search Results.” *At Thomas Scientific*, 2010, www.thomassci.com/scientific-supplies/Digital-Viscometer.

[70] Advanced Supplies ,“Tank Mounted Viscosity Sensor Unaffected by Level, Mix or Turbulence.” http://www.advancedsupplies.co.uk/news/tank-mounted-viscosity-sensor-unaffected-by-level-mix-or-turbulence/ (October 17, 2020)

[71] “Micro Motion CDM100 Compact Density Meter.” *Instrumart*, www.instrumart.com/products/46967/micro-motion-cdm100-compact-density-meter.

[72] Trevino, David. *Different oil groups* . 20 Oct. 2020

[73]Test Oil, “Viscosity.” https://testoil.com/services/oil-analysis/viscosity/ (17 October 2020)

[74] Riggins, Caleb. *Detection system*. 19 Oct. 2020

[75] “Search Results.” At Thomas Scientific, 2010, www.thomassci.com/scientific-supplies/Digital-Viscometer.

[76] “90° Horizontal Plastic Float Switch.” *SMD Fluid Controls*, www.fluidswitch.com/product/fh-viw/.

[77] “Gems FS-10798 Series Flow Switch.” *Instrumart*, www.instrumart.com/products/39172/gems-fs-10798-series-flow-switch.

[78] *MSC Industrial Supply - Metalworking Tools and MRO Supplies*, 2015, www.mscdirect.com/browse/Lubricants-Coolants-Fluids/Oil-Skimmers-Filters-Aerators?navid=12107395.

[79] “KROHNE OPTIMASS 1000 Coriolis Mass Flow Meter.” *Instrumart*, www.instrumart.com/products/40475/krohne-optimass-1000-coriolis-mass-flow-meter.

[80]”Handheld Density Meter, DensitoPro.” https://www.mt.com/us/en/home/products/Laboratory_Analytics (October 18, 2020)

[81] Olga Spakovskaja, Technical Translations UA. *PAR 99X-MA Analog Recorder*, 3 Mar. 2014, www.industrial-needs.com/technical-system/analog-recorder-par-99x-ma.htm.

[82] Grainger ,“300 mm, NIST Standards Hydrometer for Specific Gravity.” https://www.grainger.com/product/THERMCO-300-mm-32GC45 (October 18, 2020)

[83] Instrusmart ,"Rosemount 2051L Liquid Level Transmitter." **https://www.instrumart.com/products/24668/rosemount-2051l-liquid-level-transmitter** (October 16, 2020)

[84] IFM Electronic ,"LMT110 Sensor for point level detection." https://www.ifm.com/us/en/product/LMT110 (October 15, 2020)

[85] McWilliams, R. J. (n.d.). Floating Tripod Oil Skimmer: Surface Oil Skimmer: Skimoil, Inc. Retrieved October 25, 2020, from https://www.skimoil.com/tripod-floating-oil-skimmer.html

[86] "Skimpy Accessories and Replacement Belts." *Skimpy Accessories and Replacement Belts | Coolant Consultants, Inc.*, www.coolantconsultants.com/skimpy-accessories-and-replacement-belts.

[87] *MSC Industrial Supply - Metalworking Tools and MRO Supplies*, 2015, www.mscdirect.com/browse/Lubricants-Coolants-Fluids/Oil-Skimmers-Filters-Aerators?navid=12107395.

[88] "New Invention Digital Online Refined Petroleum Density Meter/Hydrometer - Buy Online Liquid Hydrometer,Refined Petroleum Density Meters,New Invention Density Meter Product on Alibaba.com." *Www.alibaba.com*, www.alibaba.com/product-detail/new-invention-digital-online-refined-petroleum_62327739111.html?spm=a2700.7724857.normalList.81.f14662f5ouInnw.

[89] Verde Supply inc., "Grooved Disc Skimmers." **https://verde.ie/products/spill-response-equipment/skimmers-accessories/** (October 14, 2020)

[90] Trevino, David. *Disk with special coating*. 17 Oct. 2020.

[91] Instrusmart, "Flowline EchoPod DL24 Ultrasonic Level Transmitter." **https://www.instrumart.com/products/35434/flowline-echopod-dl24-ultrasonic-level-transmitter** (October 15,2020

[92] Instrusmart ,"Druck 1800 Series Submersible Pressure Transmitters." https://www.instrumart.com/products/23241/druck-1800-series-submersible-pressuretransmitters (October 15, 2020)

[93] McCleland, Jacob. "Revolutionary Oil Skimmer Nets $1 Million X Prize." *NPR*, NPR, 19 Oct. 2011, www.npr.org/2011/10/19/141481055/revolutionary-oil-skimmer-nets-1-million-x-prize

[94] Trevino, David. *Grooves distancing*. 17 Oct. 2020.

[95] "Keller Acculevel Submersible Level Transmitter." *Instrumart*, www.instrumart.com/products/33962/keller-acculevel-submersible-level-transmitter.

[96] “Grooved Drum: Oil Skimmers.” *Elastec*, 8 Feb. 2017, www.elastec.com/products/oil-spill-skimmers/accessories/grooved-drum-skimmers/

[97] Cifuentes, Ximena, *Adjusted Grooved Oleophilic Disk,* October 16, 2020.

[98] Amazon, “Neiko 30252A Water and Oil Separator for Air Line, 1/4" NPT Inlet and Outlet, 90 psi.” **https://www.amazon.com/Neiko-30252A-Water-Separator-Outlet/dp/B002GQ3SUA** (October 16,2020)

[99] Elsworth, John M, “Banjo 1/2 in. x 1/2 in. Mini Polypropylene T-Strainer w/ Clear Bowl.” https://www.jmesales.com/banjo-1-2-in-x-1-2-in-mini-polypropylene-t-strainer-w-clear-bowl/ (October 15, 2020)

[100] Cifuentes, Ximena, *Increased Finger Length of Recovery Tray*, October 16, 2020.

[101] Vikoma. “In-Tank Skimmer.” *Vikoma*, 2009, www.vikoma.com/Industrial_oily_water_skimming/Skimmers/In_tank_skimmer.html.

[102]Kongsberg, “ Water in Oil Sensor.” **https://www.kongsberg.com/maritime/products/engines-engine-room-and-aut omation-systems/Machinery-Instrumentation/ engine-monitoring-systems/water-in-oil-sensor** (October 15, 2020)

[103]SMD Fluid Controls, “FS20- High Pressure Liquid Level Sensor.” **https://www.fluidswitch.com/product/high-pr essure-vertical-float-switch/** (October 14,2020)

[104] Sandford, Demetrious. *Oil water separator*. 21 Oct. 2020.

[105] Vikoma. “In-Tank Skimmer.” *Vikoma*, 2009, www.vikoma.com/Industrial_oily_water_skimming/Skimmers/In_tank_skimmer.html.

[106] Corporation, Ready-Market Online. “Oil Skimmer.” *SEHO INDUSTRY CO., LTD.*, www.sehoworld.com/en/product/Oil-Skimmer_disc_actuator_type.html.

[107] Skimoil inc., “ The Oilsmart Pump Switch.” **https://www.skimoil.com/oilsmart-systems.html** (October 15, 2020)

[108]Corporation, Ready-Market Online. “Oil Skimmer.” *SEHO INDUSTRY CO., LTD.*, www.sehoworld.com/en/product/Oil-Skimmer_disc_actuator_type.html.

[109] “Rosemount 2120 Liquid Level Switch.” *Instrumart*, www.instrumart.com/products/25475/rosemount-2120-liquid-level-switch.

[110] Northern Tool Equipment, “Filter Cart Liquid Dynamics” https://www.northerntool.com/shop/tools/product_200373284_200373284 (October 17,2020)

[111]SmartSkim, “V Series Separator,” *https://smartskim.com/sump-cleaners.html* (October 18,2020)

[112] High Purity Northwest, “Kidney Loop Filtration System,” https://highpuritynorthwest.com/wp-content/uploads/2017/02/Kidney-Loop-Web-Email.pdf (October 14, 2020)

[113] SmartSkim, “V Series Separator,” *https://smartskim.com/sump-cleaners.html* (October 18,2020)

[114] High Purity Northwest, “Kidney Loop Filtration System,” https://highpuritynorthwest.com/wp-content/uploads/2017/02/Kidney-Loop-Web-Email.pdf (October 14, 2020)

[115] Trevino, David. *Fluid separator*. 21 Oct. 2020.

[116] “Kobold REG Automatic Flow Regulating Valves.” *Instrumart*, www.instrumart.com/products/31735/kobold-reg-automatic-flow-regulating-valves.

[114] “Georg Fischer Type 127 Ball Valve.” *Instrumart*, www.instrumart.com/products/44444/georg-fischer-type-127-ball-valve.

[117]”E+E EE360 Moisture in Oil Transmitter.” *Instrumart, https://www.instrumart.com/products/44261/ee-ee360-moisture-in-oil-transmitter (October 24, 2020)*

[116]”Gems FS-400 Series Flow Switch.” *Instrumart, https://www.instrumart.com/products/39180/gems-fs-400-series-flow-switch (October 24, 2020)*

[117]Center Enamel, Oil Storage Tank. http://www.cectanks.com/sale-7586694-30000-gallon-above-ground-storage-tanks-crude-oil-storage-tank.html (17 October 2020)

[118]Abanaki, “Implementing Oil Skimmer.” https://www.plantservices.com/assets/wp_downloads/pdf/100427_Abanaki.pdf (18 October 2020)

[119] “Hermit Skimmer: Tank Oil Skimmer: Oil Tank Cleaning.” *Elastec*, 5 Oct. 2020, www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/tank-oil-skimmer/.

[120] “Floating Boom Socks - Oil-Only.” *HEXA Containment*, hexacontainment.com/collections/absorbent-booms/products/oil-only-boom-sock-net.

[121] Trevino, David. *Containment tank*. 21 Oct. 2020.

[122] SAS Tank - Oil Water Separator. (2016). Retrieved October 25, 2020, from https://www.oilskim.com/tanks-and-separators/sas-tank-oil-water-separator

SENIOR DESIGN & PROFESSIONALISM I

FALL 2020

PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: _____Concepts Generation_____

GROUP NUMBER: ___7___

Progress Report Title: Status Report VII
Due Date: 10/24/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	Amna ansari DocuSigned by: Amna Ansari E25E51620421451...	- Separate debris from fluids taken by skimmer - Accurately detect flow rate - Control rate of recovery - Maintain oil/water ratio - Self-adjust separation method to different types of oil - Contain contaminated oil - Contain the oil(filter water out of the oil)		
2				
3				
4				
5				
6				
7				

*100% means the member completed his/her assigned work *By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.*

COLLEGE OF ENGINEERING

SENIOR DESIGN AND PROFESSIONALISM 1

FALL 2020 SEMESTER

Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/24/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.
2. **Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)**
3. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.
4. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:

Concept 1 for the function " Heat the biomass"

Figure 1.1 shows the concept for this function.

Then provide a brief description of the concept and how it works to execute the function.

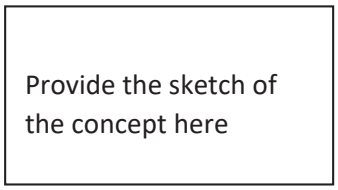


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

5. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
   The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Individual Grading Scheme

Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	**10**
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	**36**
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	**43**
4	Status report assignment sheet attached	5	**5**
	Total for Individual Report	100	**94**

Group Grading Scheme

Homework #7b

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

Table 4.1 presents functions for level 0,1,2,and 3. In addition, the Table also shows the assigned function for students. The students have to generate 4 concepts for each assigned function and present them in table 4.2, which is morphology with the functional decomposition and concepts table. The student is required to list the 4 descriptions and figures and for each function in table4. 2.

Table 4.1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name
Recover at least 25~50% on 1-inch oil slick	Skimmer Mobility	Mobilize the skimmer	Perform Floatation Stabilization			
	Collect oil through debris or choppy water	Avoid debris collection	Limit debris entering skimmer			
			Separate debris from fluids taken by skimmer	Amna A		
			contain debris			
	Measure oil recovery rate	Measure the amount of oil recovered per second	Transform rate readings			
			Calculate amount of oil intake			
			Accurately detect flow rate	Amna A		
		Control rate of recovery		Amna A		

	Able to filter various oil slick thickness	Distinguish between oil viscosities	Maintain oil/water ratio	Amna A		
			Measure oil resistance to flow			
			Detect surface tension			
		Detect type of oil				
		Self-adjust separation method to different types of oil		Amna A		
	Limit water intake	Control water intake	Differentiate specific gravities of fluids			
			Collect optimal level of fluids			
	Separate oil from water	Filter water out of the oil	Separate oil from water			
			Dissipate excess water			
			contain contaminated water	Amna A		
		Contain the oil(filter water out of the oil)		Amna A		

Table 4. 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concepts 6		Concept 7		Concept 8	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
Recover at least 25~50 % on 1-inch oil slick	Skimmer Mobility	Mobilize the Skimmer	Perform Floatation Stabilization																
	Collect oil through debris or choppy water	Avoid debris collection	Limit debris entering skimmer																
			Separate debris from fluid taken by skimmer	Booms	Figure 4.1a	net	Figure 4.1b	self-filtration debris filter	Figure 4.1c	Filter wiper	Figure 4.1d								
			Contain debris																
	Measure Oil Recovery Rate	Measure the amount of oil recovered per second	Calculate amount of oil intake																
			Transform rate readings																
			Accurately detect flow rate	Core Sensors CS84	Figure 4.2a	Core Sensors CS80	Figure 4.2b	A floating sensor	Figure 4.2c	is GE Leakwise ID-227	Figure 4.2d								
		Control rate of recovery		Blancett B2900 Flow Monitor	Figure 4.3a	Flow Meter	Figure 4.3b	ultrasonic flow meter	Figure 4.3c	Pressure Switch	Figure 4.3d								
	Able to filter various oil slick thickness	Distinguish between oil viscosities	Maintain oil/water ratio	Parametric DigitalFlow	Figure 4.4a	Thickness Gauge	Figure 4.4b	ultrasonic thickness gage	Figure 4.4c	refractometer	Figure 4.4d								
			Measure oil resistance to flow																
			Detect surface tension																

		Detect type of oil																		
		Self-adjust separation method to different types of oil		v-grooved disk skimmer	Figure 4.5a	KROHNE OPTIMASS	Figure 4.5b	handheld density	Figure 4.5c	versatile viscometer	Figure 4.5d									
	Limit water intake	Control water intake	Differentiate between specific gravities																	
			Collect optimal level of fluids																	
	Separate oil from water	Filter water out of the oil	Separate oil from water																	
			Dissipate excess water																	
			Contain contaminated water	FS-400 Series Flow Switch	Figure 4.6a	GF Signet 2551 Magmeter	Figure 4.6b	Edgetech DewMaster	Figure 4.6c	Moisture in Oil Transmitter	Figure 4.6d									
		Contain the oil		Oil skimmer tank	Figure 4.7a	Fixed skimmer tank	Figure 4.7b	Oil Tank	Figure 4.7c	Floating oil tank	Figure 4.7d									

Individual Concepts Generation

The following list contains the concept generations for the functions that have been assigned for Amna Ansari. Each list contains a description of the assigned function, and visual representations that present 4 concepts for the function.

4.1. Concept for the function “Separate debris from fluid taken by the skimmer”

In figure 4.1 the concept generation of the function “filtration system diverting that debris” is being observed. Figure 4.1A is a Booms that can be used to control spread of oil and debris. Figure 4.1B is a net that can be used to collect debris. Figure 4.1C is a self-filtration debris filter that can divert any unwanted material out of the system[3]. Finally, figure 4.1D showcases a wiper than can be used to clean the filter.

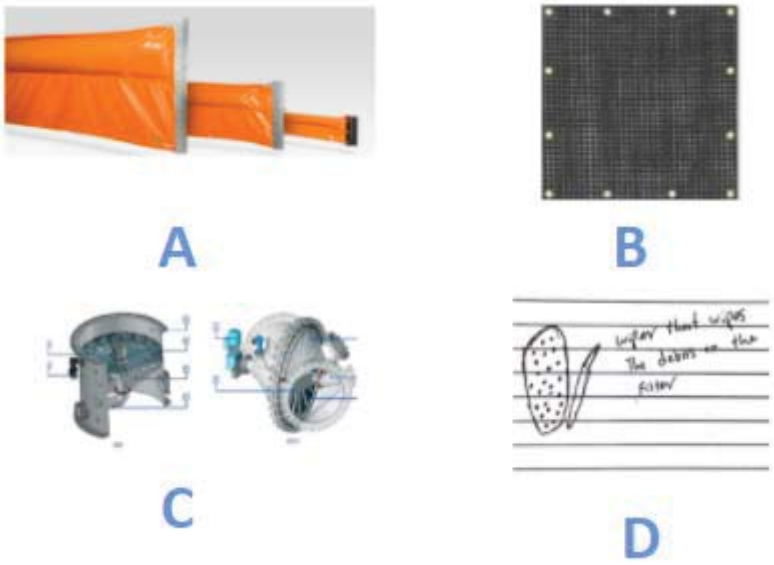


Figure 4.1 Concept Sketches for “Filtration system diverts that debris”

4.2. Concept for the function “Accurately Detect Flow Rate”

Figure 4.2 represents 4 concept generations for the function of accurately detecting the amount of oil recovered per second through a sensor. 4.2A is Core Sensors CS84, which is a sensor that can operate in a wide temperature range and it is able to be an intrinsically safe differential pressure transducer. 4.2B is Core Sensors CS80, a versatile pressure transducer that is designed to operate under the harshest conditions[6]. 4.2C is a floating sensor that can be attached to the oil skimmer, the following sensor is designed to be placed on top of the water to minimize the tendency to lift or submerge in wave action and to ensure accurate reading of the amount of oil recovered. Finally, 4.2D is GE Leakwise ID-227, which is a high frequency transceiver with two antenna elements. One antenna is located at the water interface and the other is located underwater. [8]

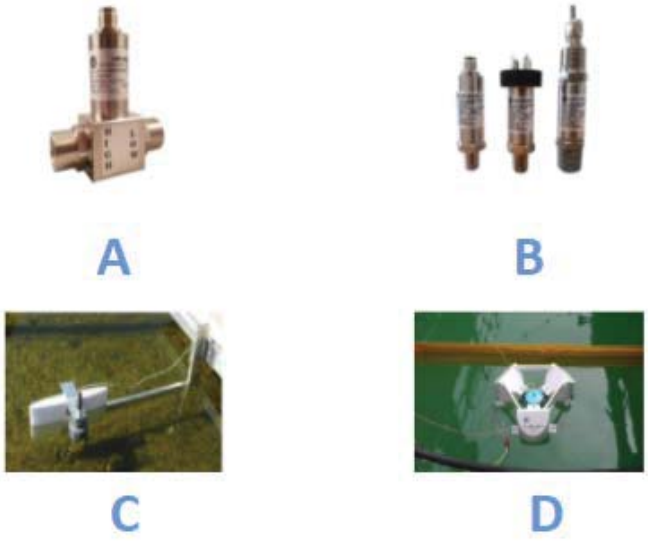


Figure 4.2 Concept Sketches for “Accurately detect through sensor”

4.3. Concept for the function “Control rate of recovery”

Figure 4.3 is the concept generation for the function of “Control rate of recovery” can be distinguished. Figure 4.3A present a Blancett B2900 Flow Monitor, a flow meter that calculates flow rate and total flow simultaneously with 10-point linearization for improved accuracy[9]. Figure 4.3B shows a flow meter, E+H Proline Promass P 100 Coriolis Flow Meter features enhanced performance of a bent tube meter and the drain ability of a straight tube meter without any compromise. Figure 4.3C, is an ultrasonic flow meter that is called Parametric TransPort PT900. Which is a portable flow meter that can be easily clipped to a pipe to take flow measurements. Lastly, figure 4.3D is a Ashcroft B400 Series Pressure Switch, a pressure switch that can control the oil rate recovery.[12]

Figure 4.3 Concept Sketches for “Control rate of recovery”

4.4. Concept for the function “maintain oil/water ratio”

The concept generation for the function “verify oil thickness” is represented in figure 4.4. Figure 4.4A is a Parametric DigitalFlow, which is an ultrasonic flow meter that can measure oil thickness by calculating other parameters such as velocity, volumetric and energy flow rates using transit time technology[13]. Figure 4.4B, DMS Go+ Thickness Gauge has the ability to provide accurate, reliable and comprehensive thickness inspection data[14]. Figure 4.4C also presents an ultrasonic thickness gage that is called CL5 Ultrasonic Thickness Gauge[15]. Figure 4.4D display a refractometer, a handheld device that can determine concentration of water in oil.

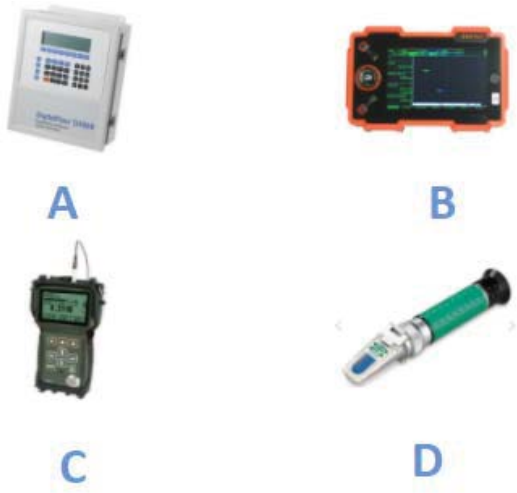


Figure 3 Concepts Sketches for “Verify oil thickness”

4.5. Concept for the function “Self-adjust to separation methods different type of oil”

In figure 4.5 the concept generation for the function of “self-adjust to different types of oil” can be observed. Figure 4.5A shows a v-grooved disk skimmer that can recover oils of different types. Figure 4.5B is KROHNE OPTIMASS 1000 Coriolis Mass Flow Meter that can measure volume, temperature, volume concentration or solid content[18]. Figure 4.5C is a handheld density meter that can adjust to different types of oil[19]. Figure 4.5D presents a versatile viscometer that can evaluate fluidity and thickness of various fluid materials.

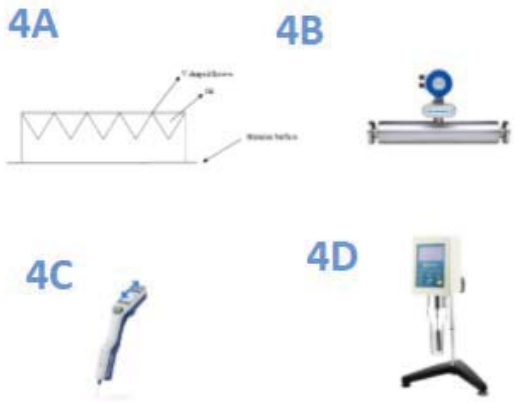


Figure 4.5 Concept Sketches for “Self-adjust to different types of oil”

4.6. Concept for the function “contain contaminating water”

In Figure 4.6 the concept generation for the function “avoid contaminating water” is present. Figure 4.6A is a Gems FS-400 Series Flow Switch, which is a switch that can be used to separate the oil[21]. Figure 4.6B presents a GF Signet 2551 Magmeter, a monitor that can be used to detect water. Figure 4.6C is Edgetech DewMaster, a dew point hygrometer that is capable of measuring dew point, absolute pressure, PPMv and other psychometric variables. Figure 4.6D present Moisture in Oil Transmitter, it offers highly accurate measurement of water activity and temperature; it uses those values to calculate the absolute water content.[24]

Figure 5 Concept Sketches for “Avoid contaminating water”

4.7. Concept for the function “Contain the oil (filter the water out of the oil)”

Figure 4.7 presents the concept generation for “containing the oil.” In Figure 4.7A, the reader can observe that an Oil skimmer tank is presented, this tank can be used to contain the oil[25]. Figure 4.7B shows Fixed skimmer tank, this type of tank is attached to a fixed oil skimmer. Figure 4.7C presents Oil Tank, which has the same concept as figure 4.7A. Figure 4.7D, is a floating oil skimmer tank that can be used in water.

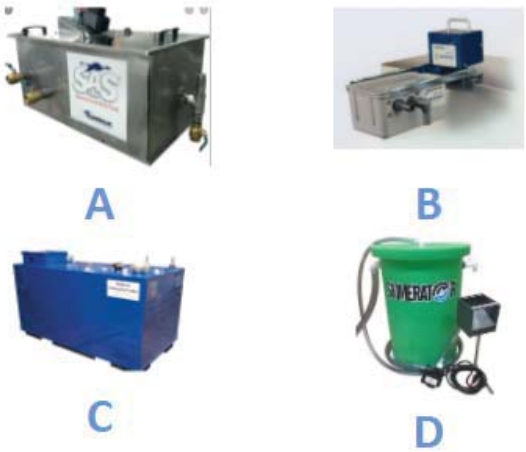


Figure 4.7 Concept Sketches for “Contain the oil”

References

[1]

[2]

[3] Instrumentation Forum, "Self-Flushing Debris filter", https://instrumentationforum.com/t/self-flushing-debris-filter/48731 (October 19, 2020)

[4]

[5]

[6] "Core Sensors CS80 Intrinsically Safe Pressure Transducer."Instrumart, https://www.instrumart.com/products/47753/core-sensors-cs80-intrinsically-safe-pressure-transducer (October 17,2020)

[7]

[8] "Core Sensors CS80 Intrinsically Safe Pressure Transducer."Instrumart, https://www.instrumart.com/products/47753/core-sensors-cs80-intrinsically-safe-pressure-transducer (October 17,2020)

[9] "Blancett B2900 Flow Monitor."Instrumart, Source: https://www.instrumart.com/products/43082/blancett-b2900-flow-monitor(October 18,2020)

[10]

[11]

[12] "Ashcroft B Series Pressure Switch."Instrumart, https://www.instrumart.com/products/37159/ashcroft-b-series-pressure-switch(October 18, 2020)

[13] "Panametrics DigitalFlow DF868 Ultrasonic Flow Meter." Instrumart https://www.instrumart.com/products/16987/panametrics-digitalflow-df868-ultrasonic-flow-meter (October 18, 2020)

[14] "Waygate Technologies CL5 Ultrasonic Thickness Gauge."Instrumart, https://www.instrumart.com/products/36262/waygate-technologies-cl5-ultrasonic-thickness-gauge (October 18,2020)

[15] ”Waygate Technologies DMS Go+ Thickness Gauge.” instrumart, https://www.instrumart.com/products/38960/waygate-technologies-dms-go-thickness-gauge (October 18,2020)

[16]

[17]

[18] “KROHNE OPTIMASS 1000 Coriolis Mass Flow Meter.” Instrumart, www.instrumart.com/products/40475/krohne-optimass-1000-coriolis-mass-flow-meter.

[19] ”Handheld Density Meter, DensitoPro.” https://www.mt.com/us/en/home/products/Laboratory_Analytics_Browse/densitymeter/portabledensitymeter/densitopro.html?SE=GOOGLEShopping&cmp=sea_04540127&Campaign=ANADERE_EN_US_Shopping&Adgroup=Handheld%20Density%20Meter&bookedkeyword=&matchtype=&adtext=380985203213&placement=&network=g&kclid=_k_CjwKCAjwlbr8BRA0EiwAnt4MTqlGN3uIijz0XKwiY_nRzEB1gqm_PrRzl_li_Mkq2BT1u1gfsfyHhoCwgsQAvD_BwE_k_&gclid=CjwKCAjwlbr8BRA0EiwAnt4MTqlGN3uIijz0XKwiY_nRzEB-1gqm_PrRzl_li_Mkq2BT1u1gfsfyHhoCwgsQAvD_BwE (October 18, 2020)

[20]

[21] ”Gems FS-400 Series Flow Switch.” Instrumart, https://www.instrumart.com/products/39180/gems-fs-400-series-flow-switch (October 24, 2020)

[22] Instrumart, “GF Signet 2551 Magmeter.” https://www.instrumart.com/products/18714/gf-signet-2551-magmeter (October 16, 2020)

[23] ”E+E EE360 Moisture in Oil Transmitter.” Instrumart, https://www.instrumart.com/products/44261/ee-ee360-moisture-in-oil-transmitter (October 24, 2020)

[24] SAS Tank - Oil Water Separator. (2016). Retrieved October 25, 2020, from https://www.oilskim.com/tanks-and-separators/sas-tank-oil-water-separator

[25]

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AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

89.5

PROJECT TITLE: Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER: 3

Progress Report Title: Concept Generation

Due Date:10/22/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Created 3 concept ideas for each function assigned. Helped with the morphology table for data input and organization.	100	
2	Fanta Kaba 	Created concepts for functions assigned to me. Added assigned parts to report.	100	
3	Christian White 	Assigned to generate conceptual solutions for the sub-functions of our systematic project and consolidate group reports.	100	
4	Abdullah EL Aker 	Assembled different concepts for multiple sub functions as well as providing sketches for each concept. Consolidated on all the concepts by the group	100	
5	Yemboado Yonli 	Assigned to create individual concepts Assigned to create morphology table Assigned to formatting	100	
6	Marcelo Epam Ona 	Generated some of the concepts and helped modify others, making sure they have a clear description and appropriate sketch.	100	

Attach the original assignment copy.

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the preliminary design chapter of the project report. Consequently, it was written in a detailed descriptive form as discussed based on the senior design manual. The purpose of this status report was to come with concepts for each function chosen in the functional decomposition. To do that, it was very necessary for the group leader to assign a function to different members of the group in order to elaborate different concepts for each individual subfunction. These concepts will actually help the group introduce solid ways that the functions and subfunctions might be conducted in order to successfully complete this project.

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

The group members were assigned to utilize the morphology table created in status report 6a to generate concepts for the final functions which were broken down into level 1, level 2, and level 3 sub-functions. The work was split as in Table 4.1. Four members were assigned per function. Each member was asked to create at least 3 concepts for each function they were assigned. Each group member was assigned 9 different final-level functions, and sub-functions, to which each group member generated 27 total concepts with the corresponding sketches which would then be consolidated by the entire group. The group then met on a zoom meeting to discuss which concepts needed to be consolidated in order to meet the appropriate amount of 4 concepts for each function. Once this was completed, each member was assigned functions to attach the various concepts with their respective functions and add the appropriate sketches to these concepts.

Table 4.1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid during the experiment	Heat up the nanofluid before pumping		Fanta	Abdoul	Christian	Marcelo
		Pump the nanofluid Through the pipes		Yemboado	Diana	Abdoul	Marcelo
		cool down the nanofluid after the measurements are made		Fanta	Christian	Yemboado	Diana
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		Yemboado	Marcelo	Christian	Abdoul
		Accommodate to the pressure boundary condition change		Diana	Fanta	Christian	Abdoul
		Accommodate the boundary layer change of the nanofluid		Yemboado	Marcelo	Diana	Fanta
	Measure the heat transfer coefficient and the thermal	Measure the heat transfer coefficient of the	Measure the voltage(V) drop in the boiler	Fanta	Abdoul	Christian	Marcelo

	conductivity of the nanofluid	nanofluid in the experiment	Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Yemboado	Diana	Abdoul	Marcelo
			Measure the intensity of the current used to heat up the nanofluid	Fanta	Christian	Yemboado	Diana
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Yemboado	Marcelo	Christian	Abdoul
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Diana	Fanta	Christian	Abdoul
			Measure the intensity of the current used to heat up the nanofluid	Yemboado	Marcelo	Diana	Fanta
		generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software	Yemboado	Marcelo	Diana	Christian

Missing function "Calculate thermal conductivity" and "Calculate heat transfer coefficient"

We discussed this in the meeting. You did not follow my comments.

			Generate Graphs showing the fluctuation of each parameter	Yemboado	Marcelo	Fanta	Abdoul

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

   In this part every group went ahead and based on the function that were assigned to them developed concepts that would help achieve the actual function of the apparatus. This assignment was made individually so the concepts could be as broad and different as possible. The number of concepts asked for each member was 3 per assigned function. It was also asked for the group member to have a brief description of their concept for better understanding.

3. Each group member should generate sketches of the various ideas/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

   Example:
   Concept 1 for the function "Heat the biomass"
   Figure 1.1 shows the concept for this function.
   Then provide a brief description of the concept and how it works to execute the function.

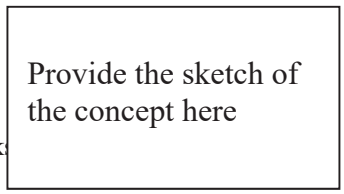

Figure 1.1 Concept 1 for the function "Heat the Biomass"

   Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

For each concept generated the student had to create or find a sketch that would represent the actual concept. the sketches were labelled and cited in the different individual assignments of the group members.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
   The example in question 3 can be used for describing the final concepts for each function.

   After each Group member had 27 concepts with the sketches needed the group met on zoom to consolidate the concepts. The consolidation was made on the basis of resemblance, ability to be applied and whether or not the concepts made sense. from all this filtering the group retained 4 concepts from each function. After the concepts were chosen, they were all put together functions by functions with their sketches. In the morphology table all chosen concepts were listed in front of corresponding functions with the figure numbers corresponding to the sketches associated with them. Table 4.2 shows the completed morphology table.

You don't make selection here. You should include all concepts generated by group members here. Each function may have more than 4 concepts and each function may have different number of concepts.

We discussed this in the meeting and you did not follow my comment.

Table 4.2 group 3 Morphology table Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch		
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid circulate during the experiment	Heat up the nanofluid before pumping		Ban heater	Figure 4.1	Heat exchanger	Figure 4.2	Boilers	Figure 4.3	Heat gun	Figure 4.4
		Pump the nanofluid Through the pipes		Gear pumps	Figure 4.5	A piston pump	Figure 4.6	Peristaltic tube pump	Figure 4.7	Horizontal centrifugal Pump	Figure 4.8
		Cool down the nanofluid after measurements		A condenser	Figure 4.9	cold plates	Figure 4.10	"Open feedwater cooler"	Figure 4.11	a liquid cooling heat exchanger	Figure 4.12
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		Stainless steel	Figure 4.13	The permeability	Figure 4.14	Crystals pipes	Figure 4.15	Magnetic field stabilizer	Figure 4.16
		Accommodate to the pressure boundary condition change		A pressure sensor	Figure 4.17	The pressure sensor	Figure 4.18	pressure Sensor	Figure 4.19	a control valve.	Figure 4.20
		Accommodate the boundary layer change of the nanofluid		Permeable linear stretching sheet	Figure 4.21	Nonlinear permeable stretches sheet	Figure 4.22	Increase flow velocity	Figure 4.23	flow meter	Figure 4.24
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Analog voltmeters	Figure 4.25	The control	Figure 4.26	An analog multimeter	Figure 4.27	A digital voltmeter	Figure 4.28
			Measure the temperature of the nanofluid	Multipoint temperature sensors" accurately	Figure 4.29	A temperature gauge" will	Figure 4.30	"Thermistors" prime function is to exhibit a	Figure 4.31	"The KD2 Pro" is wired to	Figure 4.32

Use show description.

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch		
			(Tin and Tout)	measuring temperatures at various locations along the sensor's length		accurately depict the temperature measured throughout the nanofluid		large, predictable, and precise c Call resistance		a nanofluid sampler which allows the measurement of the nanofluid sample temperature to be made.	
			Measure the intensity of the current used to heat up the nanofluid	Moving coil ammeters	Figure 4.33	Electrodynamic ammeters	Figure 4.34	Digital Ammeters	Figure 4.35	Digital Multimeters	Figure 4.36
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Voltage Control Panels	Figure 4.37	Digital Voltmeter	Figure 4.38	VTVMs and FET-VMs	Figure 4.39	Analog Voltmeters	Figure 4.40
			Measure the temperature of the nanofluid (Tin and Tout)	Voltmeters	Figure 4.41	Voltage Control Panels	Figure 4.42	The BNC control panel	Figure 4.43	Multimeters	Figure 4.44

Use short description.

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	**Sketch**	**Description**	**Sketch**	**Description**	**Sketch**		
			Measure the intensity of the current used to heat up the nanofluid	Moving coil Ammeters	Figure 4.45	Electrodynamic Ammeters	Figure 4.46	Tangent galvanometer	Figure 4.47	The KD2 pro measurement	Figure 4.48
		Generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software	SCADA software	Figure 4.49	DCS software	Figure 4.50	"IC Measure"	Figure 4.51	"Manually collecting data" is a process that involves an individual monitoring and collecting data for future use.	Figure 4.52
			Generate Graphs showing the fluctuation of each parameter	SCADA software	Figure 4.53	Entered data using EES	Figure 4.54	"Mark- 10 software+	Figure 4.55	"MATLAB" is a high-performance language for technical computing	Figure 4.56

Use short description.

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After every one ‘s individual assignment where put together this is how the group consolidated them in order to create Table 4.2

Function 1.1: Heat up the nanofluid before pumping

Concept 1: band heater

The Figure 4.1 presented below is a picture of a ban heater, which is used to heat the nanofluid during the experiment. The device is to be installed before the pump so it can adjust the temperature based on the input.

Briefly explain how this concept work.

Figure 4.1 shows an image of a Band Heater.

Concept 2: Heat exchanger

A heat exchanger in a furnace separates the combustion process from your breathing air. A combination metal chamber and passageway start at the burner assembly and ends approximately where the chimney vent connects to the furnace. Figure 4.2 shows a schematic of a heat exchanger as well as its different parts.

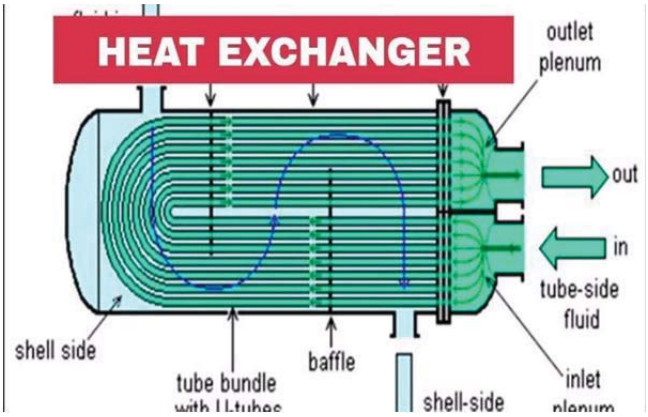


Figure 4.2 shows a picture of a heat exchanger.

Concept 3: Boiler

Allow nanofluid to heat in the boiler before the pumping process begins by feeding nanofluid into the feedwater inlet and passing through to the boiler before pushing forward in the process. Figure 4.3 is a schematic of the boiler and some of its different components.

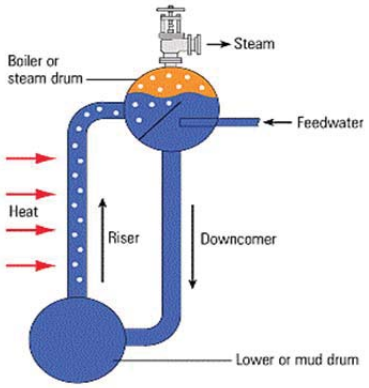


Figure 4.3 schematic of a boiler.

Concept 4: Heat gun

A heat gun is a device used to emit a stream of hot air, usually at temperatures between 100 °C and 550 °C (200-1000 °F), with some hotter models running around 760 °C (1400 °F), which can be held by hand. Heat guns usually have the form of an elongated body pointing at what is to be heated, with a handle fixed to it at right angles and a trigger, in the same general layout as a handgun, hence the name. Figure 4.4 shows an image of a heat gun heating up a polymer solution.

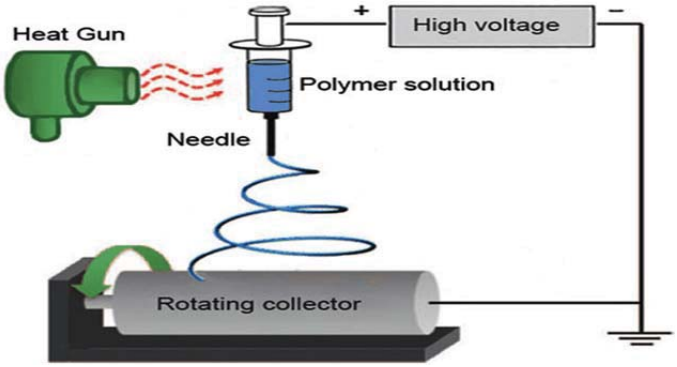


Figure 4.4 an image of a heat gun heating up a polymer solution.

Function 1.2: Pump the nanofluid Through the pipes

Concept 1: Gear pump

Gear pumps are a kind of rotating positive dislocation pump, which means they force a stable amount of liquid for every revolution. These pumps move liquid with machinery coming inside and outside of mesh for making a non-exciting pumping act. These pumps are capable of pumping on high forces & surpass at pumping high thickness fluids efficiently. A flow meter will be put at the end of the pump opening to measure the volume of liquid coming out. Figure 4.5 represents a gear pump and its different components.

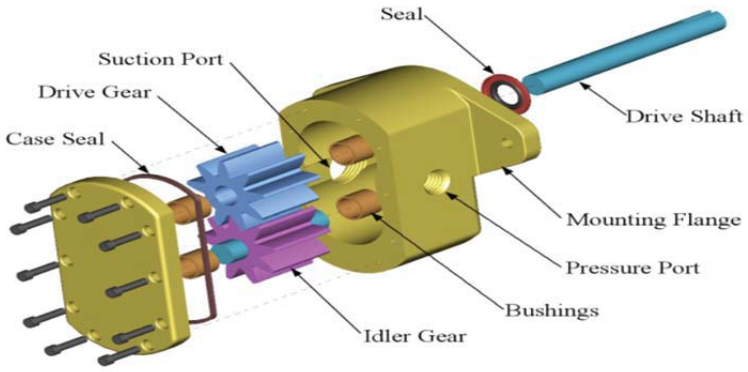


Figure 4.5 Sketch of a gear pump.

Concept 2: Piston pump

A piston pump is a type of positive displacement pump where the high-pressure seal reciprocates with the piston. Piston pumps can be used to move liquids or compress gases. Piston pumps can also deal with viscous media and media containing solid particles. Figure 4.6 shows a piston pump working system.

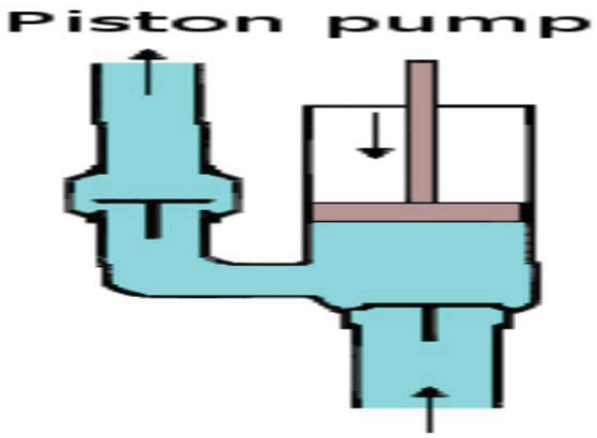


Figure 4.6 a sketch of a Piston pump.

Concept 3: Peristaltic pump

Figure 4.7 shows the concept of a peristaltic tube pump with two sprung rollers for the function of pumping nanofluids through pipes. The pump contains the fluid in the flexible tubes fitted inside a circular pump casing to circulate the fluid through the system.

Figure 4.7 Peristaltic tube pump.

Concept 4: Horizontal centrifugal Pump

This is a dynamic type of pump that is strong, efficient and cheap to make. These types of pumps include a minimum of two or more impellers. They are utilized mostly in pumping services. This is fundamentally a divide pump. All the phases are in a similar shelter & mounted on a similar shaft. On a solo horizontal shaft, minimum eight otherwise additional stages can be mounted. Every stage enhances the head by around an equal amount. Multi-stage pumps can also be single otherwise double suction on the first impeller. All kinds of pumps have been providing as well as servicing this type of centrifugal pumps. Figure 4.8 represents a horizontal centrifugal pump over a plane surface.

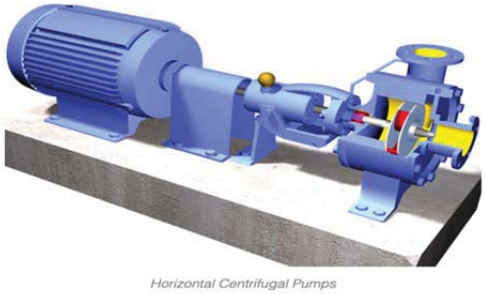


Figure 4.8 sketch of a horizontal centrifugal pump.

Function 1.3: Cool down the nanofluid after the measurements are made

Concept 1: Condenser.

A condenser can be found at the end of the experimental set up, which is used to cool nanofluid after passing through the final evaporator. Figure 4.9 shows how condenser work.

Briefly explain how this concept work.

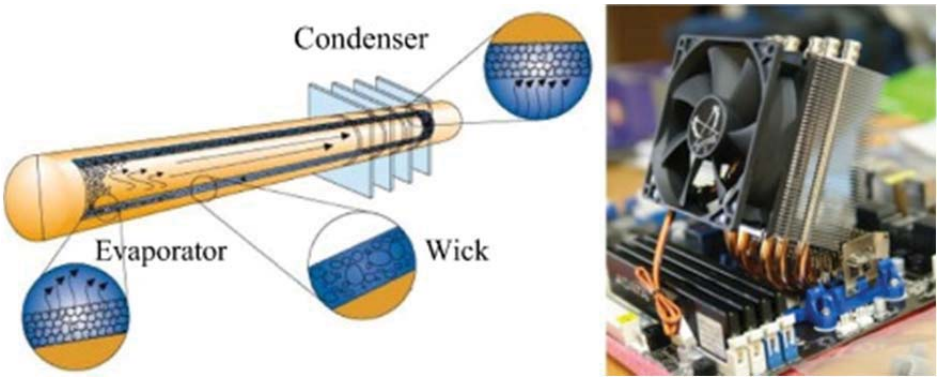


Figure 4.9 sketch of how a condenser works.

Concept 2: Cold Plate

cold plates are plane structure that can be used to cool down the nanofluid after the measurements are taken. The tubed cold plates are constructed of metal and can easily cool the fluid. Figure 4.10 represents the concept of cold plates.

Figure 4.10 sketch of a cold plate.

Concept 3: Open feedwater cooler

An open feedwater cooler is an apparatus that cools down the nanofluid when passing through the system to ensure experimental completion and it can be shown in Figure 4.11.

Briefly explain how this concept work.

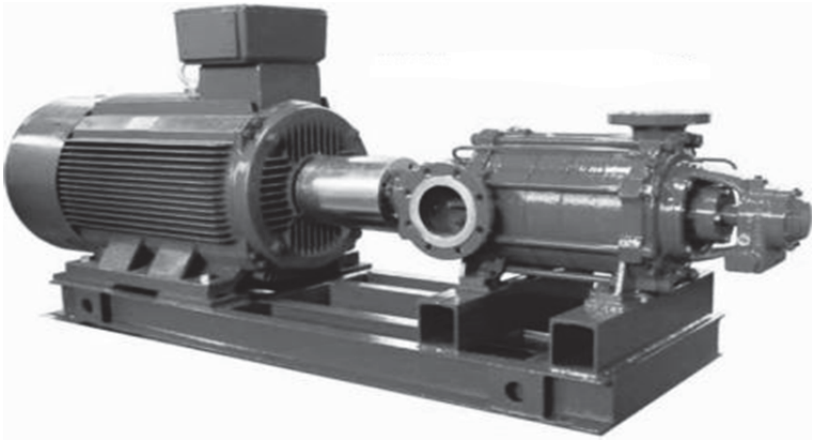


figure 4.11 shows a figure of a open feedwater cooler.

Concept 4: Liquid cooling heat exchanger

A liquid cooling heat exchanger that can be used to cool down the nanofluid after the measurements are made. The figure 4.12 shows a lightweight and small heat exchanger that can dissipate heat from a high efficiency plate-plate fin.

Figure 4.12 Liquid cooling heat exchanger.

Function 2.1: Accommodate to the magnetic field change

Concept 1: Stainless steel

It is a group of iron-based alloys that contain a minimum of approximately 11% chromium, a composition that prevents the iron from rusting, as well as providing heat-resistant properties. It cannot be easily influenced by the magnetic field. Figure 4.13 represents stainless steel bars.

Briefly explain how this concept work.

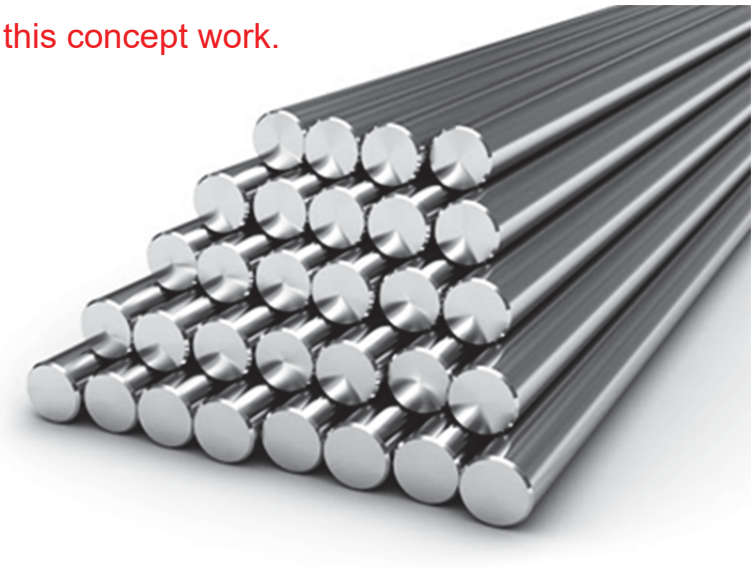


Figure 4.13 shows a sketch of Stainless steel.

Concept 2 : Permeability to magnetic field

The permeability measures the ability of the material to allow the magnetic lines of force to pass through it. This would allow to have a magnetic field that goes through the material and have a direct impact on the nanofluid without the material being affected. Permeability is typically represented by the Greek letter μ and is not a constant as it can vary with the position in the medium, the frequency of the applied magnetic field, humidity, temperature, and other parameters. Figure 4.14 represents the current concepts.

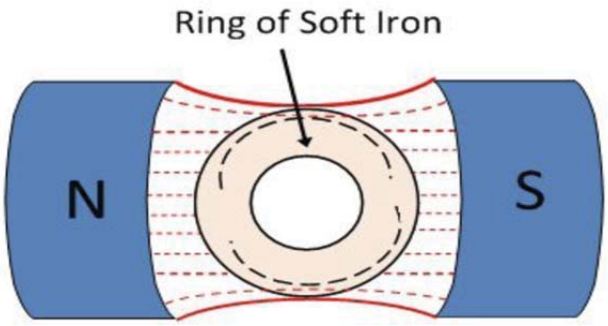


Figure 4.14 Sketch of a magnetically permeable soft iron ring.

Concept 3: Materials made of Crystals How does crystals change magnetic field?

A piece of a homogeneous solid substance having a natural geometrically regular form with symmetrically arranged plane faces. For instance, it can be used as a crystal pipe. Figure 4.15 shows a pipe made of crystal.

Figure 4.15 shows a sketch of a crystal pipe.

Concept 4: Magnetic field stabilizer.
Accommodating the magnetic field change requires a stabilizer, it works as maintaining the current throughout the different boundary conditions. A Coil ring accelerator in Figure 4.16 can also maintain the magnetic field under different boundary conditions. Transformers Figure 4.16 can maintain the current

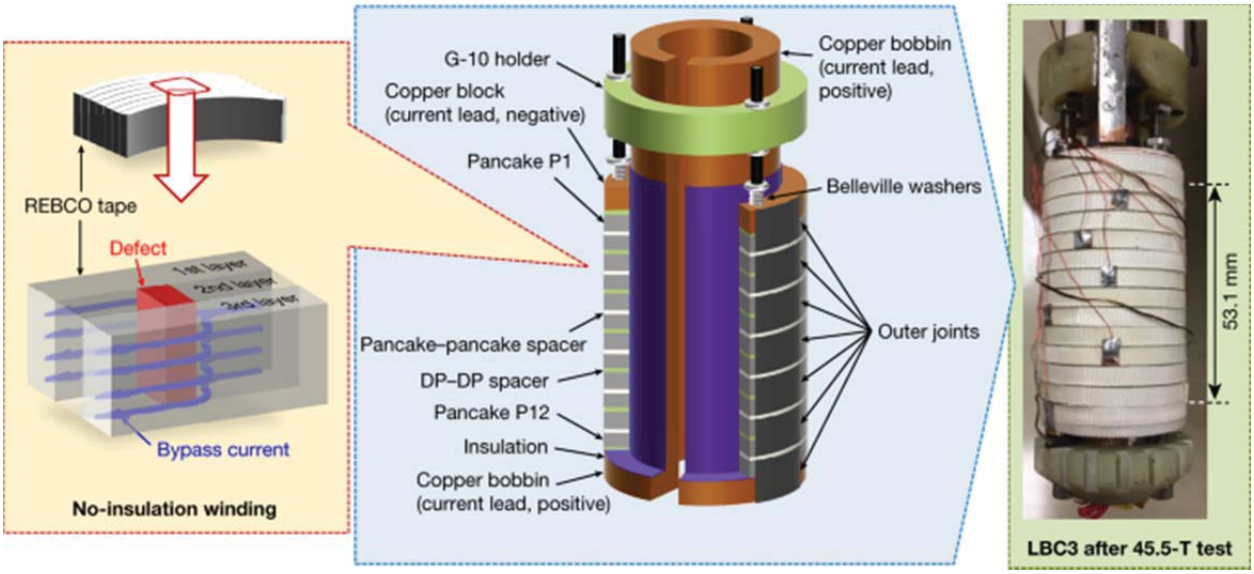


Figure 4.16 shows an image of a Magnetic field Stabilizer

Function 2.2: Accommodate to the pressure boundary condition change

Concept 1: Pressure Sensor
Not a good concept.
Figure 4.17 shows the concept of a pressure sensor to help keep track of the pressure to assure the pressure is steady. The pressure sensors are digital, ceramic and UL approved.

This is to measure pressure. You need a concept to change the pressure.

Figure 4.17 shows a image of a Pressure Sensors

Concept 2: Pressure boundary condition change

This Figure 4.18 is a schematic of a heat transfer experimental set up. Focusing mainly on pressure boundary change, located by the valve, there is a pressure sensor. The pressure sensor exits to a data acquisition which logs into a computer to see the characteristics of the pressure changes under different boundary conditions.

Explain how the pressure can be changed.

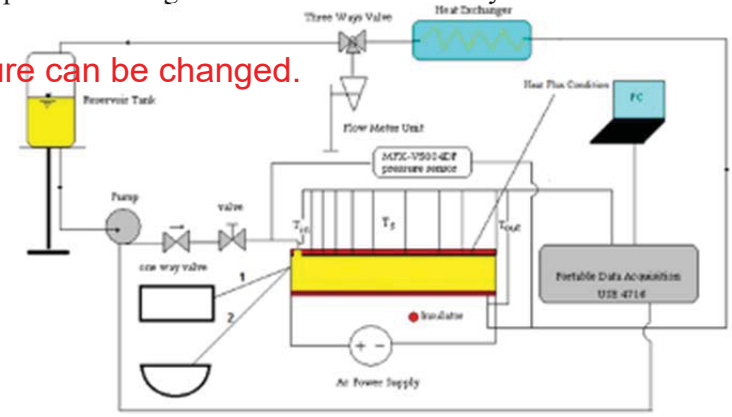


Figure 4.18 Shows an image on how the pressure boundary condition changes.

Concept 3: Set pressure inlet and outlet using pressure sensor

Set pressure inlet and pressure outlet to set pressure for specific experiments whilst using the pump in the systematic design to cause pressure to rise and fall. Figure 4.19 depicts a pressure sensor.

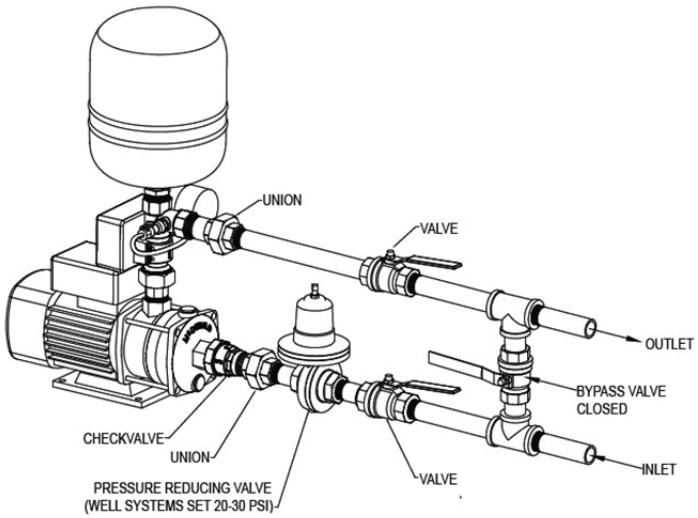


Figure 4.19 shows the image of a pressure sensor.

Delete empty spaces.

Concept 4: Valve

To control the fluid pressure in the system a control valve can be used as a device. As there are many different valves that can perform the same function pressure regulators as shown in Figure 4.20.

Figure 4.20 shows an image of a Pressure control valve

Function 2.3: Accommodate the boundary layer change of the nanofluid

Concept 1: Permeable linear stretching sheet

Figure 4.21 shows the concept of a flat metal surface to adjust the change in viscosity of the fluid by moving in opposite directions. It is a metal permeable flat surface.

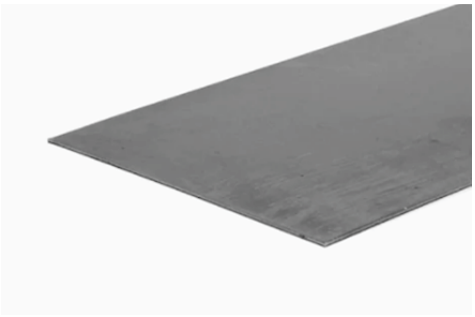


Figure 4.21 Flat Surface.

Concept 2: Nonlinear permeable stretching sheet

Figure 4.22 shows the concept of a permeable linear stretching sheet that can be used in accommodating for the change in boundary layer for nanofluids.

Nonlinear? What's nonlinear? What's the difference between concept 1 and concept 2?

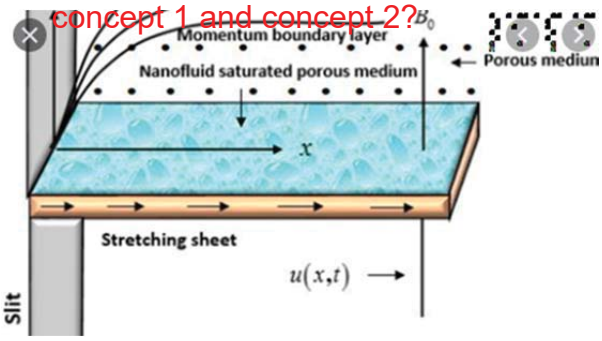


Figure 4.22 Permeable liner stretching sheet.

Concept 3: Increase flow velocity
The flow's velocity can be increased by reducing the radius of the pipe through which it goes through this can help reduce the boundary layer effect. Figure 4.23 is a sketch of velocity increase by area reduction.

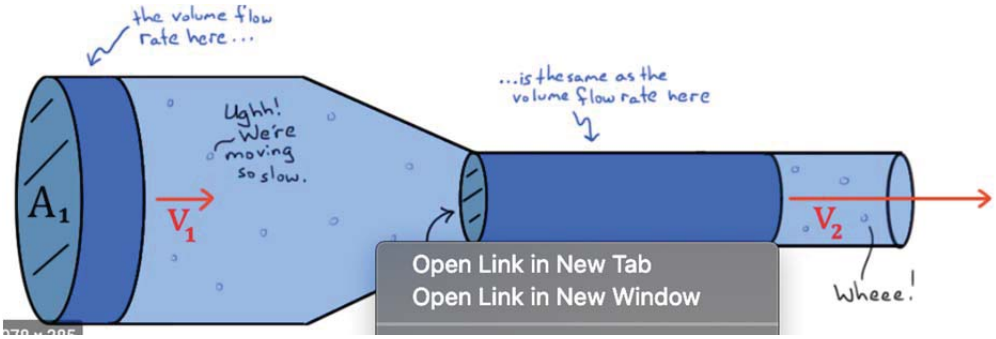


Figure 4.23 Sketch of a pipe reduction area for velocity increase.

Concept 4: Use a flow meter to maintain constant flow
A flowmeter can help control the flow rate of the fluid flowing through the pipe in order to achieve a constant flow rate. A constant flow rate can help achieve laminar flow for a fixed size pipe. Figure 4.24 is a representation of flow meter.

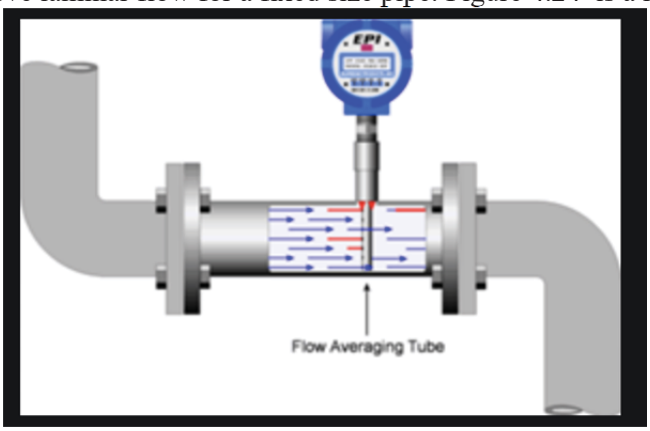


Figure 4.24 Sketch of a flowmeter.

Function 3.1.1: Measure the voltage(V) drop in the boiler (for convection calculation)

Concept 1: Analog Voltmeters
Analog voltmeters measure voltage or voltage drop in a circuit. They display readings using a needle rather than digital display. Analog voltmeters are widely used to measure voltage with d'Arsonval moving-coil galvanometers being most commonly used. Figure 4.25 is a sketch of an analog voltmeter.

Figure 4.25 shows an image of an analog voltmeter.

Concept 2: "control panel"
Using the control panel, it can monitor and measure the voltage in the system. The device has to be connected to a computer or if the experimental device has a motherboard it can be connected directly to it, a different type of the control panel has the same function. Multimeters can be used to measure the voltage manually as will. Figure 4. 26 represents control panels.

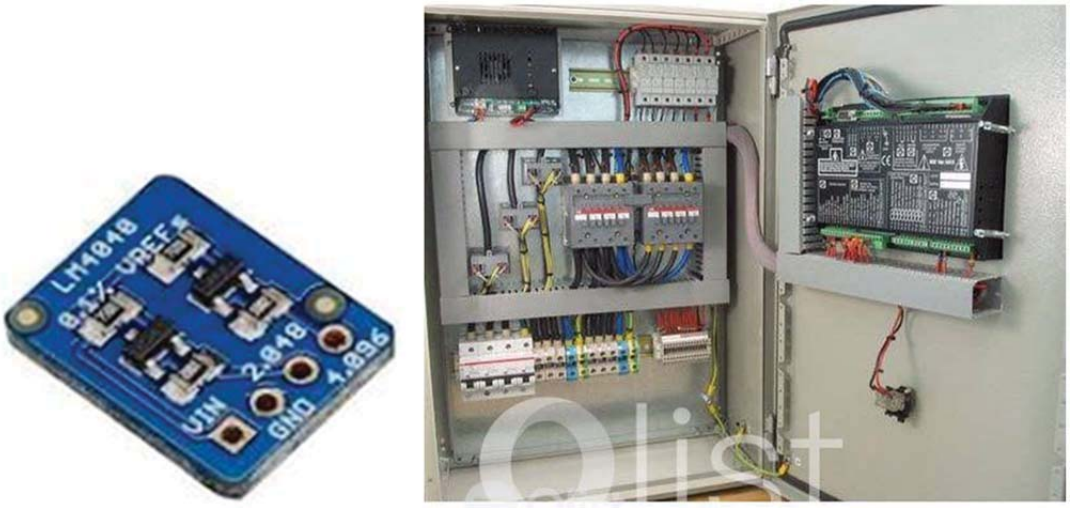


Figure 4.26 shows an image of a control panel, which is used to measure the voltage.

Concept 3: Analog multimeter
An analog multimeter to measure precise and accurate voltage for necessary computation at the end of the experiment. Figure 4.27 is a sketch of a multimeter.

Figure 4.27 shows an image of a multimeter.

Concept 4: Digital voltmeter

A digital voltmeter measures an unknown input voltage by converting the voltage to a digital value and then displays the voltage in numeric form. Digital voltmeters are usually designed around a special type of analog-to-digital converter called integrating converter. Figure 4.28 represents a digital voltmeter

Figure 4.28 shows an image of a digital voltmeter

Function 3.1.2: Measure the temperature of the nanofluid (Tin and Tout) (for convection calculation)

Concept 1: multipoint temperature sensors

multipoint temperature sensors accurately measuring temperatures at various locations along the sensor's length. Figure 4.29 is a sketch of a multipoint thermocouple.

Multipoint

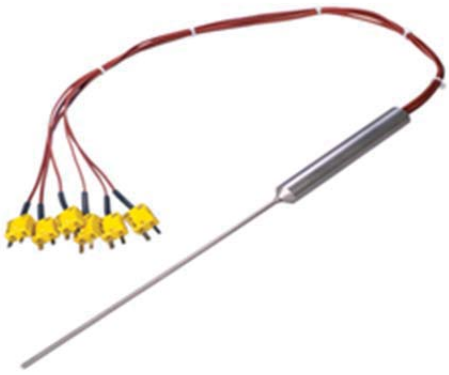


Figure 4.29 shows an image of a multipoint temperature sensors

Concept 2: Temperature gauge

Consists of utilizing a temperature gauge which will accurately depict the temperature measured throughout the nanofluid in the system. The sketch in figure 4.14 shows the appropriate temperature gauge.

Not a complete sentence.

Figure 4.30

Figure 4.30 shows an image of a temperature gauge.

Concept 3: Thermistors

consists of utilizing thermistors which have an increased sensitivity thermally whose prime function is to exhibit a large, predictable, and precise change in electrical resistance when subjected to corresponding change in body temperature. Figure 4.31 represents a thermistor.

Not a complete sentence.

Figure 4.31 shows an image of Thermistors. move to previous page.

Concept 4: KD2 Pro

The figure 4.32 is an experimental set up of measuring temperature of a nanofluid. Focusing on the KD2 Pro and the sample label, shown in the setup is a KD2 Pro which measures temperature. The KD2 Pro is wired to a nanofluid sampler. This process allows the measurement of the nanofluid sample temperature to be made.

Figure

Delete empty spaces.

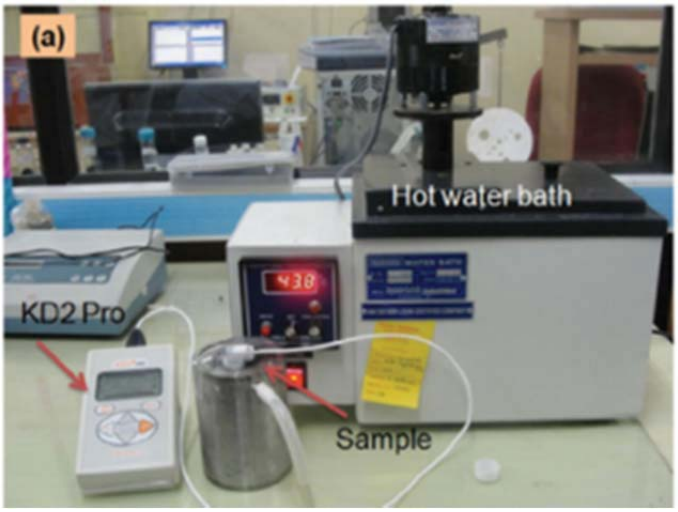


Figure 4.32 is an image that shows how KD2 operates.

<u>Function 3.1.3: Measure the intensity of the current used to heat up the nanofluid (for convection calculation)</u>

Concept 1: Moving coil Ammeter

This type of ammeter uses magnetic deflection where current passing through a coil causes the coil to move in a magnetic field. The uniform air gap between the iron core and the permanent magnet poles make the deflection of the meter linearly proportional to current. These meters have linear scales. Basic meter movements can have full-scale deflection for currents from about 25 microamperes to 10 milliamperes. Moving Coil Instruments are used for measuring DC quantities. They can be used on AC systems when fed through bridge rectifiers, but some products are rectified moving coils and can be used in AC systems directly. Figure 4.33 represents a moving coil ammeter.

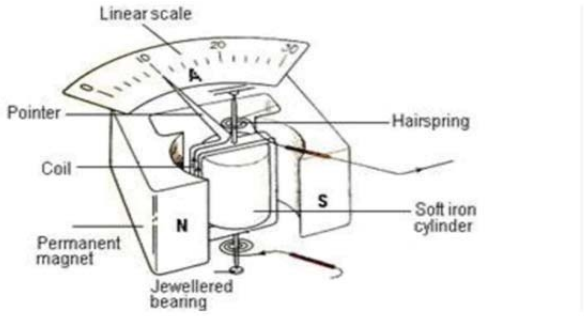


Figure 4.33 is a sketch of a moving coil ammeter.

Concept 2: Electrodynamic Ammeter

An electrodynamic movement uses an electromagnet instead of the permanent magnet of the d'Arsonval movement. This instrument can respond to both alternating and direct current and also indicates true RMS for AC. Figure 4.34 represents an electrodynamic ammeter.

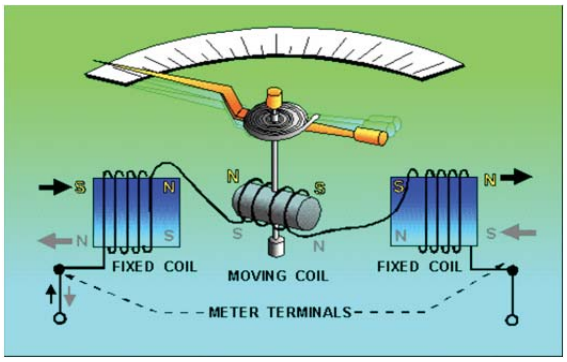


Figure 4.34 is Sketch of an electrodynamic ammeter.

Concept 3: Digital Ammeter

Digital ammeters use a shunt resistor to produce a calibrated voltage proportional to the current flowing. This voltage is then measured by a digital voltmeter, through use of an analog to digital converter (ADC); the digital display is calibrated to display the current through the shunt. Figure 4.35 represents a digital ammeter.

Figure 4.35 Sketch of a digital ammeter.

Concept 4: Digital Multimeter

Figure 4.36 shows the concept of a digital multimeter that can be used to measure the intensity of the current used to heat the nanofluid. This is a handheld digital device with two probes that connect to the multimeter and can connect to the system to measure the current.

Figure 4.36 digital multimeter.

<u>Function 3.2.1: Measure the voltage(V) drop in the boiler (for conduction calculation)</u>

Concept 1: Voltage Control Panel

Using the control panel shown in Figure 4.37, it can monitor and measure the voltage in the system. The device has to be connected to a computer or if the experimental device has a motherboard it can be connected directly to it.

Figure 4.37 Voltage control panel.

Concept 2: Digital Voltmeter

DVMs display the measured voltage using LCDs or LEDs to display the result in a floating-point format. Obviously, if voltage measurements are taken and the results are displayed digitally with LED or LCD display, the instrument has to

contain an A/D converter. Using a programmed microcontroller, ADC and LCD display, the following circuit is ready to provide accurate digital display of analog values from 0 to 15 volts DC. Figure 4.38 is a sketch of a digital voltmeter.

Figure 4.38 Sketch of a digital voltmeter.

Concept 3: VTVMs and FET-VMs
These types of instruments handle DC voltage, AC voltage, and resistance measurements. In this type of voltage measuring device an electronic amplifier is used in between the input and the meter. Figure 4.39 represents a VTMS.

Figure 4.39 Sketch of a VTVMS.

Concept 4: Analog Voltmeters
Analog voltmeter includes deflecting type of indicating voltmeters. These are like moving iron, moving coil, electrostatic types of voltmeters. Moving coil instruments are of two types namely permanent magnet and dynamometer types. Figure 4.40 is a sketch of an analog voltmeter.

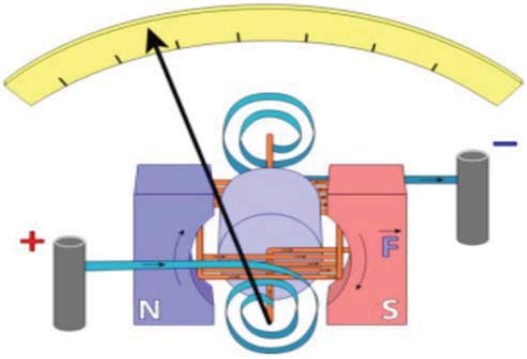


Figure 4.40 Sketch of an analog voltmeter.

Function 3.2.2: Measure the voltage(V) drop in the boiler (for conduction calculation)

Concept 1: Voltmeter
Use voltmeter with attached prongs to measure voltage as shown in Figure 4.41

Figure 4.41 shows an image of a Voltmeter.

Concept 2: Voltage control panel
Depending on how big of a panel you have we can have one-door, two-door or three-door control panel enclosures. The more equipment and devices we have, the larger the control cabinet we will need. Shown in Figure 4.42

Figure 4.42 shows an image of a voltage control panel.

Concept 3: BNC control panel
The BNC provides all the control required in the system. It will be directly connected to a satellite which can be accessed from any electronic device to adjust and monitor the voltage. shown in Figure 4.43

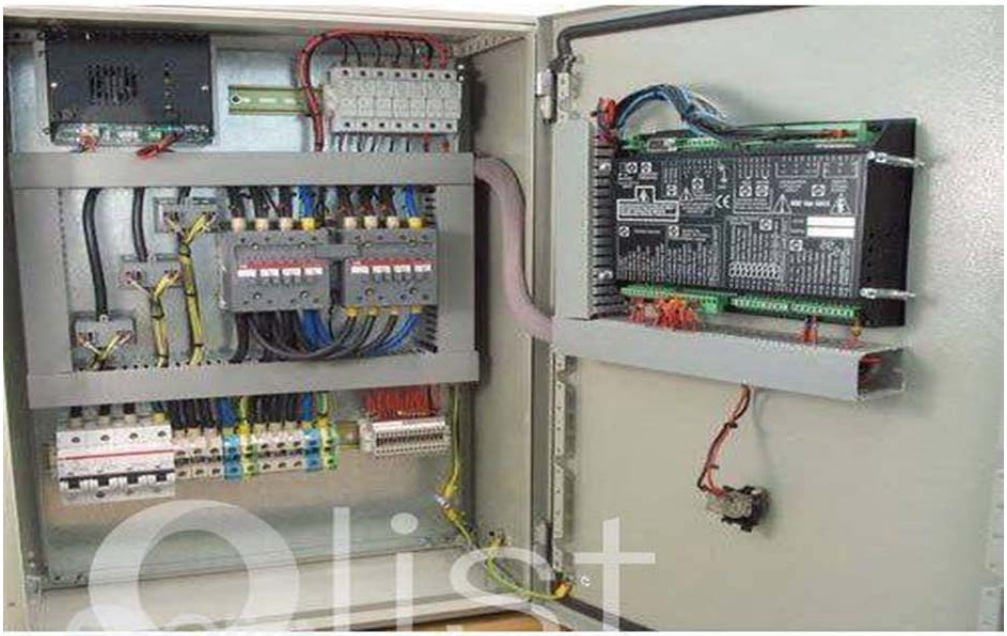


Figure 4.43 shows an image of a BNC control panel.

Concept 4: Multimeter

A multimeter or a multimeter, also known as a VOM (volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Shown in Figure 4.44.

Figure 4.44 shows an image of a multimeter.

Function 3.2.3: Measure the intensity of the current used to heat up the nanofluid (for conduction calculation)

Concept 1: Moving coil Ammeter

This type of ammeter uses magnetic deflection, where current passing through a coil causes the coil to move in a magnetic field. The uniform air gap between the iron core and the permanent magnet poles make the deflection of the meter linearly proportional to current. These meters have linear scales. Basic meter movements can have full-scale deflection for currents from about 25 microamperes to 10 milliamperes. Moving Coil Instruments are used for measuring DC quantities. They can be used on AC systems when fed through bridge rectifiers, but some products are rectified moving coil and can be used in AC systems directly. Figure 4.45 represents a moving coil ammeter.

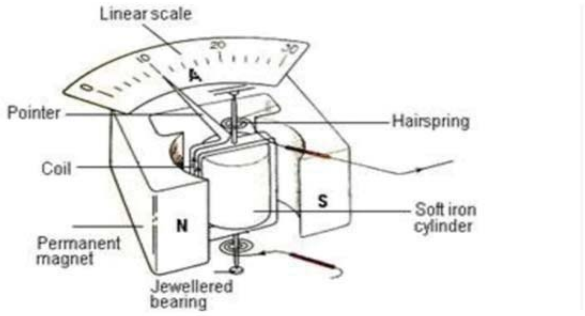


Figure 4.45 shows an image of Moving coil Ammeter

Concept 2: Electrodynamic Ammeter

An electrodynamic movement uses an electromagnet instead of the permanent magnet of the d'Arsonval movement. This instrument can respond to both alternating and direct current and also indicates true RMS for AC. Figure 4.46 is a sketch of an electrodynamic ammeter.

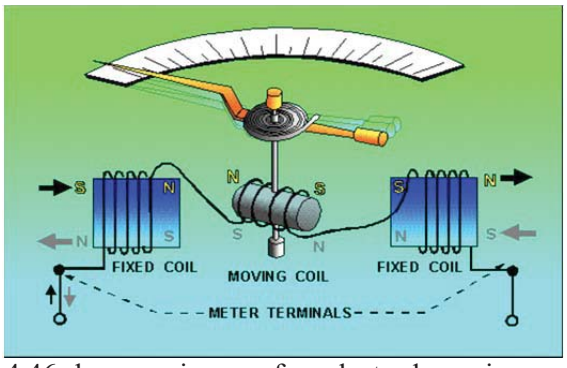


Figure 4.46 shows an image of an electrodynamic movement.

Concept 3: Tangent galvanometer

Figure 4.45 shows the concept of a tangent galvanometer that can measure the intensity of the electric current used to heat the nanofluid. Features a nonmagnetic rotating tripod base and a removable compass.

Figure 4.47 shows a tangent galvanometer.

Concept 4: KD2 pro measurement

The figure 4.48 is an experimental set up of measuring the intensity of current used to heat up nanofluid. Shown in the setup is a KD2 Pro which measures current. There is a hot water bath machine that is wired to a nanofluid sample. The sample equipment is attached to the KD2 Pro where measurement data are located.

Figure 4.48 show an image of a KD2 pro

<u>Function 3.3.1: Display readings of measured parameters on a computer software</u>

Concept 1: SCADA

Supervisory control and data acquisition systems are a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level process supervisory management. It uses a computer acquisition card that gathers data and transfers it to a computer software. Figure 4.49 represents the schematic of a SCADA system.

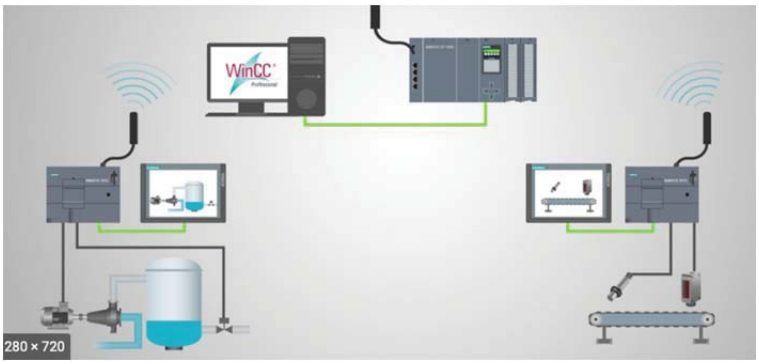


Figure 4.49 sketch of a SCADA system.

Concept 2: DCS

DCS stands for decentralized control systems. A decentralized system in system theory is a system in which lower level components operate on local information to accomplish global goals. Figure 4.50 is a sketch of a DCS system.

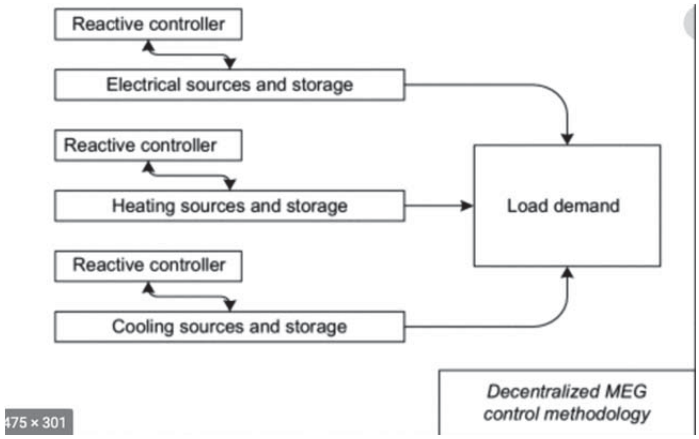


Figure 4.50 sketch of a DCS system

Concept 3: IC Measure

IC Measure from computer software technology can be used to measure calculations and parameters accurately. Figure 4.49 is a sketch of IC measure.

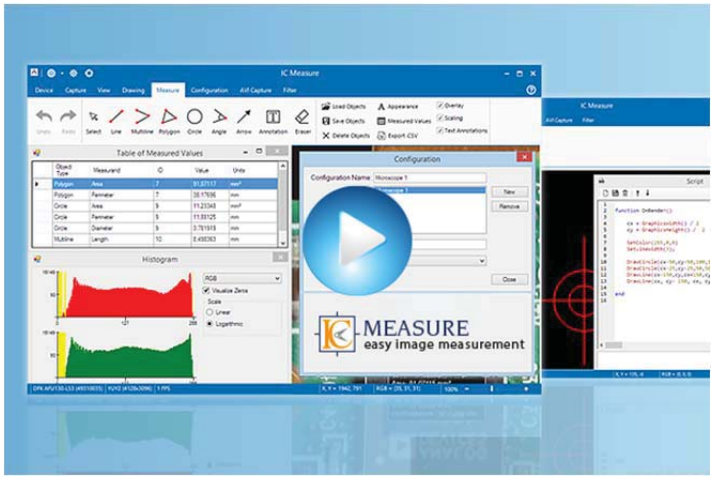


Figure 4.51 a sketch of IC Measure

Concept 4: Manually collecting data

The data of the experiment can be recorded manually at regular intervals of times instead of using a data acquisition system, and then entered manually in an engineering software to be analyzed. Figure 4.52 is a sketch of how data can be manually collected.

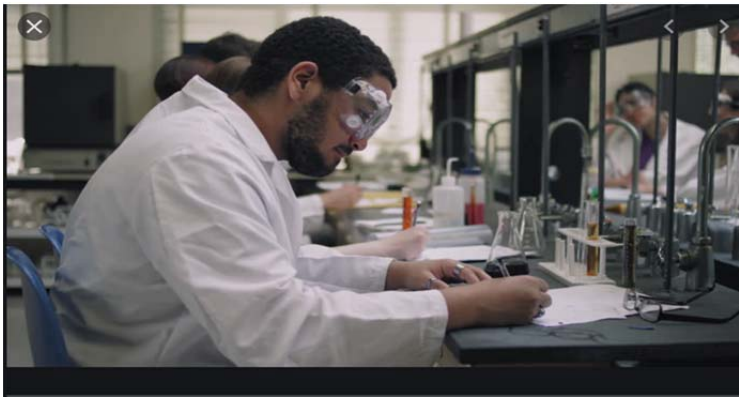


Figure 4.52 sketch of data manually collected

Function 3.3.2: Generate Graphs showing the fluctuation of each parameter

Concept 1: SCADA

Supervisory control and data acquisition are a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level process supervisory management. It uses a computer acquisition card that gathers data and transfers it to a computer software. Figure 4.53 represents the schematic of a SCADA system.

Figure 4.53 shows an image of SCADA software, which is a database operational software.

Concept 2: Graphs of manually entered data using EES

Using a software like engineering equation solver graphs of the entered parameters can be generated over time (time scale has to be included). Figure 4.54 represents a sketch of how manually collected data can be used for graphing by the Engineering Equation solver.

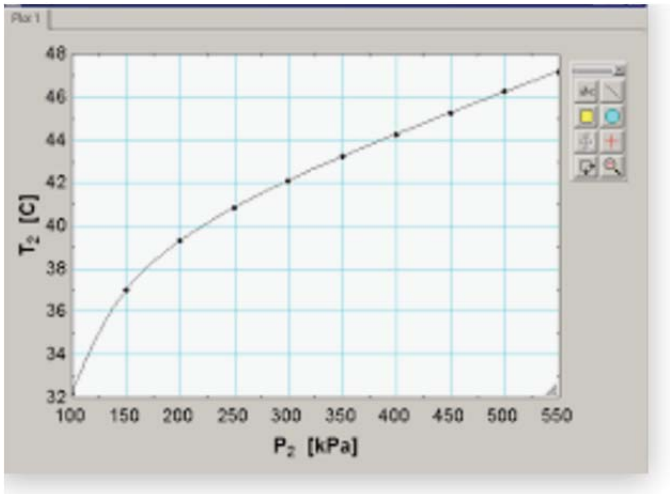


Figure 4.54 Sketch of a graph generated by EES for manually collected data

Concept 3: Mark- 10

It is a software that collects data. The programs include a set of tools to analyze test results, including statistical calculations, quick data export to Microsoft Excel, customizable reports, pass/fail indicators, and many others as shown in Figure 4.55.

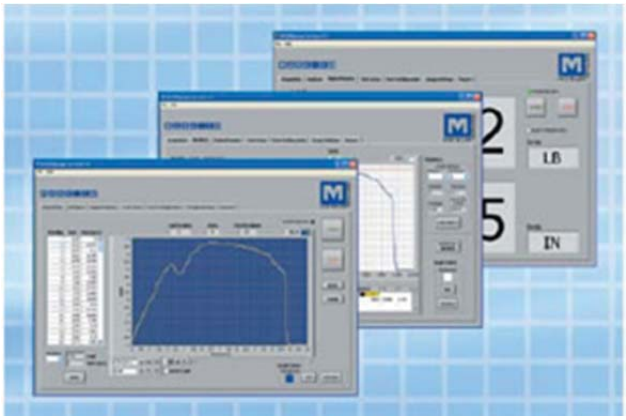


Figure 4.55 shows an image of Mark-10, which is a software database analysis.

Concept 4: MATLAB

It is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include: Data analysis, exploration, and visualization. Figure 4.56 shows a representation of what MATLAB can do.

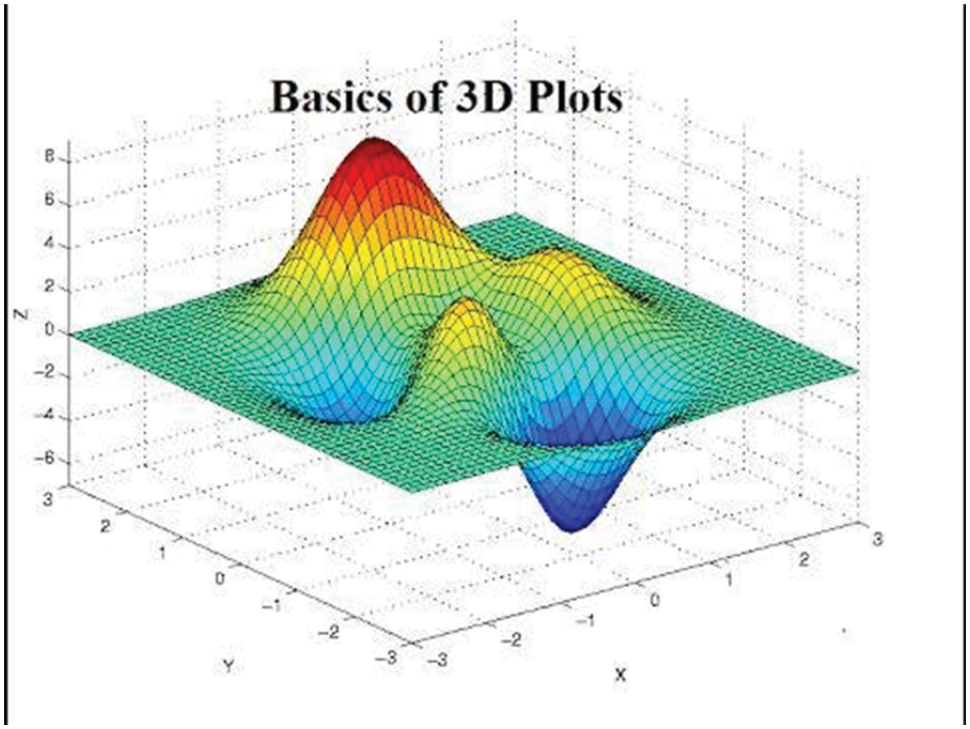


Figure 4.56 shows an image of a graphical representation made by MATLAB.

Group Grading Scheme
Homework #7b
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	9.5
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	10
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	54
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	16
	Total for Group Report	100	89.5

SENIOR DESIGN & PROFESSIONALISM I

FALL 2020

PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER __3_____
Progress Report Title:___Concept generation individual assignment_____
Due Date:___10/22/2020_____

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Yemboado Yonli 	Found different concepts Found sketch to represent the functions Created and individual report	100	
2			\	
3				
4				
5				
6				
7				
8				

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title 4.2 **Concept Generation. Note that in the original report statement question 1was question 2 and question 2 was question 3**

4.2 Concept Generation

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

1. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

In this section, Yemboado Yonli has been assigned functions for which he had to find concepts. Concepts are ways for the experimental set up to be able to achieve all functions that it is designed to accomplish. Each concept generated is followed by a visual representation called sketch. For each function the student has found 3 different concepts that will then be sorted when the group meets. Table 4.2 represents how concepts have been shared between the group members

Table 4.1 Function distribution

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid during the experiment	Heat up the nanofluid before pumping		Fanta	Abdoul	Christian	Marcelo
		Pump the nanofluid Through the pipes		Yemboado	Diana	Abdoul	Marcelo
		cool down the nanofluid after the measurements are made		Fanta	Christian	Yemboado	Diana
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		Yemboado	Marcelo	Christian	Abdoul
		Accommodate to the pressure boundary condition change		Diana	Fanta	Christian	Abdoul
		Accommodate to the boundary layer change of the nanofluid		Yemboado	Marcelo	Diana	Fanta
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Fanta	Abdoul	Christian	Marcelo
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Yemboado	Diana	Abdoul	Marcelo

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
			Measure the intensity of the current used to heat up the nanofluid	Fanta	Christian	Yemboado	Diana
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Yemboado	Marcelo	Christian	Abdoul
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Diana	Fanta	Christian	Abdoul
			Measure the intensity of the current used to heat up the nanofluid	Yemboado	Marcelo	Diana	Fanta
		generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software	Yemboado	Marcelo	Diana	Christian

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
			Generate Graphs showing the fluctuation of each parameter	Yemboado	Marcelo	Fanta	Abdoul

2. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:

Concept 1 for the function "Heat the biomass"

Figure 1.1 shows the concept for this function. Then provide a brief description of the concept and how it works to execute the function.

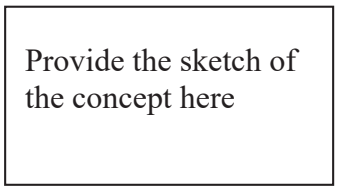


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

In this section for each function that he found Yemboado Yonli developed sketches with a little description that went into it. The objective was to visually represent his functions. When done all functions were put together and consolidated with the group. The Table 4.2 was then created.

Table 4.2 Morphology Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch		
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid circulate during the experiment	Heat up the nanofluid before pumping		Ban heater	Figure 4.1	Heat	Figure 4.2	Boiler	Figure 4.3	Heat gun	Figure 4.4
		Pump the nanofluid Through the pipes		Gear pumps	Figure 4.5	Piston pump	Figure 4.6	Peristaltic tube pump	Figure 4.7	Horizontal centrifugal Pump	Figure 4.8
		Cool down the nanofluid after measurements		A condenser	Figure 4.9	Cold plates	Figure 4.10	Open feedwater cooler	Figure 4.11	Liquid cooling heat exchanger	Figure 4.12
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		Stainless steel	Figure 4.13	The permeability	Figure 4.14	Crystals	Figure 4.15	Magnetic field stabilizer	Figure 4.16
		Accommodate to the pressure boundary condition change		Pressure sensor	Figure 4.17	Pressure boundary conditions change	Figure 4.18	Pressure Set pressure inlet and pressure outlet	Figure 4.19	Control valve can be u	Figure 4.20
		Accommodate the boundary layer change of the nanofluid		Permeable linear stretching sheet	Figure 4.21	Nonlinear permeable stretches sheet	Figure 4.22	Increase flow velocity	Figure 4.23	Flow meter	Figure 4.24
	Measure the heat transfer coefficient and the thermal conductivity of the	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Analog voltmeters	Figure 4.25	Control panel	Figure 4.26	Analog multimeter	Figure 4.27	Digital voltmeter	Figure 4.28
			Measure the temperatur	Multipoint temperature sensors	Figure 4.29	Temperature gauge	Figure 4.30	Thermistors	Figure 4.31	The KD2 Pro	Figure 4.32

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch		
	nanofluid		e of the nanofluid (Tin and Tout)								
			Measure the intensity of the current used to heat up the nanofluid	Moving coil ammeters	Figure 4.33	Electrodynamic ammeters	Figure 4.34	Digital Ammeters	Figure 4.35	Digital Multimeters	Figure 4.36
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Voltage Control Panels	Figure 4.37	Digital Voltmeter	Figure 4.38	VTVMs and FET-VMs	Figure 4.39	Analog Voltmeter	Figure 4.40
			Measure the temperature of the nanofluid (Tin and Tout)	Voltmeters	Figure 4.41	Voltage Control Panels	Figure 4.42	BNC control panel “	Figure 4.43	Multimeters	Figure 4.44
			Measure the intensity of the current used to heat up the nanofluid	Moving coil Ammeters	Figure 4.45	Electrodynamic Ammeters	Figure 4.46	Tangent galvanometer	Figure 4.47	The KD2 pro	Figure 4.48
		Generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software	SCADA	Figure 4.49	DCS	Figure 4.50	IC Measure	Figure 4.51	Manually collecting data	Figure 4.52

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch		
			Generate Graphs showing the fluctuation of each parameter	SCADA	Figure 4.53	Graphs of manually entered data using EES”	Figure 4.54	Mark- 10	Figure 4.55	MATLAB	Figure 4.56

Function 1.2: Pump The nanofluid Through the piping system

Concept 1: Horizontal centrifugal Pump
This is a dynamic type of pump that is strong, efficient and cheap to make. These types of pumps include a minimum of two or more impellers. They are utilized mostly in pumping services. This is fundamentally a divide pump. All the phases are in a similar shelter & mounted on a similar shaft. On a solo horizontal shaft, minimum eight otherwise additional stages can be mounted. Every stage enhances the head by around an equal amount. Multi-stage pumps can also be single otherwise double suction on the first impeller. All kinds of pumps have been providing as well as servicing this type of centrifugal pumps. Figure 4.1 represents a horizontal centrifugal pump.

Figure 4.1 sketch of a horizontal centrifugal pump

Concept 2: Gear Pump
These pumps are a kind of rotating positive dislocation pump, which means they force a stable amount of liquid for every revolution. These pumps move liquid with machinery coming inside and outside of mesh for making a non-exciting pumping act. These pumps are capable of pumping on high forces & surpass at pumping high thickness fluids efficiently. A flow meter will be put at the end of the pump opening to measure the volume of liquid coming out. Figure 4.2 represents a gear pump and its different components.

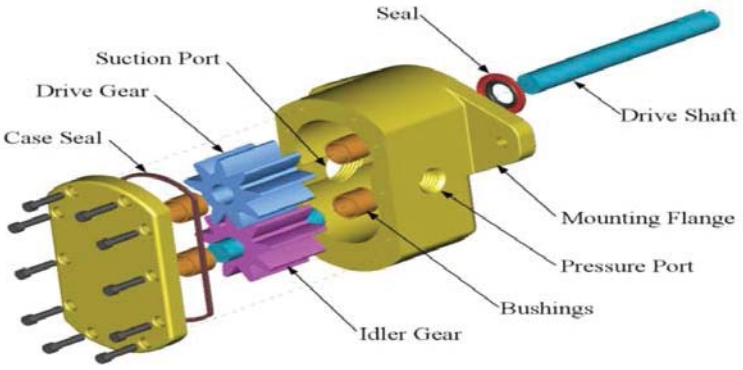


Figure 4.2 Sketch of a gear pump.

Concept 3: Lobe pumps
These pumps offer different characteristics like an excellent high efficiency, rust resistance, hygienic qualities, reliability, etc. These pumps can handle high thickness fluids & solids without hurting them. The working of these pumps can be related to gear pumps, apart from the lobes which do not approach into contact by each other. Additionally, these pumps have superior pumping rooms compare with gear pumps that allow them to move slurries. These are made with stainless steel as well as extremely polished. Figure 4.3 is a sketch of a lobe pump

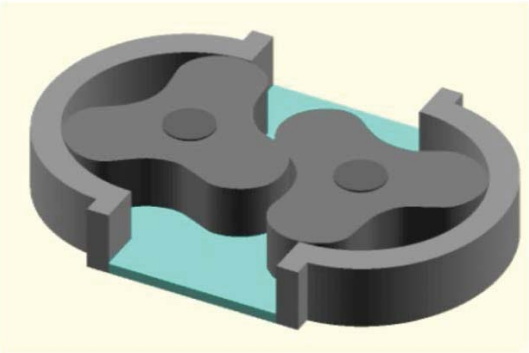


Figure 4.3 Sketch of a lobe pump

Function 1.3: Cool down the nanofluid after the measurements are made

Concept 1: Container with very cold liquid or ice
A container can be place at the end of the piping system to collect the hot nanofluid. The container can be containing ice or a really cold medium. The container will be made of a material that is heat resistant to make sure that it can take the nanofluid without melting before it is cooled down. Figure 4.4 is a sketch of the concept.

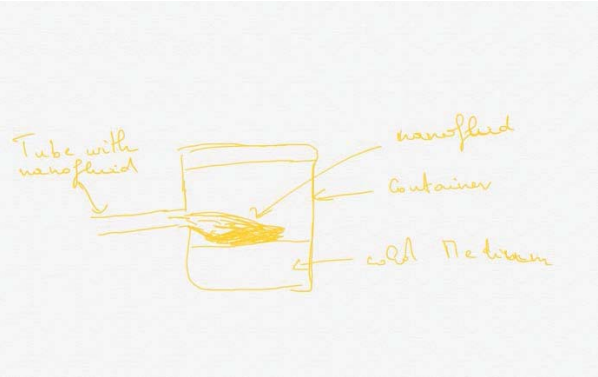


Figure 4. 4 Sketch of a container with cold medium receiving a hot nanofluid

Concept 2: Plate liquid Chiller
A plate Liquid Chiller is a type of small cooler which uses plate & frame heat exchanger to transfer heat between two fluids. It has a major advantage over a conventional heat exchanger. The fluids of plate type radiator are exposed to a much larger surface area because the fluids are spread out over the plates. Figure 4.5 represents a plate liquid chiller.

Figure 4.5 Sketch of a plate liquid chiller

Concept 3: Stainless steel liquid chiller

S-Coil Liquid Chiller is a traditional coiled tube configuration heat exchanger. The stainless-steel Coil-S liquid chiller is a compact cooling module used as heat transfer system for small liquid cooling. It applies for laser, medical-aesthetic, and many other small cooling applications. It meets customer's specific demand where weight and space are critical. The small cooling &refrigeration unit is very compact and lightweight. Figure 4.6 represents a stainless-steel liquid chiller.

Figure 4.6 Sketch of a stainless-steel liquid chiller

Function 2.1: Accommodate to the magnetic field change

Concept 1: Permeability to magnetic field

the permeability measures the ability of the material to allow the magnetic lines of force to pass through it. This would allow to have a magnetic field that goes through the material and have a direct impact on the nanofluid without the material being affected. Permeability is typically represented by the Greek letter μ and is not a constant as it can vary with the position in the medium, the frequency of the applied magnetic field, humidity, temperature, and other parameters. Figure 4.7 represents the current concepts.

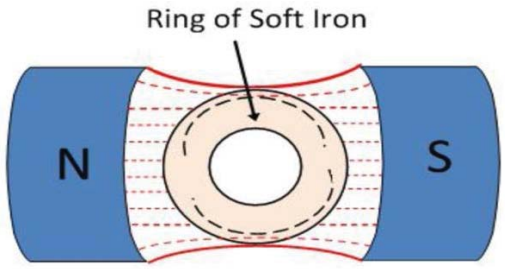


Figure 4.2.7 Sketch of a magnetically permeable soft iron ring

Concept 2: Use a material that's is not affected by magnetic field such as stainless steel

When nickel is added during the manufacturing process of stainless steel, the physical structure is changed, creating a nonmagnetic form of stainless steel called austenitic stainless steel. As a general rule, the Austenitic stainless steels, which include the 300-series of Chromium-Nickel alloys, but also the 200-series Chromium-Manganese-Nickel alloys, are non-magnetic. Figure 4.8 represents bars of grades 300 stainless steel

Figure 4.8 Sketch of stainless-steel bars

Concept 3: Use of shielding to re-route the magnetic field around the apparatus

By surrounding an object with a material which can "conduct" magnetic flux better than the materials around it, the magnetic field will tend to flow along this material and avoid the objects inside. This allows the field lines to terminate on the opposite poles, but just gives them a different route. Figure 4.9 is sketch of magnetically shielded object.

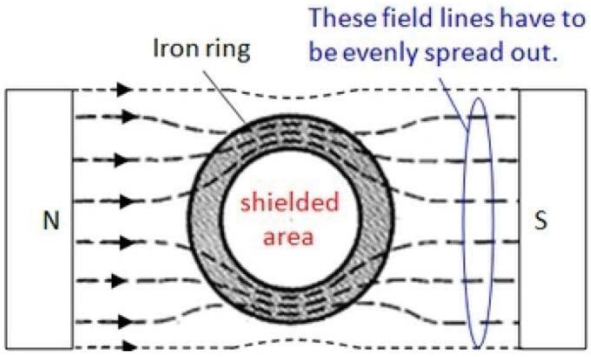


Figure 4.9 Sketch of a magnetically shielded iron ring

Function 2.3: Accommodate to the boundary layer

Concept 1: Increase the flow velocity by area reduction

The flow's velocity can be increased by reduce the radius of the pipe through which it goes through this can help reduce the boundary layer effect. Figure 4.10 is a sketch of velocity increase by area reduction.

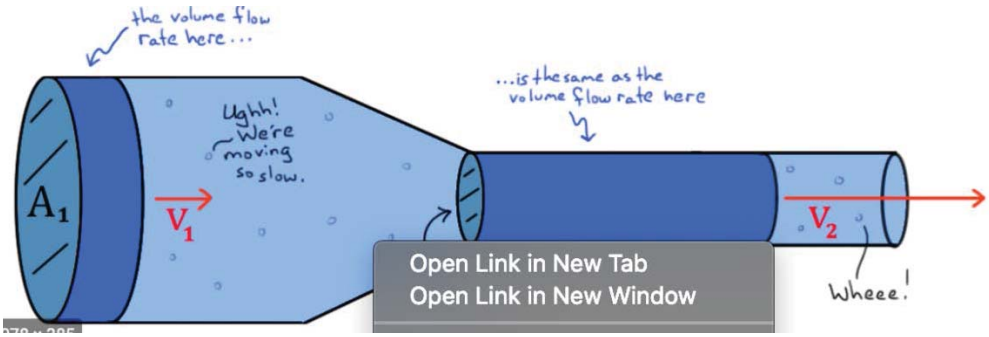


Figure 4.10 Sketch of a pipe reduction area foe velocity increase

Concept 2: Use a flow meter to maintain constant flow rate
A flowmeter can help control the flow rate of the fluid flowing through the pipe in order to achieve a constant flow rate. A constant flow rate can help achieve laminar flow for a fixed size pipe. Figure 4.11 is a representation of flow meter.

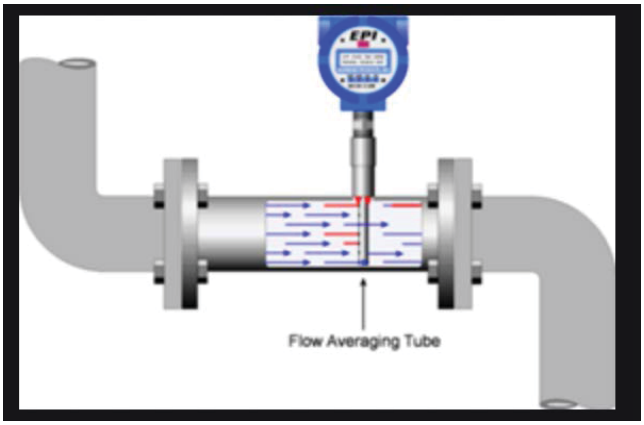


Figure 4.11 Sketch of a flowmeter

Concept 3: Air removal valves
Air should not be allowed to accumulate in the system while it is operating. For that autmatic air removal valves can be include in the system to remove the air that is accumulated. This will limit fluids collision and help in maitaining the flow laminar. Figure 4.12 represesents automatic valves removal

Figure 4.12 Sketch of a air removal valves

Function 3.1.2: Measure the nanofluid temperature of the nanofluid (Tin and Tout)

Concept 1: Multipoint Thermocouples
Multipoint temperature sensors accurately measure temperatures at various locations along the sensor's length. Figure 4.13 is a sketch of multipoint thermocouple.

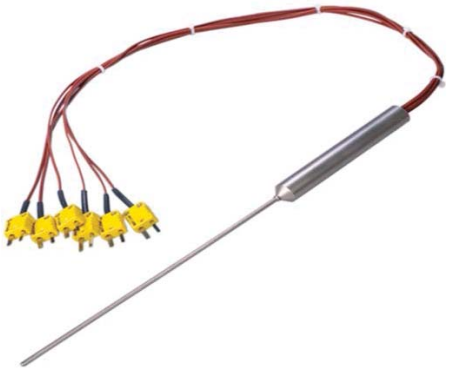


Figure 4.13 Sketch of a multipoint thermocouple

Concept 2: Type K thermocouples (Nickel-Chromium / Nickel-Alumel)
The type K is the most common type of thermocouple. It's inexpensive, accurate, reliable, and has a wide temperature range. The type K is commonly found in nuclear applications because of its relative radiation hardness. Maximum continuous temperature is around 1,100C. Figure 4.14 represent the working aspect of a K type thermocouple.

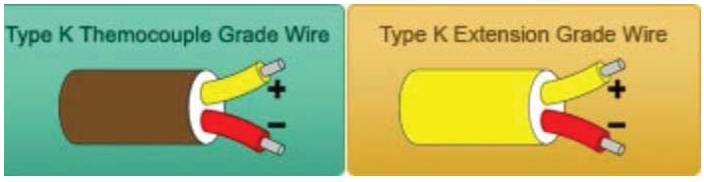


Figure 4.14 Sketch of a type k thermocouple

Concept 3: Type N thermocouple (Nicrosil / Nisil)
The Type N shares the same accuracy and temperature limits as the Type K. The type N is slightly more expensive. The type N has better repeatability between 572F to 932F (300C to 500C) compared to the type K. Figure 4.15 represent a T type thermocouple.

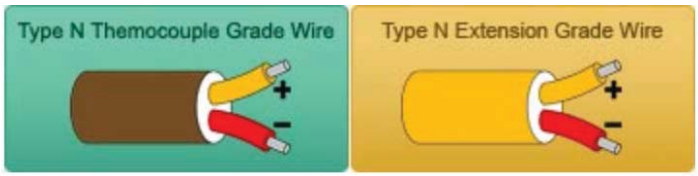


Figure 4.15 Sketch of a type N thermocouple

Function 3.1.3 Measure the intensity of the current used to heat up the nanofluid

Concept 1: Moving coil Ammeter

This type pf ammeter uses magnetic deflection, where current passing through a coil causes the coil to move in a magnetic field. The uniform air gap between the iron core and the permanent magnet poles make the deflection of the meter linearly proportional to current. These meters have linear scales. Basic meter movements can have full-scale deflection for currents from about 25 microamperes to 10 milliamperes. Moving Coil Instruments are used for measuring DC quantities. They can be used on AC systems when fed through bridge rectifiers, but some products are rectified moving coil and can be used in ac systems directly. Figure 4.16 represents a moving coil ammeter.

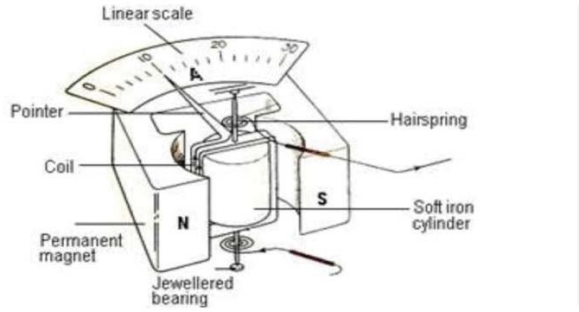


Figure 4.16 Sketch of a moving coil ammeter

Concept 2: Electrodynamic Ammeter
An electrodynamic movement uses an electromagnet instead of the permanent magnet of the d'Arsonval movement. This instrument can respond to both alternating and direct current and also indicates true RMS for AC. Figure 4.17 represents an electrodynamic ammeter.

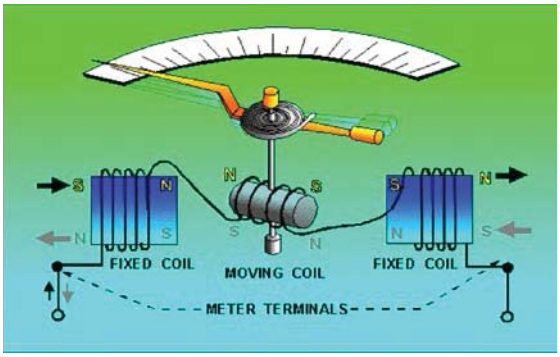


Figure 4.17 Sketch of an electrodynamic ammeter

Concept 3: Digital Ammeter
Digital ammeter designs use a shunt resistor to produce a calibrated voltage proportional to the current flowing. This voltage is then measured by a digital voltmeter, through use of an analog to digital converter (ADC); the digital display is calibrated to display the current through the shunt. Figure 4.18 represents a digital ammeter.

Figure 4.18 Sketch of a digital ammeter

Function 3.2.1: Measure the voltage(V) drop in the boiler

Concept 1: Analog Voltmeters
Analog voltmeter includes deflecting type of indicating voltmeters. These are of like moving iron, moving coil, electrostatic types of voltmeters. Moving coil instruments are of two types namely permanent magnet and dynamo meter types. Figure 4.19 is sketch of an analog voltmeter.

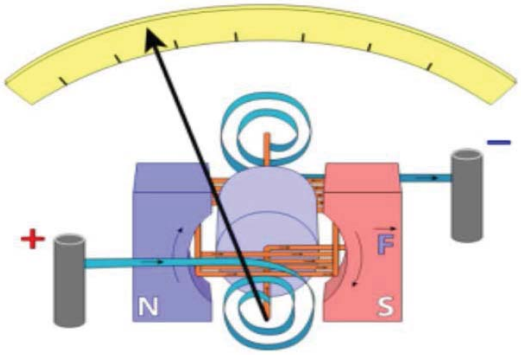


Figure 4.19 Sketch of an analog voltmeter

Concept 2: Digital Voltmeters
DVMs display the measured voltage using LCDs or LEDs to display the result in a floating-point format. Obviously, if voltage measurements are taken and the results are displayed digitally with LED or LCD display, the instrument has to contain an A/D converter. Using a programmed micro controller, ADC and LCD display, the following circuit is ready to provide accurate digital display of analog values from 0 to 15 volts DC. Figure 4.20 is a sketch of a digital voltmeter.

Figure 4.20 Sketch of a digital voltmeter

Concept 3: **VTVMs and FET-VMs**
These types of instruments handle DC voltage, AC voltage, and resistance measurements. In this type of voltage measuring device electronic amplifier is used in between the input and the meter. Figure 4.21 represents a VTMS.

Figure 4.21. Sketch of a VTVMS

Function 3.2.3: Measure the intensity of the current used to heat up the nanofluid

Concept 1: Moving coil Ammeter
This type pf ammeter uses magnetic deflection, where current passing through a coil causes the coil to move in a magnetic field. The uniform air gap between the iron core and the permanent magnet poles make the deflection of the meter linearly proportional to current. These meters have linear scales. Basic meter movements can have full-scale deflection for currents from about 25 microamperes to 10 milliamperes. Moving Coil Instruments are used for measuring DC quantities. They can be used on AC systems when fed through bridge rectifiers, but some products are rectified moving coil and can be used in ac systems directly. Figure 4.22 represents a moving coil ammeter.

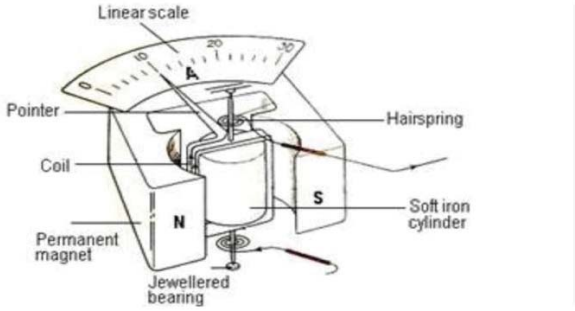


Figure 4.22 Sketch of a moving coil ammeter

Concept 2: Electrodynamic Ammeter
An electrodynamic movement uses an electromagnet instead of the permanent magnet of the d'Arsonval movement. This instrument can respond to both alternating and direct current and also indicates true RMS for AC. Figure 4.23 is a sketch of an electrodynamic ammeter.

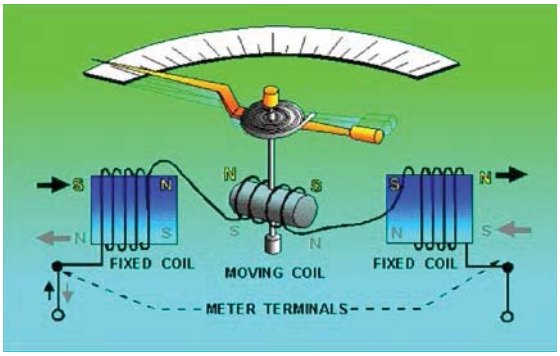


Figure 4.23 Sketch of an electrodynamic ammeter

Concept 3: Digital Ammeter
Digital ammeter designs use a shunt resistor to produce a calibrated voltage proportional to the current flowing. This voltage is then measured by a digital voltmeter, through use of an analog to digital converter (ADC); the digital display is calibrated to display the current through the shunt. Figure 4.24 is a sketch of a digital ammeter.

Figure 4.24 Sketch of a digital ammeter

Function 3.3.1: Display readings of measured parameters on a computer software

Concept 1: SCADA
Supervisory control and data acquisition systems are a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level process supervisory management. It uses a computer acquisition card that gather data and transfer it to a computer software. Figure 4.25 represents the schematic of a SCADA system.

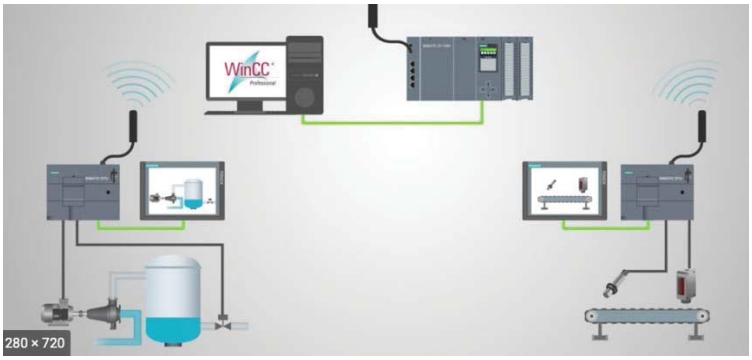


Figure 4.25 Sketch of a SCADA system

Concept 2: DCS

DCS stands for decentralized control systems. A decentralized system in system theory is a system in which lower level components operate on local information to accomplish global goals. Figure 4.26 is a sketch of a DCS system.

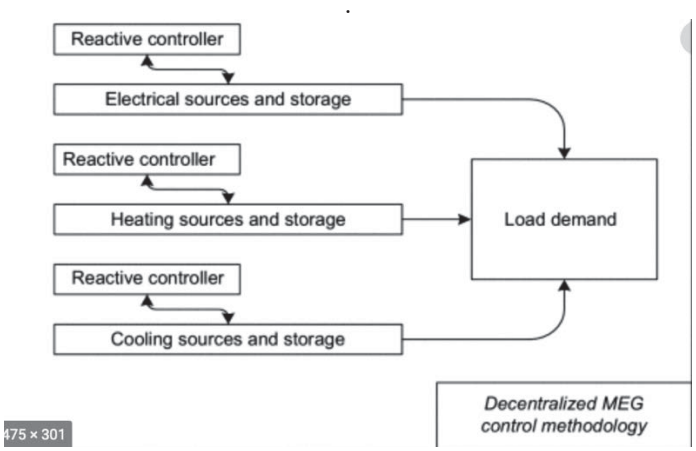


Figure 4.26 Sketch of a DCS system

Concept 3: manually collecting data
The data of the experiment can be recorded manually at regular interval of times instead of using a data acquisition system, and then entered manually in an engineering software to be analyzed. Figure 4.27 is a sketch of how data can be manually collected.

Figure 4.27 Sketch of data manually collected

Function 3.3.2: Generate Graphs showing the fluctuation of each parameter

Concept 1: Using a software linked to the SCADA system
A SCADA system can generate graphs of the data acquired to have visual representation of the fluctuation of the measured parameters. Figure 4.28 represents a sketch of how a SCADA can generate graphs of the data it receives

Figure 4.28 Sketch of a graph generated by a SCADA system

Concept 2: Using a software linked to a DCS

A DCS system can generate graphs of the data acquired to have visual representation of the fluctuation of the measured parameters. Figure 4.29 represents a sketch of how a DCS can generate graphs of the data it receives

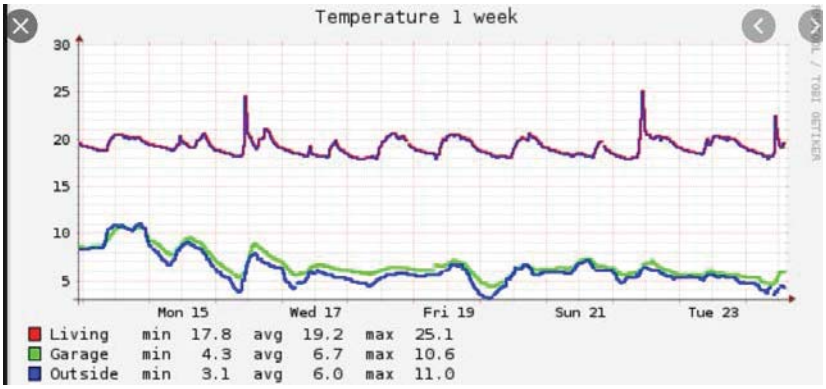


Figure 4.29 Sketch of a graph generated by a DCS system

Concept 3: Graphs of manually entered data using EES

Using a software like engineering equation solver graphs of the entered parameters can be generated over time (time scale has to be included). Figure 4.30 represents a sketch of how manually collected data can ne used for graphing by the Engineering Equation solver.

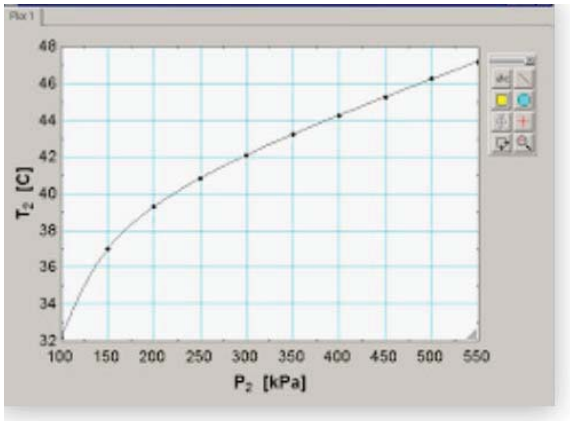


Figure 4.30 Sketch of a graph generated by EES for manually collected data

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	**10**
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	**32**
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	**43**
4	Status report assignment sheet attached	5	**5**
	Total for Individual Report	100	**90**

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 7 Concept Generation

Due Date: 10/24/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Responsible for bringing concepts for several level 3-subfunctions	100	
2	Jonathan Horta Jonathon Horta	Responsible for bringing concepts for several level 3-subfunctions	100	
3	Todd Maxwell Todd Maxwell	Responsible for bringing concepts for several level 3-subfunctions	100	
4	Michael Samuel Michael Samuel	Responsible for bringing concepts for several level 3-subfunctions	100	
5	Aramis King Aramis King	Responsible for bringing concepts for several level 3-subfunctions	100	
6	Daniel Ward Daniel C. Ward	Responsible for bringing concepts for several level 3-subfunctions	100	
7	Titus Woodard Titus Woodard	Responsible for bringing concepts for several level 3-subfunctions	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/14/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

3. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:

Concept 1 for the function " Heat the biomass"

Figure 1.1 shows the concept for this function. Then provide a brief description of the concept and how it works to execute the function.

Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
   The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***
Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Individual Grading Scheme
Homework #7a

Project Group #__8____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	
4	Status report assignment sheet attached	5	
	Total for Individual Report	100	

Group Grading Scheme
Homework #7b
Project Group #___8___

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

Table 1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
	VNM-1	VNM-1.1	VNM-1.1.1	Member 1	Member 2	Member 3	Member 4
			VNM-1.1.2	Member 5	Member 6	Member 7	Member 1
			VNM-1.1.3	Member 2	Member 3	Member 4	Member 5
		VNM-1.2	VNM-1.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-1.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-1.3 (No level 3 subfunctions)		Member 7	Member 1	Member 2	Member 3
	VNM-2	VNM-2.1	VNM-2.1.1	Member 4	Member 5	Member 6	Member 7
			VNM-2.1.2	Member 1	Member 2	Member 3	Member 4
			VNM-2.1.3	Member 5	Member 6	Member 7	Member 1
		VNM-2.2 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-2.3	VNM-2.3.1	Member 6	Member 7	Member 1	Member 2
			VNM-2.3.2	Member 3	Member 4	Member 5	Member 6
	VNM-3	VNM-3.1	VNM-3.1.1	Member 7	Member 1	Member 2	Member 3
			VNM 3.1.2	Member 4	Member 5	Member 6	Member 7
			VNM-3.1.3	Member 1	Member 2	Member 3	Member 4
		VNM-3.2 (No level 3 subfunctions)		Member 5	Member 6	Member 7	Member 1
		VNM-3.3	VNM-3.3.1	Member 2	Member 3	Member 4	Member 5
			VNM-3.3.2	Member 6	Member 7	Member 1	Member 2
	VNM-4	VNM-4.1 (No level 3 subfunctions)		Member 3	Member 4	Member 5	Member 6
		VNM-4.2	VNM-4.2.1	Member 7	Member 1	Member 2	Member 3
			VNM-4.2.2	Member 4	Member 5	Member 6	Member 7
		VNM-4.3	VNM-4.3.1	Member 1	Member 2	Member 3	Member 4
			VNM-4.3.2	Member 5	Member 6	Member 7	Member 1
	VNM-5	VNM-5.1 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-5.2	VNM-5.2.1	Member 6	Member 7	Member 1	Member 2
			VNM-5.2.2	Member 3	Member 4	Member 5	Member 6
		VNM-5.3		Member 7	Member 1	Member 2	Member 3

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt.

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
	VNM-1	VNM-1.1	VNM-1.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-1.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-1.2	VNM-1.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-1.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-1.3(No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
	VNM-2	VNM-2.1	VNM-2.1.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-2.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-2.2(No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-2.3	VNM-2.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-2.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-3	VNM-3.1	VNM-3.1.1		Figure #		Figure #		Figure #		Figure #
			VNM 3.1.2		Figure #		Figure #		Figure #		Figure #
			VNM-3.1.3		Figure #		Figure #		Figure #		Figure #
		VNM-3.2(No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-3.3	VNM-3.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-3.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-4	VNM-4.1 (No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-4.2	VNM-4.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-4.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-4.3	VNM-4.3.1		Figure #		Figure #		Figure #		Figure #
			VNM-4.3.2		Figure #		Figure #		Figure #		Figure #
	VNM-5	VNM-5.1(No level 3 subfunctions)			Figure #		Figure #		Figure #		Figure #
		VNM-5.2	VNM-5.2.1		Figure #		Figure #		Figure #		Figure #
			VNM-5.2.2		Figure #		Figure #		Figure #		Figure #
		VNM-5.3			Figure #		Figure #		Figure #		Figure #

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt

4.2 Concept Generation

This section will dive deeper in the process that the group took to come up with the overall concept generation of each system and break them down all the way to level 3 sub-functions. This will include giving a brief description and a sketch for each variable of this project.

The roles were assigned alphabetically by the last name of each member. The names were inserted on the table in that order until all the sub-sections were covered on both tables. Once the tables were completed, they were observed by all members to verify sufficiency. The members then separated and completed the descriptions and sketches individually. Table 1 shows the final results of which member was assigned to which level 3 sub-function to create sketches and descriptions for the suspension system. Table 2 shows the results of which member was assigned to which level 3 sub-function to create sketches and descriptions for the steering system.

Table 1 Individual Assignment for Suspension Concept Generation

Overall function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
Absorb and withstand forces from off-road conditions and the vehicle	Maintain contact with the ground	Force tires down with internal components	Release force from springs to the ground	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward
			Release energy from struts to the tires	Jonathon Horta	Daniel Ward	Michael Samuel	Titus Woodard
		Absorb All forces channeled from environment	Compress the springs from the external forces	Aramis King	Michael Samuel	Titus Woodard	Robert Barbee
			Compress the struts from external forces	Todd Maxwell	Aramis King	Daniel Ward	Jonathon Horta
			Rotate the control arms to decrease force intake	Michael Samuel	Todd Maxwell	Robert Barbee	Aramis King
	Sustain mobility of moving parts	Allow freedom of suspension components	Rotating of control arms to absorb excess forces	Daniel Ward	Jonathon Horta	Aramis King	Todd Maxwell
			Rotating of ball joints to absorb excess forces	Titus Woodard	Robert Barbee	Jonathon Horta	Michael Samuel
			Compressing of struts and springs from external forces	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward
		Stabilize movement of vehicle	Absorb forces with struts and springs	Jonathon Horta	Daniel Ward	Michael Samuel	Titus Woodard
			Move control arms based off environment	Aramis King	Michael Samuel	Daniel Ward	Robert Barbee
			Rotate ball joints from contact of force	Todd Maxwell	Aramis King	Titus Woodard	Jonathon Horta
	Distribute forces throughout suspension system	Channel forces through multiple pathways	Collect force through the struts	Michael Samuel	Jonathon Horta	Aramis King	Todd Maxwell
			Collect force through springs	Daniel Ward	Michael Samuel	Robert Barbee	Michael Samuel
			Transfer force through ball joint	Titus Woodard	Robert Barbee	Jonathon Horta	Daniel Ward
		Transfers loads from components to wheels	Transfer load from control arms	Robert Barbee	Titus Woodard	Todd Maxwell	Aramis King
			Transfer load from springs	Jonathon Horta	Daniel Ward	Michael Samuel	Todd Maxwell
			Transfer load from struts	Aramis King	Michael Samuel	Daniel Ward	Robert Barbee

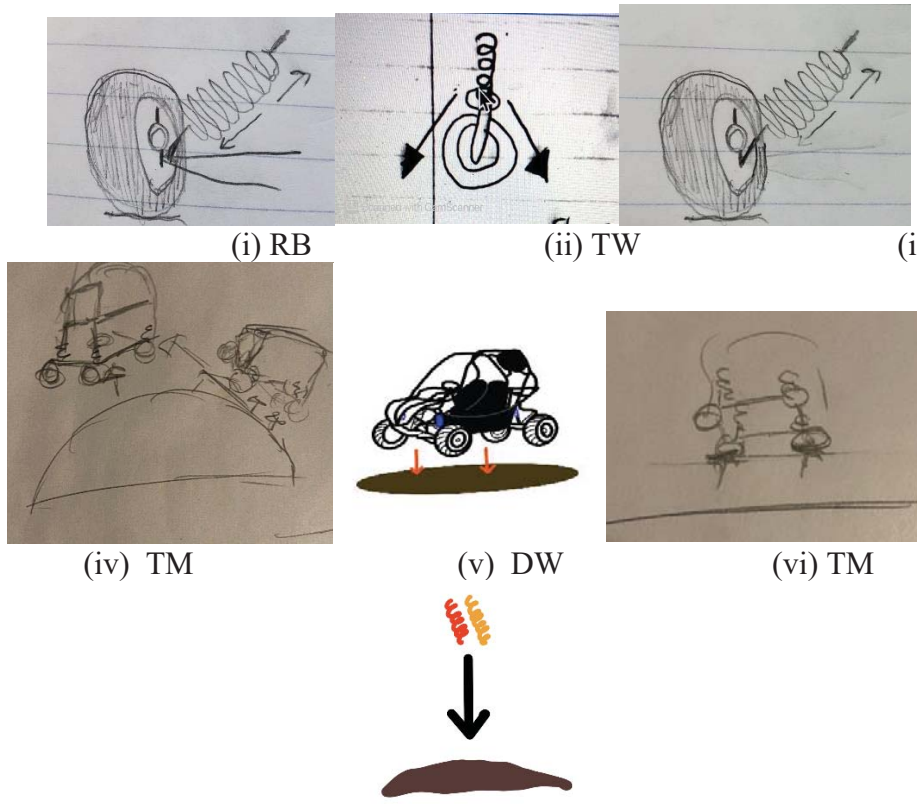
	Support external and internal forces from vehicle conditions	Counter Gravitational Force	Release force from spring to the ground	Todd Maxwell	Aramis King	Titus Woodard	Michael Samuel
			Release force from struts to ground	Michael Samuel	Todd Maxwell	Aramis King	Jonathon Horta
		Ability to manage centrifugal forces	Transfer vehicle load through struts while turning	Daniel Ward	Jonathon Horta	Robert Barbee	Titus Woodard
			Transfer vehicle load through springs while turning	Titus Woodard	Robert Barbee	Jonathon Horta	Michael Samuel
			Rotate control arms while turning	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward

Table 2 Individual Assignment for Suspension Concept Generation

overall function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
Convert driver input to change the direction of the vehicle	Maintain control of vehicle	Prevent unwanted motion due to external factors	Allow forces to be absorbed	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward
			Rotate gears only from steering wheel	Jonathon Horta	Daniel Ward	Michael Samuel	Titus Woodard
		Guide the steering wheel in direction desired	Hold the steering wheel firmly	Aramis King	Michael Samuel	Titus Woodard	Robert Barbee
			Turn the steering wheel when adjusting to external forces	Todd Maxwell	Aramis King	Daniel Ward	Jonathon Horta
			Allow horizontal motion with steering rod	Michael Samuel	Todd Maxwell	Robert Barbee	Aramis King
		Revert kinetic energy into another direction	Allow gears to move in both directions	Daniel Ward	Jonathon Horta	Aramis King	Todd Maxwell
			Allow steering rod to move horizontally in both directions	Titus Woodard	Robert Barbee	Jonathon Horta	Michael Samuel
	Transmit motion of the vehicle	Channel mechanical energy to turn vehicle	Transfer energy from steering wheel to Steering shaft	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward
			Translate motion from gears to steering rod	Jonathon Horta	Daniel Ward	Michael Samuel	Titus Woodard
			Move tires side to side from steering rod	Aramis King	Michael Samuel	Daniel Ward	Robert Barbee
		Grasp the steering wheel firmly	Contact the steering wheel tactfully	Todd Maxwell	Aramis King	Titus Woodard	Jonathon Horta
			Hold the steering wheel with hand	Michael Samuel	Jonathon Horta	Aramis King	Todd Maxwell
	Stabllize vehicle alignment	Maintain grip on the steering wheel	Contact the steering wheel firmly	Daniel Ward	Michael Samuel	Robert Barbee	Michael Samuel
			Hold the steering wheel until leaving the vehicle	Titus Woodard	Robert Barbee	Jonathon Horta	Daniel Ward

	to stay on course	Orient steering wheel based on drivers view	Avoid extreme conditions of the course	Robert Barbee	Titus Woodard	Todd Maxwell	Aramis King
			Drive along calmer environmental conditions	Jonathon Horta	Daniel Ward	Michael Samuel	Todd Maxwell
	Reduce effort of driver	Maintain Power Steering	Apply pressure to reduce force input	Aramis King	Michael Samuel	Daniel Ward	Robert Barbee
			Absorb external force to reduce driver control	Todd Maxwell	Aramis King	Titus Woodard	Michael samuel
			Reduce the turn of the steering wheel to perform a sharp maneuver	Michael Samuel	Todd Maxwell	Aramis King	Jonathon Horta
		adjusting steering effort	Allow easy motion of gears	Daniel Ward	Jonathon Horta	Robert Barbee	Titus Woodard
			Allow easy motion of steering rod	Titus Woodard	Robert Barbee	Jonathon Horta	Michael Samuel
			Allow easy motion of steering wheel	Robert Barbee	Titus Woodard	Todd Maxwell	Daniel Ward

Once the group finished their individual concepts for the assigned level 3 subfunctions, the group combined the concepts to come up with four final concepts. For the first level 3 sub-function, release force from springs to the ground, the group came up with eight concepts and decided on four that would best fit the project. In figure 7.1, all eight concepts from four different students for the first level 3 sub-functions. In table 3, it shows the final four concepts for the level 3 sub-function release force from the springs to the ground.



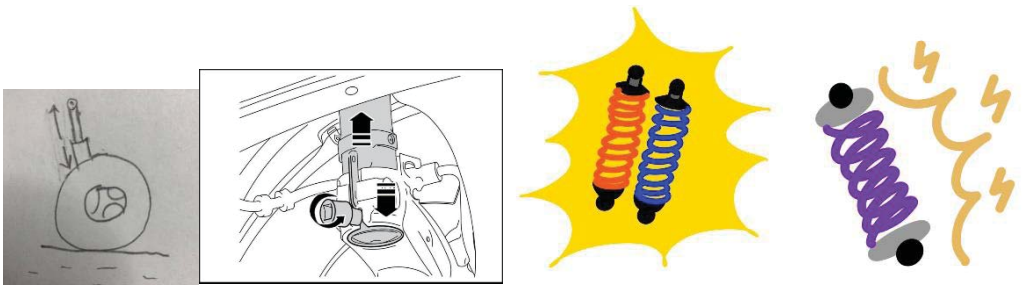
(i) RB (ii) TW (iii) RB

(iv) TM (v) DW (vi) TM

(vii) DW

Figure 7.1: Concepts for level 3 sub-function release force from the springs to the ground

For the next level 3 sub-function, release energy from the struts to the tires, the group came up with eight different concepts. In figure 7.2, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.

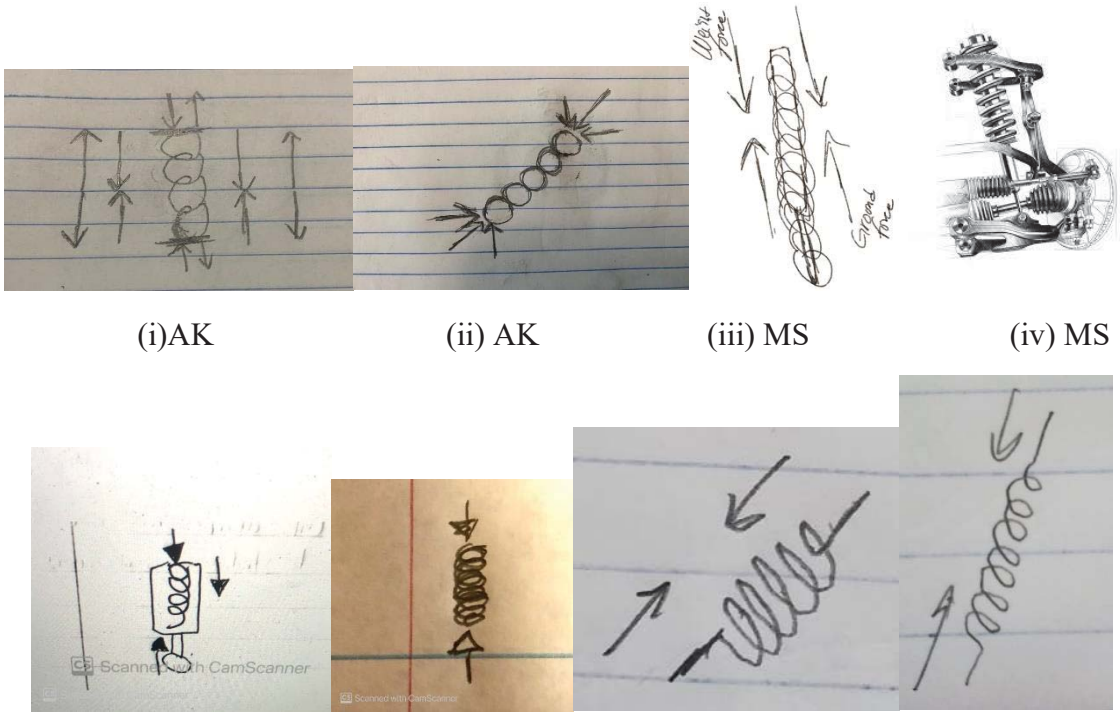


(i)JH (ii) JH (iii) DW (iv) DW

(v) MS (vi) MS (vii) TW

Figure 7.2: Concepts for level 3 sub-function release energy from struts to the tires

The next level 3 sub-function is compressing the springs from the external forces. The group created eight concepts that could work for this project. In table 3, it will have the final four concepts that will be considered for the design of this project. In figure 7.3, it will show all concepts for this level 3 sub-function.

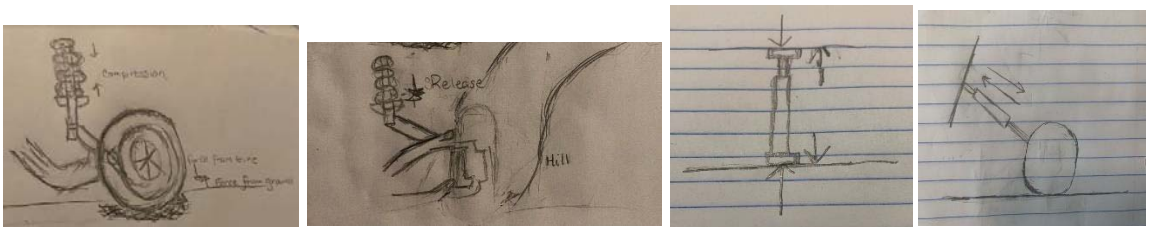


(i)AK (ii) AK (iii) MS (iv) MS

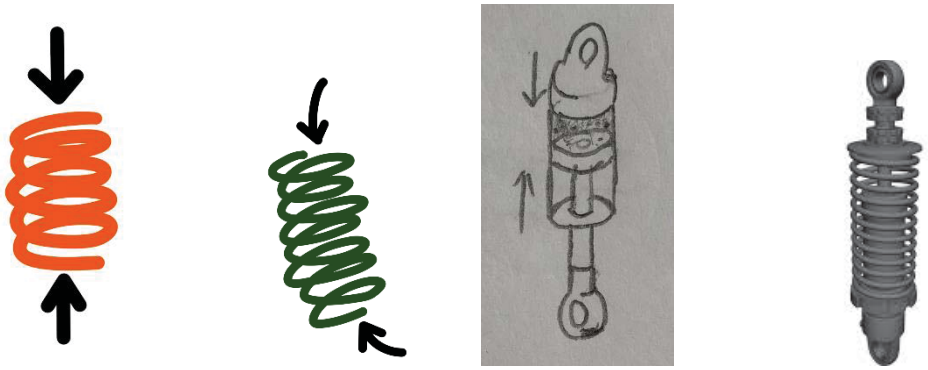
(v) TW (vi) TW (vii) RB (viii) RB

Figure 7.3: Concepts for level 3 sub-function compress the springs from the external forces

For the next level 3 sub-function, compress the struts from external forces, the group came up with eight different concepts. In figure 7.4, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



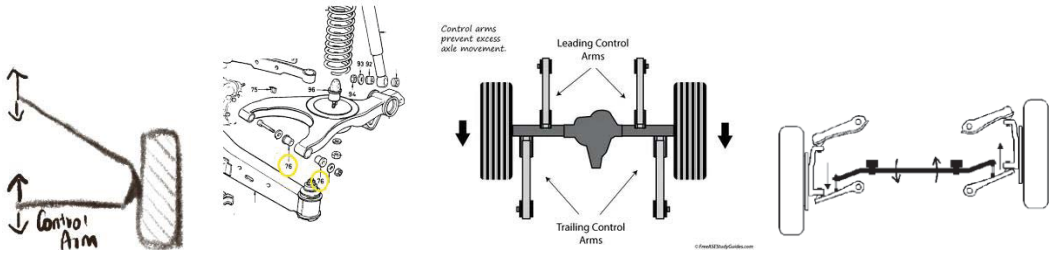
(i)TM (ii) TM (iii) AK (iv) AK



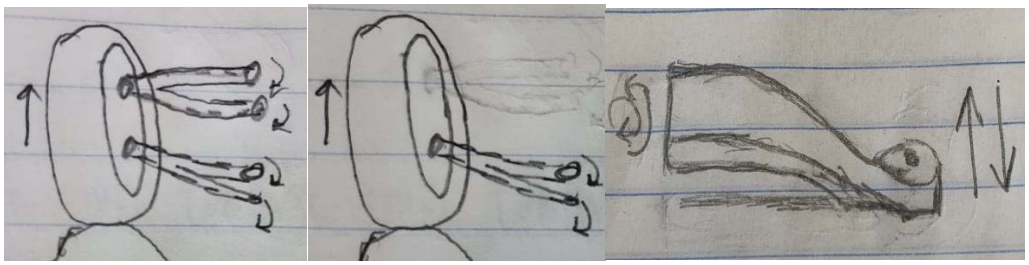
(v) DW (vi) DW (vii) JH (viii) JH

Figure 7.4: Concepts for level 3 sub-function compress the struts from external forces

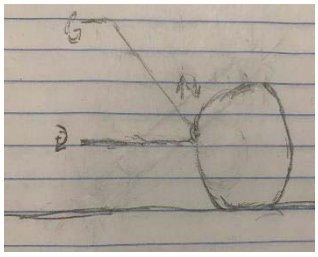
For the next level 3 sub-function, rotate the control arms to decrease force intake, the group came up with eight different concepts. In figure 7.5, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



(i)MS (ii) MS (iii) TM (iv) TM



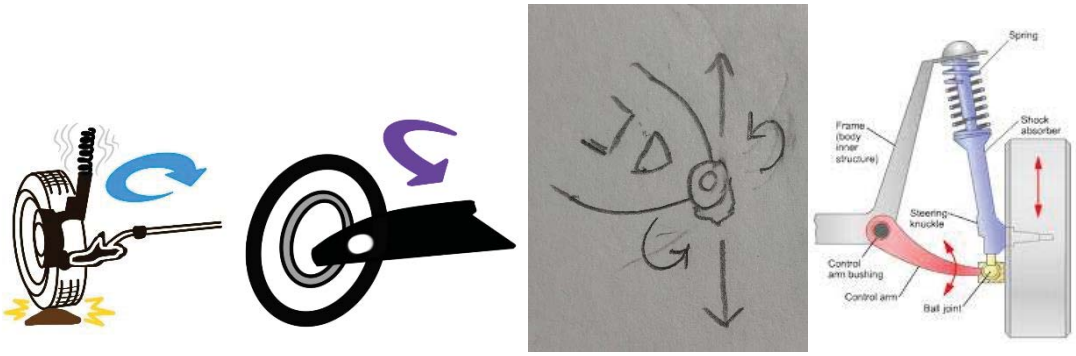
(v) RB (vi) RB (vii) AK



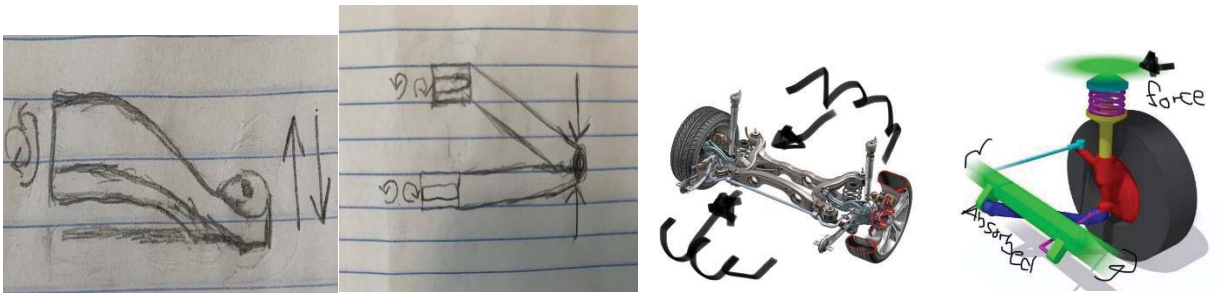
(viii) AK

Figure 7.5: Concepts for level 3 sub-function rotating the control arms to decrease force intake

For the next level 3 sub-function, rotating of control arms to absorb excess forces, the group came up with eight different concepts. In figure 7.6, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



(i)DW (ii) DW (iii)JH (iv) JH

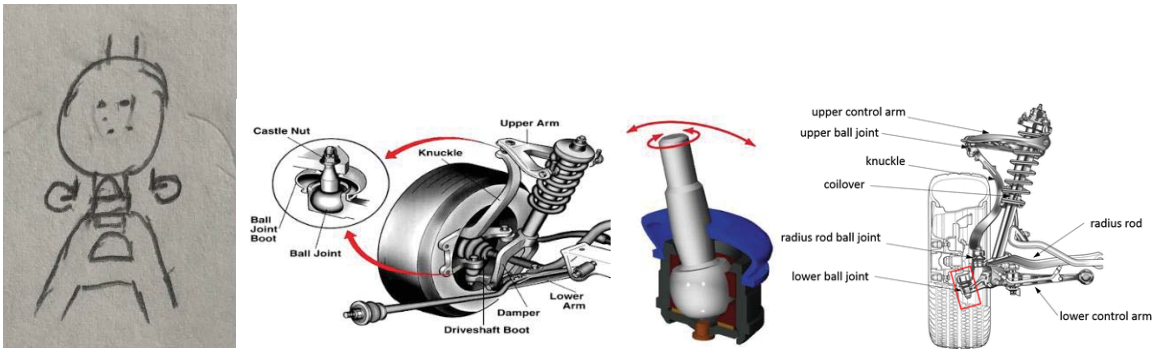


(v) AK (vi) AK (vii) TM (viii)

Figure 7.6: Concepts for level 3 sub-function rotating of control arms to absorb excess forces

For the next level 3 sub-function, rotating of ball joints to absorb excess forces, the group came up with eight different concepts. In figure 7.7, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.

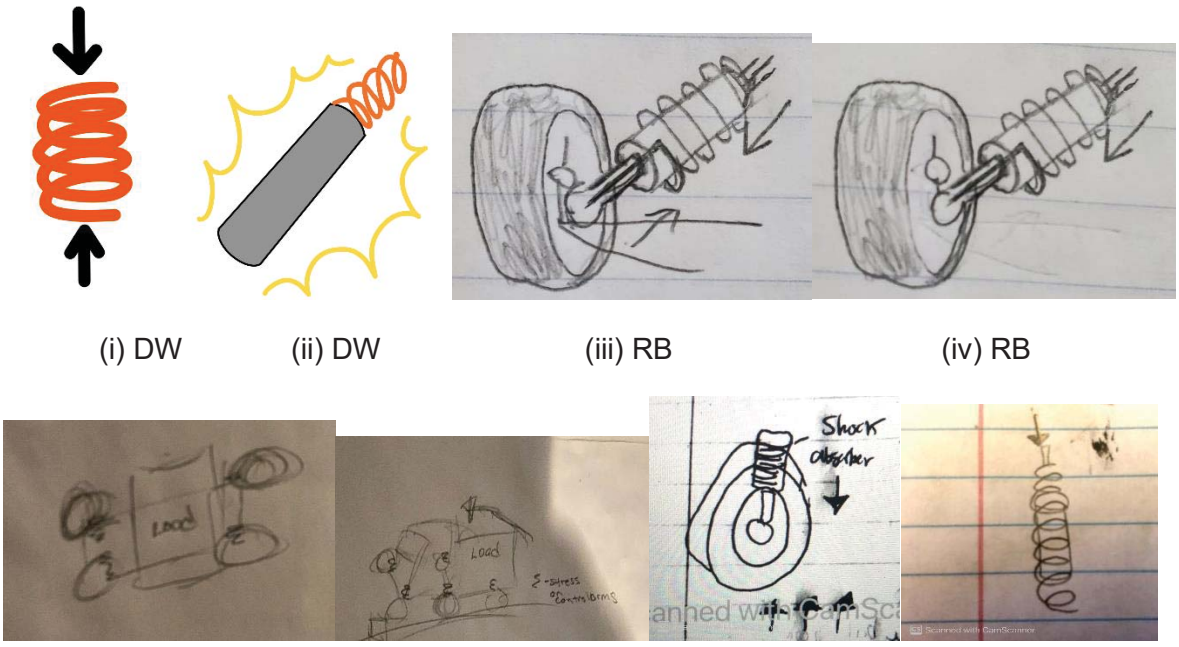
(i)TW (ii) RB (iii)RB



(iv) JH (v) JH (vi) MS (vii) MS

Figure 7.7: Concepts for level 3 sub-function rotating of ball joints to absorb excess forces

For the next level 3 sub-function, compressing of struts and springs from external forces, the group came up with eight different concepts. In figure 7.8, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.

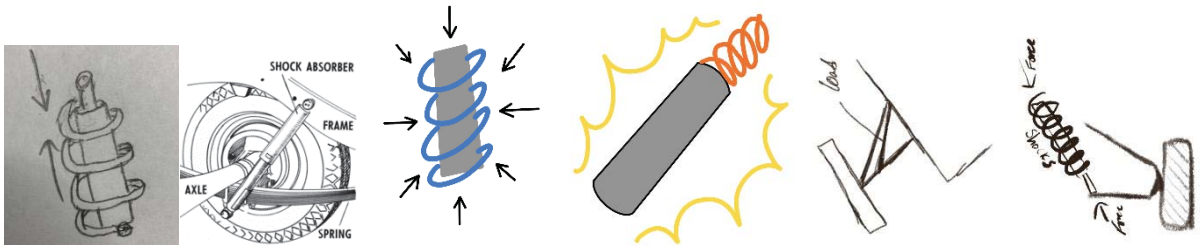


(i) DW (ii) DW (iii) RB (iv) RB

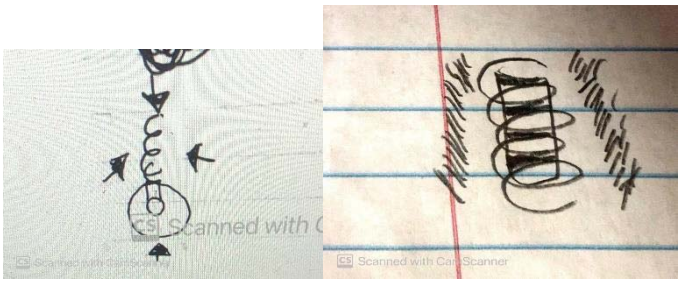
(v)TM (vi)TM (vii) TW (viii) TW

Figure 7.8: Concepts for level 3 sub-function compressing struts and springs from external forces

For the next level 3 sub-function, absorb forces with struts and springs, the group came up with eight different concepts. In figure 7.9, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



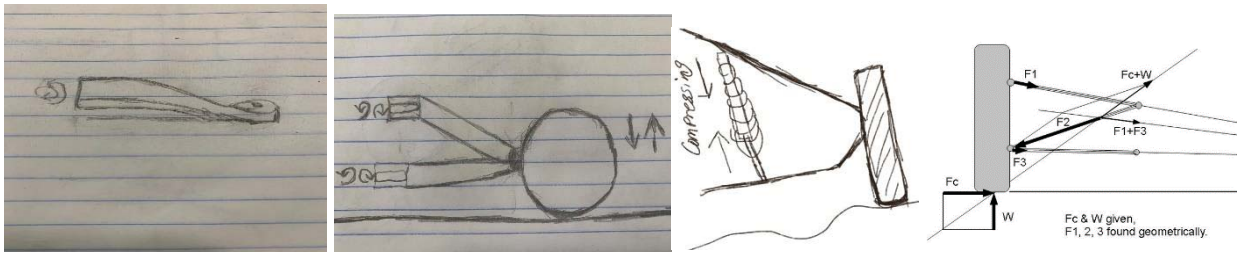
(i)JH (ii)JH (iii)DW (iv)DW (V) MS (Vi) MS



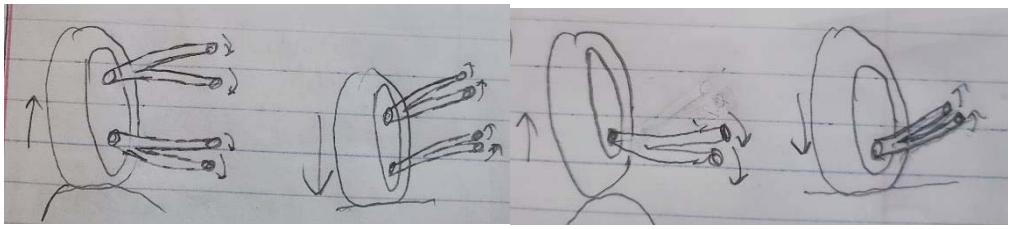
(vii) TW (vii) TW

Figure 7.9: Concepts for level 3 sub-function absorbing forces with struts and springs

For the next level 3 sub-function, move control arms based off environment, the group came up with eight different concepts. In figure 7.10, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



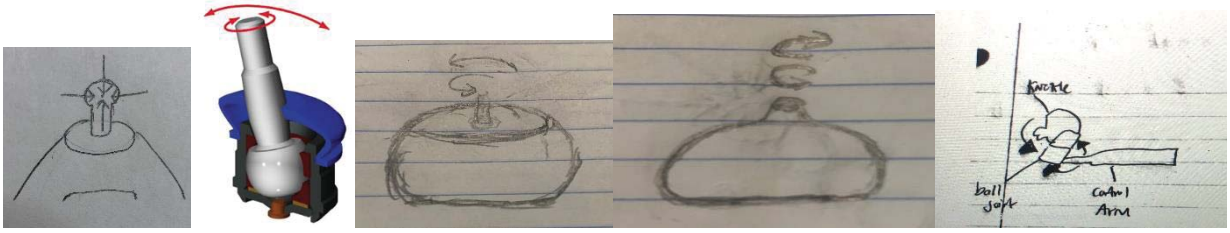
(i)AK (ii)AK (iii)MS (iV)MS



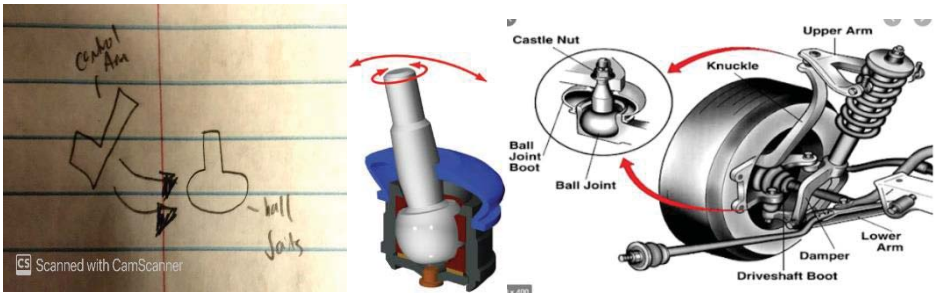
(v) RB (vi) RB

Figure 7.10: Concepts for level 3 sub-function move control arms based on the environments

For the next level 3 sub-function, rotate ball joints from contact of force, the group came up with eight different concepts. In figure 7.11, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



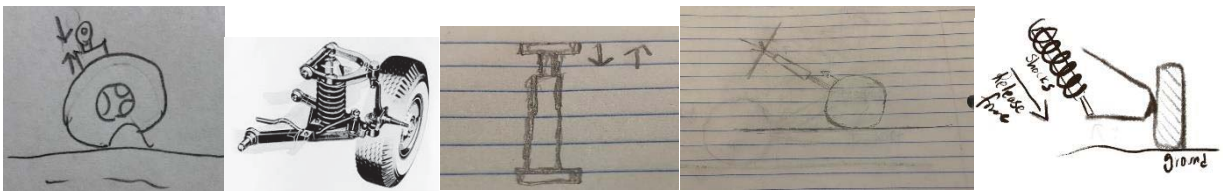
(i)JH (ii)JH (iii) AK (iv) AK (v) TW



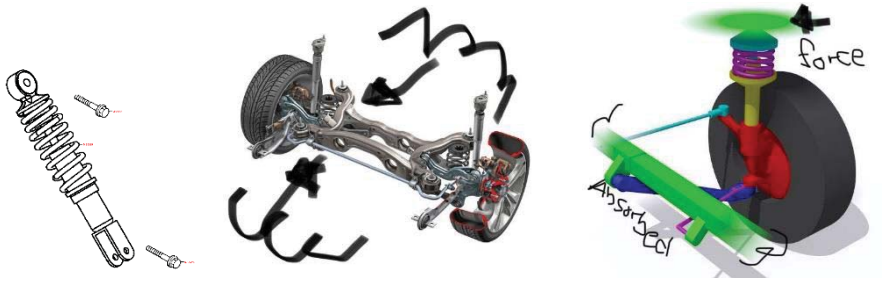
(vi) TW (vii)TM (viii)TM

Figure 7.11: Concepts for level 3 sub-function rotate ball joints from contact of force

For the next level 3 sub-function, collect force through the struts, the group came up with eight different concepts. In figure 7.12, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



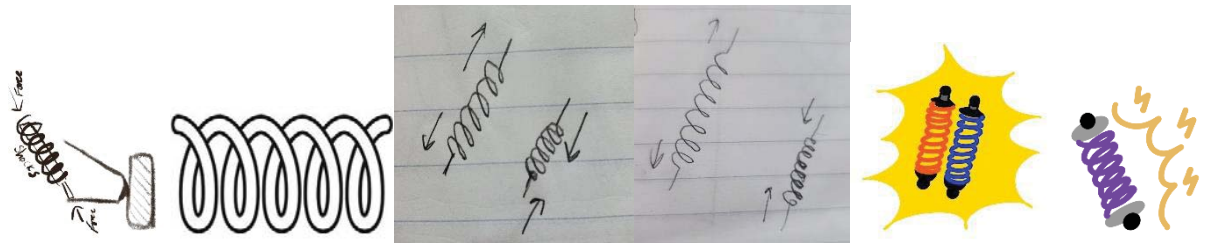
(i)JH (ii)JH (iii) AK (iv) AK (v)MS



(Vi)MS (vii)TM (viii)TM

Figure 7.12: Concepts for level 3 sub-function to collect force through the struts

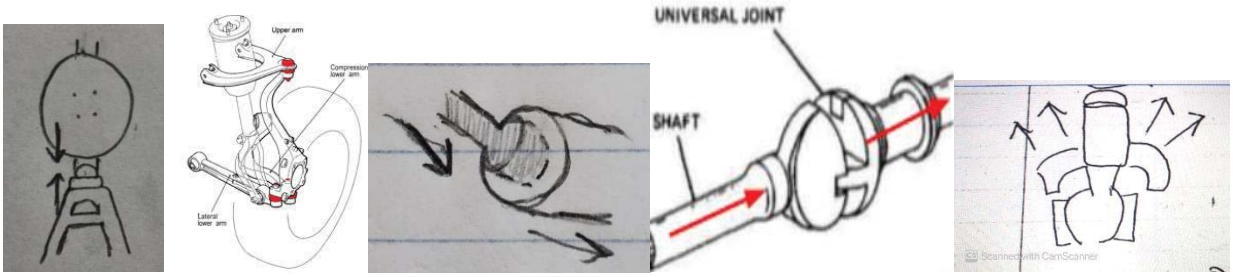
For the next level 3 sub-function, collect force through springs, the group came up with eight different concepts. In figure 7.13, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



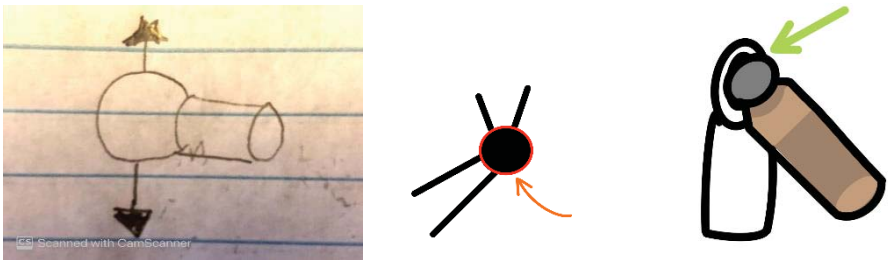
(i)MS (ii)MS (iii) RB (iv) RB (v) DW (vi) DW

Figure 7.13: Concepts for level 3 sub-function collect force through springs

For the next level 3 sub-function, transfer force through ball joint, the group came up with eight different concepts. In figure 7.14, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



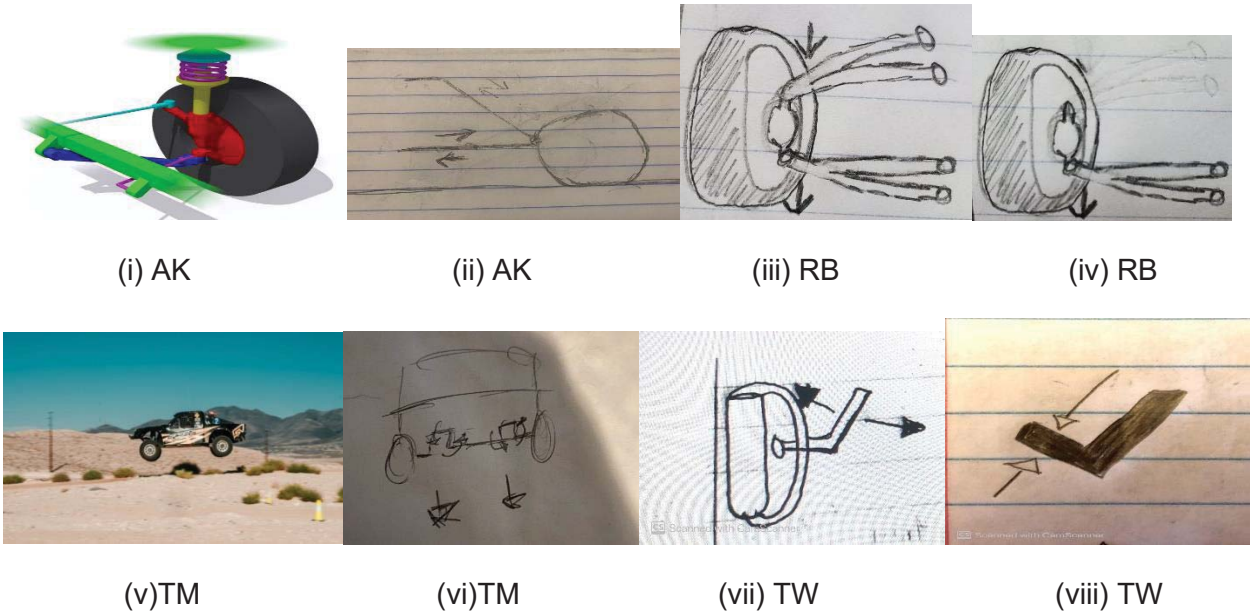
(i)JH (ii)JH (iii) RB (iv) RB (v) TW



(vi) TW (vii) DW (viii)DW

Figure 7.14: Concepts for level 3 sub-function transfer force through the ball joint

For the next level 3 sub-function, transfer load from control arms, the group came up with eight different concepts. In figure 7.15, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.

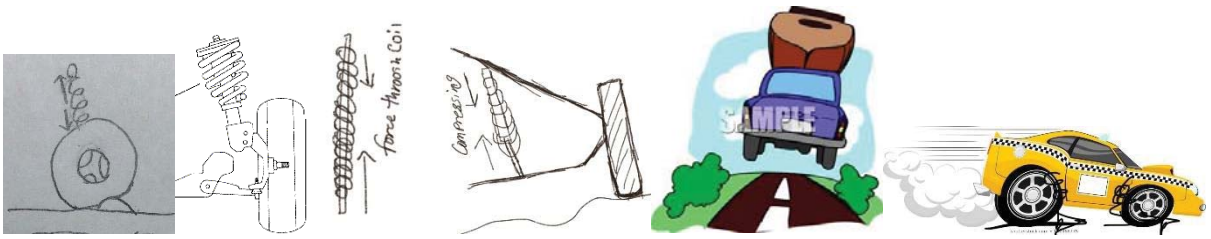


(i) AK (ii) AK (iii) RB (iv) RB

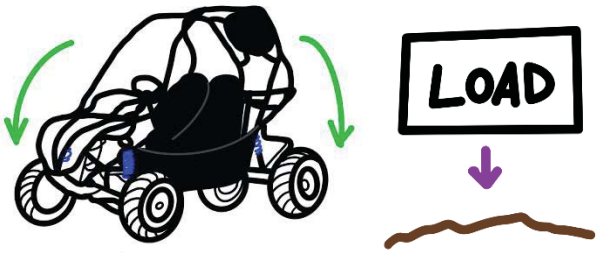
(v)TM (vi)TM (vii) TW (viii) TW

Figure 7.15: Concepts for level 3 sub-function transfer load from control arms

For the next level 3 sub-function, transfer load from springs, the group came up with eight different concepts. In figure 7.16, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



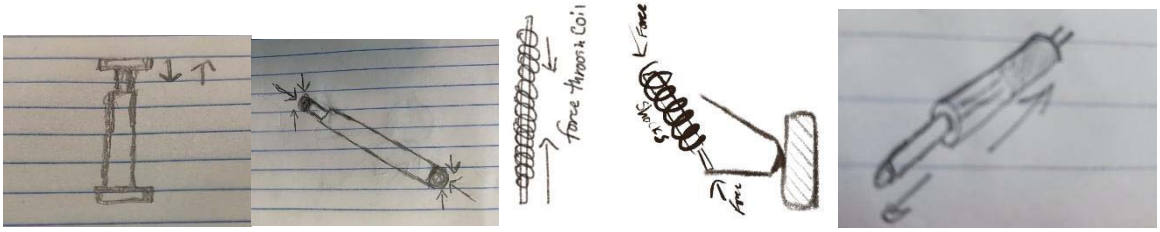
(i)JH (ii)JH (iii)MS (IV) MS (v)TM (vi)TM



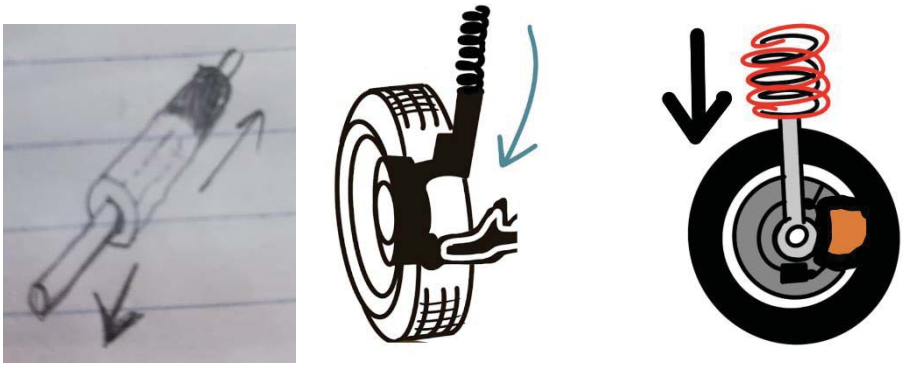
(vii) DW (viii) DW

Figure 7.16: Concepts for level 3 sub-function transfer load from springs

For the next level 3 sub-function, transfer load from struts, the group came up with eight different concepts. In figure 7.17, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



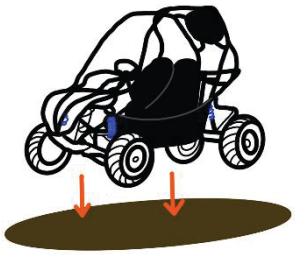
(i) AK (ii) AK (iii) MS (iV) MS (v) RB



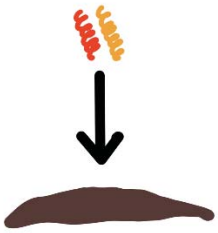
(vi) RB (vii) DW (viii) DW

Figure 7.17: Concepts for level 3 sub-function transfer load from struts

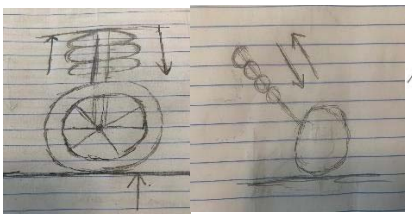
For the next level 3 sub-function, release force from the spring to the ground, the group came up with eight different concepts. In figure 7.18, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



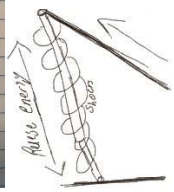
(i) DW



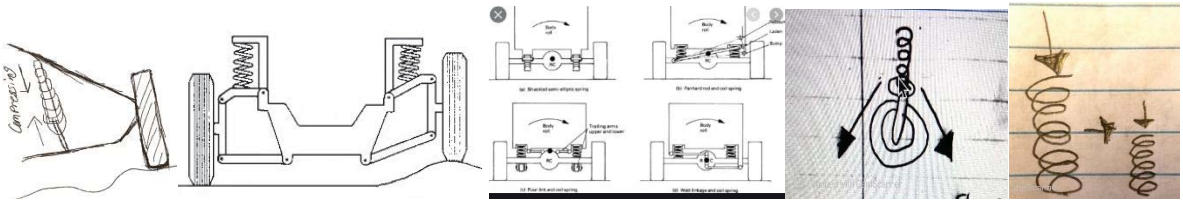
(ii) DW



(iii) AK (iv) AK



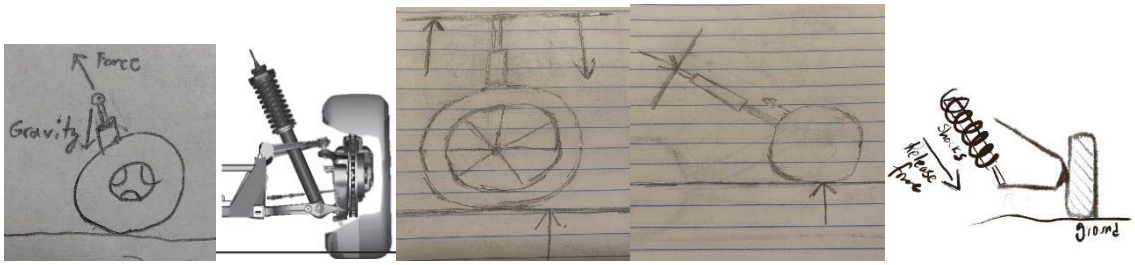
(V)MS



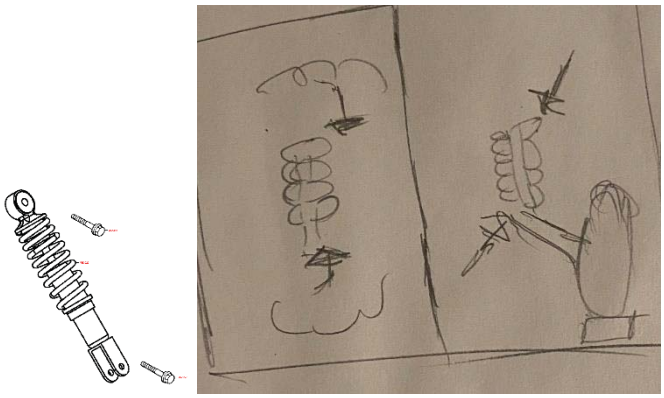
(vi) MS (vii)TM (viii)TM (ix) TW (x) TW

Figure 7.18: Concepts for level 3 sub-function releasing force from the spring to the ground

For the next level 3 sub-function, release force from the struts to ground, the group came up with eight different concepts. In figure 7.19, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



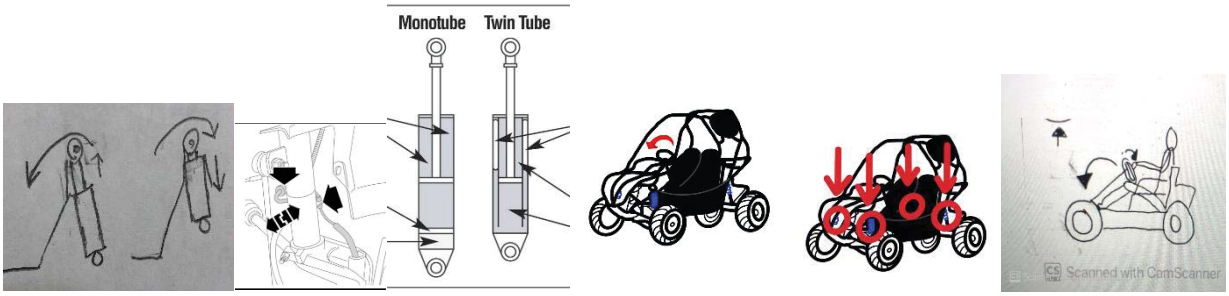
(i)JH (ii)JH (iii) AK (iv) AK (V)MS



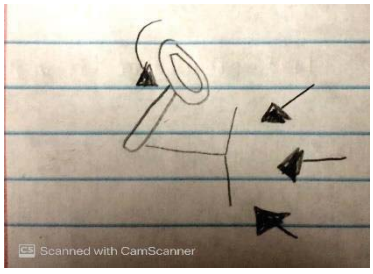
(Vi)MS (vii)TM (viii)TM

Figure 7.19: Concepts for level 3 sub-function releasing force from the struts to ground

For the next level 3 sub-function, transfer vehicle load through struts while turning, the group came up with eight different concepts. In figure 7.20, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



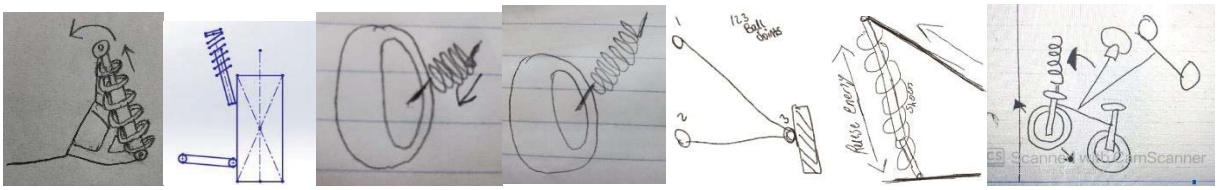
(i)JH (ii)JH (iii) RB (iv) DW (v) DW (vi) TW



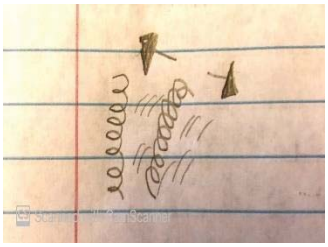
(vii) TW

Figure 7.20: Concepts for level 3 sub-function transfer vehicle load through struts while turning

For the next level 3 sub-function, transfer vehicle load through springs while turning, the group came up with eight different concepts. In figure 7.21, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.



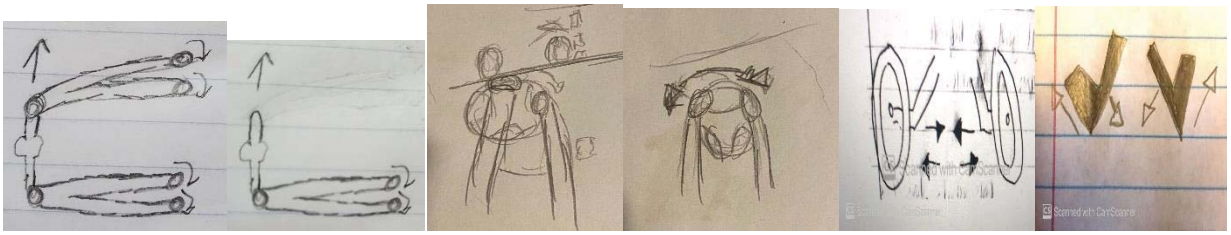
(i)JH (ii)JH (iii) RB (iv) RB (v) MS (vi) MS (vii) TW



(viii) TW

Figure 7.21: Concepts for level 3 sub-function transfer vehicle load through springs while turning

For the next level 3 sub-function, rotate control arms while turning, the group came up with eight different concepts. In figure 7.22, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 3.

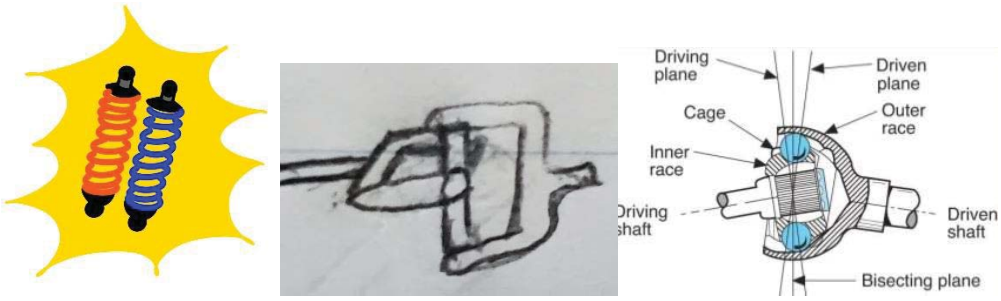


(i) RB (ii) RB (iii)TM (iv)TM (v) TW (vi)TW

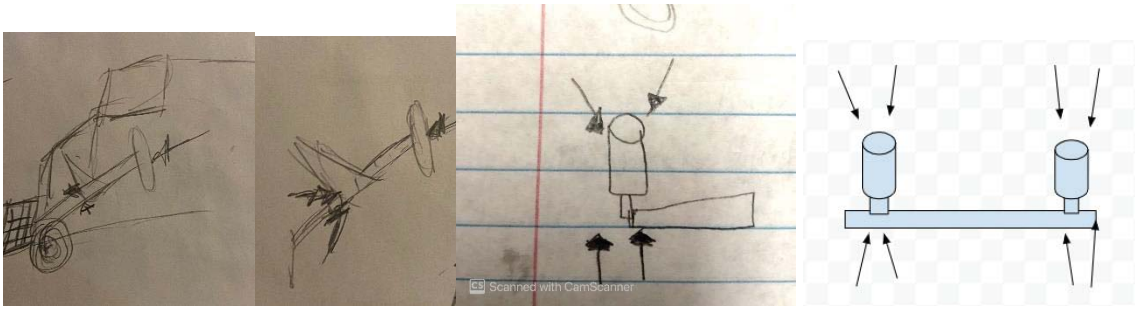
(vii) DW (viii) DW

Figure 7.22: Concepts for level 3 sub-function rotate control arms while turning

For steering, the first level 3 sub-function is allowed forces to be absorbed. The group came up with eight different concepts. In figure 7.23, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



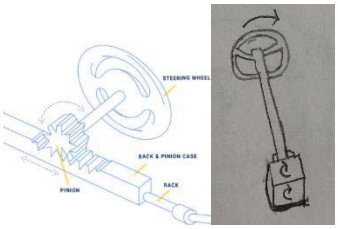
(i) DW (ii) RB (iii) RB



(iv)TM (v)TM (vi) TW (vii) TW

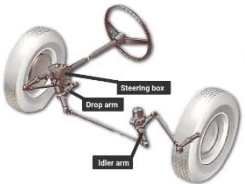
Figure 7.23: Concepts for level 3 sub-function allows forces to be absorbed

For the next level 3 sub-function, rotate gears only from steering wheel, the group came up with eight different concepts. In figure 7.24, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

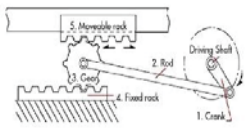


(i)JH

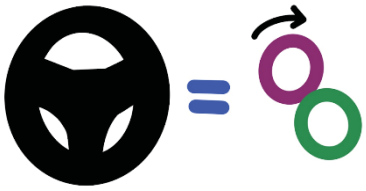
(ii)JH



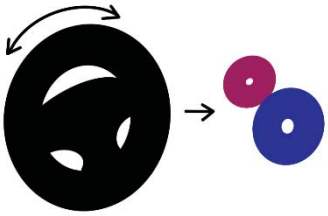
(iii)MS



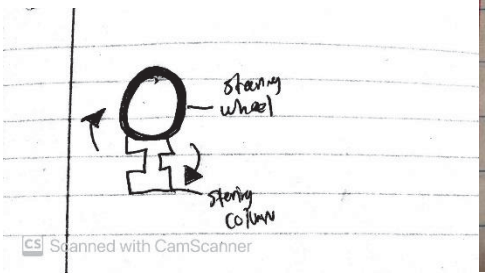
(iv)MS



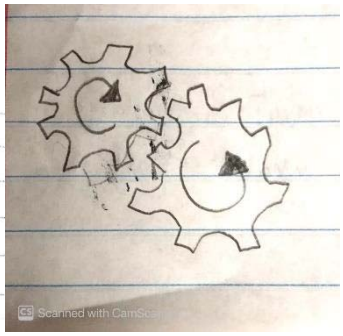
(v) DW



(vi) DW



(vii) TW

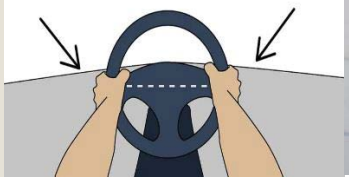


(viii) TW

Figure 7.24: Concepts for level 3 sub-function rotate gears only from the steering wheel

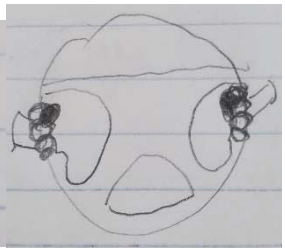
For the next level 3 sub-function, hold the steering wheel firmly, the group came up with eight different concepts. In figure 7.25, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

(i) AK

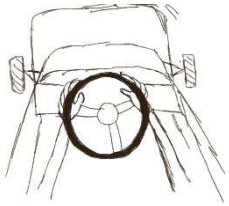


(ii) AK

(iii) RB

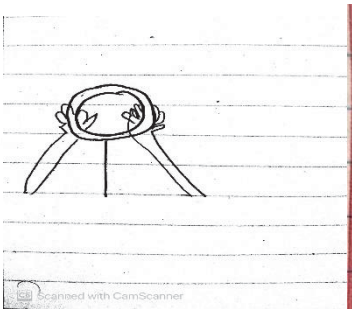


(iv) RB

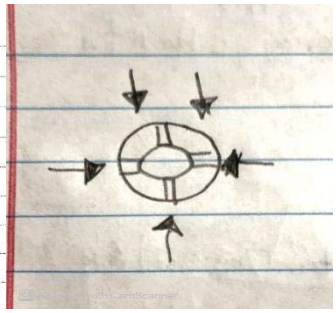


(v)MS

(Vi)MS



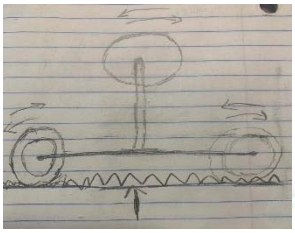
(vii) TW



(viii) TW

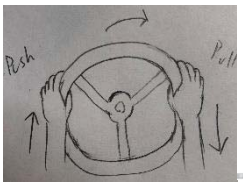
Figure 7.25: Concepts for level 3 sub-function hold the steering wheel firmly

For the next level 3 sub-function, turn the steering wheel when adjusting to external forces, the group came up with eight different concepts. In figure 7.26, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



(i) AK

(ii) AK

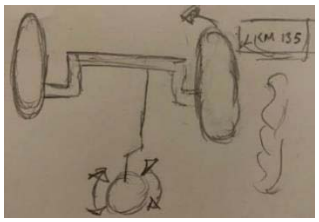


(iii)JH

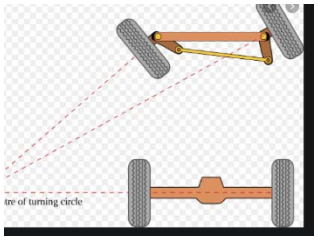
(iv)JH

(v) DW

(vi) DW



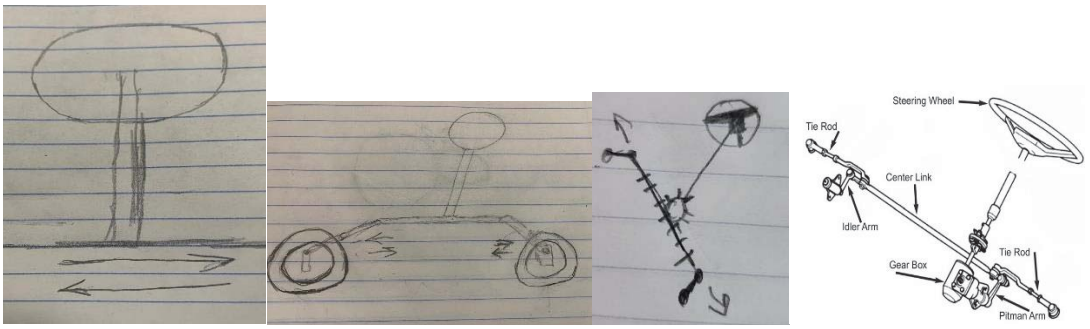
(vii)TM



(viii)TM

Figure 7.26: Concepts for level 3 sub-function turn the steering wheel when adjusting to external forces

For the next level 3 sub-function, allow horizontal motion with the steering rod, the group came up with eight different concepts. In figure 7.27, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

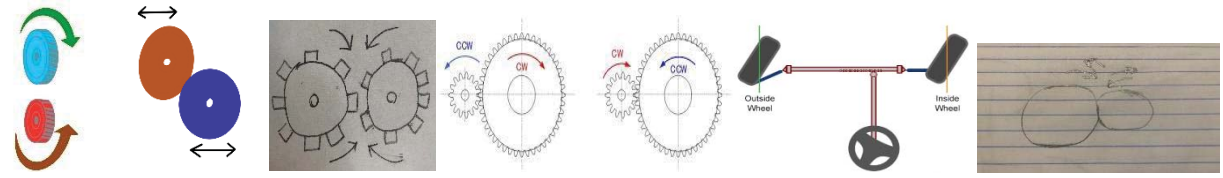


(i) AK (ii) AK (iii) RB (iv) RB

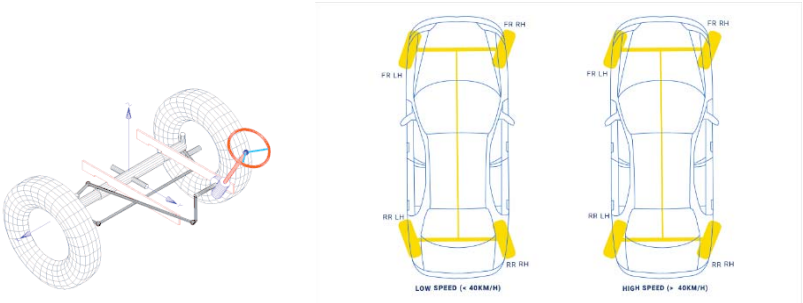
(v)MS (vi)MS (vii)TM (viii)TM

Figure 7.27: Concepts for level 3 sub-function allowing horizontal motion with the steering rod

For the next level 3 sub-function, allow gears to move in both directions, the group came up with eight different concepts. In figure 7.28, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



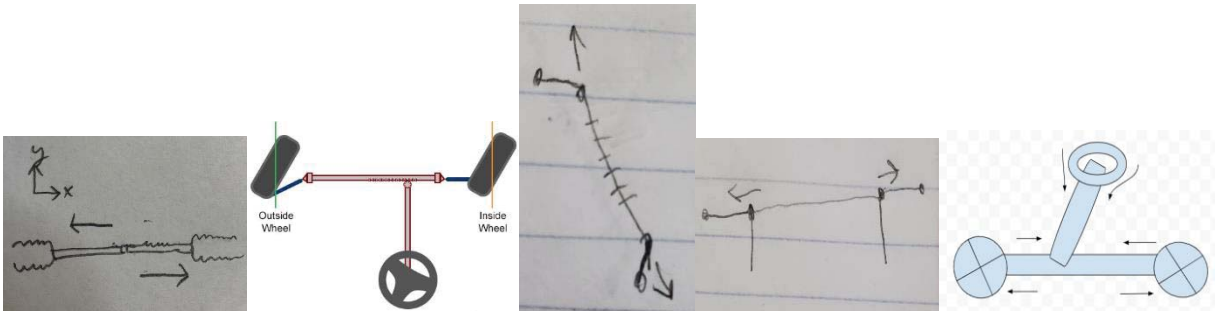
(i) DW (ii)DW (iii)JH (iv)JH (v) AK (vi) AK



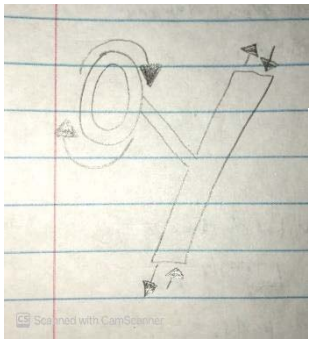
(vii)TM (viii)TM

Figure 7.28: Concepts for level 3 sub-function allowing gears to move in both directions

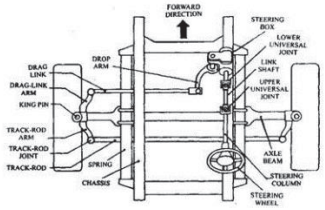
For the next level 3 sub-function, allow steering rod to move horizontally in both directions, the group came up with eight different concepts. In figure 7.29, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



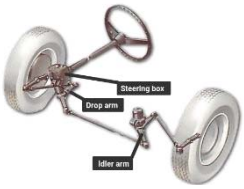
(i)JH (ii)JH (iii) RB (iv) RB (v) TW



(vi) TW



(vii) MS

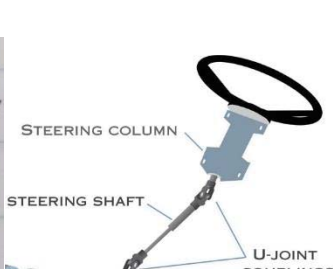


(viii) MS

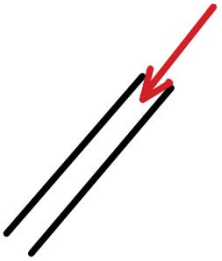
Figure 7.29: Concepts for level 3 sub-function allowing the steering rod to move horizontally in both directions

For the next level 3 sub-function, transfer energy from steering wheel to steering shaft, the group came up with eight different concepts. In figure 7.30, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

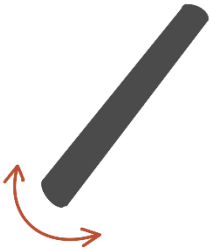
(i) RB



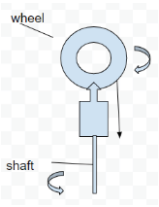
(ii) RB



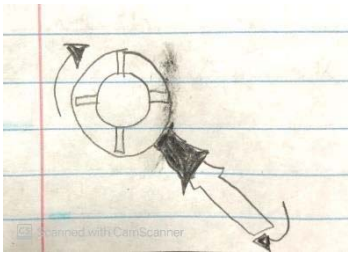
(iii) DW



(iv)DW

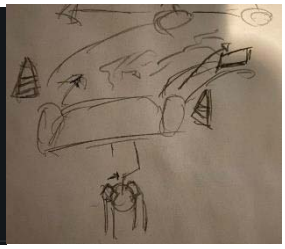


(V) TW



(vi) TW

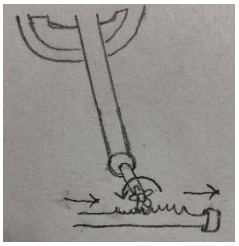
(vii)TM



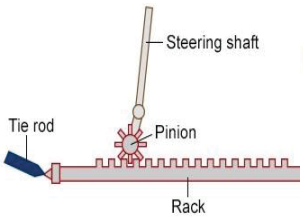
(viii)TM

Figure 7.30: Concepts for level 3 sub-function transferring energy from steering wheel to steering shaft

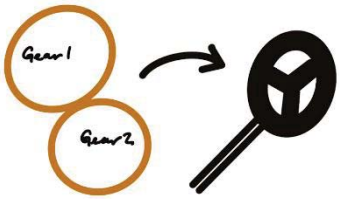
For the next level 3 sub-function, translate motion from gears to steering rod, the group came up with eight different concepts. In figure 7.31, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



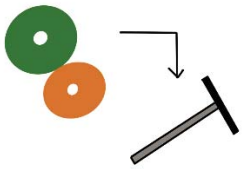
(i)JH



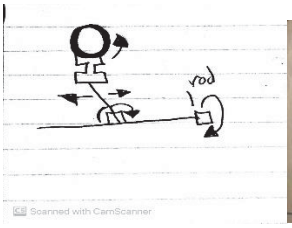
(ii)JH



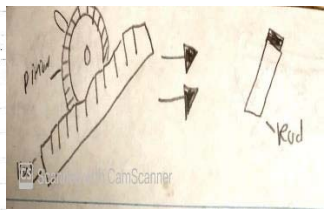
(iii) DW



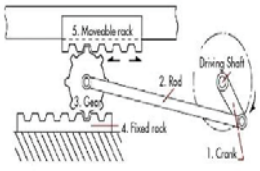
(iv) DW



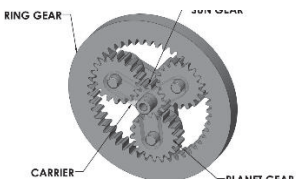
(v) TW



(vi) TW



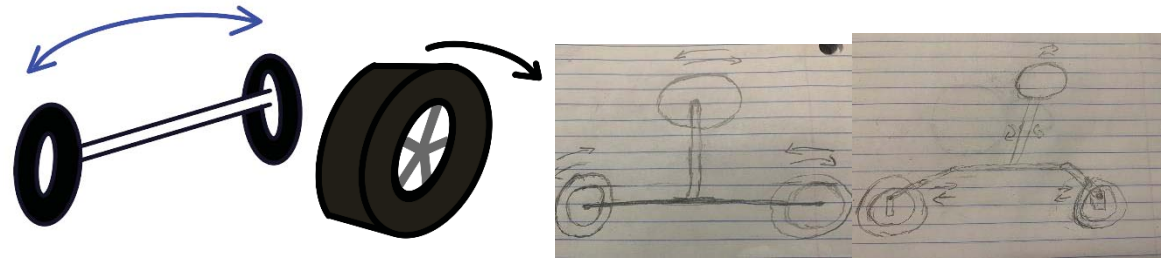
(vii) MS



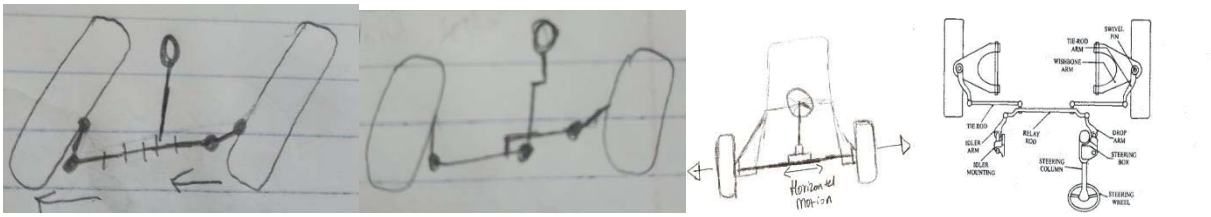
(viii) MS

Figure 7.31: Concepts for level 3 sub-function which translates motion from gears to steering rod

For the next level 3 sub-function, move tires side to side from steering rod, the group came up with eight different concepts. In figure 7.32, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



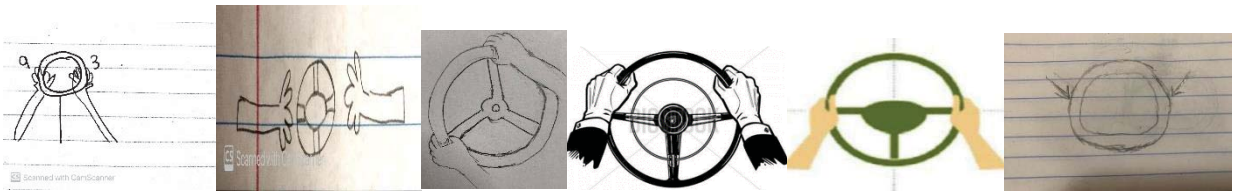
(i) DW (ii) DW (iii) AK (iv) AK



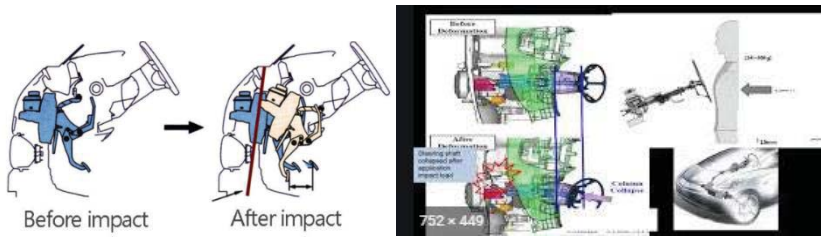
(v) RB (vi) RB (vii)MS (viii) MS

Figure 7.32: Concepts for level 3 sub-function moving tires side to side from the steering rod

For the next level 3 sub-function, contact the steering wheel tactfully, the group came up with eight different concepts. In figure 7.33, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



(i) TW (ii) TW (iii)JH (iv)JH (v) AK (vi) AK



(vii)TM (viii)TM

Figure 7.33: Concepts for level 3 sub-function contact the steering wheel tactfully

For the next level 3 sub-function, hold the steering wheel with hand, the group came up with eight different concepts. In figure 7.34, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

(i)JH (ii)JH (iii) AK (iv) AK (v)MS

(vi) MS (vii)TM (viii)TM

Figure 7.34: Concepts for level 3 sub-function hold the steering wheel with hand

For the next level 3 sub-function, contact the steering wheel firmly, the group came up with eight different concepts. In figure 7.35, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

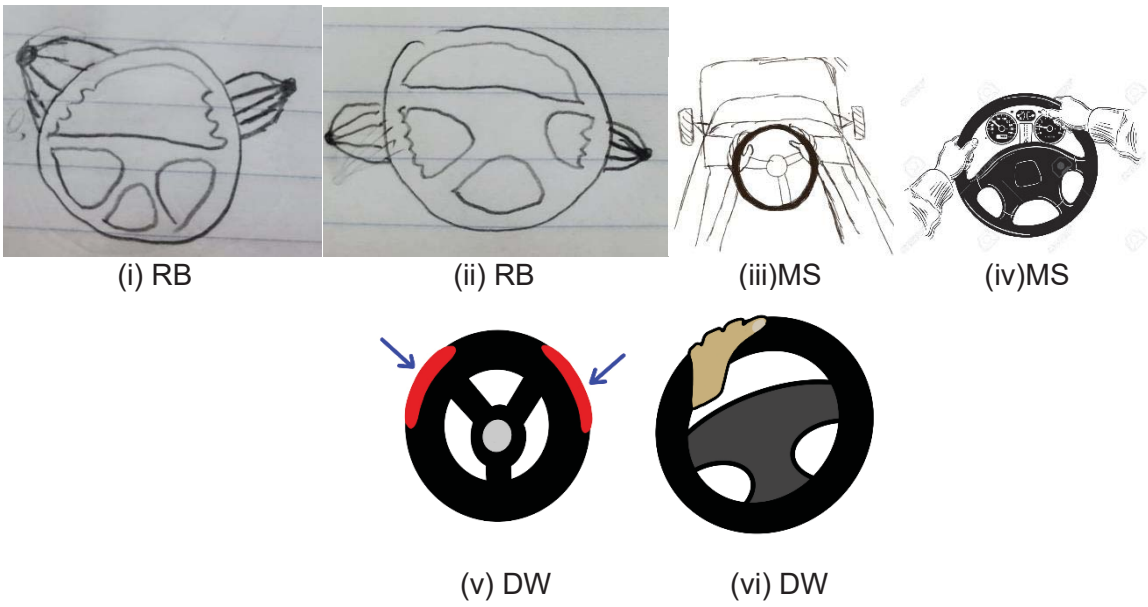


Figure 7.35: Concepts for level 3 sub-function contact the steering wheel firmly

For the next level 3 sub-function, hold the steering wheel until leaving the vehicle, the group came up with eight different concepts. In figure 7.36, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

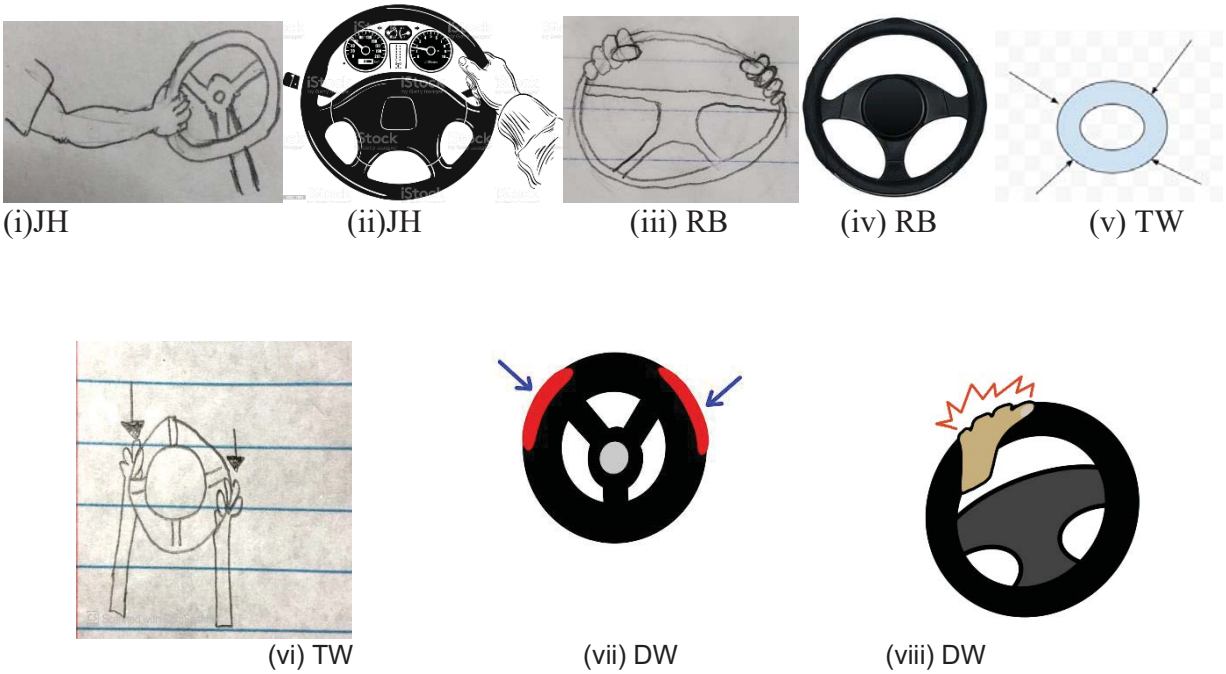
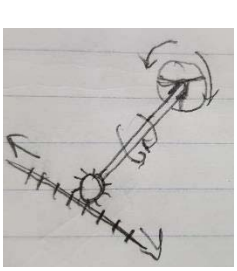
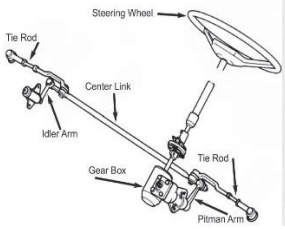


Figure 7.36: Concepts for level 3 sub-function hold the steering wheel until leaving the vehicle

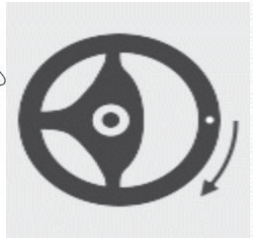
For the next level 3 sub-function, avoid extreme conditions of the course, the group came up with eight different concepts. In figure 7.37, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



(i) RB

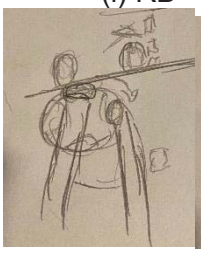


(ii) RB

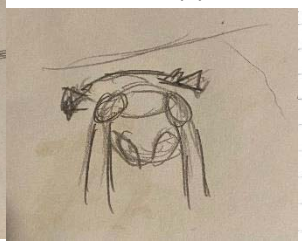


(iii) AK

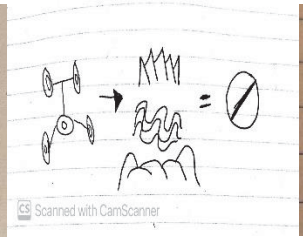
(iv) AK



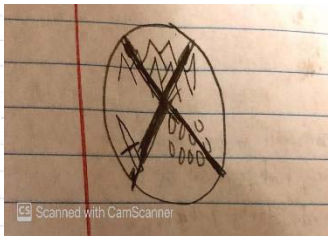
(v)TM



(vi)TM



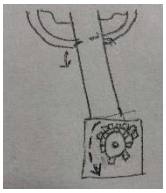
(vii) TW



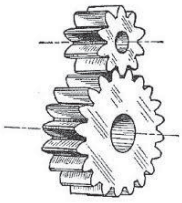
(viii) TW

Figure 7.37: Concepts for level 3 sub-function to avoid extreme conditions of the course

For the next level 3 sub-function, drive along calmer environmental conditions, the group came up with eight different concepts. In figure 7.38, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

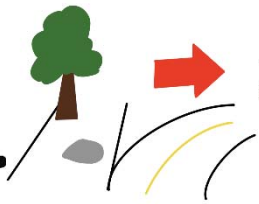


(i)JH

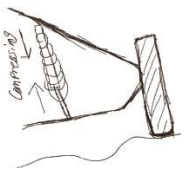


(ii)JH

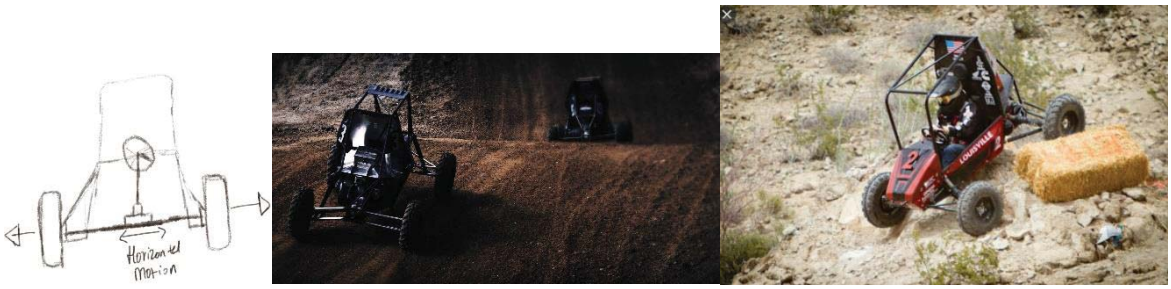
(iii) DW



(iv) DW



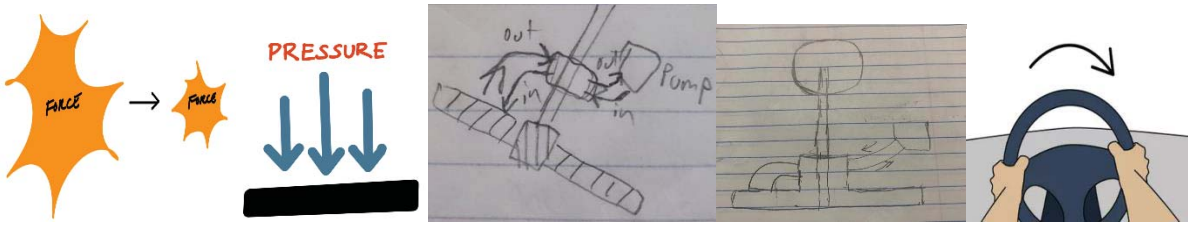
(v) MS



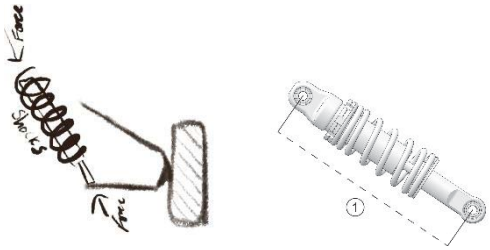
(vi)MS (vii)TM (vii)TM

Figure 7.38: Concepts for level 3 sub-function drive along calmer environmental conditions

For the next level 3 sub-function, apply pressure to reduce force input, the group came up with eight different concepts. In figure 7.39, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



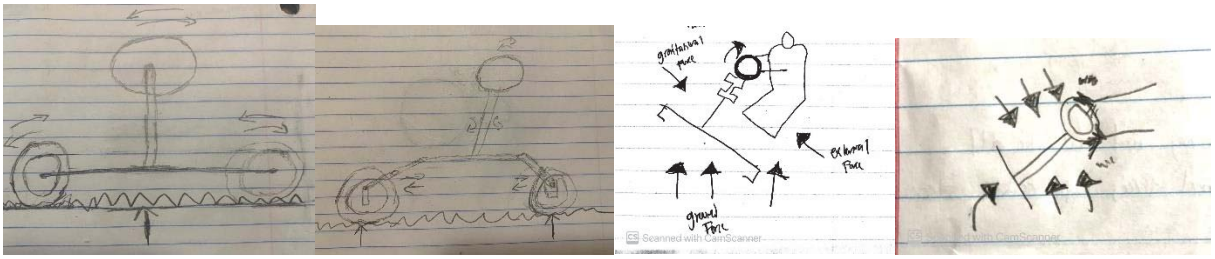
(i) DW (ii) DW (iii) RB (iv) AK (v) AK



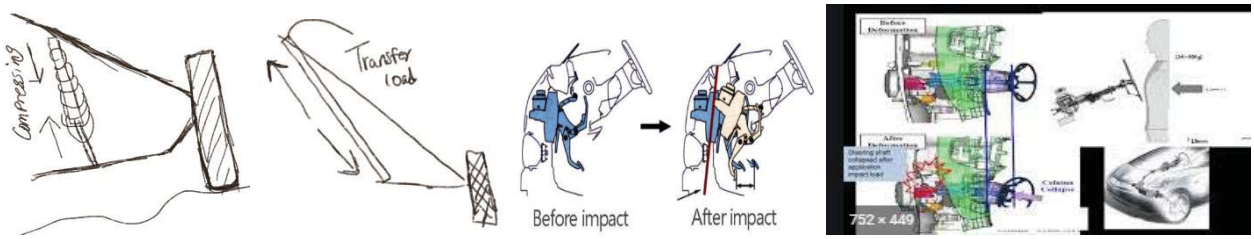
(Vi)MS (vii)MS

Figure 7.39: Concepts for level 3 sub-function applying pressure to reduce force input

For the next level 3 sub-function, absorb external force to reduce driver control, the group came up with eight different concepts. In figure 7.40, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



(i) AK (ii) AK (iii) TW (iv) TW

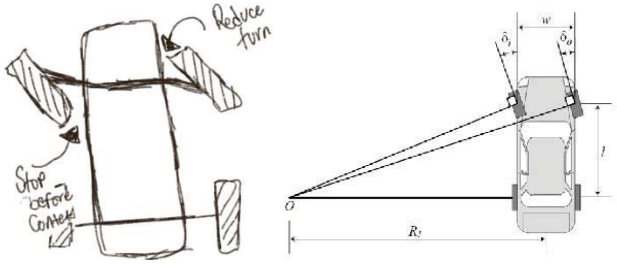


(v) MS (vi) MS (vii) TM (viii) TM

Figure 7.40: Concepts for level 3 sub-function to absorb external force to reduce driver control

For the next level 3 sub-function, reduce the turn of the steering wheel to perform a sharp maneuver, the group came up with eight different concepts. In figure 7.41, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

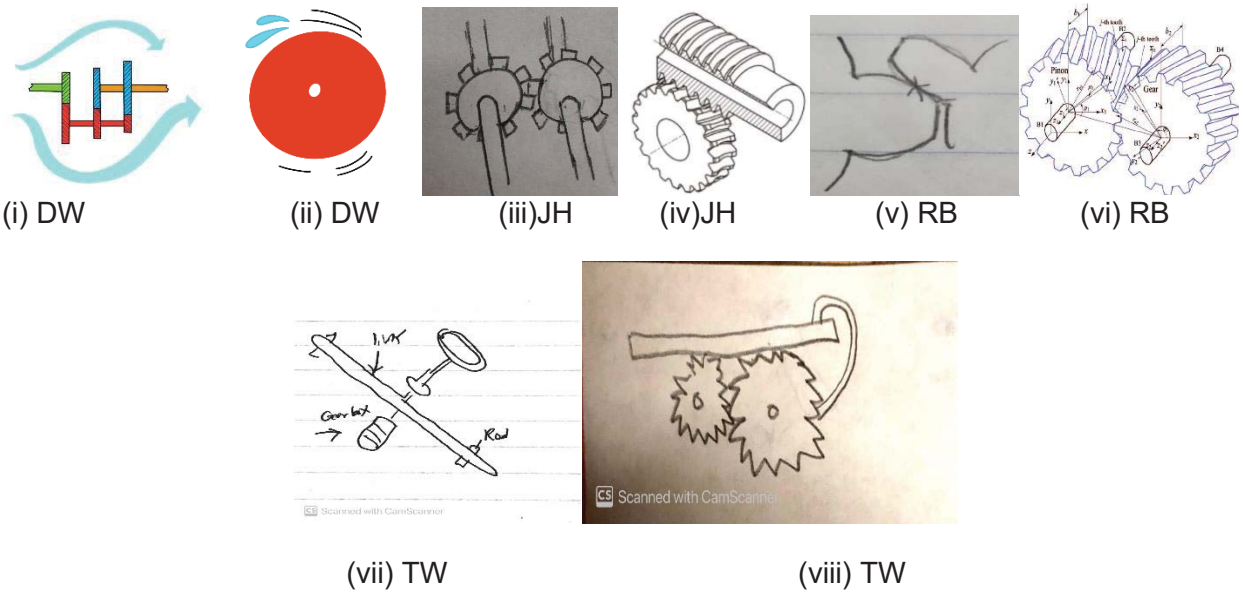
(i)JH (ii)JH (iii) AK (iv) AK



(v)MS (vi) MS

Figure 7.41: Concepts for level 3 sub-function reducing the turn of the steering wheel to perform a sharp maneuver

For the next level 3 sub-function, allow easy motion of gears, the group came up with eight different concepts. In figure 7.42, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.

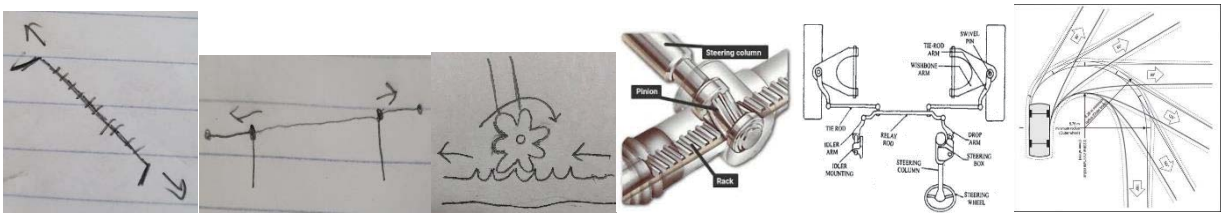


(i) DW (ii) DW (iii)JH (iv)JH (v) RB (vi) RB

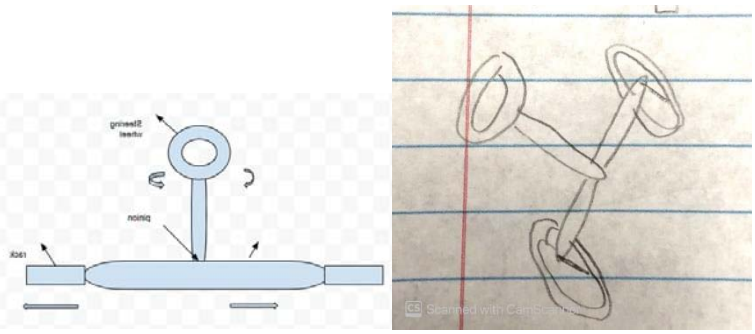
(vii) TW (viii) TW

Figure 7.42: Concepts for level 3 sub-function allowing easy motion of gears

For the next level 3 sub-function, allow easy motion of steering rod, the group came up with eight different concepts. In figure 7.43, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



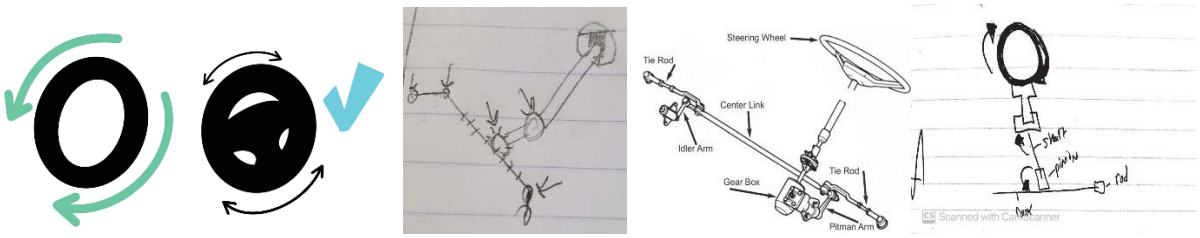
(i) RB (ii) RB (iii)JH (iv)JH (v) MS (vi) MS



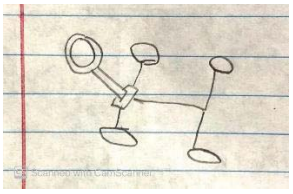
(vii) TW (viii) TW

Figure 7.43: Concepts for level 3 sub-function allowing easy motion of the steering rod

For the next level 3 sub-function, allow easy motion of steering wheel, the group came up with eight different concepts. In figure 7.44, there are eight sketches from several students showing how the level 3 sub-function can be designed. The figure number from where the sketch is first shown is in table 4.



(i) DW (ii) DW (iii) RB (iv) RB (v) TW



(vi)TW

Figure 7.44: Concepts for level 3 sub-function allowing easy motion of the steering wheel

Table 3 Morphology Table for Suspension

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
Absorb and withstand forces from off-road conditions and the vehicle	Maintain contact with the ground	Force tires down with internal components	Release force from springs to the ground	Spring on control arm	Figure 7.1: (i) RB	Spring applies force to ground	Figure 7.1: (ii)TW	Spring on knuckle	Figure 7.1: (iii) RB	Force of spring exert to ground	Figure 7.1: (v) DW
			Release energy from struts to the tires	Pressure exits strut	Figure 7.2: (i) JH	Struts push toward tires	Figure 7.2: (ii) JH	Energy transfered to tires	Figure 7.2: (iv) DW	Energy moves out of struts	Figure 7.2: (v) MS
		Absorb All forces channeled from environment	Compress the springs from the external forces	Compression in springs	Figure 7.3: (i) AK	Compression in angles	Figure 7.3: (ii) AK	Force applied to both ends	Figure 7.3: (iii) MS	Springs absorb force	Figure 7.3: (vi) TW
			Compress the struts from external forces	Struts connected to control arm	Figure 7.4: (i) TM	Compressing strut	Figure 7.4: (iii) AK	Absorb external force	Figure 7.4: (iv) AK	Struts freely compress	Figure 7.4: (vii) JH
			Rotate the control arms to decrease force intake	Allow movement	Figure 7.5: (i) MS	Rotating control arm	Figure 7.5: (iv) TM	Two control arms	Figure 7.5: (v) RB	One control arm	Figure 7.5: (vi) RB
	Sustain mobility of moving parts	Allow freedom of suspension components	Rotating of control arms to absorb excess forces	Rotating control arm	Figure 7.6: (i) DW	Better absorption of forces while rotating	Figure 7.6: (ii) DW	Control arm pivots	Figure 7.6: (iii) JH	Rotates in positive and negative direction	Figure 7.6: (vi) AK
			Rotating of ball joints to absorb excess forces	External force causes ball joint to rotate	Figure 7.7: (i) TW	Ball joint	Figure 7.7: (ii) RB	Universal joint	Figure 7.7: (iii) RB	Ability to move freely	Figure 7.7: (vi) MS

			Compressing of struts and springs from external forces	Two control arms	Figure 7.8: (iii) RB	One control arm	Figure 7.8: (iv) RB	load transfer force	Figure 7.8: (vi) TM	shocks and springs absorb external forces	Figure 7.8: (vii) TW
		Stabilize movement of vehicle	Absorb forces with struts and springs	System compresses to contain vibrations	Figure 7.9: (i) JH	struts and springs absorb forces	Figure 7.9: (iii) DW	able to hold force	Figure 7.9: (vi) MS	shocks and springs absorb vibratons	Figure 7.9: (vii) TW
			Move control arms based off environment	control arms adjust to environment	Figure 7.10: (iii) MS	external force moving the control arm	Figure 7.10: (iv) MS	Two control arms	Figure 7.10: (v) RB	One control arm	Figure 7.10: (vi) RB
			Rotate ball joints from contact of force	Ball joints spin due to forces control arms	Figure 7.11: (i) JH	Ball joints rotate to absorb forces	Figure 7.11: (ii) JH	Rotates and pivots	Figure 7.11: (iii) AK	forces rotate ball joints	Figure 7.11: (v) TW
	Distribute forces throughout suspension system	Channel forces through multiple pathways	Collect force through the struts	Struts counter vibrations	Figure 7.12: (i) JH	Forces causes movement	Figure 7.12: (iii) AK	Forces absorbed	Figure 7.12: (iv) AK	Compressing to absorb	Figure 7.12: (v) MS
			Collect force through springs	Compressing to collect force	Figure 7.13: (i) MS	Less coils	Figure 7.13: (iii) RB	More coils	Figure 7.13: (iv) RB	springs collect forces	Figure 7.13: (vi) DW
			Transfer force through ball joint	Ball joints adjust to transfer force	Figure 7.14: (i) JH	Ball joint	Figure 7.14: (iii) RB	Forces are released	Figure 7.14: (v) TW	ball joints take on force	Figure 7.14: (viii) DW
		Transfers loads from components to wheels	Transfer load from control arms	Forces absorbed	Figure 7.15: (ii) AK	Two control arms	Figure 7.15: (iii) RB	One control arm	Figure 7.15: (iv) RB	Load to control arms	Figure 7.15: (vi) TM
			Transfer load from springs	Springs transfer loads	Figure 7.16: (i) JH	Transmitting force	Figure 7.16: (iii) MS	Force moving through coils	Figure 7.16: (iv) MS	load transfered from springs	Figure 7.16: (vii) DW

			Transfer load from struts	Strut compresses and releases	Figure 7.17: (i) AK	Strut compresses and releases	Figure 7.17: (ii) AK	Force moving through struts	Figure 7.17: (iv) MS	load transfers from struts	Figure 7.17: (vii) DW
	Support external and internal forces from vehicle conditions	Counter Gravitational Force	Release force from spring to the ground	springs transfer force to ground	Figure 7.18: (i) DW	Spring compress release	Figure 7.18: (iii) AK	Forces transmit through ground	Figure 7.18: (v) MS	ground force is a reactant force onto spring	Figure 7.18: (ix) TW
			Release force from struts to ground	Struts counter downward forces	Figure 7.19: (i) JH	Compress and release	Figure 7.19: (iii) AK	force being decompressed	Figure 7.19: (v) MS	Release force to ground	Figure 7.19: (viii) TM
		Ability to manage centrifugal forces	Transfer vehicle load through struts while turning	Struts transfer loads through inertia	Figure 7.20: (i) JH	Struts collect forces	Figure 7.20: (ii) JH	vehicle load transfered through struts	Figure 7.20: (v) DW	load is transferred through vehicle to turn	Figure 7.20: (vi) TW
			Transfer vehicle load through springs while turning	Springs transfer loads through inertia	Figure 7.21: (i) JH	Less coils	Figure 7.21: (iii) RB	More coils	Figure 7.21: (iv) RB	Vehicle weight being distributed	Figure 7.21: (vi) MS
			Rotate control arms while turning	Two control arms	Figure 7.22: (i) RB	One control arm	Figure 7.22: (ii) RB	turning is done through rotation control arms	Figure 7.22: (v) TW	turning causes control arms to rotate	Figure 7.22: (vii) DW

Table 4 Morphology Table for Steering

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Concept 3		Concept 4	
				Description	Sketch	Description	Sketch	Description	Sketch	Description	Sketch
Convert driver input to change the direction of the vehicle	Maintain control of vehicle	Prevent unwanted motion due to external factors	Allow forces to be absorbed	forces are absorbed	Figure 7.23: (i) DW	Universal joint	Figure 7.23: (ii) RB	Absorbing forces	Figure 7.23: (v) TM	Absorb force through steering rod	Figure 7.23: (vii) TW
			Rotate gears only from steering wheel	Steering box allows rotation	Figure 7.24: (ii) JH	rotate the steering wheel to steer the car	Figure 7.24: (iv) MS	gears move only when steering occurs	Figure 7.24: (v) DW	Steering column	Figure 7.24: (vii) TW
		Guide the steering wheel in direction desired	Hold the steering wheel firmly	Hand grabs wheel grips firmly	Figure 7.25: (i) AK	Hold Firmly	Figure 7.25:(iii) RB	A Good grip on the steering wheel	Figure 7.25: (v) MS	A firm grip from both hands	Figure 7.25: (vii) TW
			Turn the steering wheel when adjusting to external forces	Wheel rotates in both directions	Figure 7.26: (i) AK	Push and pull on steering wheel	Figure 7.26: (iii) JH	adjustments made when steering due to external factors	Figure 7.26: (v) DW	Steering wheel adjustments	Figure 7.26: (vii) TM
			Allow horizontal motion with steering rod	Rotation transfers forces	Figure 7.27: (i) AK	Rack and pinion	Figure 7.27: (iii) RB	Moving horizontally to allow steering	Figure 7.27: (v) MS	Easy horizontal path	Figure 7.27: (viii) TM
		Revert kinetic energy into another direction	Allow gears to move in both directions	gears move both directions	Figure 7.28: (i) DW	gears move freely	Figure 7.28: (ii) DW	Driver gear directs turning direction	Figure 7.28: (iv) JH	Gears rotates simultaneously	Figure 7.28: (vi) AK
			Allow steering rod to move horizontally in both directions	Steering rod moves in x-direction	Figure 7.29: (i) JH	Rack and pinion	Figure 7.29: (iii) RB	Worm and sector	Figure 7.29: (iv) RB	Turn wheel to move left and right	Figure 7.29: (v) TW
	Transmit motion of	Channel mechanical	Transfer energy from steering wheel	No steering column	Figure 7.30: (i) RB	Steering column	Figure 7.30: (ii) RB	energy transferred to shaft	Figure 7.30: (iii) DW	Energy from steering wheel to shaft	Figure 7.30: (v) TW

	the vehicle	energy to turn vehicle	to Steering shaft								
			Translate motion from gears to steering rod	Gears translate motion between two components	Figure 7.31: (i) JH	Components interpret forces	Figure 7.31: (ii) JH	Rack and pinion	Figure 7.31: (vi) TW	Steering box system	Figure 7.31: (vii) MS
			Move tires side to side from steering rod	tires move when steering wheel moves	Figure 7.32: (i) DW	Steering causes tires turn	Figure 7.32: (iv) AK	Rack and Pinion	Figure 7.32: (v) RB	Worm and Sector	Figure 7.32: (vi) RB
		Grasp the steering wheel firmly	Contact the steering wheel tactfully	9 to 3 hand placement	Figure 7.33: (i) TW	Maintain contact with steering wheel	Figure 7.33: (iii) JH	Grab wheel position and grip	Figure 7.33: (v) AK	Forces of hand position on wheel	Figure 7.33: (vi) Ak
			Hold the steering wheel with hand	Extend arm towards steering wheel	Figure 7.34: (i) JH	Grab wheel position and grip	Figure 7.34: (iii) AK	Firm grip on the wheel	Figure 7.34: (v) MS	Hold steering wheel	Figure 7.34: (vii) TM
	Stabllize vehicle alignment to stay on course	Maintain grip on the steering wheel	Contact the steering wheel firmly	Higher hand placement	Figure 7.35: (i) RB	Firm grip on the wheel	Figure 7.35: (iii) MS	A Good grip on the steering wheel	Figure 7.35: (iv) MS	grab steering wheel firmly	Figure 7.35: (v) DW
			Hold the steering wheel until leaving the vehicle	Leverage steering wheel	Figure 7.36: (i) JH	Maintain Contact	Figure 7.36: (iii) RB	Hold steering with both hands at all times	Figure 7.36: (vi) TW	properly grip steering wheel	Figure 7.36: (viii) DW
		Orient steering wheel based on drivers view	Avoid extreme conditions of the course	Rack and pinion	Figure 7.37: (i) RB	Worm and sector	Figure 7.37: (ii) RB	Maneuvering through obstacles	Figure 7.37: (v) TM	Move around trees	Figure 7.37: (vi) TM
			Drive along calmer environmental conditions	steady drive due to reduced obstacles	Figure 7.38: (iii) DW	easier ride	Figure 7.38: (iv) DW	Following the grounds pattern	Figure 7.38: (v) MS	Driving through safe areas	Figure 7.38: (vii) TM

			Apply pressure to reduce force input	force decreased when pressure applied	Figure 7.39: (i) DW	Power steering pump	Figure 7.39: (iii) RB	Fluid/power flows from pump to steering rod	Figure 7.39: (iv) AK	Slight rotation causes car to turn	Figure 7.39: (v) AK
			Absorb external force to reduce driver control	wheel relieves excess forces	Figure 7.40: (ii) AK	Firm grip to maintain control	Figure 7.40: (iii) TW	using movement to reduce impact	Figure 7.40: (v) MS	Absorbing forces for easier control	Figure 7.40: (vii) TM
		Maintain Power Steering	Reduce the turn of the steering wheel to perform a sharp maneuver	Align steering wheel	Figure 7.41: (i) JH	rotation of wheel transfers force to wheels	Figure 7.41: (iii) AK	Small rotation causes wheels to turn	Figure 7.41:(iv) AK	Wheels stop before contact with chassis	Figure 7.41: (v) MS
			Allow easy motion of gears	motion of gears is easier	Figure 7.42: (i) DW	fluid motion	Figure 7.42: (ii) DW	Secure gear placement to transfer easily	Figure 7.42: (iii) JH	Spur gear	Figure 7.42: (v) RB
			Allow easy motion of steering rod	Rack and pinion	Figure 7.43: (i) RB	Worm and sector	Figure 7.43: (ii) RB	Components engage together perfectly	Figure 7.43: (iii) JH	No locking of joints	Figure 7.43: (vii) TW
	Reduce effort of driver	adjusting steering effort	Allow easy motion of steering wheel	fluid motion of steering wheel	Figure 7.44: (i) DW	easier handling	Figure 7.44: (ii) DW	Rack and pinion	Figure 7.44: (iii) RB	Proper connecting points	Figure 7.44: (v) TW

SENIOR DESIGN & PROFESSIONALISM I

FALL 2020

PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER __3_____
Progress Report Title:___Concept generation individual assignment_____
Due Date:___10/22/2020_____

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Christian White 	Generated different concepts and sketches for final group report and added to my individual report	100	
2			\	
3				
4				
5				
6				
7				
8				

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/22/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

1. Using the morphology table created in status report 6 for your Level 1, Level 2, Level 3 and any additional level sub-functions, assign group members to generate concepts by filling the right side of Table 1 with names of your group members assigned to provide concepts for the functions as shown in Table 1. In assigning members for the concepts, assign multiple members to generate multiple concepts for each function as shown in Table 1. With this approach, you can get several ideas or concepts for each function. Distribute the table to the members in the group. Note: It is better to assign more than one student to provide the concepts and sketches for each function, and these students should work independently. The completed Table 1 should be distributed to each group member and inserted in the group and individual status reports after the assignment statement.

Individual Assignment for questions 2 and 3 (Each member should staple the completed questions 2 and 3 and give to the group leader for submission on the due date. The individual part should have the cover page with only the individual member's name in addition to Table 1)

2. Each group member should develop concepts for each of the functions assigned to the member by providing a brief description in Table 2. The format for answering this question should be similar to that shown in Table 2 for the splashguard example but done using your Table 2 for only the concepts of the functions assigned to the member as stated in Table 1. The completed Table 2 should be included in the individual submission.

3. Each group member should generate sketches of the various idea/concepts generated in question 2. Brief description of each sketch and the function it is related to should be given. (The format for answering this question should be similar to that shown in Figures 6 and 7 for the splashguard example. Instead of placing the sketch on the table, use the Figure numbers, then cite each figure in a brief description of the sketched figure in the report.

Example:
Concept 1 for the function "Heat the biomass"
Figure 1.1 shows the concept for this function. Then provide a brief description of the concept and how it works to execute the function.

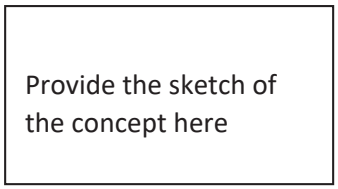


Figure 1.1 Concept 1 for the function "Heat the Biomass"

Note that the individual responses to questions 2 and 3 will not be in your group report for section 4.2 but must be used as the starting point for question 4.

Type Group

4. The group should meet and consolidate the concepts and the sketches for **each function** by discussing the multiple concepts proposed by the various group members, combining similar ideas, and refining the sketches to communicate the concepts better. For each function, the group should have at least 4 final concepts. The
5. group should then produce a final comprehensive morphology Table 2 showing concepts for all functions with sketches for each concept. Note: The group needs multiple concepts for each function. The figure numbers in the final Table 2 for the group should be the actual figure numbers used in your project report.
The example in question 3 can be used for describing the final concepts for each function.

*This assignment can be used to assess **outcome 2 in Senior Design II and outcome 5 in Senior Design I***
Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	
3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	
4	Status report assignment sheet attached	5	
	Total for Individual Report	100	

Group Grading Scheme
Homework #7b
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Comprehensive Group Morphology **Table** is completed with brief descriptions of multiple concepts and Figure numbers that point to sketches.	10	
2	Sketches/pictures/images of concepts have properly formatted figure numbers that are cited in the description of the concepts and sketches	10	
3	The descriptions and explanations provided for the concepts and the sketches/pictures/images clearly demonstrate that the concepts are capable of fulfilling the indicated functions.	60	
4	Overall, enough functions and concepts have been provided that will lead to a successful design of the system.	20	
	Total for Group Report	100	

Table 1 Individual Assignment for Concept Generation

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
	VNM-1	VNM-1.1	VNM-	Member 1	Member 2	Member 3	Member 4
			VNM-	Member 5	Member 6	Member 7	Member 1
			VNM-	Member 2	Member 3	Member 4	Member 5
		VNM-1.2	VNM-	Member 6	Member 7	Member 1	Member 2
			VNM-	Member 3	Member 4	Member 5	Member 6
		VNM-1.3 (No level 3 subfunctions)		Member 7	Member 1	Member 2	Member 3
	VNM-2	VNM-2.1	VNM-	Member 4	Member 5	Member 6	Member 7
			VNM-	Member 1	Member 2	Member 3	Member 4
			VNM-	Member 5	Member 6	Member 7	Member 1
		VNM-2.2 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-2.3	VNM-	Member 6	Member 7	Member 1	Member 2
			VNM-	Member 3	Member 4	Member 5	Member 6
	VNM-3	VNM-3.1	VNM-	Member 7	Member 1	Member 2	Member 3
			VNM	Member 4	Member 5	Member 6	Member 7
			VNM-	Member 1	Member 2	Member 3	Member 4
		VNM-3.2 (No level 3 subfunctions)		Member 5	Member 6	Member 7	Member 1
		VNM-3.3	VNM-	Member 2	Member 3	Member 4	Member 5
			VNM-	Member 6	Member 7	Member 1	Member 2
	VNM-4	VNM-4.1 (No level 3 subfunctions)		Member 3	Member 4	Member 5	Member 6
		VNM-4.2	VNM-	Member 7	Member 1	Member 2	Member 3
			VNM-	Member 4	Member 5	Member 6	Member 7
		VNM-4.3	VNM-	Member 1	Member 2	Member 3	Member 4
			VNM-	Member 5	Member 6	Member 7	Member 1
	VNM-5	VNM-5.1 (No level 3 subfunctions)		Member 2	Member 3	Member 4	Member 5
		VNM-5.2	VNM-	Member 6	Member 7	Member 1	Member 2
			VNM-	Member 3	Member 4	Member 5	Member 6
		VNM-5.3		Member 7	Member 1	Member 2	Member 3

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dirt.

Table 2 Sample Example Morphology (Functional Decomposition and Concepts) Table

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		Descri
				Description	Sketch	Description	Sketch	
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid during the experiment	Heat up the nanofluid before pumping			Figure #		Figure #	
					Figure #		Figure #	
					Figure #		Figure #	
		Pump the nanofluid Through the pipes			Figure #		Figure #	
					Figure #		Figure #	
		Cool down the nanofluid after measurements			Figure #		Figure #	
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change			Figure #		Figure #	
					Figure #		Figure #	
					Figure #		Figure #	
		Accommodate to the pressure boundary condition change			Figure #		Figure #	
		Accommodate the boundary layer change of the nanofluid			Figure #		Figure #	
					Figure #		Figure #	
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid VNM-4	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler		Figure #		Figure #	
					Figure #		Figure #	
					Figure #		Figure #	
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)		Figure #		Figure #	
			Measure the intensity of the current used to heat up the nanofluid		Figure #		Figure #	
					Figure #		Figure #	
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler		Figure #		Figure #	
					Figure #		Figure #	
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)		Figure #		Figure #	
					Figure #		Figure #	
			Measure the intensity of the current used to heat up the nanofluid		Figure #		Figure #	
					Figure #		Figure #	
		Generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software		Figure #		Figure #	
			Generate Graphs showing the fluctuation of each parameter		Figure #		Figure #	
					Figure #		Figure #	

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Concept 1		Concept 2		
				Description	Sketch	Description	Sketch	Descri
					Figure #		Figure #	

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

E.g. Protect-Rider-From Dir

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Concepts Generation with Sketches

Assigned 10/01/2020 **Due:10/22/2020**

This status report covers some of the information on the **PRELIMINARY DESIGN** chapter of the project report. Consequently, it should be written in a detailed descriptive form as we discussed in class. The report should be prepared using the section title **4.2 Concept Generation**

4.2 Concept Generation

Christian White was assigned to generate conceptual solutions which would be attached to the final-level functions for the overall function of this systematic project. Christian was given 9 level 2 or level 3 sub-functions and asked to generate a total of 27 concepts, or 3 concepts per function. The work was divided individually amongst the group and each group member was assigned an equal amount of work to be submitted three days before the official due date. Produced through a zoom meeting, the morphology table below shows the specifics of which group member was assigned each function.

Table 4.1 Function distribution

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid during the experiment	Heat up the nanofluid before pumping		Fanta	Abdoul	Christian	Marcelo
		Pump the nanofluid Through the pipes		Yemboado	Diana	Abdoul	Marcelo
		cool down the nanofluid after the measurements are made		Fanta	Christian	Yemboado	Diana
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		Yemboado	Marcelo	Christian	Abdoul
		Accommodate to the pressure boundary condition change		Diana	Fanta	Christian	Abdoul
		Accommodate to the boundary layer change of the nanofluid		Yemboado	Marcelo	Diana	Fanta

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Name	Name	Name	Name
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Fanta	Abdoul	Christian	Marcelo
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Yemboado	Diana	Abdoul	Marcelo
			Measure the intensity of the current used to heat up the nanofluid	Fanta	Christian	Yemboado	Diana
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage(V) drop in the boiler	Yemboado	Marcelo	Christian	Abdoul
			Measure the nanofluid temperature of the nanofluid (Tin and Tout)	Diana	Fanta	Christian	Abdoul
			Measure the intensity of the current used to heat up the nanofluid	Yemboado	Marcelo	Diana	Fanta
		generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software	Yemboado	Marcelo	Diana	Christian
			Generate Graphs showing the fluctuation of each parameter	Yemboado	Marcelo	Fanta	Abdoul

Christian White Concept Generation

1. **<u>Function: Heat up nanofluid before pumping</u>**

- Apply heat exchanger which is applied to apparatus to heat up the nanofluid as the nanofluid passes through the system using an ambient heat exchanger attached to a regenerator, a thermal buffer tube and a secondary ambient heat exchanger.

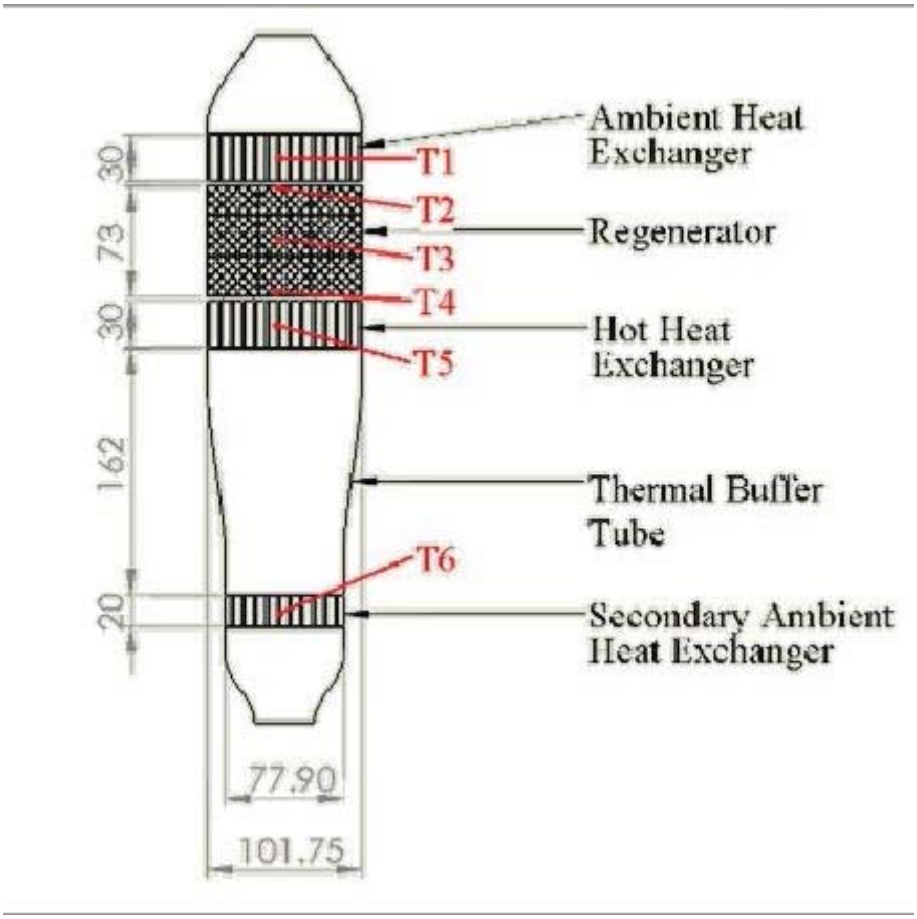


Figure 4.1

- Allow nanofluid to heat in boiler before pumping process begins by feeding nanofluid into the feedwater inlet and passing through to the boiler before pushing forward in the process.

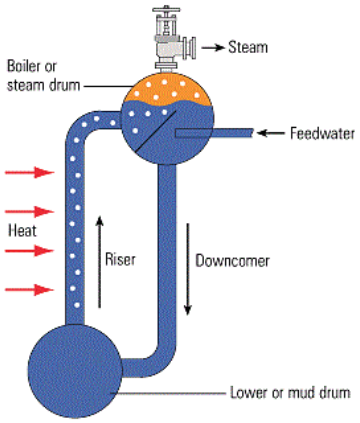


Figure 4.2

- Use evaporator to evaporate cooling nanoparticles and heat remaining nanofluid particles as nanofluid passes to compressor in the system.

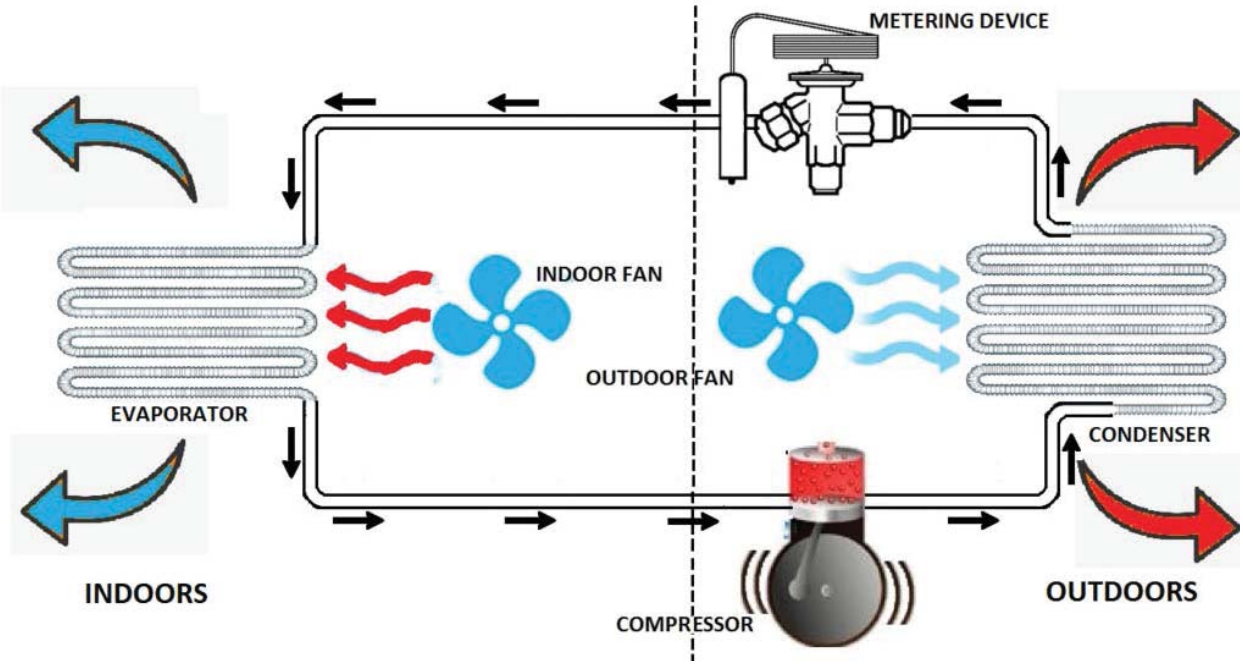


Figure 4.3

2. **Function: Cool down the nanofluid after the measurements are made**

- Use outer loop thermal exchanger for nanofluid to flow into and apply cold water in the annular space of the pipe. Once the experimental passing of the nanofluid has ceased, the nanofluid will begin to cool in the outer loop heat exchanger.

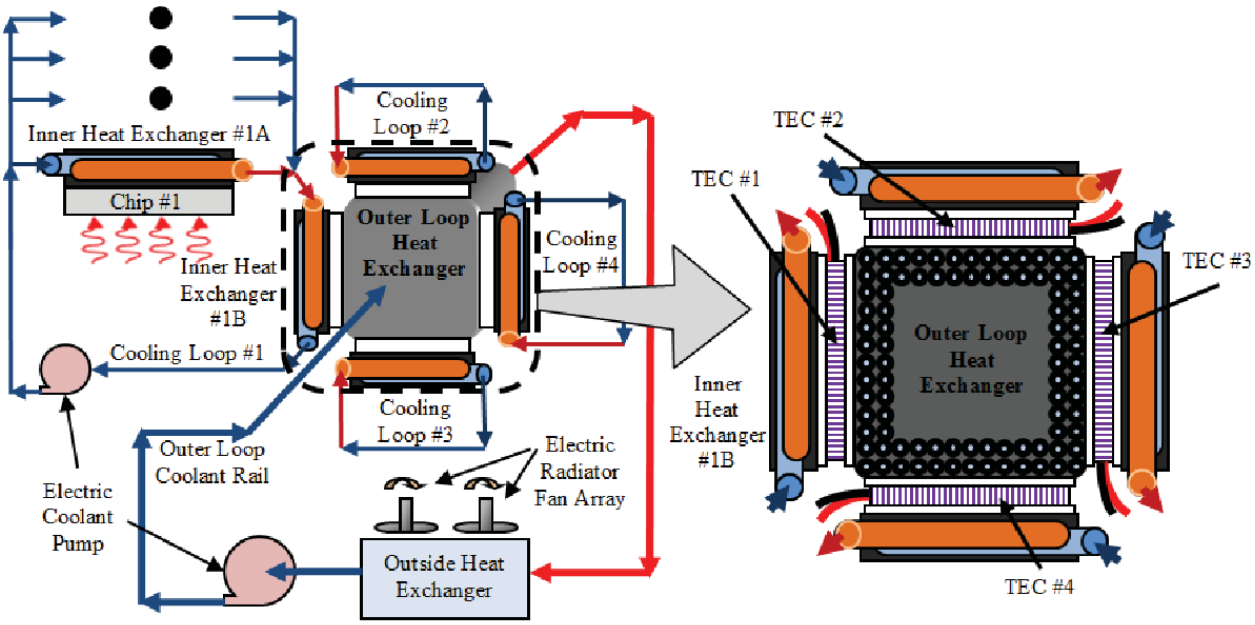


Fig. 2. Proposed remote cooling system arrangement with four TEC-cooled (multiple) loops served by a single heat exchanger.

Figure 4.4

- Use condenser at the end of the experimental set up which can cool nanofluid after passing through the final evaporator.

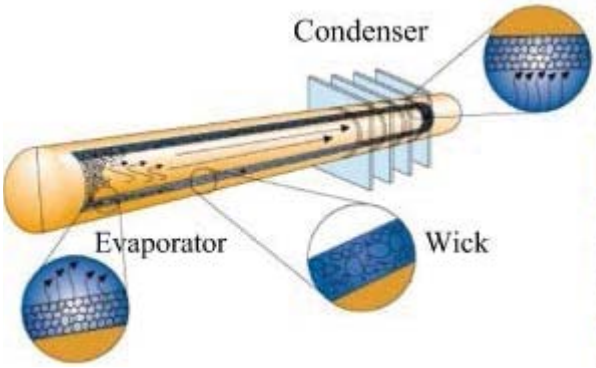


Figure 4.5

Figure 4.6

- Attach open feed water cooler which will cool nanofluid when passing through the system to ensure experimental completion.

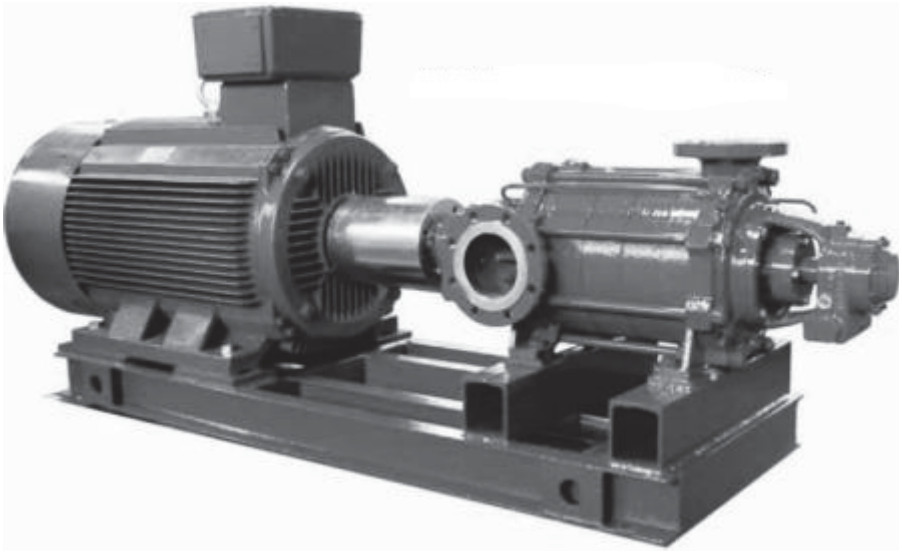


Figure 4.7

3. **<u>Accommodate to the magnetic field change</u>**

- Apply magnetometer which can measure magnetism and the change in the magnetic field.

Figure 4.8

- Apparatus will re-route magnetic field lines to appropriate directions of the system. A system will be provided through our personal cellular devices and able to see the EMF readings.

Figure 4.9

- Apply high-permeability shield alloys.

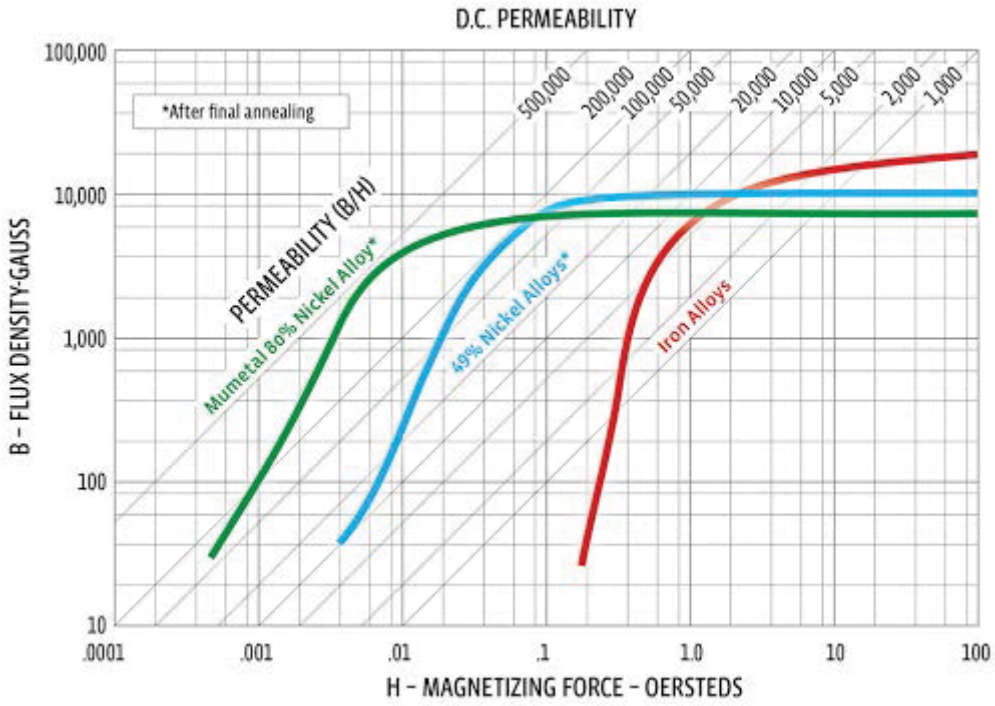


Figure 4.10

4. **<u>Accommodate to the pressure boundary condition change</u>**

- Set pressure inlet and pressure outlet to set pressure for specific experiment whilst using the pump in the systematic design to cause pressure to rise and fall.

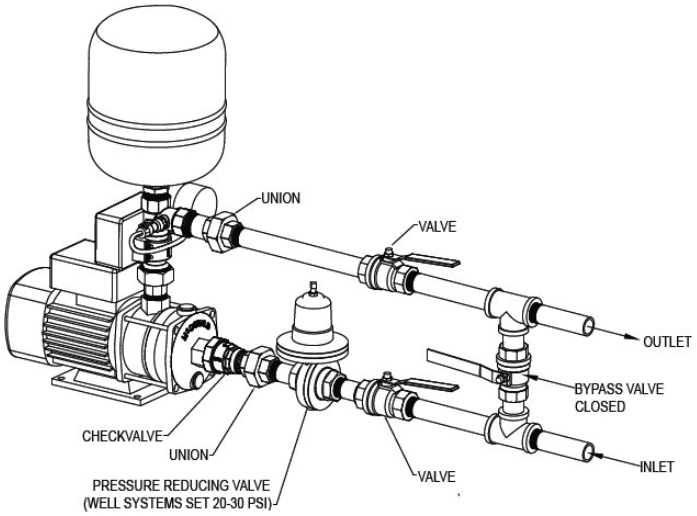


Figure 4.11

- Use pressure gauge to determine when to release and omit pressure in the system.

Figure 4.12

- Use pressure valve to omit pressure when the set pressure is not being met.

Figure 4.13

5. **Measure the voltage (V) drop in the boiler**

- Use voltmeter with attached prongs to measure voltage.

Figure 4.14

- Use digital multimeter which can measure voltage.

Figure 4.15

- Use Analog Multimeter to measure voltage.

Figure 4.16

6. <u>Measure the intensity of the current used to heat up the nanofluid</u>

- Use ammeter to measure the current.

Figure 4.17

- Use digital multimeter to measure current.

Figure 4.18

- Use Analog Multimeter to measure current.

Figure 4.19

7. **Measure the voltage (V) drop in the boiler**

- Use voltmeter with attached prongs to measure voltage.

Figurer 4.20

- Use digital multimeter which can measure voltage.

Figure 4.21

- Use Analog Multimeter to measure voltage.

Figure 4.22

8. <u>Measure the nanofluid temperature of the nanofluid (Tin and Tout)</u>

- Attach volume reader and thermometer to apparatus.

Figure 4.23

- Apply temperature gauge to inlet and outlet of the experimental set up.

Figure 4.24

- Attach temperature gauge to boiler and feedwater cooler.

Figure 4.25

9. **<u>Display readings of measured parameters on a computer software</u>**

- Manually type readings from the experiment once complete.

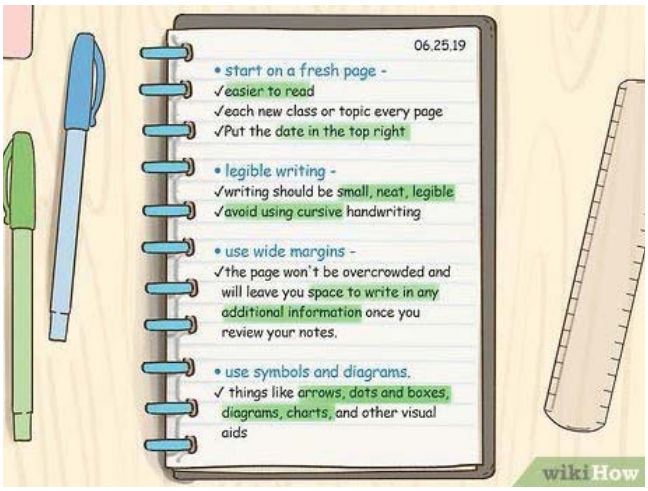


Figure 4.26

- Use the website Plural Sight to render automatic calculations of measurements from experiment for simple recalling of measurements and parameters.

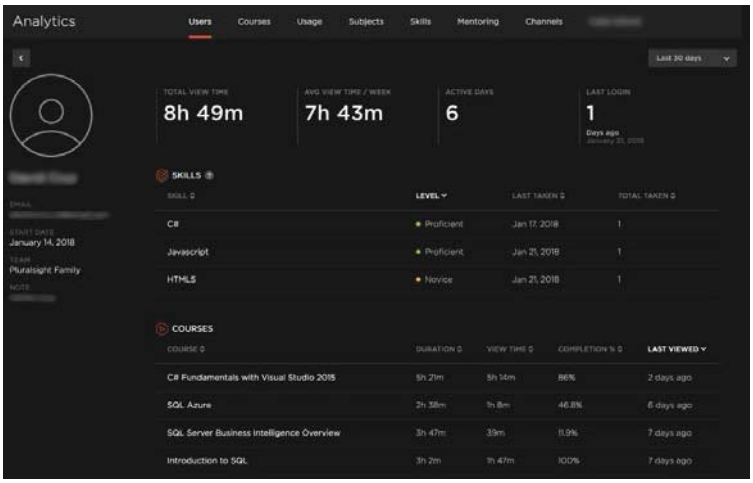


Figure 4.27

- Utilize IC Measure from computer software technology to measure calculations and parameters accurately

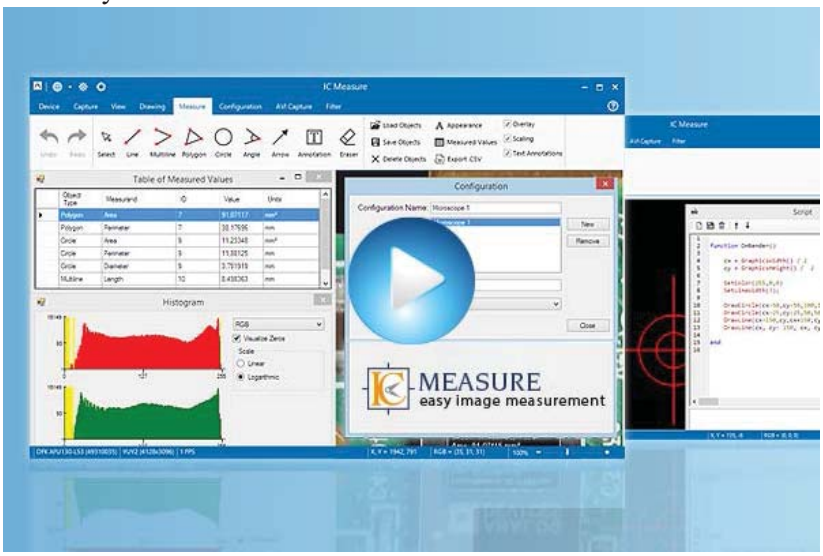


Figure 4.28

Individual Grading Scheme
Homework #7a

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Left side of Morphology Table 1 completed and names of students placed in the right side of the morphology Table.	10	**10**
2	Concepts for sub-functions assigned are provided and clearly described by member, and they are appropriate for the indicated functions.	40	**32**

3	Sketches/pictures/images of concepts and explanation of sketches that clearly demonstrate the concepts are provided.	45	**38**
4	Status report assignment sheet attached	5	**5**
	Total for Individual Report	100	**85**

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

STATUS REPORT 8

TOPICS COVERED IN STATUS REPORT 8

Concept Evaluation

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER

Status Report 8 on Concept Evaluation and Selection

Due: 10/28/2020

This status report is section 4.3of your final report. Questions 1 & 2 will constitute section 4.3.1, questions 3 & 4 will constitute section 4.3.2 and questions 5 & 6 will constitute section 4.3.3

Study the notes on concepts evaluation discussed in class and posted on e-course and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example. Each group should meet and review the concepts and sketches for each function generated as part of questions 3 and 4 in the previous status report ensuring that several concepts have been generated for each function and that the concepts are adequately supported by sketches/figures/pictures as are necessary for understanding the concept.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all of the functions you group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function. [**10 Points**]
   The requirements/criteria requested in question 1 can be obtained by considering the following questions and listing the answers:
   - What customer requirements are related to the project? Make a list of all customer requirements
   - What operating environments are related to the project? Look at all of your operating environments.
   - What constraints can affect the project? List all of your project constraints.
   - Is current technology available for the functions of the project?
   - Can the technology/concept be manufactured with known processes?
   - What are the project objectives? Look at your list of objectives
   - Is there a need for experimentation to ascertain how well certain project function can be achieved?
   - Are critical parameters that control the functions of the project identified?
   - Are the safe operating latitude and sensitivity of the parameters known?
   - Have all of the failure modes been identified for the project?

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction.**[10 Points**].

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for GO-NO-GO Table **[40 Points]**

4. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening**)** using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in details in class). From the decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

References:
http://www.enge.vt.edu/terpenny/Smart/Virtual_econ/Module2/pugh_method.htm
Read about the Pugh and go-no-go evaluation concepts from other sources to supplement your knowledge.

Table 1 Sample Example Criteria Affecting Previously identified Sub-functions for Project

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function							
				1	2	3	4	5	6	7	8
VNM-0	VNM-1	VNM-1.1	VNM-1.1.1	6	11	20	22	30			
			VNM-1.1.2								
			VNM-1.1.2								
		VNM-1.2	VNM-1.2.1								
			VNM-1.2.2								
		VNM-1.3 (No level 3 subfunctions)									
	VNM-2	VNM-2.1	VNM-2.1.1								
			VNM-2.1.2								
			VNM-2.1.2								
		VNM-2.2 (No level 3 subfunctions)									
		VNM-2.3	VNM-2.3.1								
			VNM-2.3.2								
	VNM-3	VNM-3.1	VNM-3.1.1								
			VNM-3.1.2								
			VNM-3.1.3								
		VNM-3.2 (No level 3 subfunctions)									
		VNM-3.3	VNM-3.3.1								
			VNM-3.3.2								
	VNM-4	VNM-4.1 (No level 3 subfunctions)									
		VNM-4.2	VNM-4.2.1								
			VNM-4.2.2								
		VNM-4.3	VNM-4.3.1								
			VNM-4.3.2								
	VNM-5	VNM-5.1 (No level 3 subfunctions)									
		VNM-5.2	VNM-5.2.1								
			VNM-5.2.2								
		VNM-5.3									

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

7. E.g. Protect-Rider-From Dirt

Grading Scheme
Status Report on Concepts Evaluation
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Reasonable exhaustive list of requirements/criteria for evaluating project functions	10	
2	Requirements/criteria identified and assigned to each function using Table 1	10	
3	Use of few most important requirements for GO NO GO evaluation of each function	40	
4	Evaluation of remaining functions using Decision Matrix and the selection of the best concepts for main design and the runner up concepts for the back-up design	80	
5	Detailed sketches for the main system and for the back-up system	50	
6	Evaluation of the two systems and selection of the primary system upon which design will be based.	10	
	Total	200	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Group Concepts Evaluation
GROUP NUMBER: 7
Progress Report Title: Status Report VIII
Due Date: 10/29/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan** Daniel Akpan	- Evaluate concepts for three functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations	85%	
2	**David Trevino** David Trevino	- Evaluate concepts for: Evaluate concepts for three functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations	95%	
3	**Amna Ansari** Amna Ansari	- Evaluate concepts for: Evaluate concepts for three functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations - Complete meeting minutes	99%	
4	**Demetrious Sandford** Demetrious Sandford	- Evaluate concepts for: Evaluate concepts for three functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations - Proofread full report	99%	
5	**Caleb Riggins** Caleb Riggins	- Evaluate concepts for: Evaluate concepts for two functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations -Verify and correct technical writing	100%	
6	**Ximena Cifuentes** Ximena Cifuentes	- Evaluate concepts for: Evaluate concepts for two functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations -Help format	99%	
7	**Aamna Jangda** Amna Jangda	- Evaluate concepts for: Evaluate concepts for three functions assigned -Participate in design sketching -Contribute with group report -Attend meetings -Conduct team evaluations - Help format	99%	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER

Status Report 8 on Concept Evaluation and Selection

Due:10/28/2020

This status report is section 4.3of your final report. Questions 1 & 2 will constitute section 4.3.1, questions 3 & 4 will constitute section 4.3.2 and questions 5 & 6 will constitute section 4.3.3

Study the notes on concepts evaluation discussed in class and posted on e-course and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example. Each group should meet and review the concepts and sketches for each function generated as part of questions 3 and 4 in the previous status report ensuring that several concepts have been generated for each function and that the concepts are adequately supported by sketches/figures/pictures as are necessary for understanding the concept.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all of the functions you group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function. [**10 Points**]

The requirements/criteria requested in question 1 can be obtained by considering the following questions and listing the answers:

- What customer requirements are related to the project? Make a list of all customer requirements
- What operating environments are related to the project? Look at all of your operating environments.
- What constraints can affect the project? List all of your project constraints.
- Is current technology available for the functions of the project?
- Can the technology/concept be manufactured with known processes?
- What are the project objectives? Look at your list of objectives
- Is there a need for experimentation to ascertain how well certain project function can be achieved?
- Are critical parameters that control the functions of the project identified?
- Are the safe operating latitude and sensitivity of the parameters known?
- Have all of the failure modes been identified for the project?

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction.**[10 Points**].

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for GO-NO-GO Table **[40 Points]**

4. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening**)** using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in details in class). From the decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

References:

http://www.enge.vt.edu/terpenny/Smart/Virtual_econ/Module2/pugh_method.htm

Read about the Pugh and go-no-go evaluation concepts from other sources to supplement your knowledge.

Assignment for Assessing Outcome c.2

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

Table 1 Sample Example Criteria Affecting Previously identified Sub-functions for Project

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function							
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			VNM-1.1.2								
			VNM-1.1.2								
		VNM-1.2	VNM-1.2.1								
			VNM-1.2.2								
		VNM-1.3 (No level 3 subfunctions)									
	VNM-2	VNM-2.1	VNM-2.1.1								
			VNM-2.1.2								
			VNM-2.1.2								
		VNM-2.2 (No level 3 subfunctions)									
		VNM-2.3	VNM-2.3.1								
			VNM-2.3.2								
	VNM-3	VNM-3.1	VNM-3.1.1								
			VNM-3.1.2								
			VNM-3.1.3								
		VNM-3.2 (No level 3 subfunctions)									
		VNM-3.3	VNM-3.3.1								
			VNM-3.3.2								
	VNM-4	VNM-4.1 (No level 3 subfunctions)									
		VNM-4.2	VNM-4.2.1								
			VNM-4.2.2								
		VNM-4.3	VNM-4.3.1								
			VNM-4.3.2								
	VNM-5	VNM-5.1 (No level 3 subfunctions)									

		VNM-5.2	VNM-5.2.1								
			VNM-5.2.2								
		VNM-5.3									

VNM= Verb action-Noun the verb is acting on-Modifier

E.g. Protect-Rider-From Dir

Grading Scheme
Status Report on Concepts Evaluation
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Reasonable exhaustive list of requirements/criteria for evaluating project functions	10	
2	Requirements/criteria identified and assigned to each function using Table 1	10	
3	Use of few most important requirements for GO NO GO evaluation of each function	40	
4	Evaluation of remaining functions using Decision Matrix and the selection of the best concepts for main design and the runner up concepts for the back-up design	80	
5	Detailed sketches for the main system and for the back-up system	50	
6	Evaluation of the two systems and selection of the primary system upon which design will be based.	10	
	Total	200	

4.3 Concepts Evaluation

In this section, the team developed and executed a ~~plant~~ to evaluate the concepts generated during the concept's generation phase of the project. In the concept's evaluation section, the team was able to identify the different criteria that affects each one of the skimmer functions identified during the functional decomposition phase of the project. Then, the team was able to evaluate each one of the concepts generated by using a GO-NO-GO method and a decision matrix. Towards the end of the section, detailed sketches based on the concepts that were identified to be the best in meeting the relevant requirements/criteria of the project can be observed. Finally, the team was able to evaluate the final sketches and decide on a final preliminary design.

4.3.1 Requirements/criteria

In this subsection, the team was able to analyze the different requirements related to the project, the operating environment of the design, constraints that directly affect the project development, the different technology that is relevant to the design development, the design manufacturing requirements, the project objectives, the need for analysis and testing, the functions needed to be achieved, and the safety and failure modes of the design. Once the team analyzed the mentioned points, the team developed a list of requirements/criteria needed to achieve a successful design. Then, the team was able to develop a table where each function was assigned criteria that directly affects each one of the concepts generated for each specific function.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all the functions your group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function. [**10 Points**] The requirements/criteria requested in question 1 can be obtained by considering the following questions and listing the answers:

- What customer requirements are related to the project? Make a list of all customer requirements
    1. Be able to recover oil in at least one ½ inch of oil slick at 25%-50%
    2. Easy assembly
    3. Easy to operate
    4. Eco friendly
    5. Cost effective
    6. High oil storage capacity
    7. Long skimmer life
    8. Waterproof
    9. Marketable
    10. Detachable parts
    11. Removable storage container
    12. Lightweight and compact design
- What operating environments are related to the project? Look at all your operating environments.
    13. Operational in all calm waters

14. Corrosion resistance
15. Debris proof
16. Operational in various oil thickness

- What constraints can affect the project? List all of your project constraints.
    17. Satisfy size constraint (Over all 5ft x 5ft)
    18. Small components
    19. Buoyancy
    20. Easy to transport
    21. Easy to maneuver

- Is current technology available for the functions of the project
    22. Easily designed with CAD software
    23. High water pump capacity system

- Can the technology/concept be manufactured with known processes?
    24. Easy to manufacture

- What are the project objectives? Look at your list of objectives
    25. High oil/ water separation
    26. Fast oil recovery

- Is there a need for experimentation to ascertain how well certain project functions can be achieved?
    27. ANSYS analysis

- Are critical parameters that control the functions of the project identified?
    28. Accurate Oil Thickness Detection
    29. Capability of Viscosity Sensibility
    30. Utilizes Cohesion/Surface Tension
    31. Apply Specific Gravity

- Are the safe operating latitude and sensitivity of the parameters known?
    32. Design should meet all federal and state regulations
    33. Accurate fluid sensibility

- Have all the failure modes been identified for the project?
    34. Prevent accidental oil release
    35. Prevent accidental contaminated water release

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction.**[10 Points**].

In Table 1, the level 0,1,2,3 functions can be observed. In addition, the table displays the assigned requirements/criteria that affects each one of the subfunctions.

Table 1. Requirements/Criteria Affecting Sub-function

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
				1	2	3	4	5	6	7	8	9
Recover at least 25~50% on 1-inch oil slick	Skimmer Mobility	Mobilize the skimmer	Perform Floatation Stabilization	18	16	11	2	8	9	5		
	Collect oil through debris or choppy water	Avoid debris collection	Limit debris entering skimmer	4	11	15	25	27	34	35		
			Separate debris from fluids taken by skimmer	4	14	15	17	25	34	35		
			contain debris	4	11	15	34	35				
	Measure oil recovery rate	Measure the amount of oil recovered per second	Transform rate readings	1	33	12	22	18	13	10	25	19
			Calculate amount of oil intake	1	33	12	22	18	13	10	25	2
			Accurately detect flow rate	1	33	12	22	18	13	10		
		Control rate of recovery		1	33	15	35	26	12	5		
	Able to filter various oil slick thickness	Distinguish between oil viscosities	Maintain oil/water ratio	17	6	16	24	26	3			
			Measure oil resistance to flow	13	6	16	18	24	26	3		
			Detect surface tension	33	31	26	30	1				
		Detect type of oil		28	29	1						
		Self-adjust separation method to different types of oil		18	16	22	28	24				
	Limit water intake	Control water intake	Differentiate specific gravities of fluids	1	2	9	13	16	18	19		
			Collect optimal level of fluids	1	2	6	13	14	18	20		
	Separate oil from water	Filter water out of the oil	Separate oil from water	18	6	1	4	14	30	17		
			Dissipate excess water	1	2	10	12	13	15	25		
			Contain contaminated water	4	17	35	11	14	15	23		
		Contain the oil (filter water out of the oil)		17	6	34	25	11	14	15		

4.3.2 GO-NO-GO and Decision Matrix

In this subsection, the team evaluated each concept generated for the functions identified during the functional decomposition assignment. The team generated tables where concepts were evaluated based on the relevant criteria identified in section 4.3.1. Each concept was evaluated using the GO-NO-GO method and each concept received a score from 1 to 10. The team decided that a score of 5 and below was considered a NO-GO decision and any number above 5 was considered a Go. The concepts were scored based on the concept's ability to meet each criterion assigned for the concept's function. In addition, the concepts that scored GO for most of their criteria were able to move to the next evaluation phase.

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for LGO-NO-GO Table **[40 Points]**

Tables 2-20 represent the GO-NO-GO Evaluations for each one of the concepts. These concepts were identified in the concept's generation phase, and they were based on the functions identified in the functional decomposition phase.

Table 1 Concepts GO-NO-GO Evaluation of the function "Perform Floatation Stabilization"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
	Floatation foam		Foam Filled Buoys		Buoyant Body		Foam filled modular chain buoys		Tri-float skimmer		Floating drum skimmer		Skimmer material	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Lightweight and compact design	7	GO	5	NO_GO	5	NO GO	2	NO GO	9	GO	9	GO	4	NO GO
Maneuverable	5	NO_GO	1	NO-GO	10	GO	3	NO GO	8	GO	8	GO	6	GO
Satisfy size constraint	2	NO_GO	3	NO_GO	8	GO	3	NO GO	7	GO	9	GO	6	GO
Waterproof	10	GO	10	GO	10	GO	10	GO	8	GO	10	GO	10	GO
Buoyant	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO
Easy to operate	3	NO_GO	8	GO	4	NO GO	4	NO GO	5	NO GO	7	GO	7	GO
Marketable	2	NO_GO	7	GO	9	GO	3	NO GO	6	GO	8	GO	7	GO
Overall Decision		NO_GO		GO		GO		NO GO		GO		GO		GO

Table 2 GO NO-GO for Evaluating Concepts for the function "Limit Debris Entering Skimmer"

Concepts	Monitoring sensor		Debris Net		Perimeter appendage		Repeller Grate		Debris shield		Skimmer guard		Flow Transmitter	
Requirements/Criteria	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**
Eco friendly	8	GO	6	GO	6	GO	7	GO	8	GO	7	GO	5	GO
Long skimmer life	4	NO-GO	8	GO	4	NO-GO	6	GO	8	GO	5	GO	6	GO
Prevent accidental oil release	1	NO-GO	9	GO	3	NO-GO	8	GO	9	GO	8	GO	3	NO-GO
Prevent accidental contaminated water release	1	NO-GO	9	GO	3	NO-GO	8	GO	9	GO	8	GO	3	NO-GO
small components	8	GO	8	NO-GO	8	GO	3	NO-GO	7	GO	5	GO	8	GO
ANSYS analysis	3	NO-GO	8	GO	5	GO	7	GO	8	GO	8	GO	4	NO-GO
Debris proof	4	NO-GO	9	GO	6	GO	8	GO	8	GO	9	GO	2	NO-GO
Overall Decision		NO-GO		GO		NO-GO		GO		GO		GO		NO-GO

Table 3 GO-NO-GO for Evaluating Concepts for the function "Separate debris from fluids taken by skimmer"

Concepts	Debris protection net		Floating Skimmer Fence		Self Filtration		Commercial Screened Shield		Filters		~~Concept 6~~		~~Concept 7~~		Concept 8	
Requirements/ Criteria	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**
Eco friendly	5	GO	6	GO	7	GO	8	GO	5	NO-GO						
Prevent accidental oil release	7	GO	7	GO	9	GO	9	GO	8	GO						
Prevent accidental contaminated water release	7	GO	7	GO	9	GO	9	GO	8	GO						
High oil/ water separation	2	GO	7	GO	9	GO	8	GO	9	GO						
Remove storage container	8	GO	8	GO	8	GO	8	GO	4	NO-GO						
ANSYS analysis	5	GO	5	GO	8	GO	7	GO	5	NO-GO						
Debris proof	8	GO	8	GO	8	GO	8	GO	5	GO						
Overall Decision		GO		GO		go		GO		NO GO						

Table 4 GO-NO-GO Table for Evaluating Concepts for the function "Contain the Debris"

Concepts	**Return-line filter**		**Waste Basket**		**Hydraulic system**		**Bandalong Litter Trap**		**Bom system**		**Bag float**		**Concept 7**		**Concept 8**	
Requirements/ Criteria	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**	**Score**	**Go-No-Go**
Eco friendly	5	GO	7	GO	6	GO	8	GO	6	GO	4	NO-GO				
Prevent accidental oil release	4	NO-GO	8	GO	4	NO-GO	9	GO	8	GO	7	GO				
Prevent accidental contaminated water release	4	NO-GO	8	GO	4	NO-GO	9	GO	7	GO	7	GO				
Removable storage container	4	NO-GO	9	GO	3	NO-GO	8	GO	4	NO-GO	8	GO				
Debris proof	6	GO	8	GO	4	NO-GO	8	GO	8	GO	5	GO				
Overall Decision		NO-GO		GO		NO-GO		GO		GO		GO				

Table 5 Concepts GO-NO-GO Evaluation of the function "Transform Rate Readings"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Transmitter		Detector Array		Control panel		Electrical panel		Oil Monitor		Flow Meter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Oil recovery efficiency of 25%-	8	GO	10	GO	6	GO	1	NO-GO	3	NO-GO	4	NO-GO
Accurate Fluid Sensibility	7	GO	9	GO	1	NO-GO	2	NO-GO	8	GO	3	NO-GO
Lightweight and compact	10	GO	8	GO	1	NO-GO	2	NO-GO	4	NO-GO	10	GO
High oil/water separation	2	GO	5	GO	1	NO-GO	1	NO-GO	1	NO-GO	5	GO
Small Components	10	GO	4	GO	1	NO-GO	1	NO	4	NO	10	GO
Operational in all calm waters	10	GO	8	GO	3	NO-GO	3	NO-GO	3	NO-GO	10	GO
Detachable	10	GO	8	GO	1	NO-GO	2	NO-GO	4	NO-GO	10	GO
Easily designable with CAD	9	GO	4	GO	1	NO-GO	4	GO	3	NO-GO	7	GO
Easy to Operate	8	GO	7	GO	4	NO-GO	6	NO-GO	4	NO-GO	10	GO
Overall Decisio		**GO**		**GO**								**GO**

Table 6 Concepts GO-NO-GO Evaluation of the function "Calculate Amount of Oil Intake"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
	Mass Flow Meter		Flow Monitor		Magmeter		Badge Meter		Series Flow Switch		Lightweight Flow Meter		Clamp Flow Meter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Oil recovery efficiency of 25%-50% on ½ in oil	9	GO	7	GO	8	GO	5	No-Go	6	No-Go	7	GO	6	No-Go
Accurate Fluid Sensibility	7	GO	6	No-Go	8	GO	7	GO	5	No-Go	7	GO	9	GO
Lightweight and compact design	7	No-Go	5	No-Go	8	GO	3	No-Go	9	GO	9	GO	6	No-Go
High oil/water separation	9	GO	5	No-Go	7	GO	5	No-Go	5	No-Go	5	No-Go	7	GO
Small Components	7	No-Go	8	No-Go	9	GO	5	No-Go	9	GO	9	GO	5	No-Go
Operational in all calm waters	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO
Detachable parts	8	GO	6	No-Go	10	GO	2	No-Go	10	GO	8	GO	5	No-Go
Easily designable with CAD	10	GO	5	No-Go	6	No-Go	3	No-Go	10	GO	8	GO	3	No-Go
Fast Oil Recovery	7	GO	8	GO	6	No-Go	5	No-Go	8	GO	6	No-Go	6	No-Go
Overall		GO				GO						GO		

Table 7 Concepts GO-NO-GO Evaluation of the function "Accurately Detect Flow Sensor"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
	Mass Flow Meter		Flow Monitor		Magmeter		Badge Meter		Series Flow Switch		Lightweight Flow Meter		Clamp Flow Meter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Oil recovery efficiency of 25%-50% on ½ in oil	9	GO	7	GO	8	GO	5	No-Go	6	No-Go	7	GO	6	No-Go
Accurate Fluid Sensibility	7	GO	6	No-Go	8	GO	7	GO	5	No-Go	7	GO	9	GO
Lightweight and compact design	7	No-Go	5	No-Go	8	GO	3	No-Go	9	GO	9	GO	6	No-Go
High oil/water separation	9	GO	5	No-Go	7	GO	5	No-Go	5	No-Go	5	No-Go	7	GO
Small Components	7	No-Go	8	No-Go	9	GO	5	No-Go	9	GO	9	GO	5	No-Go
Operational in all calm waters	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO	10	GO
Detachable parts	8	GO	6	No-Go	10	GO	2	No-Go	10	GO	8	GO	5	No-Go
Easily designable with CAD	10	GO	5	No-Go	6	No-Go	3	No-Go	10	GO	8	GO	3	No-Go
Fast Oil Recover	7	GO	8	GO	6	No-Go	5	No-Go	8	GO	6	No-Go	6	No-Go
Overall		GO				GO						GO		

Table 8 Concepts GO-NO-GO Evaluation of the function "Control rate of recovery"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Fixed orifice model		Flow Monitor		Pressure Switch		DataFlo Remote controller		oil traffic controller		Actuator	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Oil recovery efficiency of 25%-50% on ½ in oil slick	4	NO GO	3	NO GO	5	NO GO	5	NO GO	4	NO GO	6	GO
Accurate fluid sensibility	6	GO	7	GO	7	GO	6	GO	6	GO	6	GO
debris prof	8	GO	2	NO GO	4	NO GO	3	NO GO	4	NO GO	7	GO
Prevent accidental contaminated water release	6	GO	2	NO GO	7	GO	5	NO GO	8	GO	6	GO
Fast oil recovery	3	NO GO	6	GO	6	GO	3	NO GO	4	NO GO	3	NO GO
Lightweight and compact design	7	GO	7	GO	7	GO	6	GO	6	GO	5	NO GO
Cost Effective	10	GO	3	NO GO	9	GO	3	NO GO	6	GO	5	NO GO
Overall Decision		GO		NO GO		GO		NO GO		GO		GO

Table 9 Concepts GO-NO-GO Evaluation of the function "Maintain oil/water ratio"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
	Microwave signal generator		DMS Thickness Gauge		Ultrasonic thickness gauge		Ultrasound Ultrasonic Testing		Line transducer		Flow transmitter		Digital flow meter	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Accurate fluid sensibility	6	GO	7	GO	6	GO	5	NO GO	8	GO	7	GO	6	GO
high oil/water separation	6	GO	5	NO GO	4	NO GO	3	NO GO	4	NO GO	5	NO GO	5	NO GO
Oil recovery efficiency of 25%-50% on ½ in oil slick	5	NO GO	3	NO GO	4	NO GO	3	NO GO	6	GO	5	NO GO	6	GO
Light weight and compact design	4	NO GO	7	GO	9	GO	6	GO	7	GO	9	GO	4	NO GO
Detachable part	6	GO	8	GO	8	GO	6	GO	5	NO GO	7	GO	0	NO GO
Small Component	5	NO GO	6	GO	8	GO	6	GO	8	GO	8	GO	3	NO GO
Cost effective	3	NO GO	0	NO GO	0	NO GO	2	NO GO	0	NO GO	6	NO GO	0	NO GO
Overall Decision		NO GO		GO		GO		NO GO		GO		GO		NO GO

Table 10 Concepts GO-NO-GO Evaluation of the function "Measure oil resistance to flow"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5	
	Viscometer fork		Oval Gear Flow Meter		Flow meter		Flow Meter DulcoFlow		Hand viscosity meter	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Accurate fluid sensibility	8	GO	8	GO	8	GO	7	GO	7	GO
Oil recovery efficiency of 25%-50% on ½ in oil slick	4	NO GO	7	GO	5	NO GO	5	NO GO	4	NO GO
Lightweight and compact design	8	GO	4	NO GO	7	GO	5	NO GO	5	NO GO
Easy to operate	7	GO	6	GO	8	GO	7	GO	8	GO
Detachable part	8	GO	5	NO GO	4	NO GO	5	NO GO	8	GO
Small Component	7	GO	6	GO	6	GO	7	GO	5	NO GO
Cost effective	5	NO GO	5	NO GO	0	NO GO	4	NO GO	5	NO GO
Overall Decision		GO		GO		GO		NO GO		NO GO

Table 11 Concepts GO-NO-GO Evaluation of the function "Detect Surface Tension"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Surface tension meter		Tension Meter		Grease Grabber		Portable Tensiometer		Surface tension detector		Tensiometer	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Accurate fluid sensibility	6	GO	5	NO_GO	5	NO GO	2	NO GO	3	NO GO	7	GO
Applies Specific Gravity	7	GO	1	GO	10	GO	3	NO GO	6	GO	6	GO
Fast oil recovery	2	NO_GO	3	NO_GO	8	GO	3	NO GO	4	NO GO	4	NO GO
Utilizes Cohesion/Surface Tension of Oil	10	GO	10	GO	10	GO	8	GO	8	GO	10	GO
Oil recovery efficiency	3	NO_GO	8	NO_GO	4	NO GO	2	NO GO	5	NO GO	4	NO GO
Overall Decision		GO		NO GO		GO		NO GO		NO GO		GO

Table 12 Concepts GO-NO-GO Evaluation of the function "Detect Type of Oil"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Digital viscometer		Viscometer		Compact density meter		Viscosities and Densities Detector		Viscosity tester		Detection system	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Accurate Oil Detection Thickness	7	GO	5	NO_GO	5	NO GO	6	GO	6	GO	10	GO
Capability of Viscosity Sensibility	6	GO	10	GO	8	GO	7	GO	8	GO	7	GO
Oil Recovery efficiency	3	NO_GO	4	NO GO	4	NO GO	4	NO GO	4	NO GO	6	GO
Overall Decision		GO		NO_GO		NO_GO		NO GO		GO		GO

Table 13 Concepts GO-NO-GO Evaluation of the function "Self-adjust separation method to different types of oil"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
	Viscometer		Compact Density Meter		Flow gauge		Vibration Viscometer		Mass flow meter		Density meter		Analog recorder	
Criteria/Requirements	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO	Score	GO NO GO
Small components	6	GO	6	GO	6	GO	6	GO	9	GO	7	GO	7	GO
Operational in various Oil Thickness	4	NO GO	1	NO-GO	4	NO GO	3	NO GO	8	GO	4	NO GO	6	GO
Easily designable with CAD software	2	NO_GO	3	NO_GO	8	GO	3	NO GO	3	NO GO	3	NO GO	4	NO GO
Accurate Oil Detection Thickness	6	GO	10	GO	6	GO	7	GO	2	NO GO	8	GO	3	NO GO
Easy to manufacture	3	NO_GO	5	NO GO	7	GO	4	NO GO	5	NO GO	6	GO	7	GO
Overall Decision		NO_GO		NO GO		GO		NO GO		NO GO		GO		GO

Table 14 Concepts GO-NO-GO Evaluation of the function "Differentiate specific gravities of fluids"

Concepts	Simple Hydrometer		Liquid level transmitter		Point Level Sensor		Weir skimmer		Model 8 oil grabber		PetroXtractor Skimmer		Tuning fork density meter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Eco friendly	9	GO	8	GO	9	GO	5	NO GO	6	GO	8	GO	9	GO
Satisfy size constraint	9	GO	8	GO	8	GO	3	NO GO	3	NO GO	4	NO GO	9	GO
Buoyant	6	GO	4	NO GO	6	GO	8	GO	5	NO GO	3	NO GO	5	NO GO
Accurate fluid Sensibility	8	GO	9	GO	8	GO	3	NO-GO	6	GO	5	NO GO	8	GO
Lightweight and compact design	9	GO	8	GO	5	NO GO	4	NO GO	5	NO GO	3	NO GO	9	GO
Easy to operate	9	GO	7	GO	6	GO	8	GO	5	NO GO	5	NO GO	2	NO-GO
Easy to assemble	9	GO	4	NO GO	8	GO	4	NO GO	2	NO GO	3	NO GO	7	GO
Overall Decision	59	GO	44	GO	50	GO	35	NO GO	32	NO GO	28	NO GO	49	GO

Table 15 **Concepts GO-NO-GO Evaluation of the function "Collect optimal level of fluids"**

Concepts	Disk		Grooves		polycarbonate Ultrasonic Transmission		Submersible Pressure transmitters		Spinning grooves disk		Filtration Plate		Submersible level transmitter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Eco friendly	9	GO	8	GO	7	GO	7	GO	8	GO	8	GO	8	GO
Satisfy size constraint	9	GO	8	GO	7	GO	7	GO	5	NO GO	5	NO GO	9	GO
Oil recovery efficiency of 25% - 50% on ½ in oil slick	9	GO	7	GO	8	GO	8	GO	9	GO	8	GO	8	GO
Accurate fluid sensibility	8	GO	7	GO	8	GO	8	GO	7	GO	8	GO	9	GO
Prevent accidental oil release	7	GO	8	GO	8	GO	7	GO	8	GO	8	GO	8	GO
Easy to operate	9	GO	8	GO	7	GO	8	GO	8	GO	7	GO	9	GO
Easy oil recovery	9	GO	7	GO	8	GO	8	GO	9	GO	9	GO	8	GO
Overall Decision		GO		GO		GO		GO		GO		GO		GO

Table 16 Concepts GO-NO-GO Evaluation of the function "Separate Oil from Water"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Grooved drum		Grooved disk		Oil Water Filter		Strainer		fingers		Oil filter	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	GO	10	NO_GO	6	GO	7	GO	9	GO	9	GO
Prevent accidental oil release	8	GO	7	NO-GO	8	GO	8	GO	2	NO-GO	6	GO
High oil storage capacity	9	GO	8	NO-GO	5	NO-GO	3	NO-GO	5	NO-GO	4	GO
High oil/ water separation	10	GO	10	GO	10	GO	10	GO	8	GO	10	GO
Debris proof	3	NO-GO	5	NO-GO	2	NO-GO	3	NO-GO	3	GO	4	GO
Easy to operate	7	GO	8	GO	3	NO-GO	3	NO GO	6	NO GO	3	GO
Eco friendly	7	GO	7	GO	7	GO	8	GO	5	NO-GO	1	NO-GO
Overall Decision		GO		GO		GO		GO		NO-GO		NO-GO

Table 17 Concepts GO-NO-GO Evaluation of the function "Dissipate Excess water"

Concepts	Moisture & temperature transmission series		High pressure liquid level sensor		Baffle		Decanter		Oil smart pump switch		Hose		Liquid level transmitter	
Requirements/Criteria	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go	Score	Go-No-Go
Eco Friendly	8	GO	8	GO	6	GO	8	GO	8	GO	8	GO	5	NO GO
Satisfy size constraint	8	GO	6	GO	4	NO-GO	6	GO	7	GO	6	GO	7	GO
Easy to manufacture	6	GO	7	GO	5	NO-GO	6	GO	5	NO GO	7	GO	4	NO-GO
High water pump capacity	7	GO	6	GO	8	GO	7	GO	8	GO	6	GO	7	GO
Accurate fluid sensibility	8	GO	9	GO	5	NO GO	7	GO	8	GO	8	GO	8	GO
Prevent accidental contaminated water release	4	NO-GO	6	GO	8	GO	8	GO	3	NO GO	7	GO	4	NO-GO
Removable storage container	2	NO GO	2	NO GO	7	GO	5	NO GO	3	NO GO	4	NO GO	3	NO GO
Overall Decision		GO		GO		NO-GO		GO		NO GO		GO		NO GO

Table 19 Concepts GO-NO-GO Evaluation of the function "Contain contaminated water"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7		Concept 8	
	Contaminant removal filter cart (portable)		Oil separator from industrial fluids System		Kidney loop filtration system		Oil/water separator using density sensor		Automatic flow regulating valve		Ball valve that separates oil and water		Series flow switch		Moisture in oil transmitter	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
1.Eco friendly	7	GO	6	GO	7	GO	9	GO	10	GO	9	GO	7	GO	8	GO
2. Satisfy size constraint	6	GO	4	NO-GO	6	GO	9	GO	10	GO	10	GO	10	GO	10	GO
15. Prevent accidental contaminated water release	6	GO	7	GO	5	NO-GO	4	NO-GO	4	NO-GO	4	NO-GO	1	NO-GO	6	GO
25. Removable storage container	9	NO-GO	1	NO-GO	1	NO-GO	6	GO	4	NO-GO	1	GO	1	NO-GO	1	NO-GO
27. Corrosion resistance	7	GO	6	GO	4	NO-GO	9	GO	8	GO	5	NO-GO	4	NO-GO	9	GO
30. Debris proof	5	NO-GO	4	NO-GO	6	GO	5	NO-GO	1	NO-GO	5	NO-GO	1	NO-GO	4	NO-GO
12. High water pump capacity	5	NO-GO	5	NO-GO	1	NO-GO	5	NO-GO	1	NO-GO	5	NO-GO	1	NO-GO	4	NO-GO
Overall Decision		GO		NO-GO		NO-GO		GO		NO-GO		GO		NO-GO		GO

Table 20 Concepts GO-NO-GO Evaluation of the function "Contain the oil (filter water out of the oil)"

	Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Oil Storage tank		Oil retainer where oil is whiped off before containtment		Oil container for oil skimmer		Floating boom sock		Oil containtment tank for storage		Large oil skimmer tank	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
2. Satisfy size constraint	8	GO	8	GO	7	GO	10	GO	8	GO	2	NO-GO
4. High oil storage capacity	7	GO	10	GO	10	GO	2	NO-GO	10	GO	10	GO
14. Prevent accidental oil release	6	GO	7	GO	4	NO-GO	2	NO-GO	8	GO	5	NO-GO
17. High oil/ water separation	4	NO-GO	8	GO	4	NO-GO	5	NO-GO	9	GO	3	NO-GO
25. Removable storage container	7	GO	8	GO	5	NO-GO	9	GO	8	GO	3	NO-GO
27. Corrosion resistance	9	GO	7	GO	7	GO	5	NO-GO	8	GO	7	GO
30. Debris Proof	4	NO-GO	2	NO-GO	5	NO-GO	5	NO-GO	4	NO-GO	6	GO
Overall Decision		GO		GO		NO-GO		NO-GO		GO		NO-GO

The second evaluation phase consisted in a decision matrix, where all of the remainder concepts were evaluated. In this phase each criterion was assigned a specific weight from 1 to 10. Then the scores for each concept were transferred from the GO-NO-GO phase and were multiplied by the weight assigned for each criterion. Then the total amount of points for each concept was calculated and the two concepts per function that had the highest score, were selected to move into the final design evaluation stage.

2. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening) using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in details in class). From the decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

Tables 21-39 display the matrix decision method to evaluate the concepts that passed the GO-NO-GO test.

Table 21 Concepts Decision Matrix Evaluation of the function "Perform Floatation Stabilization"

		Concept 2		Concept 3		Concept 5		Concept 6		Concept 7	
		Foam Filled Buoys		Buoyant Body		Tri-float skimmer		Floating drum skimmer		Skimmer material	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Lightweight and compact design	10	5	50	8	80	9	90	9	90	4	40
Maneuverable	6	1	6	9	56	8	48	8	48	6	36
Satisfy size constraint	8	3	24	8	64	7	56	9	72	6	48
Waterproof	10	10	100	10	100	8	80	10	100	10	100
Buoyant	10	10	100	10	100	10	100	10	100	10	100
Easy to operate	6	8	48	7	42	5	30	7	42	7	42
Marketable	6	7	35	9	63	6	36	8	48	7	42
Overall Decision			363		505		440		500		408

Table 22 Decision Matrix Table for the Function "Limit Debris Entering Skimmer"

		Concept 2		Concept 4		Concept 5		Concept 6	
		Debris Net		Repeller Grate		Debris shield		Skimmer guard	
Requirements/Criteria	**Weight**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Eco friendly	5	6	30	7	35	8	40	7	35
Long skimmer life	7	8	56	6	42	8	56	5	35
Prevent accidental oil release	9	9	81	8	72	9	81	8	72
Prevent accidental contaminated water release	9	9	81	8	72	9	81	8	72
small components	3	8	24	3	9	7	24	5	15
ANSYS analysis	6	8	48	7	42	8	48	8	48
Debris proof	10	9	90	8	80	8	80	9	90
Total Weighted Score			**410**		**352**		**410**		**367**

Table 23 Decision Matrix Table for the Function "Separate debris from fluids taken by skimmer"

		Concept 1		Concept 2		Concept 3		Concept 6	
		Debris protection net		Floating Skimmer Fence		Self Filtration		Commercial Screened Shield	
Requirements/Criteria	**Weight**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Eco friendly	6	5	30	6	36	7	42	8	48
Long skimmer life	6	7	42	7	42	9	54	9	54
Prevent accidental oil release	10	7	70	7	70	9	90	9	90
Prevent accidental contaminated water release	10	2	20	7	70	9	90	8	80
small components	4	8	32	8	32	8	32	8	32
ANSYS analysis	8	5	40	5	40	8	64	7	56
Debris proof	7	8	56	8	56	8	56	8	56
Total Weighted Score			290		346		428		416

Table 24 Decision Matrix Table for the Function "Contain the Debris"

		Concept 2		Concept 4		Concept 5		Concept 6	
		Waste basket		Bandalong Litter Trap		Bom system		Bag float	
Requirements/Criteria	**Weight**	**Score**	**Weighted Score**		**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Eco friendly	7	7	42	8	56	6	42	4	28
Long skimmer life	7	8	56	9	63	8	56	7	42
Prevent accidental oil release	10	8	80	9	90	7	70	7	70
Prevent accidental contaminated water release	10	9	90	8	80	4	40	8	80
small components	5	8	40	8	40	8	40	5	25
Total Weighted Score			308		329		248		245

Table 25 Concepts Decision Matrix Evaluation of the function "Separate Oil from Water"

		Concept 2		Concept 3		Concept 5		Concept 6	
		Grooved drum		Grooved disk		Oil Water Filter		Strainer	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	10	100	10	100	6	60	7	70
Prevent accidental oil release	10	8	80	7	70	8	80	8	80
High oil storage capacity	8	9	72	8	64	5	40	3	24
High oil/ water separation	10	10	100	10	100	10	100	10	24
Debris proof	6	3	18	5	30	2	12	3	18
Easy to operate	7	7	49	8	56	3	21	3	21
Eco friendly	10	7	70	7	70	7	70	8	80
Overall Decision			489		490		383		317

Table 26 Concepts Decision Matrix Evaluation of the function "Transform Rate Readings"

		Concept 1		Concept 2		Concept 6	
		Digital Transmitter		Detector Array		Flow Meter	
Requirements/Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Oil recovery efficiency of 25%-50% on ¼ in oil	10	8	80	10	100	4	40
Accurate Fluid Sensibility	9	7	63	9	81	3	27
Lightweight and compact design	6	10	60	8	48	10	60
High oil/water separation	9	2	18	5	40	5	40
Small Components	3	10	30	4	12	10	30
Operational in all calm waters	5	10	50	8	40	10	50
Detachable	1	10	10	8	8	10	10
Easily designable with CAD software	7	9	63	4	28	7	49
Easy to Operate	8	8	64	7	56	10	80
Total Weighted Score			438		413		386

Table 27 Concepts Decision Matrix Evaluation of the function "Calculate Amount of Oil Intake"

		Concept 1		Concept 3		Concept 6	
		Mass Flow Meter		Magmeter		Lightweight Flow Meter	
Requirements/Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Oil recoverg efficiency of 25%-50% on ¼ in oil	10	9	90	8	80	7	70
Accurate Fluid Sensibility	9	7	63	8	72	7	63
Lightweight and compact design	6	7	42	8	48	9	54
High oil/water separation	9	9	81	7	63	5	45
Small Components	3	7	21	9	27	9	27
Operational in all calm waters	5	10	50	10	50	10	50
Detachable	1	8	8	10	10	8	8
Easily designable with CAD software	7	10	70	6	42	8	56
Past Oil Recover	8	7	56	6	48	6	48
Total Weighted Score			481		440		421

Table 28 Concepts Decision Matrix Evaluation of the function "Accurately Detect Flow Sensor"

		Concept 2		Concept 5		Concept 6	
		Pressure Transducer		Transceiver		Sensor	
Requirements/Criteria	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Oil recovery efficiency of 25%-50% on ¼ in oil	10	6	60	7	70	7	70
Accurate Fluid Sensibility	9	7	63	7	63	9	81
Lightweight and compact design	6	9	54	8	48	9	54
Small Components	3	9	27	7	21	9	27
Operational in all calm waters	5	10	50	10	50	10	50
Detachable	1	9	9	7	7	9	9
Easily designable with CAD software	7	8	56	6	42	7	49
Total Weighted Score			319		301		340

Table 29 Concepts Decision Matrix Evaluation of the function "Differentiate specific gravities of fluids"

		Concept 1		Concept 2		Concept 3		Concept 7	
		Simple Hydrometer		Liquid level Transmitter		Point level Sensor		Tuning Fork density meter	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Eco Friendly	5	9	45	8	40	9	45	9	45
Satisfy size constraint	7	9	63	8	56	8	56	9	63
Buoyant	7	6	42	4	28	6	42	5	35
Accurate fluid sensibility	9	8	72	9	81	8	72	8	72
Lightweight and compact design	8	9	72	8	64	5	40	9	72
Easy to Operate	9	9	81	7	63	6	54	2	18
Easy to assemble	8	9	72	4	32	8	64	7	56
Overall Decision			447		364		373		361

Table 30 Concepts Decision Matrix Evaluation of the function "Collect optimal level of fluids"

		Concept 1		Concept 2		Concept 3		Concept 4		Concept 5		Concept 6		Concept 7	
		Disk		Grooves		Polycarbonate Ultrasonic Transmission		Submersible pressure transmitter		Spinning grooves disk		Filtration plate		Submersible level transmitter	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Eco friendly	7	9	63	8	56	7	49	7	49	8	56	8	56	8	56
Satisfy size constraint	7	9	63	8	56	7	49	7	49	5	35	5	35	9	63
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	9	90	7	70	8	80	8	80	9	90	8	80	8	80
Accurate fluid sensibility	10	8	80	7	70	8	80	8	80	7	70	8	80	9	90
Prevent accidental oil release	7	7	49	8	56	8	56	7	49	8	56	8	56	8	56
Easy to operate	7	9	63	8	56	7	49	8	56	8	56	7	49	9	63
Easy oil recovery	8	9	72	7	56	8	64	8	64	9	72	9	72	8	64
Overall Decision			480		420		427		427		435		428		472

Table 31 Concepts Decision Matrix Evaluation of the function "Dissipate excess water"

		Concept 1		Concept 2		Concept 4		Concept 6	
		Moisture and temperature transmission series		High pressure liquid sensor		Decanter		Hose	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Eco Friendly	8	8	64	8	64	8	64	8	64
Satisfy size constraint	7	8	56	6	42	6	42	6	42
Easy to manufacture	7	6	42	7	49	6	42	7	49
High water pump capacity	6	7	42	6	36	7	42	6	36
Accurate fluid sensibility	8	8	64	9	72	7	56	8	64
Prevent accidental contaminated water release	8	4	32	6	48	8	64	7	56
Removable storage container	9	2	18	2	18	5	45	4	36
Overall Decision			318		329		355		347

Table 32 Concepts Decision Matrix Evaluation of the function "Detect Surface Tension"

		Concept 1		Concept 5		Concept 6	
		Surface tension meter		Grease Grabber		Tensiometer	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accurate fluid sensibility	7	6	60	5	78	7	68
Applies Specific Gravity	6	7	75	10	89	6	57
Fast oil recovery	8	2	20	8	82	4	34
Utilizes Cohesion/Surface Tension of Oil	10	10	100	10	100	10	90
Oil recovery efficiency	10	3	24	4	65	4	35
Overall Decision			279		414		284

Table 33 Concepts Decision Matrix Evaluation of the function "Detect Type of Oil"

		Concept 1		Concept 5		Concept 6	
		Digital Viscometer		Viscosity Tester		Detection System	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accurate Oil Detection Thickness	10	7	65	6	58	10	100
Capability of Viscosity Sensibility	7	6	53	8	75	7	80
Oil recovery efficiency	10	3	35	4	35	6	65
Overall Decision			153		168		245

Table 34 Concepts Decision Matrix Evaluation of the function "Self-adjust separation method to different types of oil"

		Concept 3		Concept 6		Concept 7	
		Flow gauge		Density meter		Analog recorder	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Small components	8	6	77	7	80	7	80
Operational in various Oil Thickness	10	4	89	4	56	6	68
Easily designable with CAD software	7	8	45	3	35	4	46
Accurate Oil Detection Thickness	10	6	65	8	85	3	30
Easy to manufacture	10	7	100	6	90	7	70
Overall Decision			376		346		294

Table 35 Concepts Decision Matrix Evaluation of the function "Control Rate of recovery"

		Concept 1		Concept 3		Concept 5		Concept 6	
		Fixed orifice mode		Pressure Switch		oil traffic controller		Actuator	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	4	40	5	50	4	40	6	60
Accurate fluid sensibility	10	6	60	7	70	6	60	6	60
debris prof	5	8	40	4	20	4	20	7	35
Prevent accidental contaminated water release	9	6	54	7	63	8	72	6	54
Fast oil recovery	7	3	21	6	42	4	28	3	21
Lightweight and compact design	7	7	49	7	49	6	42	5	35
Cost effective	8	10	80	9	72	6	48	5	40
Overall Decision			344		366		310		305

Table 36 Decision Matrix Evaluation of the function "Maintain oil/water ratiol"

		Concept 2		Concept 3		Concept 5		Concept 6	
		DMS Thickness Gauge		Ultrasonic thickness gauge		Line transducer		Flow transmitter	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accurate fluid sensibility	9	7	63	6	54	8	72	7	63
high oil/water separation	9	5	45	4	36	4	36	5	45
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	3	30	4	40	6	60	5	50
Light weight and compact design	7	7	49	9	63	7	49	9	63
Detachable part	6	8	48	8	48	5	30	7	42
Small Component	7	6	42	8	56	8	56	8	56
Cost effective	8	0	0	0	0	0	0	6	48
Overall Decision			277		297		303		367

Table 37 Concepts Decision Matrix Evaluation of the function "Measure oil resistance to flow"

		Concept 1		Concept 2		Concept 3	
		Viscometer fork		Oval Gear Flow Meter		Flow meter	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accurate fluid sensibility	10	8	80	8	80	8	80
Oil recovery efficiency of 25%-50% on ½ in oil slick	10	4	40	7	70	5	50
Lightweight and compact design	7	8	56	4	28	7	49
Easy to operate	8	7	56	6	48	8	64
Detachable part	5	8	40	5	25	4	20
Small Component	7	7	49	6	42	6	42
Cost effective	8	5	40	5	40	0	0
Overall Decision			361		333		305

Table 38 Concepts Decision Matrix Evaluation of the function "Contain contaminated water"

		Concept 1		Concept 4		Concept 8	
		Contaminant removal filter cart (portable)		Oil/water separator using density sensor		Moisture in oil transmitter	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
1.Eco friendly	8	7	56	9	72	8	64
2. Satisfy size constraint	10	6	60	9	90	10	100
15. Prevent accidental contaminated water release	7	6	42	4	28	6	42
25. Removable storage container	4	9	36	6	24	1	4
27. Corrosion resistance	9	7	63	9	81	9	81
30. Debris proof	5	5	25	5	25	4	20
12. High water pump capacity	6	5	30	5	30	4	24
Total Weighted Score			312		350		335

Table 39 Concepts Decision Matrix Evaluation of the function "Contain the oil (filter water out of the oil)"

		Concept 1		Concept 2		Concept 5	
		Oil Storage tank		Oil retainer where oil is wiped off before containment		Oil containment tank for storage	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
2. Satisfy size constraint	10	8	80	8	80	8	80
4. High oil storage capacity	7	7	49	10	70	10	70
14. Prevent accidental oil release	10	6	60	7	70	8	80
17. High oil/ water separation	10	4	40	8	80	9	90
25. Removable storage container	4	7	28	8	32	8	32
27. Corrosion resistance	9	9	81	7	63	8	72
30. Debris Proof	5	4	20	2	10	4	20
Total Weighted Score			358		405		444

~~**4.3.2 GO-NO-GO and Decision Matrix**~~

In this subsection, the team compiled all the concepts that were selected from the matrix decision phase of the design evaluation. Once the concepts were compiled the team generated two detailed sketches using the concepts that were identified to best meet the important criteria of the project. Then, both systems were evaluated, and the team made a decision of a finalized preliminary design.

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

In ~~figure~~ 1 the sketch of the higher score components is displayed.

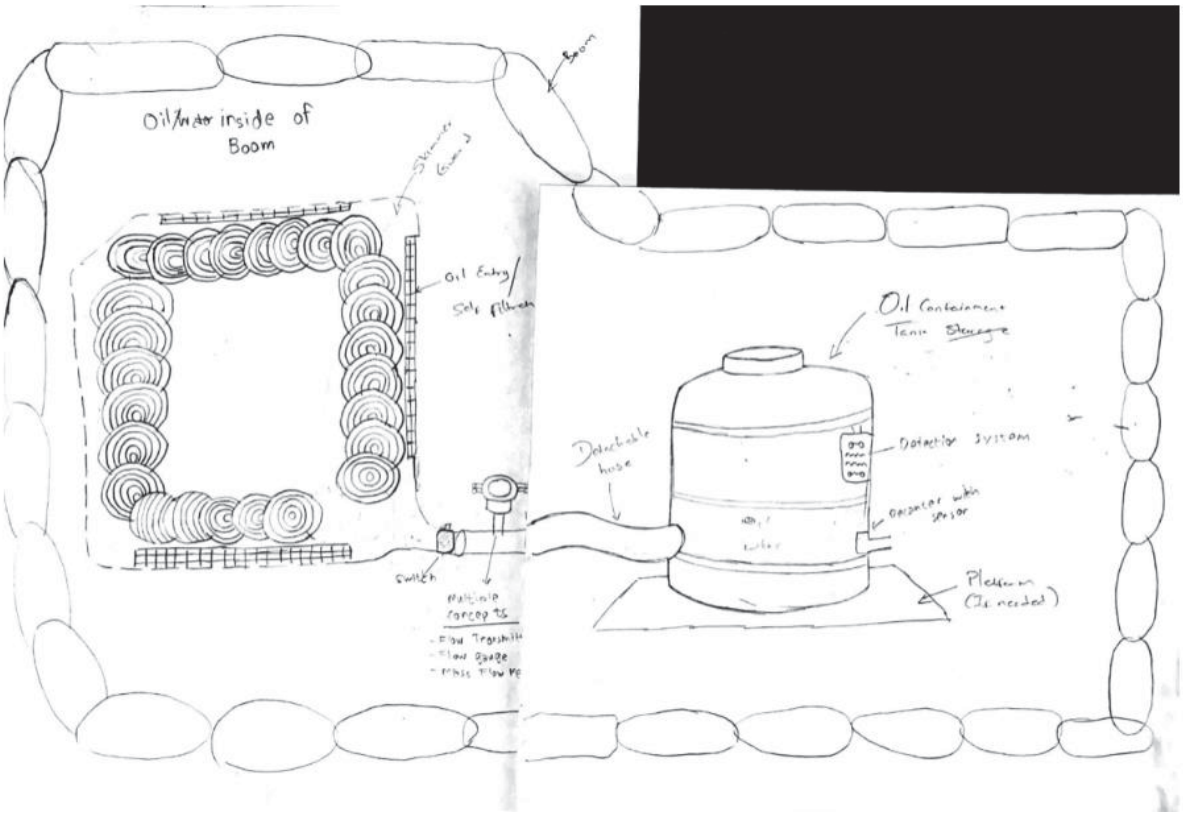


Figure 1 Skimmer Sketch 1

In ~~figure~~ 2, the sketch that contains the components with the second highest score in the decision matrix is displayed.

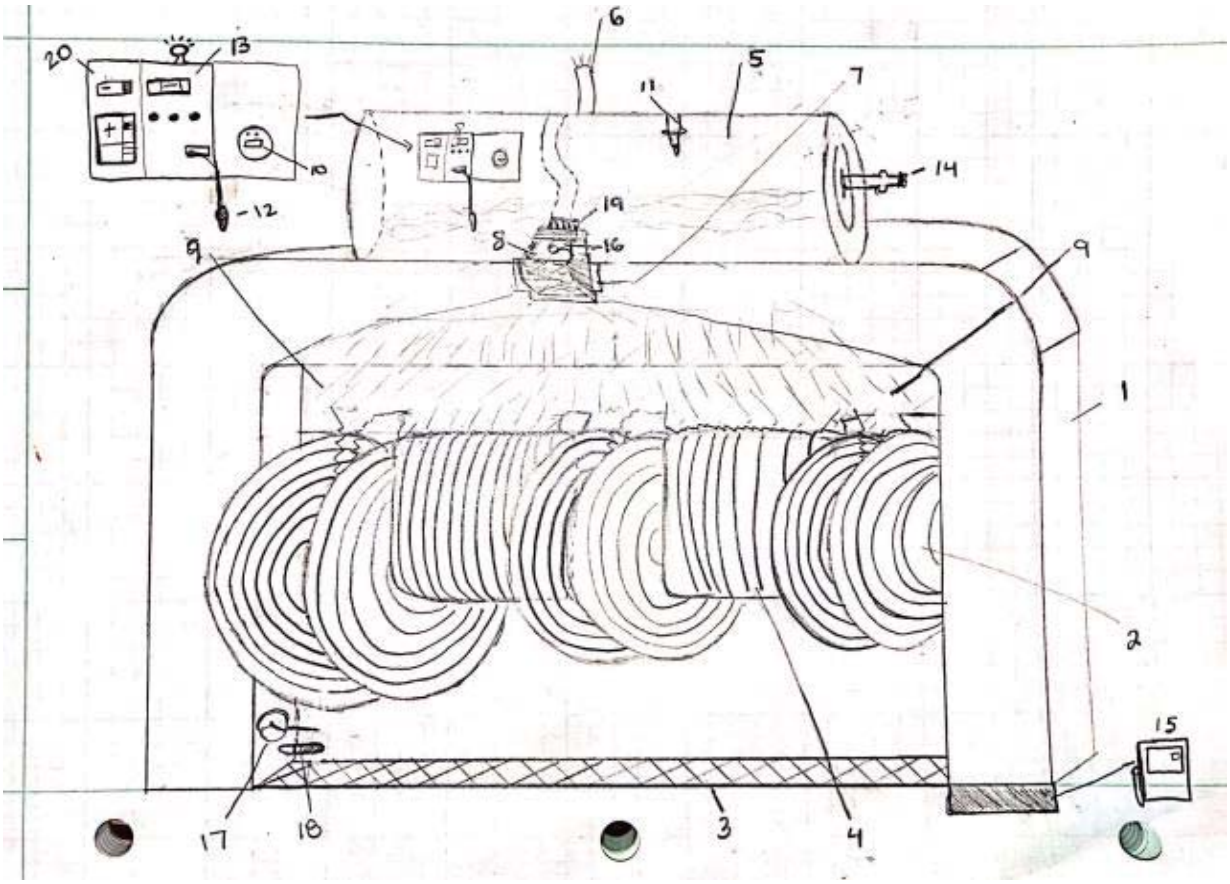


Figure 2 Skimmer Sketch 2

In ~~figure~~ 3 a legend for figure 2 is displayed.

```
Sketch 2 Legend
1. U-shaped body
2. Grooved disk
3. Debris shield
4. Floating Drum skimmer
5. Oil retainer
6. Hose
7. Waste Basket
8. Commercial screen shield
9. Oil ramp
10. Magmeter
11. Point level sensor
12. Submersible level
transmitter
13. Detector array
14. Pressure Transducer
15. Line transducer
16. Oval gear flow meter
17. Tensiometer
18. Density meter
19. Fixed Orifice system
20. Moisture oil transmitter
```

Figure 3 Legend of Figure 2

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

The second sketch featuring the second tier of concepts from the decision matrix was chosen to be the favorite over the first sketch. Due to the complexities of some of the concepts within the first tier, the design for the first sketch was more difficult to imagine as a fully functional and apprehensive model. The first sketch had too many moving parts that could become a size constraint issue if not properly designed. The second tier of concepts flowed more fluidly when meshed together while also being able to add a few small components to make the functions of the concepts coincide with one another. Although the first sketch presented better concepts overall, the assembly of the second sketch is more comprehensive and also a more reliable in terms of a compact and lightweight design.

REFERENCES

Group 7 “Skimmer Hand Drawings 1”

Group 7 “Skimmer Hand Drawing 2”

Grading Scheme
Status Report on Concepts Evaluation
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Reasonable exhaustive list of requirements/criteria for evaluating project functions	10	
2	Requirements/criteria identified and assigned to each function using Table 1	10	
3	Use of few most important requirements for GO NO GO evaluation of each function	40	
4	Evaluation of remaining functions using Decision Matrix and the selection of the best concepts for main design and the runner up concepts for the back-up design	80	
5	Detailed sketches for the main system and for the back-up system	50	
6	Evaluation of the two systems and selection of the primary system upon which design will be based.	10	
	Total	200	

AVERAGE

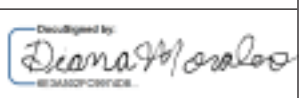
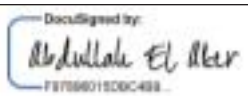
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: _ Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER: 3

Progress Report Title: Concept Evaluation and Selection

Due Date:10/29/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Contributed to list of criteria, filled out assigned go, No go tables and matrices tables. Applied cover sheet and original report to the submitted report.	100	
2	Fanta Kaba	Created the requirements/criteria and completed my assigned part of the GO NO-GO and the matrix table.	100	
3	Christian White	Generated list of criteria and completed portion of the go-no-go tables as well as matrix tables. Proofread final document for submission.	100	
4	Abdullah EL Aker 	Contributed to the list of criteria. Completed the assigned GO NO-GO tables and the corresponding matrix tables. Reinforced concepts of sub functions	100	
5	Yemboado Yonli	Contributed to the criteria's Wrote paragraphs for certain paragraphs Contributed to GO-NO-GO and the decision matrix. Drew sketches of the 2 apparatus	100	
6	Marcelo Epam Ona	Create the GO-NO-GO and matrixes table. Help fill up the GO-NO-GO tables and Make sure the overall status report is properly written and compacted.	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER

Status Report 8 on Concept Evaluation and Selection

Due: 10/28/2020

This status report is section 4.3of your final report. Questions 1 & 2 will constitute section 4.3.1, questions 3 & 4 will constitute section 4.3.2 and questions 5 & 6 will constitute section 4.3.3

Study the notes on concepts evaluation discussed in class and posted on e-course and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example. Each group should meet and review the concepts and sketches for each function generated as part of questions 3 and 4 in the previous status report ensuring that several concepts have been generated for each function and that the concepts are adequately supported by sketches/figures/pictures as are necessary for understanding the concept.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all of the functions you group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function. [**10 Points**]

The requirements/criteria requested in question 1 can be obtained by considering the following questions and listing the answers:

- What customer requirements are related to the project? Make a list of all customer requirements
- What operating environments are related to the project? Look at all of your operating environments.
- What constraints can affect the project? List all of your project constraints.
- Is current technology available for the functions of the project?
- Can the technology/concept be manufactured with known processes?
- What are the project objectives? Look at your list of objectives
- Is there a need for experimentation to ascertain how well certain project function can be achieved?
- Are critical parameters that control the functions of the project identified?
- Are the safe operating latitude and sensitivity of the parameters known?
- Have all of the failure modes been identified for the project?

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction.**[10 Points**].

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for GO-NO-GO Table **[40 Points]**

4. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening**)** using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in details in class). From the

decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

References:
http://www.enge.vt.edu/terpenny/Smart/Virtual_econ/Module2/pugh_method.htm
Read about the Pugh and go-no-go evaluation concepts from other sources to supplement your knowledge.

Assignment for Assessing Outcome c.2

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

Table 1 Sample Example Criteria Affecting Previously identified Sub-functions for Project

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function							
				1	2	3	4	5	6	7	8
VNM-0	VNM-1	VNM-1.1	VNM-	6	11	20	22	30			
			VNM-								
			VNM-								
		VNM-1.2	VNM-								
			VNM-								
		VNM-1.3 (No level 3 subfunctions)									
	VNM-2	VNM-2.1	VNM-								
			VNM-								
			VNM-								
		VNM-2.2 (No level 3 subfunctions)									
		VNM-2.3	VNM-								
			VNM-								
	VNM-3	VNM-3.1	VNM-								
			VNM-								
			VNM-								
		VNM-3.2 (No level 3 subfunctions)									
		VNM-3.3	VNM-								
			VNM-								
	VNM-4	VNM-4.1 (No level 3 subfunctions)									
		VNM-4.2	VNM-								
			VNM-								
		VNM-4.3	VNM-								
			VNM-								
	VNM-5	VNM-5.1									

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function							
				1	2	3	4	5	6	7	8
		(No level 3 subfunctions)									
		VNM-5.2	VNM-								
			VNM-								
		VNM-5.3									

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

7. E.g. Protect-Rider-From Dirt

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER

Status Report 8 on Concept Evaluation and Selection

Due:10/28/2020

This status report is section 4.3 of the final report and it focuses on the selection of concepts the group came up with on the previous status report titled concept generation. In this status report, group members were extremely concentrated on selecting concepts that could actually help develop the different functions stated on functional decomposition. To do that. A list of GO-NO-GO and matrices tables were created using a list of criteria's that can help the group achieve the goals and objectives of the overall project.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all of the functions you group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function.
[**10 Points**]

In this section the group generated an exhaustive list of criteria's that were going to serve as a check mark for the selection of different concepts found on the concept generation. These concepts were later used to design a set-up of what the groups final apparatus will look like. The list of criteria below was obtained by answering some of the questions stated in the bullet points below.

- What customer requirements are related to the project? Make a list of all customer requirements

1) safety
2) cost effectiveness
3) Ease to operate
4) Durability
5) Ease of assembly

- What operating environments are related to the project? Look at all of your operating environments.

6) applicable to lab settings
7) Eliminate radiation
8) Eliminate convection

- What constraints can affect the project? List all of your project constraints.

9) Size
10) Weight
11) Heat resistance
12) Physical resistance
13) concepts easily influenced by the magnetic field.

- Is current technology available for the functions of the project?

14) Availability of technology and materials

15) Accessibility of technology and materials

- Can the technology/concept be manufactured with known processes?

16) Feasibility
17) ~~Ease to operate~~
18) Reliability

- What are the project objectives? Look at your list of objectives

19) Speed in measuring the heat transfer coefficient and thermal conductivity under different BCs.
20) Accuracy in measuring the heat transfer coefficient and thermal conductivity under different BCs.
21) Measuring HTC and thermal conductivity under different boundary conditions

- Is there a need for experimentation to ascertain how well certain project functions can be achieved?

22) Magnetic field accommodation
23) ~~Heat resistance~~
24) Boundary layers accommodation.
25) Pressure boundary layer accommodation.
26) Radiation shields.

- Are critical parameters that control the functions of the project identified?

27) Heat transfer coefficient
28) fluid flow
29) Heat flux
30) Temperature
31) Current
32) Fluid thermal conductivity
33) Voltage

- Have all of the failure modes been identified for the project?

34) Not being able to measure the HTC under different boundary conditions.
35) Not being able to measure thermal conductivity under different conditions
36) Using materials such as metal can negatively influence measurement when using magnetic fields as boundary conditions.
37) No using radiation shields can also negatively affect measurements.

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction. **[10 Points]**

Table 4.1 is a representation of some requirements and criteria from the list above that were implemented to the functions and subfunctions of the apparatus. If a criterion was thought to be applicable to a function it was assigned to it by using the corresponding number of the criteria from the above list. These criteria would be the ones to be used to evaluate the different concepts tied to the functions

Table 4.1 Requirements/Criteria's Tabl2

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
				1	2	3	4	5	6	7	8	
Measure the heat transfer coefficient and the thermal conductivity of nanofluid under different boundary conditions	Make the nanofluid during the experiment	Heat up the nanofluid before pumping		1	2	11	9	17				
		Pump the nanofluid Through the pipes		4	2	11	18	9	16	5		
		cool down the nanofluid after the measurements are made		1	2	10	5	19	3			
	Accommodate to different type of boundary conditions for the experiment	Accommodate to the magnetic field change		4	2	15	22	20	18	16		
		Accommodate to the pressure boundary condition change		15	2	9	20	3	18	16		
		Accommodate the boundary layer change of the nanofluid		18	2	9	20	15	16			

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions		Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
					1	2	3	4	5	6	7	8	
	Measure the heat transfer coefficient and the thermal conductivity of the nanofluid	Measure the heat transfer coefficient of the nanofluid in the experiment	Measure the voltage(V) from the source		1	2	9	10	13				
			Measure the nanofluid temperature of the nanofluid and set up (Tin and Tout)		10	2	1	4	9	3			
			Measure the current coming from the source		1	2	9	4	19	3			
		Measure the thermal conductivity of the nanofluid in the experiment	Measure the voltage from the source		1	2	9	10	3				
			Measure the nanofluid temperature of the nanofluid and set up (Tin and Tout)		10	2	1	4	9	3			

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions		Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
					1	2	3	4	5	6	7	8	
			Measure the current(I) from the source		1	2	9	4	19	3			
		generate readings of the parameters necessary for calculation	Display readings of measured parameters on a computer software		5	2	3	10	9	1			
			Calculate the heat transfer coefficient and thermal conductivity based on the obtained data		22	8	15	7					
			Generate graphs showing the fluctuation of each parameter		1	2	20	4	9	5			

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
				1	2	3	4	5	6	7	8	
	Insulate to avoid heat loss	Avoid heat loss from radiation		2	1	3	4	7	11			
		Avoid heat loss from convection		1	2	4	8	16	11			

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for GO-NO-GO Table **[40 Points]**

In this section the group proceeded to evaluate the different concepts based on GO-NO-GO screening. In order to do so, an odd number of criteria were chosen out of the list above and applied to the concepts stated on ~~table~~ 4.1. If the concept received more GO's than NO-GO's, then the concept was selected and later on moved to the next evaluation system. Otherwise the concept was rejected or not used. Table 4.2 up to ~~4.17~~ represents the GO-NO-GO's screening of the concepts of every function that the overall system is supposed to perform.

Table 4.2 GO-NO-GO table for Function 1.1 "Heat up the nanofluid before pumping."

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Band heater	Heat exchanger	Boiler	Heat gun
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Safety	GO	GO	GO	GO
Cost effectiveness	NO-GO	NO-GO	GO	GO
Heat resistance	GO	GO	GO	GO
Size	GO	NO-GO	GO	GO
Easy to operate	NO-GO	GO	GO	GO
Weight	GO	NO-GO	GO	GO
Overall Decision	GO	NO-GO	GO	GO

Table 4.3 GO-NO GO table for evaluating the concepts for the function1.2 Pump the nanofluid through the pipes

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Rotary gear Pump	Piston Pump	Peristaltic Pump	Horizontal centrifugal Pump
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Durability	GO	GO	NO-GO	GO
Cost effectiveness	NO-GO	NO-GO	NO-GO	GO
Reliability	GO	GO	NO-GO	GO
Overall Decision	GO	GO	NO-GO	GO

Table 4.4 GO-NO-GO for function 2.2: Cool down the Nanofluid after the measurement are made

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Condenser	Cold plate	Open feedwater cooler	Liquid cooling heat exchanger
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Safety	GO	NO	GO	GO
Feasibility	GO	NO	GO	GO
ease assembly	GO	NO	GO	GO
Overall Decision	GO	NO	GO	GO

Table 4.5 GO-NO-GO for function 2.2: Accommodate to the magnetic field change.

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Stainless steel	Permeability to magnetic field	Material made of crystal	Magnetic field stabilizer
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Cost effectiveness	GO	GO	GO	NO
Magnetic field accommodation	GO	GO	GO	NO
Size	GO	GO	GO	NO
Overall Decision	GO	GO	GO	NO

Table 4.6 GO-NO-GO for function 2.2 Accommodate to pressure boundary condition

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Pressure Sensor	Pressure boundary condition	set Pressure sensor inlet and outlet using Pressure sensor	Pressure Control Valve
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Accuracy	GO	NO GO	NO GO	GO
Cost effectiveness	GO	NO GO	GO	GO
Size	GO	NO GO	GO	GO
Overall Decision	GO	NO GO	GO	GO

Table 4.7 GO-NO-GO for function 2.3 Accommodate to the boundary layer change

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Permeable linear stretching sheet	Nonlinear permeable stretching sheet	Increase flow velocity	Maintain constant flow with flowmeter
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Feasibility	NO-GO	NO-GO	GO	GO
Cost effectiveness	GO	GO	GO	GO
Reliability	GO	NO GO	GO	GO
Overall Decision	GO	NO GO	GO	GO

Table 4.8 GO-NO GO table for evaluating the concepts for the function 3.1.1 Measure the voltage(V) from the source (for convection calculation)

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Analog Voltmeters	Control Panel	Analog multimeter	Digital Voltmeter
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Size	GO	NO-GO	GO	GO
Easy to operate	GO	NO-GO	GO	GO
Cost effectiveness	GO	NO-GO	GO	GO
Overall Decision	GO	NO-GO	GO	GO

Table 4.9 GO-NO-GO table for Function 3.1.2 “Measure the temperature of the nanofluid and set up (Tin and Tout)”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Multipoint temperature sensors	Temperature gauge	Thermistors	KD2 Pro
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Weight	GO	GO	GO	GO
Cost effectiveness	NO-GO	GO	GO	NO-GO
Safety	GO	GO	GO	GO
Durability	NO-GO	GO	NO-GO	GO
Size	GO	GO	GO	GO
Easy to operate	GO	GO	GO	GO
Overall Decision	NO-GO	GO	GO	GO

Table 4.10 GO-NO-GO table for Function 3.1.3 “Measure the intensity of the current source”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Moving coil ammeter	Electrodynamic ammeter	Digital ammeter	Digital multimeter
Criteria/Requirement				
Accuracy	GO	GO	GO	GO
Reliability	GO	GO	NO-GO	GO
Cost Effectiveness	GO	GO	GO	GO
Overall Decision	GO	GO	GO	GO

Table 4.11 GO-NO-GO table for evaluating the concepts for the function 3.2.1 Measure the voltage(V) from the source (for convection calculation)

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Voltage Control Panel	Digital Voltmeter	VTVMs and FET-VMs	Analog Voltmeters
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Size	NO-GO	GO	GO	GO
Ease to operate	NO-GO	GO	NO-GO	GO
Cost Effectiveness	NO-GO	GO	GO	GO
Overall Decision	NO-GO	GO	GO	GO

Table 4.12 GO-NO-GO table for Function 3.2.2 “Measure the temperature of the nanofluid and set up (Tin and Tout)”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Temperature sensor	Pyrometer	Thermocouple probe	Thermocouple
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Weight	GO	NO-GO	GO	GO
Cost effectiveness	GO	NO-GO	GO	GO
Safety	GO	GO	GO	GO
Durability	GO	GO	GO	GO
Size	GO	NO-GO	GO	GO
Easy to operate	GO	GO	GO	GO
Overall Decision	GO	NO-GO	GO	GO

Table 4.13 GO-NO-GO table for Function 3.2.3 “Measure the intensity of the current source”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Moving coil ammeter	Electrodynamic ammeter	Tangent galvanometer	KD2 pro measurement
Criteria/Requirement				
Accuracy	GO	GO	GO	GO
Reliability	GO	GO	GO	GO
Cost Effectiveness	GO	GO	GO	GO
Overall Decision	GO	GO	GO	GO

Table 4.14 GO-NO GO table for evaluating the concepts for the function “Display readings of measured parameters on a computer software.”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	SCADA	DCS	IC Measure	Manually collecting data
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Ease of accessibility	GO	GO	NO-GO	GO
Cost effective	NO-GO	NO-GO	NO-GO	GO
Easy to operate	GO	GO	NO-GO	GO
Overall Decision	GO	GO	NO-GO	GO

Table 4.15 GO-NO GO table for evaluating the concepts for the function “Calculate the heat transfer coefficient and the thermal conductivity after data collection”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Lab view	EES	IC Measure	Manual calculation
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Ease of accessibility	GO	GO	GO	NO-GO
Cost effective	GO	GO	GO	NO-GO
Easy to operate	GO	GO	GO	NO-GO
Overall Decision	GO	GO	GO	NO-GO

Table 4.16 GO-NO GO table for evaluating the concepts for the function “Generate graphs showing the fluctuation of each parameter.”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	SCADA	Mark-10	MATLAB	EES
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Ease to operate	GO	NO-GO	GO	GO
Accessibility of technology	NO-GO	NO-GO	GO	GO
Availability of technology	GO	GO	GO	GO
Overall Decision	GO	NO-GO	GO	GO

Table 4.17 GO-NO GO table for evaluating the concepts for the function “Avoid the heat loss from radiation”

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Aluminum foil	Fiberglass	Mineral wool	Foam glass
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Eliminate convection	GO	GO	GO	NO
Elimination of radiation	GO	GO	GO	NO
Safety	GO	GO	GO	NO
Overall Decision	GO	GO	GO	NO

Table 4.18 GO-NO-GO screening for the function 4.2 avoid heat loss from convection

Concepts	Concept 1	Concept 2	Concept 3	Concept 4
Concepts title	Vacuum insulation panel	Vacuum insulation pump	Glass insulation	Double pipe vacuum insulation
Criteria/Requirement	GO-NO-GO	GO-NO-GO	GO-NO-GO	GO-NO-GO
Safety	GO	GO	GO	GO
Feasibility	GO	GO	GO	NO GO
Eliminate convection	GO	GO	GO	GO
Overall Decision	GO	GO	GO	NO GO

4. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening**)** using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in detail in class). From the decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

In this Section the group evaluated all the concepts that passed the GO-NO-GO screening. All the criteria's that were applicable to the functions were used in this particular section. All criteria's have been weighed on the basis of their importance going from 1 to 10, 1 being for lesser criteria's and 10 for very important criteria's. Then a score was given to the concept based on how the criteria's influenced it. The score was then multiplied by weight to obtain the weighted average of the compete for the corresponding criteria. all the weighted scores were then added together and a definitive score was attributed to each concept. The concepts with the two highest scores were then respectively selected for design 1 and 2. Table ~~4.18~~ up to ~~4.33~~ represents the matrix evaluation.

Table 4.19 Decision matrix table for evaluating concepts for function "Display readings of measured parameters on a computer software."

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Band heater		Boiler		Heat gun	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	10	8	80	8	80	8	80
Cost effectiveness	10	7	70	8	80	8	80
Heat resistance	10	10	100	10	100	10	100
Size	9	8	72	8	72	7	63
Easy to operate	9	8	72	8	72	8	72
Weight	9	9	81	8	72	8	72
Overall Decision			474		476		467

Table 4.20 Decision Matrix table for evaluating concepts for function 1.2 Pump the nanofluid through the pipes

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Rotary gear Pump		Piston Pump		Horizontal Centrifugal Pump	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Durability	8	10	80	7	56	6	48
Cost Effectiveness	6	8	48	8	48	6	36
Reliability	10	9	90	9	90	10	100
Weight	8	8	64	8	64	5	40
Size	7	6	42	9	63	6	42
Feasibility	9	8	72	8	72	5	45
Ease of assembly	6	9	54	7	42	4	24
Heat resistance	10	9	90	10	100	10	100
Overall Decision			539		535		435

Table 4.21 Decision matrix table for evaluating concepts for the function “Cool down the Nanofluid after the measurement is made.”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Condenser		Liquid cooling heat exchanger		Open feedwater cooler	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	9	10	90	7	63	6	54
Cost effectiveness	7	7	49	6	42	5	35
weight	5	8	40	7	35	6	30
Ease to assembly	6	6	36	5	30	7	42
Speed	7	8	56	5	35	7	49
Ease to operate	8	5	40	7	56	6	48
Overall Decision			311		261		258

Table 4.22 Decision matrix table for evaluating concepts for the function “Accommodate the magnetic field change.”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Stainless Steel		Permeability to magnetic field		Material made of crystal	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Durability	7	7	49	6	42	7	49
Cost effectiveness	7	8	56	7	49	7	49
Accessibility	7	7	49	6	42	8	56
Magnetic field accommodation	9	9	81	8	72	9	81
Accuracy	8	8	64	7	56	7	56
Reliability	7	5	35	4	28	4	28
Feasibility	9	9	81	8	72	9	81
Overall Decision			415		361		400

Table 4.23 Decision matrix table for evaluating concepts for the function 2.2 to accommodate the pressure boundary conditions.

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Pressure sensor		Set Pressure inlet and outlet using Pressure sensor		Pressure control valve	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Accessibility	3	8	24	8	24	7	21
Cost effectiveness	6	9	54	8	54	6	36
Size	8	9	72	9	72	8	64
Accuracy	3	9	27	9	27	5	15
Ease To Operate	8	8	64	8	64	9	72
reliability	6	9	54	9	54	6	36
feasibility	7	8	56	8	56	8	56
Overall Decision			351		351		300

Table 4.24 Decision matrix for function 2.3 Accommodate to the boundary layer change of the nanofluid

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Permeable linear stretching sheet		Increase flow velocity		Flow meter	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
reliability	6	5	30	7	42	8	48
Cost effectiveness	6	5	30	6	36	8	48
Size	8	3	24	4	32	9	72
Accuracy	3	5	15	6	18	7	21
Accessibility	3	6	18	6	18	7	21
feasibility	7	4	28	6	42	8	56
Overall Decision			145		188		266

Table 4.25 Decision matrix table below is showing the matrix for evaluating concepts for function 3.1.1 Measure the voltage from the source

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Analog Voltmeters		Analog Multimeter		Digital Voltmeter	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	10	10	100	10	100	10	100
Cost Effectiveness	6	5	35	8	48	6	36
Size	5	7	35	7	35	7	35
Weight	3	5	15	6	18	8	24
Ease to Operate	9	9	81	9	81	9	81
Overall Decision			266		282		273

Table 4.26 Decision matrix table for evaluating concepts for the Function 3.1.2 “Measure the temperature of the nanofluid and the set up (Tin and Tout).”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Multipoint temperature sensors		Temperature gauge		Thermistors	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Weight	8	8	64	8	64	8	64
Cost effectiveness	9	7	63	9	81	9	81
Safety	9	8	72	9	81	8	72
Durability	9	8	72	9	81	7	63
Size	7	7	49	7	49	7	49
Easy to operate	7	7	49	7	49	7	49
Overall Decision			369		405		378

Table 4.27 Decision matrix table for Function 3.1.3 “Measure the intensity of the current source”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Moving coil ammeter		Electrodynamic ammeter		Digital ammeter	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	10	10	100	10	100	8	80
Cost effectiveness	10	7	70	9	90	7	70
Size	8	8	64	9	81	5	40
Durability	10	10	100	10	100	10	100
Speed	10	10	100	10	100	10	100
Ease to operate	7	7	49	7	49	10	70
Overall Decision			488		520		460

Table 4.28 Decision matrix table for evaluating concepts for function 3.2.1 Measure the voltage from the source

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Digital Voltmeter		VTMs and FET-VMs		Analog Voltmeters	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	10	10	100	10	100	10	100
Cost Effectiveness	6	8	48	6	36	6	36
Size	5	5	25	5	25	4	20
Weight	1	1	1	1	1	1	1
Ease to Operate	9	8	72	7	63	6	54
Overall Decision			246		225		211

Table 4.29 Decision matrix table for evaluating concepts for the Function 3.2.2 “Measure the temperature of the nanofluid and the set up (Tin and Tout).”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Temperature sensor		Thermocouple probe		Thermocouple	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Weight	8	8	64	8	64	7	56
Cost effectiveness	9	8	72	8	72	8	72
Safety	8	7	56	7	56	8	64
Durability	8	6	48	7	56	7	56
Size	9	8	72	8	72	8	72
Easy to operate	7	7	49	7	49	7	49
Overall Decision			361		369		369

Table 4.30 Decision matrix table for Function 3.2.3 “Measure the intensity of the current source”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Moving coil ammeter		Electrodynamic ammeter		Tangent galvanometer	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	10	10	100	10	100	10	100
Cost effectiveness	10	7	70	9	90	9	90
Size	8	8	64	9	81	10	80
Durability	10	10	100	10	100	10	100
Accuracy	10	10	100	10	100	10	100
Ease to Operate	7	7	49	7	49	6	42
Overall Decision			488		520		512

Table 4.31 Decision matrix table for evaluating concepts for the function “Display readings of measured parameters on a computer software.”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		SCADA		DCS		Manually collecting data	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Ease of accessibility	5	9	45	5	25	10	50
Cost effective	9	9	81	7	63	10	90
Ease to operate	4	5	20	4	16	10	40
Weight	1	1	1	1	1	1	1
Size	3	3	9	2	6	1	3
Reliability	8	8	64	6	48	10	80
Overall Decision			220		159		264

Table 4.32 Decision matrix table for evaluating concepts for the function “Calculate the heat transfer coefficient and thermal conductivity after data collection”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		lab view		EES		IC measure	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Ease of accessibility	5	9	45	5	25	2	10
Availability of technology	9	9	81	7	63	6	54
Ease to operate	4	5	20	5	20	10	40
Feasibility	1	1	1	1	1	1	1
Overall Decision			147		109		105

Table 4.33 Decision matrix table for evaluating concepts for the function “Generate graphs showing the fluctuation of each parameter.”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		SCADA		MATLAB		EES	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Ease of accessibility	5	9	45	10	50	9	45
Cost effective	9	9	81	10	90	9	81
Ease to operate	4	5	20	4	16	9	36
Weight	1	1	1	1	1	1	1
Size	3	1	3	2	6	1	3
Reliability	8	9	72	9	71	9	72
Total weighted			222		234		238

Table 4.34 Decision matrix table for evaluating concepts for the function “Avoid heat loss from radiation.”

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Aluminum foil		Fiberglass		Mineral wool	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Cost effectiveness	9	10	90	8	72	7	63
Safety	10	9	90	9	90	9	90
Ease to operate	9	9	81	7	63	7	63
Durability	8	6	48	6	48	5	40
Eliminate radiation	8	9	72	8	64	8	64
Heat resistance	4	5	20	3	12	2	8
Overall Decision			401		349		328

Table 4.35 Decision matrix for function 4.2 avoid heat loss from convection

Concepts		Concept 1		Concept 2		Concept 3	
Concepts title		Vacuum insulation Panel		Vacuum insulation pump		Glass vacuum insulation	
Criteria/Requirement	Weights	Scores	Weighted Score	Scores	Weighted Score	Scores	Weighted Score
Safety	9	7	63	8	72	8	72
Cost effectiveness	6	7	42	7	49	7	49
Durability	8	8	64	7	56	8	64
Eliminate convection	6	7	42	8	48	8	48
Feasibility	8	6	48	8	64	8	64
Heat resistance	8	9	72	9	72	9	72
Overall Decision			331		361		369

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

After the decision matrix, each member of the group used the final two sets of the best concepts, primary and backup, to come up with two different systems. This is summarized in Table 4.36. The next meeting, the group discussed the different ideas, compared them and designed two final systems. Those two systems contain the most important part of our final design and were carefully selected. Figure 4.1 and 4.2 are the representation of the two concepts.

Table 4.36 Concepts for apparatus 1 and 2

	APPARATUS 1	**Score**	**APPARATUS 2**	**Score**
Concept 1	**Band heater**	474	**Boiler**	467
Concept 2	**Rotary Gear pump**	539	**Piston pump**	535
Concept 3	**Condenser**	311	**Liquid cooling heat exchanger**	261
Concept 4	**Stainless steel**	415	**Material made of crystal**	400
Concept 5	**Pressure Sensor**	351	**Inlet and outlet Pressure Sensor**	351
Concept 6	**Flow meter**	266	**Increase flow velocity**	188
Concept 7	**Analog Multimeter**	282	**Digital Voltmeter**	273

	APPARATUS 1	Score	APPARATUS 2	Score
Concept 8	**Temperature gauge**	405	**Thermistors**	378
Concept 9	**Electrodynamic ammeter**	520	**Moving coil ammeter**	488
Concept 10	**Digital Voltmeter**	246	**VTMs and FET-VMs**	225
Concept 11	**Thermocouple probe**	369	**Thermocouple**	369
Concept 12	**Electrodynamic ammeter**	520	**Tangent galvanometer**	512
Concept 13	**Manually collecting data**	264	**SCADA**	220
Concept 14	**Lab View**		**EES**	
Concept 15	**EES**	238	**MATLAB**	234
Concept 16	**Aluminum foil**	401	**Fiberglass**	349
Concept 17	**Glass Vacuum insulation**	369	**Vacuum insulation Pump**	361

Figure 4.1 is a representation of the primary apparatus based on the grades obtained by the concepts in the matrix evaluation.

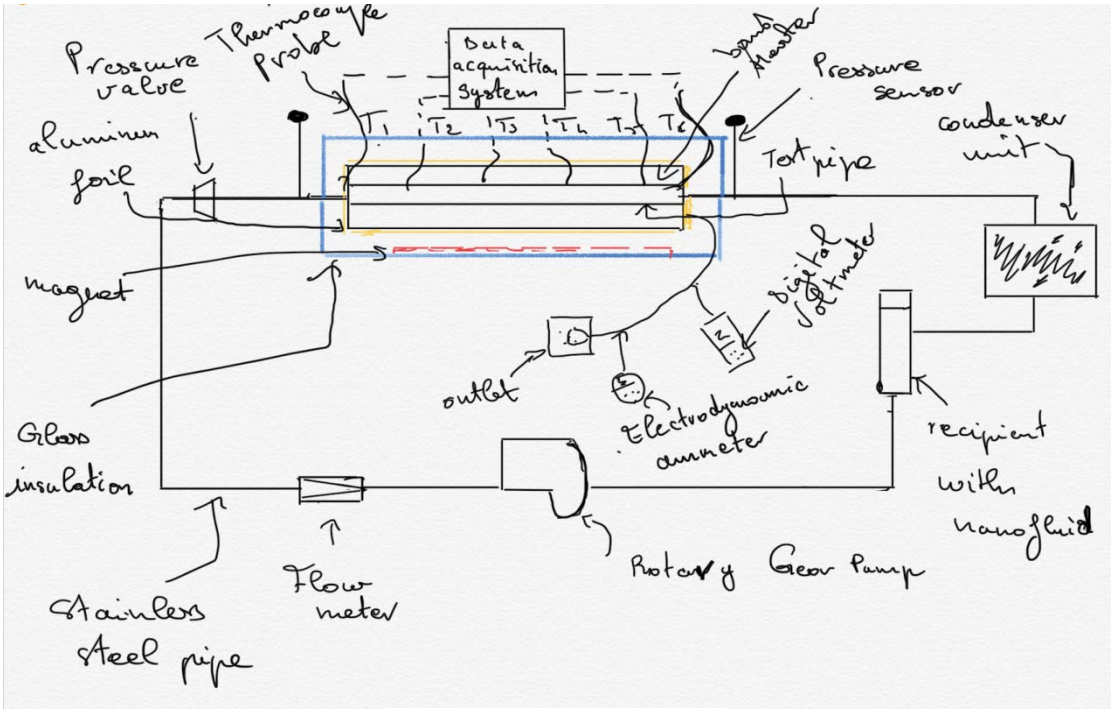


Figure 4.1 Primary apparatus

Figure 4.2 represents the figure of the secondary apparatus that the group came up with based on the points obtained after the matrix evaluation.

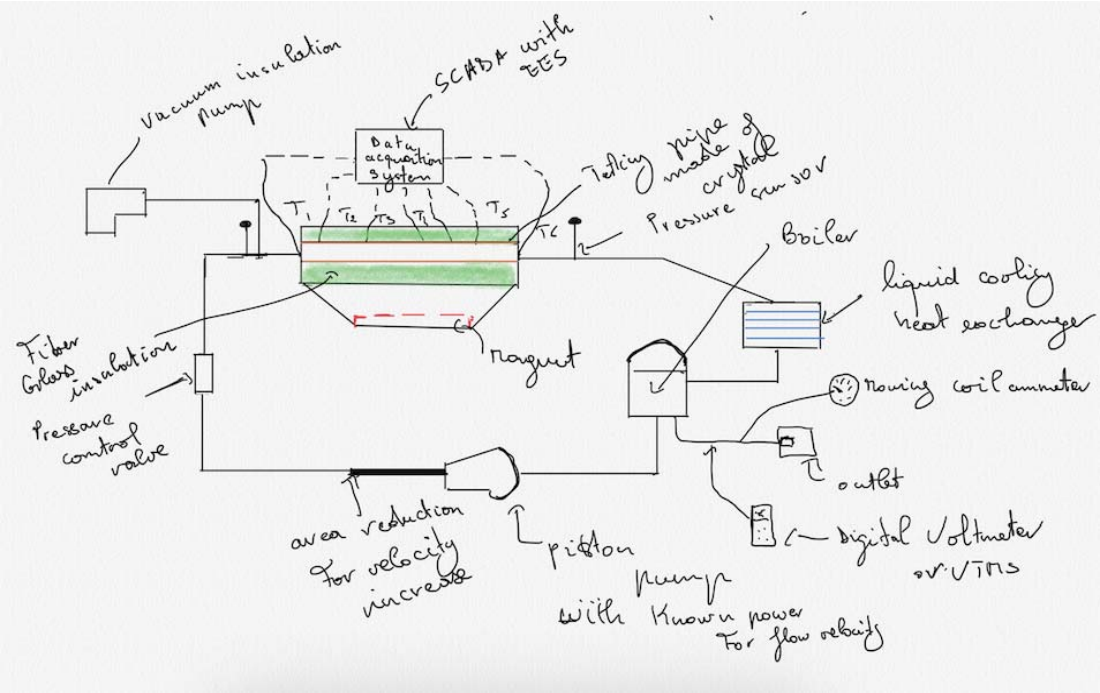


Figure 4.2 secondary apparatus

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

From the two systems, the group decided that the primary design in Figure 4.1 was more complete than the second one in Figure 4.2. The group members defined the first system as providing more insulation than the second one. Even though the vacuum insulation pump was seen as a good add to the first system, the insulation in the first system still seemed better. The first system also possesses a flow meter which was deemed to be very important to control fluid flow and maintain a laminar flow while the area reduction was deemed not really accurate. The whole pipe is made of a uniform material that is stainless steel instead of two in the second apparatus. besides the price of a strong heat resistant crystal. Stainless steel costs about $6.95 to $10 per pound while a good strong heat resistant crystal costs about $10 to $15 per pound. on a cost analysis basis stainless is more attractive.

References:
http://www.enge.vt.edu/terpenny/Smart/Virtual_econ/Module2/pugh_method.htm
Read about the Pugh and go-no-go evaluation concepts from other sources to supplement your knowledge.

Assignment for Assessing Outcome c.2

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

Grading Scheme
Status Report on Concepts Evaluation
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Reasonable exhaustive list of requirements/criteria for evaluating project functions	10	
2	Requirements/criteria identified and assigned to each function using Table 1	10	
3	Use of few most important requirements for GO NO GO evaluation of each function	40	
4	Evaluation of remaining functions using Decision Matrix and the selection of the best concepts for main design and the runner up concepts for the back-up design	80	
5	Detailed sketches for the main system and for the back-up system	50	
6	Evaluation of the two systems and selection of the primary system upon which design will be based.	10	
	Total	200	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 8 Concept Evaluation

Due Date:10/29/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Responsible for Answering question 1,4, and correct the format	100	
2	Jonathan Horta Jonathon Horta	Responsible for creating tables, transitioning grades and concepts to propper tables, and answering question 3.	100	
3	Todd Maxwell Todd Maxwell	Responsible for answering question 6 and formatting	100	
4	Michael Samuel Michael Samuel	Responsible for adding and multiplying our numbers on each table. also answered number 6	100	
5	Aramis King Aramis King	Responsible forAnswering question 5 and adding sketches	100	
6	Daniel Ward Daniel C. Ward	Responsible forAnswering question 5 and adding sketches	100	
7	Titus Woodard Titus Woodard	Responsible forAnswering question 2, 5, and fixing format	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER

Status Report 8 on Concept Evaluation and Selection

Due: 10/29/2020

This status report is section 4.3of your final report. Questions 1 & 2 will constitute section 4.3.1, questions 3 & 4 will constitute section 4.3.2 and questions 5 & 6 will constitute section 4.3.3

Study the notes on concepts evaluation discussed in class and posted on e-course and do the following for your design project. You can refer to the splashguard example for guidance, but note that your project is completely different from the splashguard example. Each group should meet and review the concepts and sketches for each function generated as part of questions 3 and 4 in the previous status report ensuring that several concepts have been generated for each function and that the concepts are adequately supported by sketches/figures/pictures as are necessary for understanding the concept.

1. Make an exhaustive list of requirements/criteria that can be used to evaluate the concepts for all of the functions you group has identified. This should be a really long list from which you can select a subgroup to use to evaluate the concepts for each function. The best approach is to consider each function list the requirements/criteria that can be used to evaluate the concepts for the function. [**10 Points**]
   The requirements/criteria requested in question 1 can be obtained by considering the following questions and listing the answers:
   - What customer requirements are related to the project? Make a list of all customer requirements
   - What operating environments are related to the project? Look at all of your operating environments.
   - What constraints can affect the project? List all of your project constraints.
   - Is current technology available for the functions of the project?
   - Can the technology/concept be manufactured with known processes?
   - What are the project objectives? Look at your list of objectives
   - Is there a need for experimentation to ascertain how well certain project function can be achieved?
   - Are critical parameters that control the functions of the project identified?
   - Are the safe operating latitude and sensitivity of the parameters known?
   - Have all of the failure modes been identified for the project?

2. From the list you have made for question 1, make a Table similar to Table 1 that provides a list of the requirements/criteria from question 1 that are directly related to or affect each sub-function and which you can use to evaluate the concepts for that subfunction.**[10 Points**].

3. Evaluate the group's ideas/concepts for each function using the procedure below: If several ideas have been suggested by members of the group, **use a few of the most important requirements or criteria** develop in your Table 1 to make a quick evaluation for the concepts using a GO-NO-GO screening as done in Table 4.11 in the PowerPoint notes. Repeat this evaluation for the concepts generated for each function. Your go no go evaluation should result in no less than 3 concepts for each function in order to be able to do question 4. See the separate Excel File for GO-NO-GO Table **[40 Points]**

4. Evaluate the remaining concepts (for each function that passed the GO-NO-GO screening**)** using a decision matrix and the detailed list of requirements/criteria identified for the sub-function (as done in Table 4.12 of the notes and discussed in details in class). From the decision matrix table, select the best two concepts for each function. See the separate Excel File for Decision Matrix Table **[80 Points].**

5. Make detailed sketches of **the two systems** from the two sets of the best concepts. **[50 points]**

6. Evaluate the two systems and select the primary system upon which your design will be based justifying your selection. **[10 Points]**

References:

http://www.enge.vt.edu/terpenny/Smart/Virtual_econ/Module2/pugh_method.htm

Read about the Pugh and go-no-go evaluation concepts from other sources to supplement your knowledge.

Assignment for Assessing Outcome c.2

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

Table 1 Sample Example Criteria Affecting Previously identified Sub-functions for Project

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Func					
				1	2	3	4	5	
VNM-0	VNM-1	VNM-1.1	VNM-1.1.1	6	11	20	22	30	
			VNM-1.1.2						
			VNM-1.1.2						
		VNM-1.2	VNM-1.2.1						
			VNM-1.2.2						
		VNM-1.3 (No level 3 subfunctions)							
	VNM-2	VNM-2.1	VNM-2.1.1						
			VNM-2.1.2						
			VNM-2.1.2						
		VNM-2.2 (No level 3 subfunctions)							
		VNM-2.3	VNM-2.3.1						
			VNM-2.3.2						
	VNM-3	VNM-3.1	VNM-3.1.1						
			VNM-3.1.2						
			VNM-3.1.3						
		VNM-3.2 (No level 3 subfunctions)							
		VNM-3.3	VNM-3.3.1						
			VNM-3.3.2						
	VNM-4	VNM-4.1 (No level 3 subfunctions)							
		VNM-4.2	VNM-4.2.1						
			VNM-4.2.2						
		VNM-4.3	VNM-4.3.1						
			VNM-4.3.2						
	VNM-5	VNM-5.1 (No level 3 subfunctions)							
		VNM-5.2	VNM-5.2.1						
			VNM-5.2.2						
		VNM-5.3							

VNM= **V**erb action-**N**oun the verb is acting on-**M**odifier

7. E.g. Protect-Rider-From Dirt

Grading Scheme
Status Report on Concepts Evaluation
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Reasonable exhaustive list of requirements/criteria for evaluating project functions	10	
2	Requirements/criteria identified and assigned to each function using Table 1	10	
3	Use of few most important requirements for GO NO GO evaluation of each function	40	
4	Evaluation of remaining functions using Decision Matrix and the selection of the best concepts for main design and the runner up concepts for the back-up design	80	
5	Detailed sketches for the main system and for the back-up system	50	
6	Evaluation of the two systems and selection of the primary system upon which design will be based.	10	
	Total	200	

4.3 Concept Evaluation

This selection will discuss the group evaluations for each level 3 sub-function concept. The group breaks down each concept and through a series of ratings the group was able to end on two concepts that would be considered for the design for the project. The group was also able to end on a final design ~~for each level 3 sub-function~~.

4.3.1 Requirements/ Criteria for each Level 3 Sub-function

In this section, the group will break down a handful of questions that were given to them from the professors. The questions will be stated below with the group's responses that will be the requirements/ criteria of level 3 sub-functions.

- What customer requirements are related to the project? Make a list of all customer requirements
    1. Safety
    2. Is this reliable?
    3. Is it durable?
    4. Is this affordable?
    5. Is this high performance?
    6. Is it easy to use?
    7. Is this efficient?
    8. Is this high quality?
    9. Can this be used in other vehicles?
    10. Will this be low maintenance?
    11. Is it easy to turn?
    12. Can it handle all weather conditions?
- What operating environments are related to the project? Look at all of your operating environments.
    13. Can it withstand water?
    14. Can it operate in muddy conditions?
    15. Can it operate in off-road obstacles?
    16. Can it operate on concrete?
    17. Can it operate in hot/cold temperatures?
    18. Can it withstand unexpected external forces?
- What constraints can affect the project? List all of your project constraints.
    19. Is the suspension system too wide?
    20. Can it hold the weight of the vehicle and driver?
    21. Cannot be made from a kit
    22. Suspension and steering system have to be compatible with each other
- Can the technology/concept be manufactured with known processes?
    23. Can this be manufactured with known processes?
- Is there a need for experimentation to ascertain how well certain project function can be achieved?
    24. What simulation software are we going to use?
    25. How are we going to test prototypes?
- What are the project objectives? Look at your list of objectives
    26. Economical
    27. Safe for environment

28. Driver safety
29. Safety of bystanders
30. Easy Repair
31. High range of motion
32. Withstand high speeds
33. Stability of vehicle
34. Sustainable
35. Able to adjust to different terrains
36. Is the alignment correct?

Question 2

Table 4.1 below displays the suspension criteria identified by each subfunction. In a collaborative effort, the group decided the more efficient way to group our required criteria was to create nine available slots to show how each individual criteria affects a particular level 3 sub function. All nine slots for table 4.1 are numbered 1-36 for each sub function. The 36 requirements/criteria options are listed above.

Table 4.1 Criteria Affecting Previously identified Sub-functions for Suspension System

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Absorb and withstand forces from off-road conditions and the vehicle	Maintain contact with the ground	Force tires down with internal components	Release force from springs to the ground	5	9	15	16	18	20	23	35	36
			Release energy from struts to the tires	1	2	3	7	18	24	33	34	35
		Absorb All forces channeled from environment	Compress the springs from the external forces	2	3	5	10	12	17	18	24	25
			Compress the struts from external forces	2	3	5	10	12	17	18	24	25
			Rotate the control arms to decrease force intake	2	3	9	15	16	18	28	31	35

Sustain mobility of moving parts	Allow freedom of suspension components	Rotating of control arms to absorb excess forces	3	5	8	9	10	18	23	30	35
		Rotating of ball joints to absorb excess forces	3	4	5	10	12	14	17	30	31
		Compressing of struts and springs from external forces	3	5	8	12	14	15	18	20	35
	Stabilize movement of vehicle	Absorb forces with struts and springs	1	3	5	10	12	14	15	17	20
		Move control arms based off environment	2	4	5	9	12	15	23	31	35
		Rotate ball joints from contact of force	1	2	4	10	13	14	15	24	31
Distribute forces throughout suspension system	Channel forces through multiple pathways	Collect force through the struts	3	4	5	12	18	24	30	33	35
		Collect force through springs	3	4	5	12	20	24	30	33	35
		Transfer force through ball joint	2	3	7	12	14	18	24	30	31
	Transfers loads from components to wheels	Transfer load from control arms	5	7	10	12	14	16	17	30	33
		Transfer load from springs	2	7	8	10	12	18	20	24	30
		Transfer load from struts	5	8	9	10	12	15	23	30	35
Support external	Counter Gravitation	Release force from spring to the ground	2	4	12	17	20	24	32	33	34

	and internal forces from vehicle conditions	al Force	Release force from struts to ground	2	5	10	12	14	18	23	30	33
		Ability to manage centrifugal forces	Transfer vehicle load through struts while turning	2	4	5	12	15	28	31	33	34
			Transfer vehicle load through springs while turning	2	4	5	12	15	28	31	33	34
			Rotate control arms while turning	1	2	4	10	12	15	31	33	35

Table 4.2 below displays the steering criteria identified by each subfunction. In a collaborative effort, the group decided the more efficient way to group our required criteria was to create nine available slots to show how each individual criteria affects a particular level 3 sub function. At least 6 slots for table 4.2 are numbered 1-36 for each sub function. The 36 requirements/criteria options are listed above.

Table 4.2 Criteria Affecting Previously identified Sub-functions for Steering System

Overall Function	Level 1 Sub-functions	Level 2 Sub-functions	Level 3 Sub-functions	Requirements/Criteria Affecting Sub-Function								
				1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Convert driver input to change the direction of the vehicle	Maintain control of vehicle	Prevent unwanted motion due to external factors	Allow forces to be absorbed	3	5	7	12	14	15	17	18	34
			Rotate gears only from steering wheel	1	2	5	10	11	14	15	18	30
		Guide the steering wheel in	Hold the steering wheel firmly	1	2	6	11	28	32			

		direction desired	Turn the steering wheel when adjusting to external forces	1	2	6	11	12	15	18	32	35
			Allow horizontal motion with steering rod	2	3	7	12	15	18	30	32	36
		Revert kinetic energy into another direction	Allow gears to move in both directions	2	3	4	7	10	12	14	24	30
			Allow steering rod to move horizontally in both directions	2	3	7	12	15	18	30	32	36
	Transmit motion of the vehicle	Channel mechanical energy to turn vehicle	Transfer energy from steering wheel to Steering shaft	2	4	5	7	11	12	15	18	24
			Translate motion from gears to steering rod	2	5	7	11	12	14	18	30	36
			Move tires side to side from steering rod	2	5	7	11	12	14	16	18	36
		Grasp the steering wheel firmly	Contact the steering wheel tactfully	1	2	6	11	28	32			
			Hold the steering wheel with	1	2	6	11	28	32			

		hand										
Stabllize vehicle alignment to stay on course	Maintain grip on the steering wheel	Contact the steering wheel firmly	1	2	6	11	28	32			
		Hold the steering wheel until leaving the vehicle	1	2	6	11	28	32			
	Orient steering wheel based on drivers view	Avoid extreme conditions of the course	1	3	4	5	6	11	12	18	35
		Drive along calmer environmental conditions	1	2	6	7	11	12	31	34	35
Reduce effort of driver	Maintain Power Steering	Apply pressure to reduce force input	1	2	4	5	7	10	11	12	18
		Absorb external force to reduce driver control	3	5	7	11	12	18	28	29	35
		Reduce the turn of the steering wheel to perform a sharp maneuver	2	4	5	7	8	11	12	18	30
	adjusting steering effort	Allow easy motion of gears	1	2	7	8	11	30	31	32	34

			Allow easy motion of steering rod	1	2	7	8	11	30	31	32	34
			Allow easy motion of steering wheel	1	2	7	8	11	30	31	32	34

4.3.2 Evaluating Concepts with Requirements/ Criteria

Table 4.3 below presents twenty-two GO-NO-GO tables created from the level 3 sub-functions the group created for the suspension system. The group collaboratively decided on the scores for the individual criterions pertaining to each level 3 function. Scores presenting "6" or above were considered GO's and scores presenting "5" or below were considered "NO-GO's." The group took all the GO's from these tables and pushed them forward for evaluations for the next section.

Table 4.3 GO-NO-GO Tables for ~~Suspension~~

Release force from springs to the ground	**Concept 1**		**Concept 2**		**Concept 3**		**Concept 4**	
Criteria/Requirements	**Score**	**GO-NO-GO**	**Score**	**GO-NO-GO**	**Score**	**GO-NO-GO**	**Score**	**GO-NO-GO**
~~Criterion 1~~	**10**	**GO**	**4**	**NO-GO**	**8**	**GO**	**6**	**GO**
~~Criterion 2~~	**7**	**GO**	**7**	**GO**	**7**	**GO**	**9**	**GO**

~~Criterion 3~~	9	GO	5	NO-GO	8	GO	5	NO-GO
~~Criterion 4~~	10	GO	5	NO-GO	9	GO	7	GO
Overall Decision		GO		NO-GO		GO		GO

Release energy from struts to the tires	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	8	GO	6	GO	10	GO
Criterion 2	8	GO	7	GO	5	NO-GO	9	GO
Criterion 3	7	GO	5	NO-GO	4	NO-GO	8	GO
Criterion 4	9	GO	7	GO	6	GO	9	GO
Overall Decision		GO		GO		NO-GO		GO

Compress the springs from the external forces	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	NO-GO	6	GO	8	GO	10	GO
Criterion 2	8	GO	5	NO-GO	7	GO	9	GO
Criterion 3	7	GO	5	NO-GO	8	GO	8	GO
Criterion 4	8	GO	5	NO-GO	9	GO	9	GO
Overall Decision		GO		NO-GO		GO		GO

Compress the struts from external forces	Concept 1	Concept 2	Concept 3	Concept 4

Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	5	NO-GO	9	GO	5	NO-GO
Criterion 2	8	GO	7	GO	8	GO	6	GO
Criterion 3	9	GO	6	GO	9	GO	6	GO
Criterion 4	7	GO	8	GO	9	GO	4	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Rotate the control arms to decrease force intake	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	8	GO	9	GO	7	GO
Criterion 2	6	GO	6	GO	8	GO	6	GO
Criterion 3	8	GO	7	GO	7	GO	5	NO-GO
Criterion 4	8	GO	9	GO	9	GO	5	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Rotating of control arms to absorb excess forces	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	9	GO	7	GO	7	GO
Criterion 2	5	NO-GO	8	GO	6	GO	6	GO
Criterion 3	5	NO-GO	9	GO	5	NO-GO	7	GO
Criterion 4	5	NO-GO	8	GO	6	GO	4	NO-GO
Overall Decision		NO-GO		GO		GO		GO

Rotating of ball joints to absorb excess forces	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	9	GO	9	GO	7	GO	4	NO-GO
Criterion 2	7	GO	7	GO	8	GO	7	GO
Criterion 3	8	GO	4	NO-GO	8	GO	5	NO-GO
Criterion 4	9	GO	6	GO	5	NO-GO	6	GO
Overall Decision		GO		GO		GO		NO-GO

Compressing of struts and springs from external forces	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	4	NO-GO	6	GO	8	GO
Criterion 2	9	GO	3	NO-GO	6	GO	9	GO
Criterion 3	8	GO	5	NO-GO	5	NO-GO	9	GO
Criterion 4	8	GO	9	GO	8	GO	7	GO
Overall Decision		GO		NO-GO		GO		GO

Absorb forces with struts and springs	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	9	GO	8	GO	7	GO	8	GO
Criterion 2	6	GO	7	GO	4	NO-GO	6	GO

Criterion 3	5	NO-GO	9	GO	6	GO	4	NO-GO
Criterion 4	7	GO	8	GO	4	NO-GO	7	GO
Overall Decision		GO		GO		NO-GO		GO

Move control arms based off environment	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	9	GO	4	NO-GO	8	GO	4	NO-GO
Criterion 2	8	GO	6	GO	8	GO	4	NO-GO
Criterion 3	7	GO	6	GO	7	GO	5	NO-GO
Criterion 4	9	GO	8	GO	6	GO	7	GO
Overall Decision		GO		GO		GO		NO-GO

Rotate ball joints from contact of force	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	6	GO	4	NO-GO	7	GO
Criterion 2	4	NO-GO	5	NO-GO	6	GO	9	GO
Criterion 3	8	GO	7	GO	5	NO-GO	8	GO
Criterion 4	8	GO	9	GO	6	GO	9	GO
Overall Decision		GO		GO		NO-GO		GO

Collect force through the struts	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO

Criterion 1	9	GO	4	NO-GO	8	GO	7	GO
Criterion 2	7	GO	8	GO	6	GO	5	NO-GO
Criterion 3	9	GO	7	GO	7	GO	6	GO
Criterion 4	8	GO	6	GO	7	GO	4	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Collect force through springs	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	4	NO-GO	8	GO	6	GO
Criterion 2	9	GO	4	NO-GO	6	GO	7	GO
Criterion 3	8	GO	5	NO-GO	7	GO	5	NO-GO
Criterion 4	9	GO	7	GO	4	NO-GO	8	GO
Overall Decision		GO		NO-GO		GO		GO

Transfer force through ball joint	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	8	GO	7	GO	5	NO-GO	5	NO-GO
Criterion 2	7	GO	7	GO	8	GO	4	NO-GO
Criterion 3	9	GO	5	NO-GO	7	GO	6	GO
Criterion 4	9	GO	8	GO	6	GO	7	GO
Overall Decision		GO		GO		GO		NO-GO

Transfer load from control arms	Concept 1	Concept 2	Concept 3	Concept 4

Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	8	GO	5	NO-GO	7	GO
Criterion 2	5	NO-GO	8	GO	5	NO-GO	9	GO
Criterion 3	8	GO	6	GO	4	NO-GO	8	GO
Criterion 4	6	GO	5	NO-GO	8	GO	9	GO
Overall Decision		GO		GO		NO-GO		GO

Transfer load from springs	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	6	GO	7	GO	6	GO
Criterion 2	6	GO	8	GO	9	GO	4	NO-GO
Criterion 3	9	GO	5	NO-GO	8	GO	5	NO-GO
Criterion 4	7	GO	7	GO	9	GO	7	GO
Overall Decision		GO		GO		GO		NO-GO

Transfer load from struts	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	5	NO-GO	7	GO	5	NO-GO
Criterion 2	7	GO	8	GO	9	GO	7	GO
Criterion 3	6	GO	6	GO	9	GO	4	NO-GO
Criterion 4	9	GO	9	GO	8	GO	6	GO
Overall Decision		GO		GO		GO		NO-GO

Release force from	Concept 1	Concept 2	Concept 3	Concept 4

spring to the ground								
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	7	GO	4	NO-GO	7	GO
Criterion 2	8	GO	6	GO	5	NO-GO	9	GO
Criterion 3	6	GO	7	GO	5	NO-GO	8	GO
Criterion 4	7	GO	8	GO	6	GO	8	GO
Overall Decision		GO		GO		NO-GO		GO

Release force from struts to ground	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	7	GO	6	GO	6	GO
Criterion 2	9	GO	9	GO	8	GO	5	NO-GO
Criterion 3	7	GO	8	GO	8	GO	4	NO-GO
Criterion 4	7	GO	9	GO	7	GO	7	GO
Overall Decision		GO		GO		GO		NO-GO

Transfer vehicle load through struts while turning	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	8	GO	4	NO-GO	5	NO-GO	8	GO
Criterion 2	7	GO	5	NO-GO	8	GO	7	GO
Criterion 3	5	NO-GO	3	NO-GO	7	GO	9	GO
Criterion 4	6	GO	7	GO	6	GO	9	GO

Overall Decision		GO		NO-GO		GO		GO

Transfer vehicle load through springs while turning	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	4	NO-GO	8	GO	10	GO
Criterion 2	8	GO	6	GO	7	GO	8	GO
Criterion 3	6	GO	5	NO-GO	6	GO	9	GO
Criterion 4	7	GO	3	NO-GO	8	GO	8	GO
Overall Decision		GO		NO-GO		GO		GO

Rotate control arms while turning	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	4	NO-GO	9	GO	6	GO
Criterion 2	8	GO	3	NO-GO	7	GO	8	GO
Criterion 3	7	GO	5	NO-GO	8	GO	7	GO
Criterion 4	9	GO	6	GO	10	GO	9	GO
Overall Decision		GO		NO-GO		GO		GO

Table 4.3 below presents twenty-two GO-NO-GO tables created from the level 3 sub-functions the group created for the steering system. The group collaboratively decided on the scores for the individual criterions pertaining to each level 3 function. Scores presenting "6" or above were considered GO's and scores presenting "5" or below were considered "NO-GO's." The group took all the GO's from these tables and pushed them forward for evaluations for the next section.

Table 4.4 GO-NO-GO Tables for ~~Steering~~

Allow forces to be absorbed	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
~~Criterion 1~~	7	GO	8	GO	7	GO	9	GO
~~Criterion 2~~	6	GO	7	GO	5	NO-GO	8	GO
~~Criterion 3~~	4	NO GO	3	NO-GO	4	NO-GO	6	GO
~~Criterion 4~~	8	GO	8	GO	8	GO	8	GO
Overall Decision		GO		GO		NO-GO		GO

Rotate gears only from steering wheel	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	6	GO	6	GO	6	GO
Criterion 2	8	GO	7	GO	4	NO-GO	4	NO-GO
Criterion 3	9	GO	7	GO	6	GO	6	GO
Criterion 4	8	GO	5	NO-GO	6	GO	5	GO
Overall Decision		GO		GO		GO		NO-GO

Hold the steering wheel firmly	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	9	GO	8	GO	7	GO	8	GO
Criterion 2	7	GO	6	GO	4	NO-GO	7	GO
Criterion 3	8	GO	5	NO-GO	5	NO-GO	5	NO-GO
Criterion 4	9	GO	7	GO	7	GO	7	GO

Overall Decision		GO		GO		NO-GO		GO

Turn the steering wheel when adjusting to external forces	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	7	GO	9	GO	7	GO
Criterion 2	6	GO	5	NO-GO	8	GO	5	NO-GO
Criterion 3	4	NO-GO	7	GO	7	GO	4	NO-GO
Criterion 4	7	GO	8	GO	8	GO	6	GO
Overall Decision		GO		GO		GO		NO-GO

Allow horizontal motion with steering rod	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	8	GO	6	GO	6	GO	5	NO-GO
Criterion 2	7	GO	7	GO	5	GO	6	GO
Criterion 3	8	GO	6	GO	4	NO-GO	4	NO-GO
Criterion 4	7	GO	5	NO-GO	6	GO	5	GO
Overall Decision		GO		GO		GO		NO-GO

Allow gears to move in both directions	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	4	NO-GO	7	GO	9	GO

Criterion 2	5	NO-GO	5	NO-GO	7	GO	9	GO
Criterion 3	7	GO	5	GO	6	GO	9	GO
Criterion 4	8	GO	6	GO	5	NO-GO	9	GO
Overall Decision		GO		NO-GO		GO		GO

Allow steering rod to move horizontally in both directions	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	4	NO-GO	5	NO-GO	5	NO-GO	8	GO
Criterion 2	5	GO	6	GO	6	GO	8	GO
Criterion 3	5	NO-GO	8	GO	7	GO	8	GO
Criterion 4	4	GO	8	GO	8	GO	9	GO
Overall Decision		NO-GO		GO		GO		GO

Transfer energy from steering wheel to Steering shaft	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	8	GO	8	GO	6	GO
Criterion 2	5	NO-GO	5	NO-GO	7	GO	5	NO-GO
Criterion 3	6	GO	6	GO	8	GO	5	NO-GO
Criterion 4	7	GO	6	GO	7	GO	4	NO-GO
Overall Decision		NO-GO		NO-GO		GO		NO-GO

Translate motion from gears to steering rod	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	8	GO	6	GO	4	NO-GO	5	GO
Criterion 2	7	GO	5	NO-GO	6	GO	4	NO-GO
Criterion 3	8	GO	6	GO	5	GO	4	NO-GO
Criterion 4	9	GO	6	GO	6	GO	5	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Move tires side to side from steering rod	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	7	GO	4	NO-GO	4	NO-GO
Criterion 2	6	GO	8	GO	5	GO	5	GO
Criterion 3	5	NO-GO	8	GO	6	GO	6	GO
Criterion 4	5	NO-GO	8	GO	6	GO	6	GO
Overall Decision		NO-GO		GO		GO		GO

Contact the steering wheel tactfully	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	8	GO	7	GO	4	NO-GO
Criterion 2	4	NO-GO	9	GO	6	GO	4	NO-GO
Criterion 3	6	GO	8	GO	3	NO-GO	5	NO-GO
Criterion 4	4	NO-GO	9	GO	6	GO	5	NO-GO

Overall Decision		NO-GO		GO		GO		NO-GO

Hold the steering wheel with hand	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	4	NO-GO	9	GO	7	GO	4	NO-GO
Criterion 2	6	GO	8	GO	6	GO	4	NO-GO
Criterion 3	6	GO	9	GO	7	GO	5	GO
Criterion 4	5	GO	9	GO	5	NO-GO	5	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Contact the steering wheel firmly	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	4	NO-GO	7	GO	6	GO	9	GO
Criterion 2	4	NO-GO	6	GO	6	GO	9	GO
Criterion 3	6	GO	6	GO	7	GO	8	GO
Criterion 4	5	NO-GO	5	NO-GO	4	NO-GO	8	GO
Overall Decision		NO-GO		GO		GO		GO

Hold the steering wheel until leaving the vehicle	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	7	GO	8	GO	5	NO-GO
Criterion 2	5	NO-GO	7	GO	8	GO	7	GO
Criterion 3	4	NO-GO	5	NO-GO	9	GO	8	GO

Criterion 4	6	GO	7	GO	9	GO	7	GO
Overall Decision		NOGO		GO		GO		GO

Avoid extreme conditions of the course	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	6	NO-GO	8	GO	7	GO
Criterion 2	7	GO	8	GO	9	GO	5	NO-GO
Criterion 3	5	NO-GO	8	GO	9	GO	5	NO-GO
Criterion 4	6	GO	7	GO	8	GO	4	NO-GO
Overall Decision		GO		GO		GO		NO-GO

Drive along calmer environmental conditions	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	8	GO	9	GO	4	NO-GO
Criterion 2	4	NO-GO	5	NO-GO	9	GO	7	GO
Criterion 3	6	GO	7	GO	8	GO	7	GO
Criterion 4	4	NO-GO	6	GO	8	GO	6	GO
Overall Decision		NO-GO		GO		GO		GO

Apply pressure to reduce force input	Concept 1	Concept 2	Concept 3	Concept 4

Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	8	GO	4	NO-GO	7	GO	6	GO
Criterion 2	9	GO	5	NO-GO	7	GO	7	GO
Criterion 3	9	GO	7	GO	8	GO	5	NO-GO
Criterion 4	8	GO	4	NO-GO	5	NO-GO	6	GO
Overall Decision		GO		NO-GO		GO		GO

Absorb external force to reduce driver control	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	4	NO-GO	8	GO	9	GO
Criterion 2	7	GO	6	GO	7	GO	9	GO
Criterion 3	4	NO-GO	5	NO-GO	7	GO	8	GO
Criterion 4	6	GO	4	NO-GO	5	NO-GO	9	GO
Overall Decision		GO		NO-GO		GO		GO

Reduce the turn of the steering wheel to perform a sharp maneuver	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	9	GO	6	GO	7	GO	8	GO
Criterion 2	9	GO	5	NO-GO	7	GO	7	GO
Criterion 3	9	GO	4	NO-GO	5	NO-GO	5	NO-GO
Criterion 4	8	GO	4	NO-GO	6	GO	7	GO

Overall Decision		GO		NO-GO		GO		GO

Allow easy motion of gears	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	5	NO-GO	8	GO	9	GO	8	GO
Criterion 2	5	NO-GO	7	GO	9	GO	6	GO
Criterion 3	6	GO	7	GO	9	GO	6	GO
Criterion 4	4	NO-GO	5	NO-GO	8	GO	5	NO-GO
Overall Decision		NO-GO		GO		GO		GO

Allow easy motion of steering rod	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	6	GO	7	GO	8	GO	4	NO-GO
Criterion 2	7	GO	5	NO-GO	9	GO	5	NO-GO
Criterion 3	4	NO-GO	7	GO	9	GO	4	NO-GO
Criterion 4	8	GO	7	GO	9	GO	6	GO
Overall Decision		GO		GO		GO		NO-GO

Allow easy motion of steering wheel	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO	Score	GO-NO-GO
Criterion 1	7	GO	4	NO-GO	6	GO	9	GO
Criterion 2	8	GO	4	NO-GO	7	GO	9	GO
Criterion 3	7	GO	6	GO	7	GO	8	GO
Criterion 4	5	NO-GO	4	NO-GO	4	NO-GO	8	GO

Overall Decision		**GO**		**NO-GO**		**GO**		**GO**

After the GO-NO-GO tables were completed by the group, the next round of tables were created to end with two concepts that can be the design for each level 3 sub-function. At the beginning, the group created a list of requirements that each level 3 sub-function will be rated by and the tables below show each concept being rated by at least 6 requirements for that sub-function. Each requirement/criteria was weighted based on how important the requirement/ criteria was for each level 3 sub-function.

The group held a meeting and collaborated on each concept and rated the concepts. Table 4.5 shows all of the scoring for the three concepts for the suspension system that passed the GO-NO-GO scoring. In the end, the two highest scores are highlighted and were passed on to the next section.

Table 4.5 Decision matrices for Suspension system

Release force from springs to the ground		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	8	10	80	8	64	6	48
Criterion 2	9	7	63	7	63	9	81
Criterion 3	9	9	81	8	72	5	45
Criterion 4	5	10	50	9	45	7	35
Criterion 5	9	9	81	6	54	5	45
Criterion 6	8	8	64	7	56	6	48
Criterion 7	8	9	72	8	64	5	40
Criterion 8	8	7	56	6	48	8	64
Criterion 9	7	8	56	8	56	5	35
Total Weighted Score			603		522		441

Release energy from struts to the tires		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	5	50	8	80	10	100
Criterion 2	9	8	72	7	63	9	81
Criterion 3	9	7	63	5	45	8	72
Criterion 4	9	9	81	7	63	9	81
Criterion 5	9	7	63	9	81	9	81
Criterion 6	7	6	42	8	56	7	49
Criterion 7	9	7	63	6	54	9	81
Criterion 8	9	8	72	7	63	9	81
Criterion 9	8	7	56	8	64	9	72

Total Weighted Score			562		569		698

Compress the springs from the external forces		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	6	54	8	72	10	90
Criterion 2	9	8	72	7	63	9	81
Criterion 3	8	7	56	8	64	8	64
Criterion 4	7	8	56	9	63	9	63
Criterion 5	7	7	49	8	56	8	56
Criterion 6	6	8	48	9	54	9	54
Criterion 7	9	8	72	8	72	9	81
Criterion 8	7	6	42	7	49	9	63
Criterion 9	8	5	40	8	64	9	72
Total Weighted Score			489		557		624

Compress the struts from external forces		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	5	45	9	81
Criterion 2	9	8	72	7	63	8	72
Criterion 3	8	9	72	6	48	9	72
Criterion 4	7	7	49	8	56	9	63
Criterion 5	7	6	42	8	56	9	63
Criterion 6	6	5	30	9	54	8	48

Criterion 7	8	7	56	7	56	7	56
Criterion 8	7	6	42	6	42	9	63
Criterion 9	8	6	48	7	56	9	72
Total Weighted Score			474		476		590

Rotate the control arms to decrease force intake		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	9	81
Criterion 2	9	6	54	6	54	8	72
Criterion 3	4	8	32	7	28	7	28
Criterion 4	9	8	72	9	81	9	81
Criterion 5	5	7	35	9	45	7	35
Criterion 6	9	7	63	8	72	8	72
Criterion 7	10	8	80	9	90	9	90
Criterion 8	8	6	48	7	56	9	72
Criterion 9	8	9	72	8	64	9	72
Total Weighted Score			519		562		603

Rotating of control arms to absorb excess forces		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	9	81	7	63	7	63
Criterion 2	8	8	64	6	48	6	48
Criterion 3	8	9	72	5	40	7	56

Criterion 4	4	8	32	6	24	4	16
Criterion 5	7	7	49	7	49	6	42
Criterion 6	9	9	81	8	72	5	45
Criterion 7	8	8	64	6	48		0
Criterion 8	9	9	81	7	63	7	63
Criterion 9	8	8	64	8	64	6	48
Total Weighted Score			588		471		381

Rotating of ball joints to absorb excess forces		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	9	81	9	81	7	63
Criterion 2	7	7	49	7	49	8	56
Criterion 3	8	8	64	4	32	8	64
Criterion 4	7	9	63	6	42	5	35
Criterion 5	7	9	63	7	49	6	42
Criterion 6	7	7	49	8	56	7	49
Criterion 7	6	6	36	6	36	5	30
Criterion 8	9	9	81	7	63	6	54
Criterion 9	8	8	64	9	72	6	48
Total Weighted Score			550		480		441

Compressing of struts and springs from external forces		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score

Criterion 1	9	6	54	6	54	8	72
Criterion 2	8	9	72	6	48	9	72
Criterion 3	8	8	64	5	40	9	72
Criterion 4	7	8	56	8	56	7	49
Criterion 5	7	7	49	4	28	8	56
Criterion 6	9	8	72	6	54	9	81
Criterion 7	9	7	63	7	63	7	63
Criterion 8	9	8	72	5	45	8	72
Criterion 9	8	9	72	4	32	9	72
Total Weighted Score			574		420		609

Absorb forces with struts and springs		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	9	90	8	80	8	80
Criterion 2	9	6	54	7	63	6	54
Criterion 3	8	5	40	9	72	4	32
Criterion 4	7	7	49	8	56	7	49
Criterion 5	7	7	49	8	56	5	35
Criterion 6	7	7	49	9	63	6	42
Criterion 7	9	8	72	8	72	5	45
Criterion 8	6	8	48	9	54	5	30
Criterion 9	9	8	72	9	81	7	63
Total Weighted Score			523		597		430

Move control arms based off environment		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	9	81	4	36	8	72
Criterion 2	7	8	56	6	42	8	56
Criterion 3	8	7	56	6	48	7	56
Criterion 4	4	9	36	8	32	6	24
Criterion 5	7	9	63	7	49	7	49
Criterion 6	9	9	81	6	54	7	63
Criterion 7	8	8	64	8	64	8	64
Criterion 8	8	7	56	7	56	9	72
Criterion 9	8	8	64	7	56	7	56
Total Weighted Score			557		437		512

Rotate ball joints from contact of force		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	6	60	6	60	7	70
Criterion 2	9	4	36	5	45	9	81
Criterion 3	7	8	56	7	49	8	56
Criterion 4	7	8	56	9	63	9	63
Criterion 5	7	7	49	8	56	8	56
Criterion 6	7	8	56	9	63	9	63
Criterion 7	9	7	63	8	72	8	72
Criterion 8	7	8	56	7	49	9	63
Criterion 9	8	7	56	8	64	9	72
Total Weighted Score			488		521		596

Collect force through the struts		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	9	81	4	36	8	72
Criterion 2	7	7	49	8	56	6	42
Criterion 3	8	9	72	7	56	7	56
Criterion 4	7	8	56	7	49	7	49
Criterion 5	9	8	72	7	63	8	72
Criterion 6	7	9	63	8	56	8	56
Criterion 7	9	8	72	6	54	7	63
Criterion 8	9	6	54	7	63	9	81
Criterion 9	8	9	72	8	64	8	64
Total Weighted Score			591		497		555

Collect force through springs		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	6	54
Criterion 2	7	9	63	6	42	7	49
Criterion 3	8	8	64	7	56	5	40
Criterion 4	7	9	63	4	28	8	56
Criterion 5	9	7	63	6	54	7	63
Criterion 6	7	8	56	7	49	6	42
Criterion 7	9	9	81	8	72	7	63
Criterion 8	9	9	81	7	63	8	72
Criterion 9	8	8	64	6	48	9	72

Total Weighted Score			598		484		511

Transfer force through ball joint		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	8	72	7	63	5	45
Criterion 2	9	7	63	7	63	8	72
Criterion 3	9	9	81	5	45	7	63
Criterion 4	7	9	63	8	56	6	42
Criterion 5	7	9	63	7	49	5	35
Criterion 6	9	7	63	9	81	6	54
Criterion 7	7	8	56	8	56	7	49
Criterion 8	9	9	81	8	72	6	54
Criterion 9	8	7	56	7	56	8	64
Total Weighted Score			598		541		478

Transfer load from control arms		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	8	7	56	8	64	7	56
Criterion 2	9	5	45	8	72	9	81
Criterion 3	7	8	56	6	42	8	56
Criterion 4	7	6	42	5	35	9	63
Criterion 5	7	7	49	8	56	9	63
Criterion 6	5	7	35	9	45	8	40
Criterion 7	6	8	48	8	48	9	54

Criterion 8	9	7	63	7	63	8	72
Criterion 9	9	8	72	6	54	9	81
Total Weighted Score			466		479		566

Transfer load from springs		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	6	54	7	63
Criterion 2	9	6	54	8	72	9	81
Criterion 3	8	9	72	5	40	8	64
Criterion 4	7	7	49	7	49	9	63
Criterion 5	7	6	42	7	49	9	63
Criterion 6	9	7	63	7	63	9	81
Criterion 7	9	8	72	8	72	8	72
Criterion 8	7	5	35	8	56	8	56
Criterion 9	9	8	72	7	63	7	63
Total Weighted Score			522		518		606

Transfer load from struts		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	6	5	30	5	30	7	42
Criterion 2	8	7	56	8	64	9	72
Criterion 3	4	6	24	6	24	9	36
Criterion 4	7	9	63	9	63	8	56
Criterion 5	7	7	49	8	56	9	63
Criterion 6	9	6	54	8	72	9	81

Criterion 7	8	8	64	9	72	8	64
Criterion 8	9	7	63	7	63	9	81
Criterion 9	8	7	56	8	64	9	72
Total Weighted Score			459		508		567

Release force from spring to the ground		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	5	45	7	63	7	63
Criterion 2	7	8	56	6	42	9	63
Criterion 3	7	6	42	7	49	8	56
Criterion 4	6	7	42	8	48	8	48
Criterion 5	9	6	54	8	72	9	81
Criterion 6	7	7	49	7	49	9	63
Criterion 7	7	7	49	8	56	8	56
Criterion 8	9	7	63	8	72	8	72
Criterion 9	9	8	72	7	63	7	63
Total Weighted Score			472		514		565

Release force from struts to ground		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	5	45	7	63	6	54
Criterion 2	8	9	72	9	72	8	64
Criterion 3	7	7	49	8	56	8	56
Criterion 4	7	7	49	9	63	7	49

Criterion 5	7	8	56	9	63	7	49
Criterion 6	9	7	63	9	81	6	54
Criterion 7	8	7	56	8	64	7	56
Criterion 8	9	7	63	8	72	7	63
Criterion 9	9	8	72	7	63	7	63
Total Weighted Score			525		597		508

Transfer vehicle load through struts while turning		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	8	72	5	45	8	72
Criterion 2	7	7	49	8	56	7	49
Criterion 3	8	5	40	7	56	9	72
Criterion 4	7	6	42	6	42	9	63
Criterion 5	9	6	54	7	63	9	81
Criterion 6	10	7	70	7	70	9	90
Criterion 7	8	7	56	8	64	8	64
Criterion 8	9	8	72	7	63	7	63
Criterion 9	9	6	54	7	63	8	72
Total Weighted Score			509		522		626

Transfer vehicle load through springs while turning		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	10	90

Criterion 2	7	8	56	7	49	8	56
Criterion 3	8	6	48	6	48	9	72
Criterion 4	7	7	49	8	56	8	56
Criterion 5	9	8	72	7	63	10	90
Criterion 6	10	8	80	7	70	9	90
Criterion 7	8	7	56	8	64	9	72
Criterion 8	9	6	54	8	72	8	72
Criterion 9	9	8	72	7	63	9	81
Total Weighted Score			550		557		679

Rotate control arms while turning		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	9	90	6	60
Criterion 2	9	8	72	7	63	8	72
Criterion 3	7	7	49	8	56	7	49
Criterion 4	7	9	63	10	70	9	63
Criterion 5	7	7	49	8	56	6	42
Criterion 6	9	6	54	9	81	7	63
Criterion 7	8	7	56	9	72	8	64
Criterion 8	9	5	45	7	63	8	72
Criterion 9	8	7	56	9	72	7	56
Total Weighted Score			514		623		541

The group held a meeting and collaborated on each concept and rated the concepts. Table 4.6 shows all of the scoring for the three concepts for the steering system that passed the GO-NO-GO scoring. Just like the table 4.5, the two highest scoring concepts are passed on to the next section.

Table 4.6 Decision matrices for ~~steering system~~

Allow forces to be absorbed		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	9	81
Criterion 2	8	6	48	7	56	8	64
Criterion 3	9	4	36	3	27	6	54
Criterion 4	7	8	56	8	56	8	56
Criterion 5	7	7	49	6	42	7	49
Criterion 6	6	8	48	7	42	8	48
Criterion 7	6	7	42	8	48	9	54
Criterion 8	9	9	81	6	54	7	63
Criterion 9	9	8	72	7	63	7	63
Total Weighted Score			495		460		532

Rotate gears only from steering wheel		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	6	60	6	60
Criterion 2	9	8	72	7	63	4	36
Criterion 3	8	9	72	7	56	6	48
Criterion 4	7	8	56	5	35	6	42
Criterion 5	8	7	56	5	40	5	40
Criterion 6	7	8	56	6	42	4	28
Criterion 7	9	6	54	4	36	6	54

Criterion 8	9	7	63	5	45	5	45
Criterion 9	9	8	72	5	45	4	36
Total Weighted Score			571		422		389

Hold the steering wheel firmly		Concept 1		Concept 2		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	9	90	8	80	8	80
Criterion 2	9	7	63	6	54	7	63
Criterion 3	7	8	56	5	35	5	35
Criterion 4	8	9	72	7	56	7	56
Criterion 5	10	8	80	6	60	5	50
Criterion 6	7	9	63	5	35	4	28
		8		4		5	
		7		4		4	
		7		5		6	
Total Weighted Score			424		320		312

Turn the steering wheel when adjusting to external forces		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	7	70	9	90
Criterion 2	9	6	54	5	45	8	72
Criterion 3	7	4	28	7	49	7	49
Criterion 4	8	7	56	8	64	8	64
Criterion 5	7	6	42	7	49	7	49
Criterion 6	9	4	36	6	54	8	72

Criterion 7	9	5	45	5	45	6	54
Criterion 8	7	4	28	7	49	7	49
Criterion 9	8	5	40	5	40	8	64
Total Weighted Score			399		465		563

Allow horizontal motion with steering rod		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	8	72	6	54	6	54
Criterion 2	9	7	63	7	63	5	45
Criterion 3	9	8	72	6	54	4	36
Criterion 4	7	7	49	5	35	6	42
Criterion 5	9	7	63	4	36	5	45
Criterion 6	9	8	72	5	45	6	54
Criterion 7	9	7	63	6	54	7	63
Criterion 8	7	8	56	7	49	4	28
Criterion 9	9	6	54	5	45	4	36
Total Weighted Score			564		435		403

Allow gears to move in both directions		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	6	54	7	63	9	81
Criterion 2	9	5	45	7	63	9	81
Criterion 3	7	7	49	6	42	9	63
Criterion 4	9	8	72	5	45	9	81
Criterion 5	7	8	56	6	42	8	56

Criterion 6	7	6	42	7	49	7	49
Criterion 7	7	7	49	5	35	9	63
Criterion 8	7	5	35	8	56	8	56
Criterion 9	9	5	45	7	63	7	63
Total Weighted Score			447		458		593

Allow steering rod to move horizontally in both directions		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	5	45	5	45	8	72
Criterion 2	9	6	54	6	54	8	72
Criterion 3	9	8	72	7	63	8	72
Criterion 4	7	8	56	8	56	9	63
Criterion 5	9	7	63	6	54	8	72
Criterion 6	9	4	36	5	45	9	81
Criterion 7	9	5	45	5	45	7	63
Criterion 8	7	6	42	4	28	7	49
Criterion 9	9	4	36	6	54	6	54
Total Weighted Score			449		444		598

Transfer energy from steering wheel to Steering shaft		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	8	72
Criterion 2	7	5	35	5	35	7	49
Criterion 3	8	6	48	6	48	8	64

Criterion 4	9	7	63	6	54	7	63
Criterion 5	8	5	40	5	40	7	56
Criterion 6	7	6	42	4	28	8	56
Criterion 7	9	6	54	5	45	6	54
Criterion 8	9	7	63	4	36	8	72
Criterion 9	7	5	35	5	35	7	49
Total Weighted Score			443		393		535

Translate motion from gears to steering rod		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	8	72	6	54	4	36
Criterion 2	8	7	56	5	40	6	48
Criterion 3	9	8	72	6	54	5	45
Criterion 4	8	9	72	6	48	6	48
Criterion 5	7	8	56	5	35	5	35
Criterion 6	7	8	56	6	42	6	42
Criterion 7	5	9	45	7	35	5	25
Criterion 8	9	8	72	6	54	6	54
Criterion 9	9	7	63	7	63	5	45
Total Weighted Score			564		425		378

Move tires side to side from steering rod		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	4	36	4	36
Criterion 2	8	8	64	5	40	5	40

Criterion 3	9	8	72	6	54	6	54
Criterion 4	8	8	64	6	48	6	48
Criterion 5	7	7	49	5	35	5	35
Criterion 6	7	8	56	4	28	6	42
Criterion 7	5	7	35	6	30	6	30
Criterion 8	9	7	63	6	54	4	36
Criterion 9	9	8	72	4	36	5	45
Total Weighted Score			538		361		366

Contact the steering wheel tactfully		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	6	60	8	80	7	70
Criterion 2	9	4	36	9	81	6	54
Criterion 3	7	6	42	8	56	3	21
Criterion 4	8	4	32	9	72	6	48
Criterion 5	10	5	50	8	80	5	50
Criterion 6	7	4	28	9	63	4	28
Total Weighted Score			248		432		271

Hold the steering wheel with hand		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	4	40	9	90	7	70
Criterion 2	9	6	54	8	72	6	54

Criterion 3	7	6	42	9	63	7	49
Criterion 4	8	5	40	9	72	5	40
Criterion 5	10	5	50	8	80	5	50
Criterion 6	7	4	28	7	49	4	28
Total Weighted Score			281		426		291

Contact the steering wheel firmly		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	6	60	9	90
Criterion 2	9	6	54	6	54	9	81
Criterion 3	7	6	42	7	49	8	56
Criterion 4	8	5	40	4	32	8	64
Criterion 5	10	4	40	4	40	7	70
Criterion 6	7	5	35	5	35	9	63
Total Weighted Score			281		270		424

Hold the steering wheel until leaving the vehicle		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	8	80	5	50

Criterion 2	9	7	63	8	72	7	63
Criterion 3	7	5	35	9	63	8	56
Criterion 4	8	7	56	9	72	7	56
Criterion 5	10	6	60	8	80	6	60
Criterion 6	7	5	35	9	63	5	35
Total Weighted Score			319		430		320

Avoid extreme conditions of the course		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	6	60	8	80
Criterion 2	9	7	63	8	72	9	81
Criterion 3	7	5	35	8	56	9	63
Criterion 4	8	6	48	7	56	8	64
Criterion 5	7	5	35	6	42	9	63
Criterion 6	8	4	32	5	40	7	56
Criterion 7	7	5	35	6	42	8	56
Criterion 8	9	6	54	7	63	7	63
Criterion 9	8	5	40	5	40	6	48
Total Weighted Score			412		471		574

Drive along calmer environmental conditions		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score

Criterion 1	10	8	80	9	90	4	40
Criterion 2	9	5	45	9	81	7	63
Criterion 3	7	7	49	8	56	7	49
Criterion 4	9	6	54	8	72	6	54
Criterion 5	8	9	72	7	56	4	32
Criterion 6	7	7	49	8	56	6	42
Criterion 7	8	7	56	7	56	8	64
Criterion 8	9	9	81	9	81	7	63
Criterion 9	8	8	64	8	64	9	72
Total Weighted Score			550		612		479

Apply pressure to reduce force input		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	8	80	7	70	6	60
Criterion 2	9	9	81	7	63	7	63
Criterion 3	7	9	63	8	56	5	35
Criterion 4	8	8	64	5	40	6	48
Criterion 5	9	7	63	5	45	5	45
Criterion 6	7	6	42	7	49	4	28
Criterion 7	8	8	64	8	64	5	40
Criterion 8	7	9	63	6	42	4	28
Criterion 9	9	7	63	8	72	8	72
Total Weighted Score			583		501		419

Absorb external force to reduce driver control		Concept 1	Concept 3	Concept 4

Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	7	63	8	72	9	81
Criterion 2	8	7	56	7	56	9	72
Criterion 3	9	4	36	7	63	8	72
Criterion 4	8	6	48	5	40	9	72
Criterion 5	7	7	49	8	56	8	56
Criterion 6	9	8	72	6	54	9	81
Criterion 7	10	6	60	7	70	8	80
Criterion 8	5	4	20	8	40	7	35
Criterion 9	8	8	64	8	64	9	72
Total Weighted Score			468		515		621

Reduce the turn of the steering wheel to perform a sharp maneuver		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	9	9	81	7	63	8	72
Criterion 2	7	9	63	7	49	7	49
Criterion 3	8	9	72	5	40	5	40
Criterion 4	9	8	72	6	54	7	63
Criterion 5	8	8	64	5	40	7	56
Criterion 6	8	7	56	7	56	6	48
Criterion 7	7	6	42	7	49	8	56
Criterion 8	9	9	81	9	81	7	63
Criterion 9	9	8	72	5	45	8	72
Total Weighted Score			603		477		519

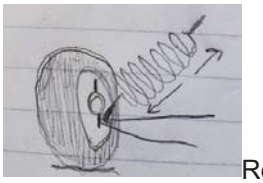
Allow easy motion of gears		Concept 2		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	8	80	9	90	8	80
Criterion 2	9	7	63	9	81	6	54
Criterion 3	9	7	63	9	81	6	54
Criterion 4	8	5	40	8	64	5	40
Criterion 5	8	6	48	7	56	7	56
Criterion 6	9	7	63	6	54	6	54
Criterion 7	8	5	40	8	64	5	40
Criterion 8	7	9	63	9	63	8	56
Criterion 9	9	6	54	9	81	9	81
Total Weighted Score			514		634		515

Allow easy motion of steering rod		Concept 1		Concept 2		Concept 3	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	6	60	7	70	8	80
Criterion 2	9	7	63	5	45	9	81
Criterion 3	9	4	36	7	63	9	81
Criterion 4	8	8	64	7	56	9	72
Criterion 5	8	4	32	8	64	7	56
Criterion 6	9	6	54	5	45	8	72
Criterion 7	8	5	40	8	64	6	48
Criterion 8	7	9	63	6	42	9	63
Criterion 9	9	7	63	7	63	9	81
Total Weighted Score			475		512		634

Allow easy motion of steering wheel		Concept 1		Concept 3		Concept 4	
Criteria/Requirements	Weight	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Criterion 1	10	7	70	6	60	9	90
Criterion 2	9	8	72	7	63	9	81
Criterion 3	9	7	63	7	63	8	72
Criterion 4	8	5	40	4	32	8	64
Criterion 5	8	7	56	6	48	7	56
Criterion 6	9	8	72	7	63	7	63
Criterion 7	8	6	48	8	64	8	64
Criterion 8	7	7	49	7	49	9	63
Criterion 9	9	9	81	9	81	7	63
Total Weighted Score			551		523		616

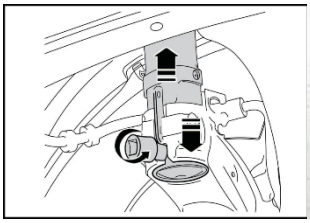
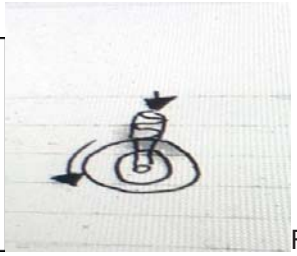
4.3.3 Selection of Concept as Project Design

This section will provide detailed sketches of the remaining concepts that were rated by the group. Once all of the rating was completed the concepts were redrawn with more detail. Since the group divided the project into two systems, the sketches are divided into two figures. Figure 4.1 shows both concepts the main idea and the back up idea for all 22 level 3 sub-functions for the suspension system.The group organized the sketches where the sketches labeled (i) are the main ideas and the sketches labeled (ii) are the back up design.



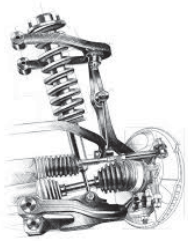
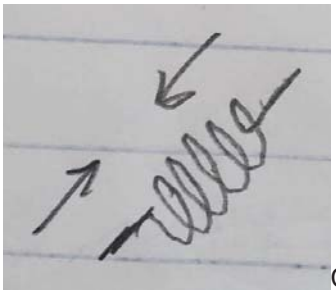
Release force from springs to the ground

(i) (ii)

Release energy from struts to the tires

(i) (ii)

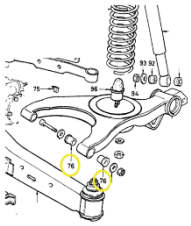



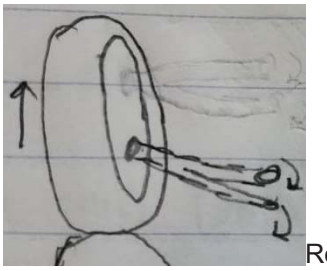
Compress the springs from the external forces

(i) (ii)

Compress the struts from external forces

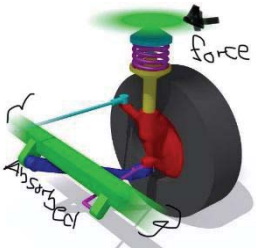
(i) (ii)





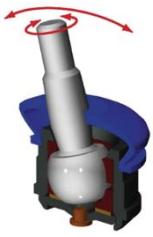
Rotate the control arms to decrease force intake

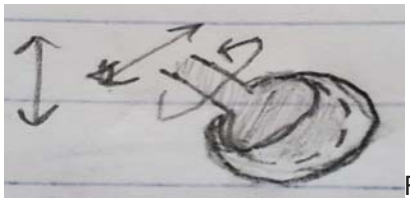
(i) (ii)



Rotating of control arms to absorb excess forces

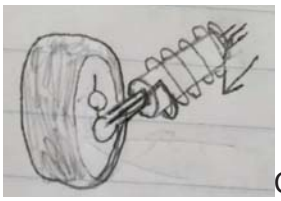
(i) (ii)



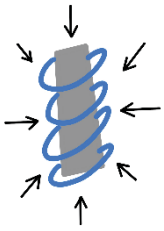
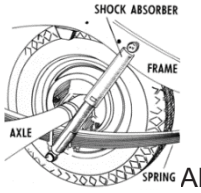


Rotating of ball joints to absorb excess forces

(i) (ii)

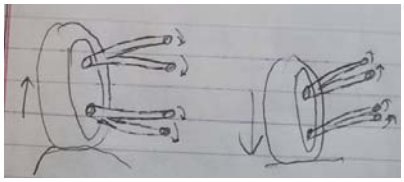
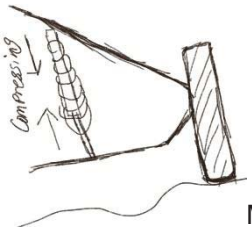

Compressing of struts and springs from external forces

(i) (ii)

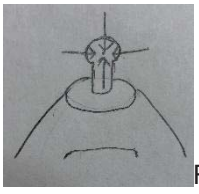



Absorb forces with struts and springs

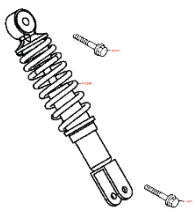
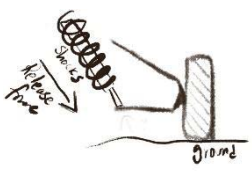
(i) (ii)



Move control arms based off environment

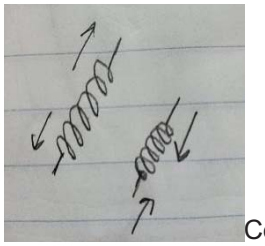
(i) (ii)


Rotate ball joints from contact of force

(i) (ii)

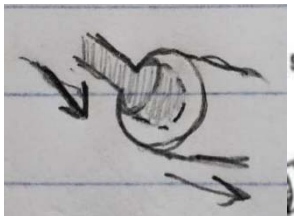
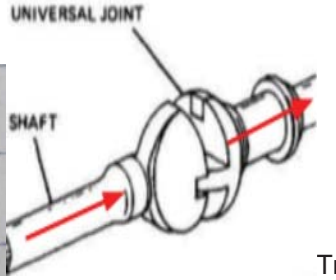


Collect force through the struts

(i) (ii)



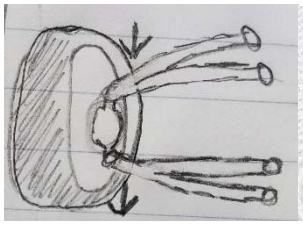
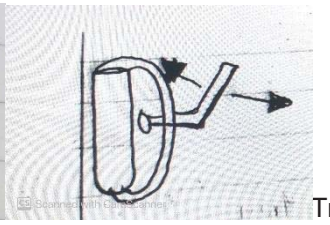
Collect force through springs

(i) (ii)

Transfer force through ball joint

(i) (ii)

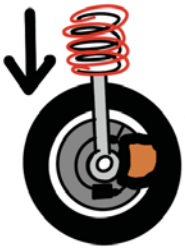



Transfer load from control arms

(i) (ii)

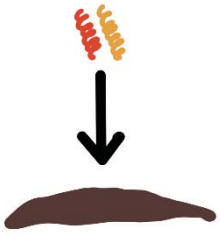
Transfer load from springs

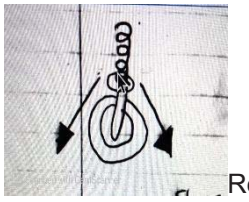
(i) (ii)



Transfer load from struts

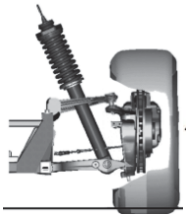
(i) (ii)

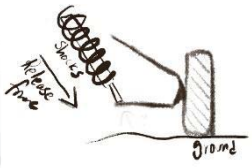




Release force from spring to the ground

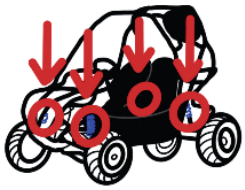
(il (ii)

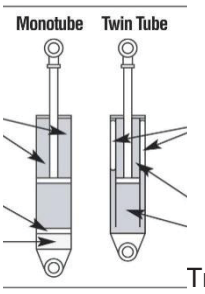




Release force from struts to ground

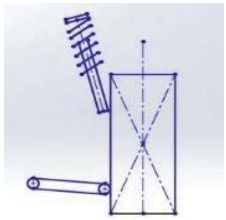
(i) (ii)

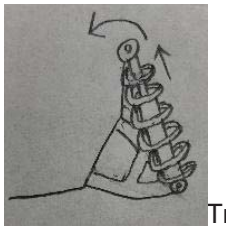




Transfer vehicle load through struts while turning

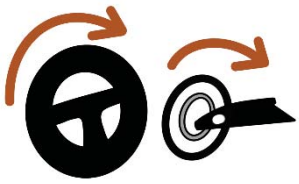
(i) (ii)

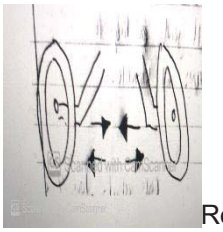




Transfer vehicle load through springs while turning

(i) (ii)



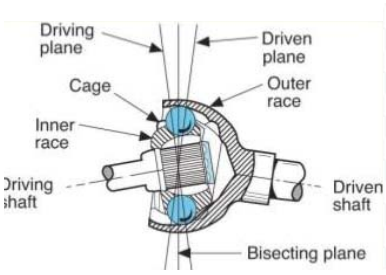


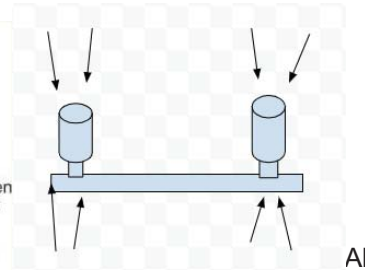
Rotate control arms while turning

(i) (ii)

Figure 4.1 All sketches for the suspension system

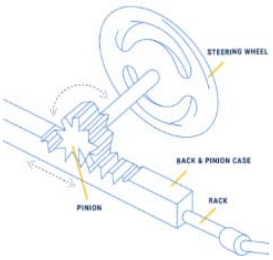
Figure 4.2 shows both concepts the main idea and the back up idea for all 22 level 3 sub-functions for the steering system. The group organized the sketches where the sketches labeled (i) are the main ideas and the sketches labeled (ii) are the back up design.

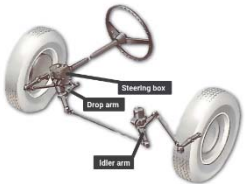




Allow forces to be absorbed

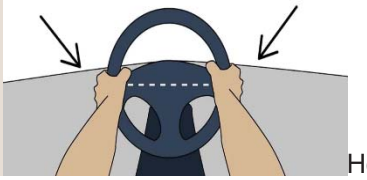
(i) (ii)





Rotate gears only from steering wheel

(i) (ii)

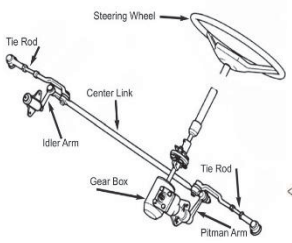


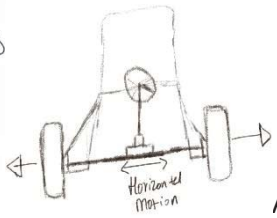
Hold the steering wheel firmly

(i) (ii)

Turn the steering wheel when adjusting to external forces

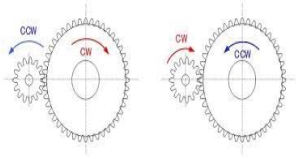
(i) (ii)





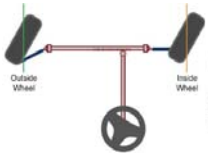
Allow horizontal motion with steering rod

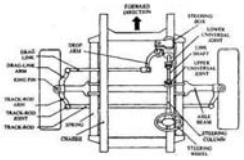
(i) (ii)



Allow gears to move in both directions

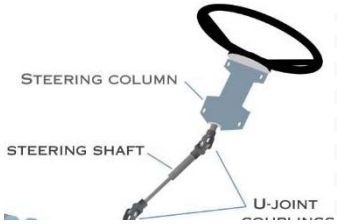
(i) (ii)

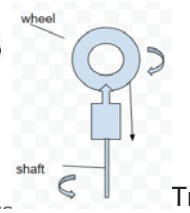




Allow steering rod to move horizontally in both directions

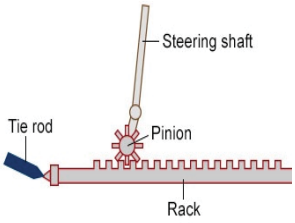
(i) (ii)

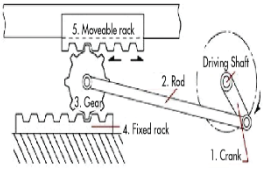




Transfer energy from steering wheel to Steering shaft

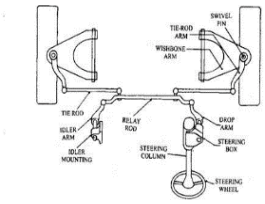
(i) (ii)

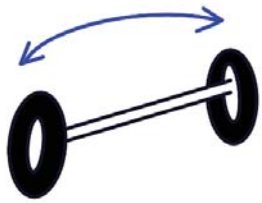




Translate motion from gears to steering rod

(i) (ii)



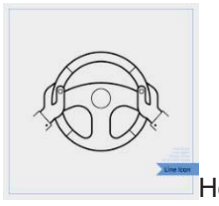


Move tires side to side from steering rod

(i) (ii)

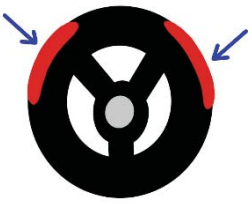
Contact the steering wheel tactfully

(i) (ii)



Hold the steering wheel with hand

(i) (ii)

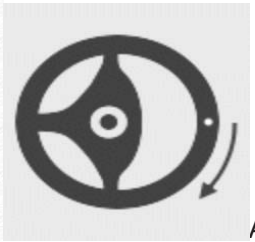


Contact the steering wheel firmly

(i) (ii)

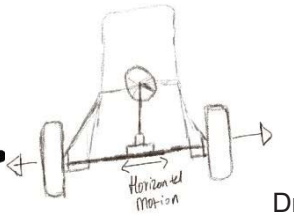
Hold the steering wheel until leaving the vehicle

(i) (ii)



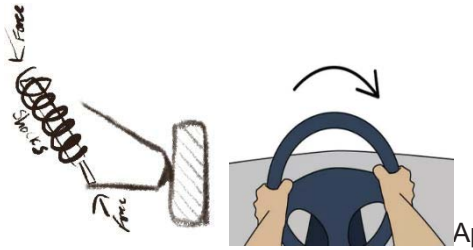
Avoid extreme conditions of the course

(i) (ii)



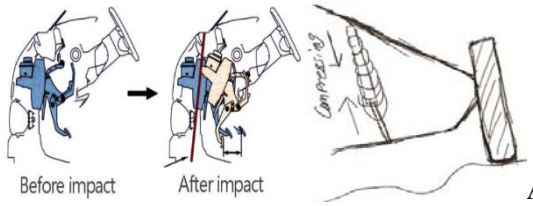
Drive along calmer environmental conditions

(i) (ii)



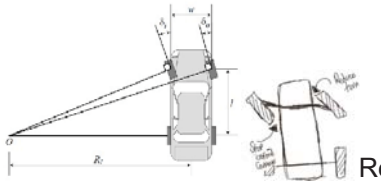
Apply pressure to reduce force input

(i) (ii)



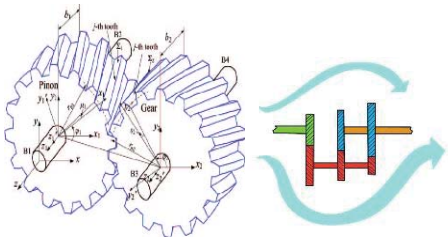
Absorb external force to reduce driver control

(i) (ii)



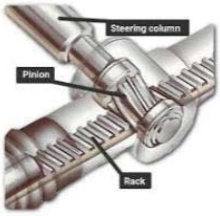
Reduce turn of the steering wheel to perform a sharp maneuver

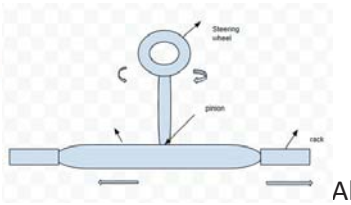
(i) (ii)



Allow easy motion of gears

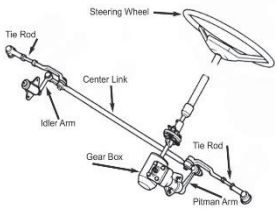
(i) (ii)

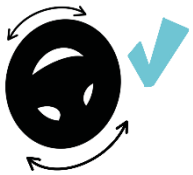




Allow easy motion of steering rod

(i) (ii)





Allow easy motion of steering wheel

(i) (ii)

Figure 4.2 All sketches for the steering system

The most ideal approach to show the groups sketches will be by separating them into two figures, suspension, and Steering. Each consideration will be partitioned along with two sub functions. On each figure, the principal sub function sketch will be the groups best option and the back up idea will be the second choice. The representations are marked with roman numerals with the sketches labeled (i) are the main designs and the sketches labeled (ii) are the back up designs. Based on the level 3 sub-function ratings for the suspension and steering systems, the decisions were made for the labels (i) and (ii) for the previous sketches. The final two concepts were passed on from the GO-NO-GO scoring and the Decision Matrix scoring. From the literature review and all the scoring, the group was able to confirm that the final two concepts were relevant.

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

STATUS REPORT 9

TOPICS COVERED IN STATUS REPORT 9

Preliminary & Detailed Analysis by Group

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Preliminary and Detailed Analysis by Group

Due: 11/11/2020

This status report is a part of Chapter 5 of your final report. Chapter 5 contains the following sections and this assignment covers the first two highlighted sections.

5. DETAILED SYSTEM DESIGN …….. 40
5.1 **Identification and Plans for Types of Analysis Needed for the Design** …….. 40
5.2 Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design……. 45
~~5.3~~
~~5.4 Engineering Analysis and Simulation …….. 47~~
~~5.5. Layout/Detailed Drawings/Equipment selection and specifications …….. 48~~
~~5.6 Application of Engineering Codes and Standards in design . 49~~
~~5.7 Economic Analysis …….. 55~~
~~5.8 Fabrication and Testing …….. 58~~

5. DETAILED SYSTEM DESIGN

1. Provide an introductory paragraph for this chapter using the information about the content of this chapter provided above**.**

5.1 Identification and Plans for Types of Analysis Needed for the Design

Provide an introductory paragraph for this section making use of what is to be done in question 2 below.

2. Make a table containing the list of items in your system for which some form of engineering analysis will be needed in order to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis

Approval by Project owner: Name_____ Signature _____

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

Provide an introductory paragraph for this section making use of what is to be done in question 3 below.

3. Perform detailed engineering analyses required to **design**, **specify,** and **size** all components of the system you are designing as planned in Table 5.1. Depending on your type of project, the detailed analysis may consist of but not limited to (1) thermal analysis (heat transfer and thermodynamics), (2) fluid mechanics analysis, (3) machine elements & machine design analysis of project elements, (4) kinematics analysis of moving elements, (5) power and energy analysis, (6) electrical energy/storage analysis, (7) structural/strength of materials analysis, (8) control analysis including programming, (9) geometric analysis to define shape and size, (10) special analysis specific to design such as chemical reactions, etc., and (11) manufacturing processes that may be required for the project. Provide adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

(i) For each analysis, provide a sub-title, followed by a brief description, then provide either a free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables), then using the equation editing feature of MS Word, provide the equations needed for the analysis. The variables in the equations should be defined right after the equation.

(ii) Then without directly substituting values into the equation, provide the values of the known variables, followed by the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

(iii) Provide specification for the specific part if the part is selected after the analysis for that part.

(iv) On the cover page of this assignment indicate the sections of the analysis (sections 5.2.1, 5.2.2, 5.2.3, etc) contributed by each member.

Note that the analysis should be fully descriptive and that you may provide equation numbers that can then be cited in the report.

Question 3 should be answered using the subsection example below:

5.2.1 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

5.2.2 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

This section contains notes for you.

NOTES ON DESIGN ANALYSIS
DETAILED ENGINEERING ANALYSIS NOTES AND SAMPLE

Detailed engineering analyses required in order to **design**, **specify,** and **size** all components of the system you are designing must be provided. Depending on your type of project, the detailed analysis may consist of but not limited to

(1) thermal analysis (heat transfer and thermodynamics),
(2) fluid mechanics analysis,
(3) machine elements & machine design analysis of project elements,
(4) kinematics analysis of moving elements,
(5) power and energy analysis,
(6) electrical energy/storage analysis,
(7) structural/strength of materials analysis,
(8) control analysis including programming,
(9) geometric analysis to define shape and size,
(10) special analysis specific to design such as chemical reactions, etc.,
(11) manufacturing processes that may be required for the project.
(12) providing adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

IMPORTANT INSTRUCTIONS TO FOLLOW
For each analysis, provide the following:

A sub-title for the specific design parameter being calculated, followed by a brief description,

1. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
2. Then using the equation editing feature of MS Word, provide the equations needed for the analysis and define all of the variables in the equations right after the equation.
3. Provide the values of all known variables
4. Without substituting values directly into the equation, provide the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

An example analysis based on the 4 analysis steps is provided.

5.2.1 Analysis for determining the power required for lifting mechanism and selection for DC Motor

Since DC motors were to be used to drive components for 3 out of 5 of the functions of the design, its selection was based on the output torque required by the most arduous function. Therefore, for the general analysis to get the servo motor specification, the torque calculation for lifting a 4 lb weight was used. It was assumed that the 4 lb weight would be the heaviest load the robot had to lift. 4lbs was selected for the weight in order to ensure that the robot lifted a load that was safe. The competition gave no specification for the amount of weight that needed to be lifted.

The calculation for the lifting torque is provided below. The free body diagram below depicts the forces that would act on the system during the lifting procedure. Figure 5.2 displays the free body diagram of the lifting component showing all the forces. Figure 5.3 shows the initial ideal design for the robot, which also shows the location of each of the functions.

(a) Free Body Diagram (FBD)

The free body diagram showing the lifting mechanism and the forces acting is shown in Figure 5.2

In this mechanism, a gear driven by an electric motor engages with a vertical shaft whose gears mesh with the rotating gear driven by the electric motor. The load to be lifted is placed on a platform fixed to the vertical geared shaft as shown in the Figure 5.2

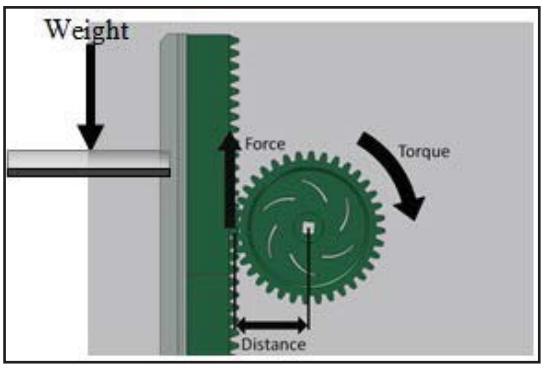


Figure 5.2 Free Body Diagram of Lifting Component

(b) Analysis Equations

Using the force equilibrium equation, a general expression was derived to come up with an equation for the power. Then, from knowing the linear speed of the ascending platform, the rotational speed of the pinion (which is connected to the shaft) was determined.

$$F_y = F_{applied} - W = 0 \quad (1)$$

(The assumption was that power was to be transmitted so that the rack would translate upward at a constant velocity). Therefore,

$$F_{applied} = W \quad (2)$$

and the power, P, required is given by

$$P = F_{applied} V_{avg} \quad (3)$$

where,

$F_{applied}$ is the force applied by the motor

W is the weight of the mass (the weight is **overloaded** to ensure that the motor is not underspecified)

P is the power delivered by the motor

V_{avg} is the average velocity for lifting the weight

The average speed for the lift was assumed and the rotation speed for lift was approximated by the following equation:

$$N = \frac{60 V_{avg}}{\pi D_{gear}} \quad (4)$$

where N is the rotational speed for the motor shaft in RPM

D_{gear} is the diameter of the pinion.

Knowing the power and the rotation speed, the torque transmitted was then calculate using.

$$T = \frac{60P}{2\pi N} \quad (5)$$

where T is the torque provided by the motor

(c) Values of known variables

A reasonable estimate for the linear velocity, V_{avg} **= 0.98 ft/s** was chosen for the lift speed.
The weight to be lifted was set to be W = **4 lb**.
A standard diameter for the pinion was chosen to be D= **2.5 inches** (0.21 ft)

(d)Values of computed variables

With these values, the power was computed using equation (3) to be P=**3.92 lb. ft/s** (Customary Units)
The rotational speed was computed using equation (4) to be N=89.1 RPM using EES program
The torque was computed using equation (5) to be T=0.42 ft-lbf (5.04 in-lbf) using EES program

Figure 5.3 shows the DC motor that was selected to carry out the lifting function. From the calculated

results and the specification of this specific DC motor as shown in Table 5.2, the motor has enough torque to actuate the lifting mechanism at the assumed average velocity.

Figure 5.3: VEX 2-wire DC motor

Table 5.1 Detailed specification for motor selected

2 Wire Motor 393

- Free Speed: 100 rpm (As Shipped)/160 rpm (High Speed Option)
- Stall Torque: 1.67 N-m (14.76 in-lbs) (As Shipped)/1.04 N-m (9.2 in-lbs) (High Speed Option)
- Stall Current: 4.8A
- Free Current: 0.37A

Note: All motor specifications are at 7.2 volts.

5.2.2 Analysis for determining XXXXXXXXXXXXX

Grading Scheme for Status Report 8
Detailed Engineering Analysis

Project Group #_____

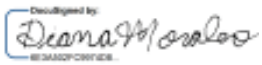
Item	Description	Maximum Points	Your Score
1	Table listing description of items for which analysis are needed, description of type of analysis needed and the subject area of the analysis	25	
2	Signature of advisor	10	
2	Well planned and detailed analysis of each part with free body /other diagrams provided where needed.	140	
3	Parts specifications resulting from the analysis	20	
4	Assignment attached	5	
	Total	**200**	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: _ Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER: 3
Progress Report Title: Preliminary and Detailed Analysis
Due Date:11/11/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Assigned to analyze pressure control valve, pressure sensor and aluminum foil. Also to review report before submission.	100	
2	Fanta Kaba 	Conducted the analysis on the temperature sensor and Ammeter.	100	
3	Christian White 	Assigned to input contribution in the table for the temperature gauge and digital voltmeter as well as the detailed analysis. Assigned to submit the status report.	100	
4	Abdullah EL Aker 	Assigned to analyze, represent and summarize a glass insulation component.	100	
5	Yemboado Yonli 	Conducted an analysis on the band heater, on the rotary gear pump and on the magnet	100	
6	Marcelo Epam Ona 	Conducted an analysis on the condenser, Stainless Steel pipe and checked the overall status report.	100	

FALL 2020 SEMESTER

Status Report on Preliminary and Detailed Analysis by Group

Due: 11/11/2020

This status report is a part of Chapter 5 of your final report. Chapter 5 contains the following sections and this assignment covers the first two highlighted sections.

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~~5.3~~

~~5.4 Engineering Analysis and Simulation …….. 47~~

~~5.5. Layout/Detailed Drawings/Equipment selection and specifications …… 48~~

~~5.6 Application of Engineering Codes and Standards in design . 49~~

~~5.7 Economic Analysis …….. 55~~

~~5.8 Fabrication and Testing …….. 58~~

5. DETAILED SYSTEM DESIGN

1. Provide an introductory paragraph for this chapter using the information about the content of this chapter provided above**.**

5.1 Identification and Plans for Types of Analysis Needed for the Design

Provide an introductory paragraph for this section making use of what is to be done in question 2 below.

2. Make a table containing the list of items in your system for which some form of engineering analysis will be needed in order to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis

Approval by Project owner: Name_____ Signature _____

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

Provide an introductory paragraph for this section making use of what is to be done in question 3 below.

3. Perform detailed engineering analyses required to **design**, **specify,** and **size** all components of the system you are designing as planned in Table 5.1. Depending on your type of project, the detailed analysis may consist of but not limited to (1) thermal analysis (heat transfer and thermodynamics), (2) fluid mechanics analysis, (3) machine elements & machine design analysis of project elements, (4) kinematics analysis of moving elements, (5) power and energy analysis, (6) electrical energy/storage analysis, (7) structural/strength of materials analysis, (8) control analysis including programming, (9) geometric analysis to define shape and size, (10) special analysis specific to design such as chemical reactions, etc., and (11) manufacturing processes that may be required for the project. Provide adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

(i) For each analysis, provide a sub-title, followed by a brief description, then provide either a free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables), then using the equation editing feature of MS Word, provide the equations needed for the analysis. The variables in the equations should be defined right after the equation.

(ii) Then without directly substituting values into the equation, provide the values of the known variables, followed by the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

(iii) Provide specification for the specific part if the part is selected after the analysis for that part.

(iv) On the cover page of this assignment indicate the sections of the analysis (sections 5.2.1, 5.2.2, 5.2.3, etc) contributed by each member.

Note that the analysis should be fully descriptive and that you may provide equation numbers that can then be cited in the report.

Question 3 should be answered using the subsection example below:

5.2.1 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)

b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

5.2.2 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

Assignment for Assessing Outcomes 2 & 5

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

This section contains notes for you.

NOTES ON DESIGN ANALYSIS
DETAILED ENGINEERING ANALYSIS NOTES AND SAMPLE

Detailed engineering analyses required in order to **design**, **specify,** and **size** all components of the system you are designing must be provided. Depending on your type of project, the detailed analysis may consist of but not limited to

(1) thermal analysis (heat transfer and thermodynamics),
(2) fluid mechanics analysis,
(3) machine elements & machine design analysis of project elements,
(4) kinematics analysis of moving elements,
(5) power and energy analysis,
(6) electrical energy/storage analysis,
(7) structural/strength of materials analysis,
(8) control analysis including programming,
(9) geometric analysis to define shape and size,
(10) special analysis specific to design such as chemical reactions, etc.,
(11) manufacturing processes that may be required for the project.
(12) providing adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

IMPORTANT INSTRUCTIONS TO FOLLOW
For each analysis, provide the following:

A sub-title for the specific design parameter being calculated, followed by a brief description,

1. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
2. Then using the equation editing feature of MS Word, provide the equations needed for the analysis and define all of the variables in the equations right after the equation.

3. Provide the values of all known variables
4. Without substituting values directly into the equation, provide the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

An example analysis based on the 4 analysis steps is provided.

5.2.1 Analysis for determining the power required for lifting mechanism and selection for DC Motor

Since DC motors were to be used to drive components for 3 out of 5 of the functions of the design, its selection was based on the output torque required by the most arduous function. Therefore, for the general analysis to get the servo motor specification, the torque calculation for lifting a 4 lb weight was used. It was assumed that the 4 lb weight would be the heaviest load the robot had to lift. 4lbs was selected for the weight in order to ensure that the robot lifted a load that was safe. The competition gave no specification for the amount of weight that needed to be lifted.

The calculation for the lifting torque is provided below. The free body diagram below depicts the forces that would act on the system during the lifting procedure. Figure 5.2 displays the free body diagram of the lifting component showing all the forces. Figure 5.3 shows the initial ideal design for the robot, which also shows the location of each of the functions.

(a) Free Body Diagram (FBD)

The free body diagram showing the lifting mechanism and the forces acting is shown in Figure 5.2

In this mechanism, a gear driven by an electric motor engages with a vertical shaft whose gears mesh with the rotating gear driven by the electric motor. The load to be lifted is placed on a platform fixed to the vertical geared shaft as shown in the Figure 5.2

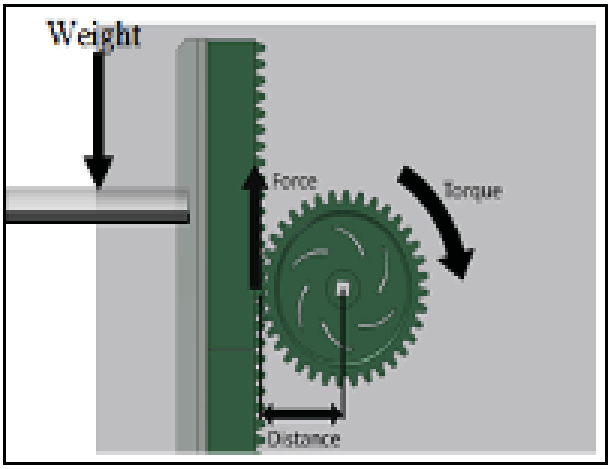


Figure 5.2 Free Body Diagram of Lifting Component

(b) Analysis Equations

Using the force equilibrium equation, a general expression was derived to come up with an equation for the power. Then, from knowing the linear speed of the ascending platform, the rotational speed of the pinion (which is connected to the shaft) was determined.

(1)

(The assumption was that power was to be transmitted so that the rack would translate upward at a constant velocity). Therefore,

(2)

and the power, P, required is given by

(3)

where,

$F_{applied}$ is the force applied by the motor
W is the weight of the mass (the weight is **overloaded** to ensure that the motor is not underspecified)
P is the power delivered by the motor
V_{avg} is the average velocity for lifting the weight

The average speed for the lift was assumed and the rotation speed for lift was approximated by the following equation:

(4)

where N is the rotational speed for the motor shaft in RPM
D_{gear} is the diameter of the pinion.

Knowing the power and the rotation speed, the torque transmitted was then calculate using.

(5)

where T is the torque provided by the motor

(c) Values of known variables

A reasonable estimate for the linear velocity, V_{avg} **= 0.98 ft/s** was chosen for the lift speed.
The weight to be lifted was set to be W = **4 lb**.
A standard diameter for the pinion was chosen to be D= **2.5 inches** (0.21 ft)

(d)Values of computed variables

With these values, the power was computed using equation (3) to be P=**3.92 lb. ft/s** (Customary Units)
The rotational speed was computed using equation (4) to be N=89.1 RPM using EES program
The torque was computed using equation (5) to be T=0.42 ft-lbf (5.04 in-lbf) using EES program
Figure 5.3 shows the DC motor that was selected to carry out the lifting function. From the calculated

results and the specification of this specific DC motor as shown in Table 5.2, the motor has enough torque to actuate the lifting mechanism at the assumed average velocity

Figure 5.3: VEX 2-wire DC motor

Table 5.1 Detailed specification for motor selected

2 Wire Motor 393

▷ Free Speed:	100 rpm (As Shipped)/160 rpm (High Speed Option)
▷ Stall Torque:	1.67 N-m (14.76 in-lbs) (As Shipped)/1.04 N-m (9.2 in-lbs) (High Speed Option)
▷ Stall Current:	4.8A
▷ Free Current:	0.3/A

Note: All motor specifications are at 7.2 volts.

5.2.2 Analysis for determining XXXXXXXXXXXXX

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Preliminary and Detailed Analysis by Group

Due: 11/11/2020

This status report is a part of Chapter 5 of your final report. Chapter 5 contains the following sections and this assignment covers the first two highlighted sections.

5. DETAILED SYSTEM DESIGN

In this status report an analysis is conducted on the most important parts of the apparatus. The analysis is conducted on multiple aspects allowing the choice of elements that could help reach the desired specs. Multiple formulas are used and each of the areas of engineering are touched.

5.1 Identification and Plans for Types of Analysis Needed for the Design

Provide an introductory paragraph for this section making use of what is to be done in question 2 below.

1. Make a table containing the list of items in your system for which some form of engineering analysis will be needed in order to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve

the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

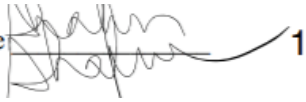
Table 5.1 represents the components of the system for which an engineering analysis was performed. A description of the analysis conducted in mentioned as well as the engineering areas that the analysis would touch. In the last column, the sources used for the analysis are mentioned.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis
1	Band heater	A performance analysis of the band heater should be conducted (Maximum Temperature, maximum watt density), which will include an electrical analysis with the maximum voltage and maximum amperage, resistance tolerance, and a geometry and size analysis on the inner and outer diameter, width and length and the appropriate brackets and bolts needed	Heat transfer Thermodynamics Electrical engineering Machine Design	https://www.thermaldevices.com/wp-content/uploads/2016/12/Mica-Band-Updated.pdf Fundamentals of electrical engineering, Giorgio Rizzoni
2	Rotary Gear pump	the gears in the pumps need to be analyzed (gear size, torque, rpm) The pressure differential between the inlet and outlet need to be analyzed tithe volumetric flow rate needs to be analyzed the power input in the pump news to be analyzed	Machine Design Fluid mechanic Electrical engineering	http://www.northern-pump.com/PDFs/Golden%20Gear%20Presentations/Golden%20Gear%20Pump%20102%20Lesson%201%20.pdf Fluid mechanics, Fundamentals and application, Yunus A. Cengel, third edition Shigley's mechanical engineering Design ,tenth edition
3	Condenser	A performance analysis of the units that feed with the same voltage and frequency of the power supply. When it comes to the	Thermodynamics. intro to E.E	Shigley's mechanical engineering Design ,tenth edition

		torque, it must be made sure that the compressor is in the condensing unit has a high starting torque. Also an analysis on the maximum temperature a condenser could take.		
4	Stainless steel pipe	A performance analysis on the amount and type of corrosion resistance desired, Consider your operating environment and consider the magnetic response.	Machine design, Material science.	Fluid mechanics, Fundamentals and application, Yunus A. Cengel, third edition
5	Pressure control valve	flow rate through valve, total pressure drops across valve	Fluid Mechanics	Yunus Cengel, Cimbala John Cimbala (n.d.) *Fluid Mechanics: Fundamentals and Applications*, 4th edn., USA: McGraw-Hill Education.
6	Pressure sensor	density of fluid, standard gravity, height of fluid, column above pressure sensor.	Fluid Mechanics	Yunus Cengel Cengel, Cimbala John Cimbala (n.d.) *Fluid Mechanics: Fundamentals and Applications*, 4th edn., USA: McGraw-Hill Education.
7	Flow meter	Measurement of mass or volume flow rate	Fluid Mechanics	Yunus Cengel Cengel, Cimbala John Cimbala (n.d.) *Fluid Mechanics: Fundamentals and Applications*, 4th edn., USA: McGraw-Hill Education.
8	Electrodynamic ammeter	Measurement of current	Electrical Circuits	Nave, Rod. "Ammeter." *Moving Coil Meters*, 2000, hyperphysics.phy-astr.gsu.edu/hbase/magnetic/movcoil.html.
9	Temperature gauge (RTD's)	Measurement of the nanofluid temperature	Fluid Mechanics, Heat Transfer	Yunus Cengel Cengel, Cimbala John Cimbala (n.d.) *Fluid Mechanics: Fundamentals and Applications*, 4th edn., USA: McGraw-Hill Education

10	Digital voltmeter	Measurement of the voltage drop within the nanofluid	Electrical Engineering, Fluid Mechanics	Yunus Cengel Cengel, Cimbala John Cimbala (n.d.) *Fluid Mechanics: Fundamentals and Applications*, 4th edn., USA: McGraw-Hill Education
11	Aluminum foil	foil thickness, foil length, manufactured purpose. (made for insulating?)	Shape and Size	Katie Tonarey (2018) *Why Is Aluminum Foil a Better Insulator Than Cotton or Paper?,* Available at: *https://www.hunker.com/13416236/why-is-aluminum-foil-a-better-insulator-than-cotton-or-paper* (Accessed: 4th November 2020).
12	Glass insulation	A performance analysis on the amount and type thermal conductivity, which involves the thickness of the material.	Heat transfer	Incropera, F. P., DeWitt, D. P., Incropera, F. P., & Incropera, F. P. (1990). *Solutions Manual to accompany Fundamentals of heat and mass transfer, 3rd ed. and Introduction to heat transfer, 2nd ed.* New York: Wiley.
13	Magnet	Magnetic power analysis of the magnet size and geometry	Electrical engineering	http://www.calctool.org/CALC/phys/electromagnetism/solenoid https://www.mscdirect.com/product/details/06586507

Approval by Project owner: Name Dr. Shafiee Signature  11/18/2020

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

In this section a detailed engineering analysis was performed on each item that the group selected as a major factor or component needed to conduct this project.. The engineering analysis was performed on the shape, size, resistance, heat resistance, pressure and any other aspect that would need to be thoroughly analyzed. After each analysis the group member came up with the design that would be able to meet the parameters of their analysis with their respective values.

5.2.1 Analysis for determining the performance of the band heater

Since band heaters have to be used to heat up a specific area of the pipe (experimental chamber or test pipe) a thorough performance analysis ~~H~~has to be conducted in order to choose the most appropriate band heater and also the number of band heaters necessary for conducting the experiment. The band heater choice in the system emerged as it allows controllable, specific heated area. The performance of the band heater depends on many factors such ~~has~~ the size, the geometry of the band heater and the electrical power that is sent to the band heater

a) Process Diagram of the band heater

The process diagram of the band heater is shown below in Figure 5.1. In this mechanism the electrical energy received by the band heater is converted into heat that is then transferred to the surface that is supposed to be heated.

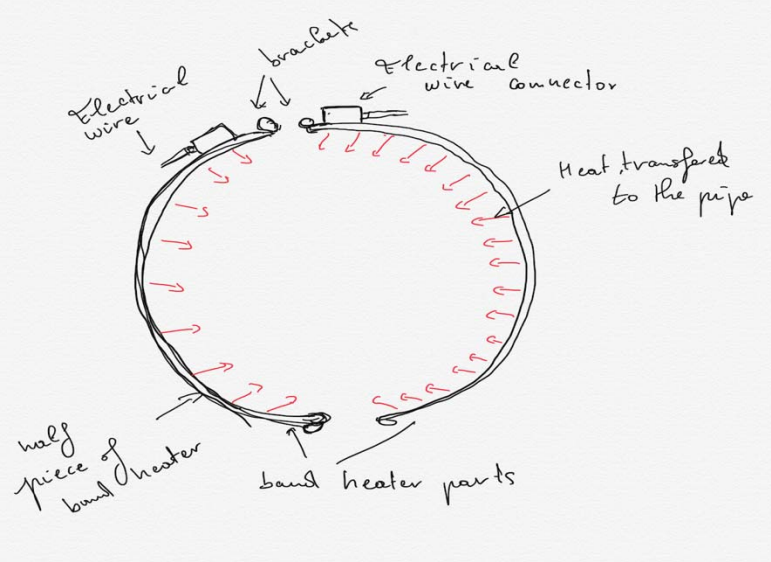


Figure 5.1 Band heater's process diagram

b) Analysis equations

The area heated will be calculated using the width and inner diameter of the ~~and~~ heater.
The area of a circular cylindrical surface is calculated using

$$A = \sout{Pi *} \frac{\sout{ID}}{\sout{2}} \sout{*} Width \qquad (1)$$

With ID being the inner diameter.
But since there is a gap the actual area heated Aa 1ill be calculated as

$$Aa = \left(\left(pi * \frac{ID}{2}\right) - gap\right) * width$$

$$gap = \left(\frac{3}{8}\right) * ID$$

Using the power analysis, calculating the wattage will be used

$$Wattage = (WT * Cp * \Delta T) * 3412 * h \qquad (2)$$

$$weight = mass * g$$

With g=gravitational velocity

$$mass = volume * density$$

$$volume = Pi * width * (ODp^2 - IDp^2)/4$$

WT=weight of the heated surface
Cp= specific of the surface area (specific heat of grade 304 stainless steel)
~~H~~=hours
~~⊗T~~= change in temperature $\Delta T = Tmax - Troom$
Tmax= Temperature wanted

Troom=room Temperature

From the wattage it is possible to determine the voltage and current required by adjusting either one or the other

$$Wattage = VI \qquad (3)$$

The watt density with allow us to choose the appropriate band heater

$$Watt\ density = \frac{Wattage}{Aa} \qquad (4)$$

c) Values of known variable

the inner diameter value is chosen for this experiment to be 1" or 25.4 mm
The band heater width will also be assumed to be 1" or 25.4 mm
Suppose gap as 5 mm
Let's assume that the a Tmax that is wanted is 100℃ and Troom 25℃
Stainless steel grade 304 density = 7930 kg/m^3
Cp stainless steel grade 304= 0.0005J/Kg℃
Hours to heat= 0.25 h
The g=9.8$\frac{m}{s^2}$
ODp=25.4 mm
IDp=22.4 mm

d) calculated variables

From equation 1, 2, 3 and 4 we obtained the following results.

The calculated area heated
Aa=0.00088641 m^2
Heated area mass= 0.02269 kg
Weight of the pipe part= 0.222 N
Wattage= 7.101 W
Watt density of the band heater= 8010 W/m^2

e) Type of band heater chosen

In regards to the conducted analysis the following band heater was chosen as the one to use in the current project. It is the Durabrand from thermal devices type T2 with a diameter of 25.4 mm and width of 25.4 mm. it is represented in Figure 5.2. Figure 5.2 has a bigger diameter but the diameter can be reduced to 25.4 mm if the constructor is contacted and the width can also be adapted.

Figure 5.2 Duraband band heater with built in straps

5.2.2 Analysis for calculating the rotary gear pump performance based on gear ration

Since a rotary gear pump has to be used to push the nanofluid into the pipes a thorough analysis has to be conducted on the pressure provided by the pump at the inlet and outlet. The fluid is pulled to the pump by the hydraulic vacuum force

a) Process diagram of a rotary gear pump

The process diagram of the rotary gear pump is shown in Figure 5.3. and Figure 5.4 it shows how the fluid is sucked then pushed out by the gears. Figure 5.3 shows an internal view of how the fluid is sucked and how depending on the gear rotation the fluid is then pushed out with the wanted pressure. Figure 5.4 shows and outside view of the process and underlining the importance of the shaft and the power that is sent to the gears through the shaft.

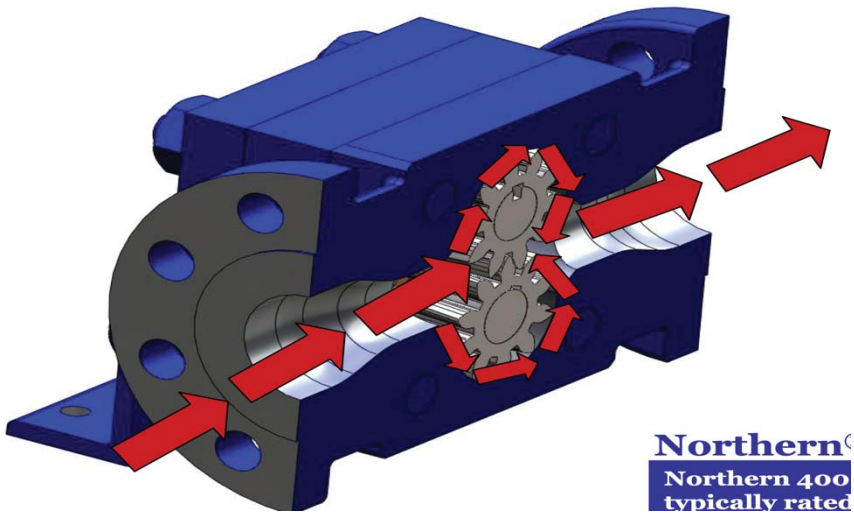


Figure 5.3 internal process of a gear pump

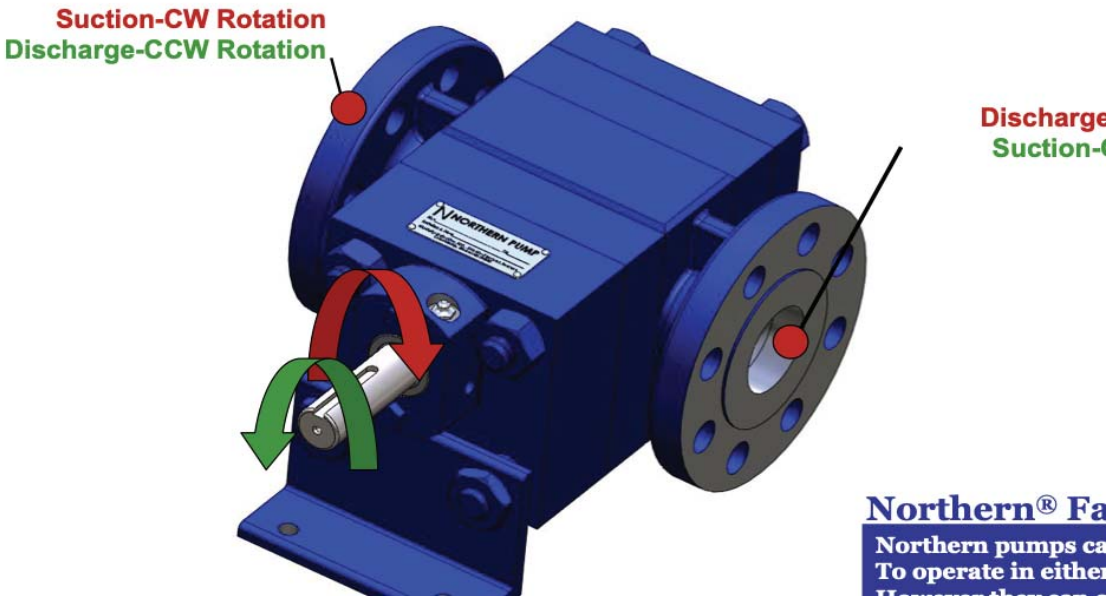


Figure 5.4 external process of a gear pump

b) Analysis equations

~~the~~ outlet pressure is the pressure need to push the fluid of the pump and is pretty much what need to be assessed

$$Wt = Q * deltaP \qquad (5)$$

Q= displacement volume
PI=inlet pressure
WT= Input power

In order to calculates the displacement volume, we use the following formula

$$Q = \frac{Pi}{4} * (Da^2 - Dr^2) * gw * \eta \qquad (6)$$

Da=addendum diameter of the gear
Dr=dedendum diameter of the gear
Gw=gear width
η= number of revolution per minute
Since the addendum and dedendum are important to calculate the displacement volume

$$Da = D + 2a$$
$$Dr = D - 2r$$
$$a = 1 * m$$
$$r = 1.25 * m$$
$$d = m * N$$

m=module
N=number of teeth of gears
from all this the input power can then be calculated
Once the input power is calculated the actual input power can be calculated using the mechanical efficiency of the pump

$$Wa = \frac{Wt}{n} \qquad (7)$$

Wa =actual power needed to reach the wanted outlet pressure
n= pump mechanical efficiency

Once the Wa is obtained the drive torque of the gear pump can be obtained

$$Torque = Wa * \frac{60}{2pi * \eta} \qquad (8)$$

c) Values of known variables

Pump speed = 2000 rpm,
number of teeth = 12
Gear module = 1 mm,
gear width = 2.5 mm
Pressure angle = 20 degrees
delta P= 20 Mpa
mechanical efficiency = 0.85
Volume efficiency = 0.9
If we consider our pressure angle to be 20° then

d) Values of the calculated Variables

From equation 5, 6,7,8 the following results were obtained.

The calculated variables using the equations and the known variables are the following
D= 42 mm
Da=54mm
Dr= 39.5 mm
Q=0.0014 m^3/s

Wt=28 kW
Wa=32.941kW
T=78.6N.m

e) Type of pump used

Based on the previous calculation made, the chosen pump for the project was the pump below represented in figure 5.5 with the specs.

Hover over image to zoom

[+] What do you think of our product images?

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Ship It
Backordered Online — ships in 3 - 8 Business Days
See Shipping Options

Store Pickup within 2hrs (In-Store or Curbside)
Not Available at Lewisville
Check Other Stores
See Pickup Details

- GPM: 22
- Shaft: 5/8in. dia. x 1 15/16in.L
- Inlet: 1 1/4in.
- Outlet: 1in. NPT
- 2-bolt mount

Features + Benefits

- GPM: 22
- Shaft: 5/8in. dia. x 1 15/16in.L
- Inlet: 1 1/4in.
- Outlet: 1in. NPT
- 2-bolt mount

Key Specs

Item#	1057	**GPM**	22
Brand	Haldex	**Stage**	2
Manufacturer's Warranty	1 year Limited Warranty	**Material**	Cast iron
Ship Weight	21.0 lbs	**Usage**	Open center hydraulic systems
Max. PSI	3,000	**Rotations Per Minute**	4,000
Shaft Diameter (in.)	5/8	**Weight (lbs.)**	22
Shaft Type	Straight keyed		

Figure 5.5 Concentric hydraulic gear pump rotary gear pump

5.2.3 Analysis on the condenser's voltage and torque

In this section, the motor of the condenser will be analyzed in order to determine the highest starting torque needed to condense the Nanofluid., which is the case on choosing a good condenser, has to be the

same as the compressor. To do that, the motor of the condenser will become the center and focus of this analysis. Furthermore, group members were trying to achieve a torque higher than 5 N.m, which is the torque needed to condense the Nanofluid.

a) Free Body Diagram of a condenser

Figure 5.6 represents an illustration of the free body diagram where a direct current motor is found in a condenser. As it can be observed on the left side of the diagram, a current is making its way through the resistance, inductor voltage and finally through the DC motor.

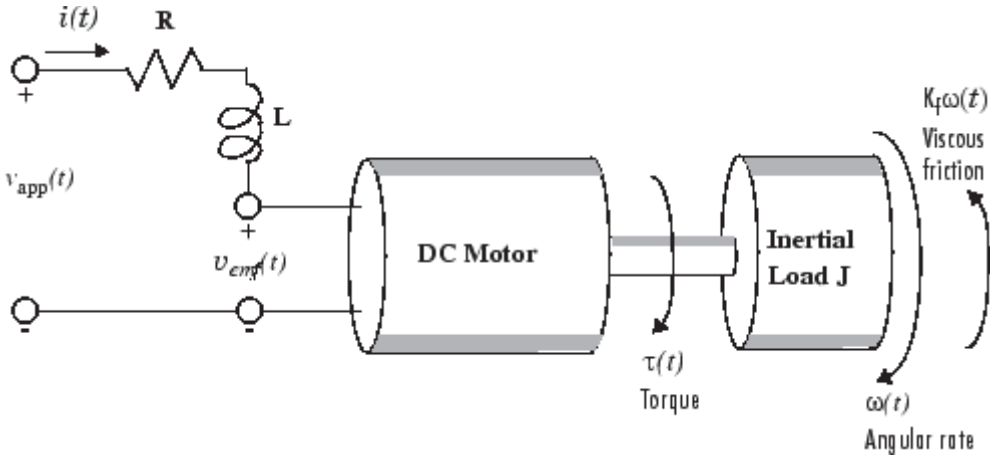


Figure 5.6 shows the free body diagram of dc current motor inserted in a condenser.

b) Analysis Equation

Using the power equation, a general expression was derived in order to come up with an equation for the voltage. Then, from knowing the voltage, which should be in the same unit as the power supply (S.I) and the current, the power was determined.

$$P = VI \quad (9)$$

After getting the electric power, which is on watts, a conversion is to be made to go from watts to HP in order to get a torque higher than 1000.This should be done if the process is done in English units but since the group is working in S.I, it can simply be avoid.
As it is known that:

Then the force could be gotten by using the force equation in order to finally get the Torque:

$$\mathbf{W_t}=\frac{60000 \times H}{\pi \times N \times D} \quad (10)$$

Where N as the rotational speed of the shaft in RPM
D as the diameter of the shaft mm
H as the power in Kw
W_t as the force in KN

Finally, the Torque equation is used in order to know the voltage, current, and diameter values that are needed to achieve a torque value higher than 5N.m.

$T=W_t \times R$ where W_t is the force exerted by the shaft

R is the radius of the shaft in mm and it can be obtained by $R = \frac{D}{2}$=1mm.

c) **Known parameters**

The known parameters are:

V=230 volt , I= 4 amp

N=1200 RPM D=2mm

$R = \frac{D}{2}$=1mm

e) **Values of the calculated Variables**

P=230 volt×4amp=1380 W

1W=0.001341 hp based on this P=1.23 hp

$\mathbf{W_t}=\frac{60000 \times\ 1.38KW}{\pi \times 1200rev/min \times 2mm} = 12.25\ KN$

T=12.25KN ×1mm=12.25N.m ≥ 5N. m

d) **Types of Condenser Motor**

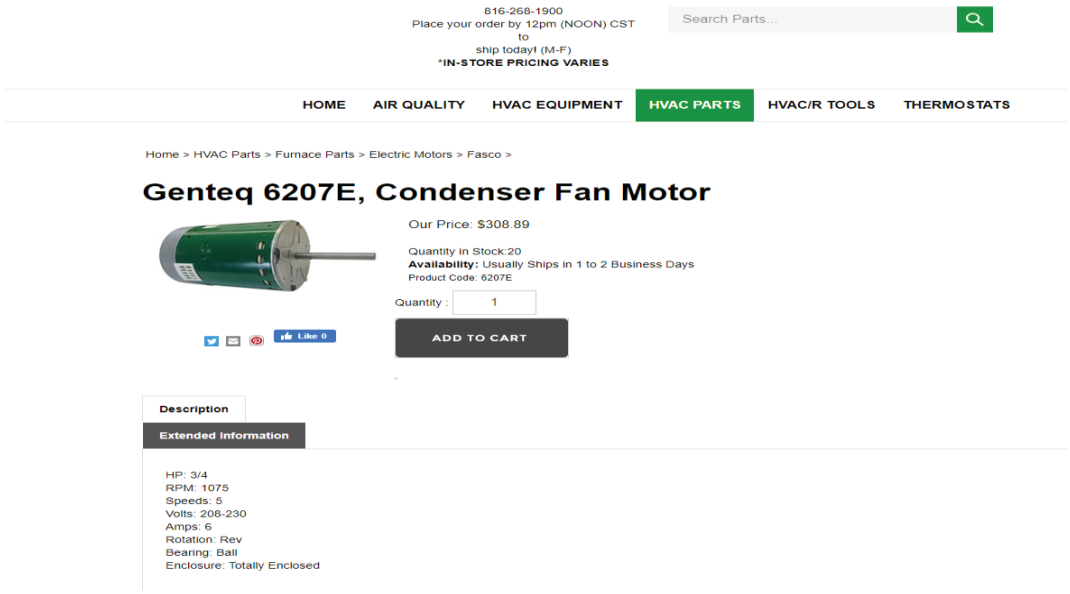


Figure 5.7 is an image condenser motor.

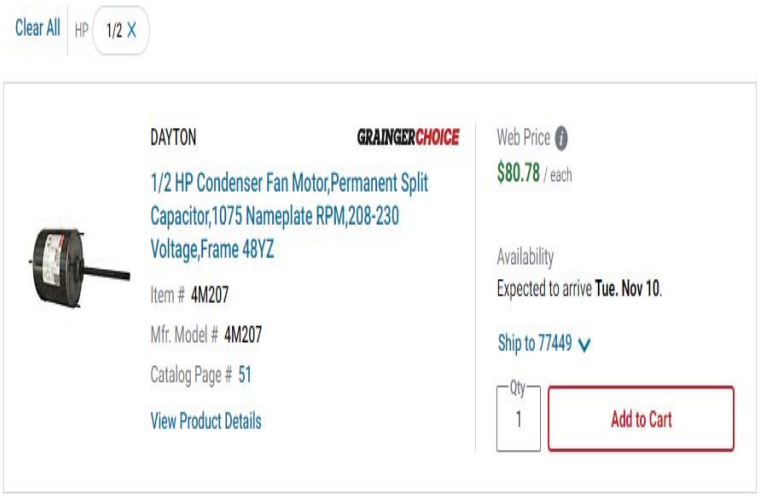


figure 5.8 shows an image of another possible condenser motor.

5.2.1 Analysis on the on the stainless-steel pipe's temperature (corrosion resistance and operating environment)

In this section, the analysis on the stainless-steel pipe are performed by understanding the corrosion resistance and whether it can conduct a laminar flow. To do that, the melting point of the stainless steel has to be known such as the pipe inner and outer diameter.
First, the passive layer on stainless steel can be attacked by certain chemical species. Chloride ion is the most common of these and is found in everyday materials such as salt and bleach. Harsh pitting corrosion is a localized damage that eats pits into stainless steel. In addition to chloride ion, can be caused by elevated temperatures for extended amounts of time or lack of oxygen to the surface. This means that the Nano-Fluid should not incorporate none of the chemical mentioned above because the pipes' layer would not be attacked.

a) Free Body diagram on the pipe.

Figure 5.9 is a representation of the diagram of a laminar and turbulent flow in a pipe. However, in this section the group is trying to achieve a laminar flow, which can be obtained by knowing the inner, outer diameters of the pipe and the Reynolds numbers. To do that, the Reynolds number must be determined. Based on the value obtained it can be said that the flow is:

- **laminar** - when $Re < 2300$
- **transient** - when $2300 < Re < 4000$
- **turbulent** - when $Re > 4000$

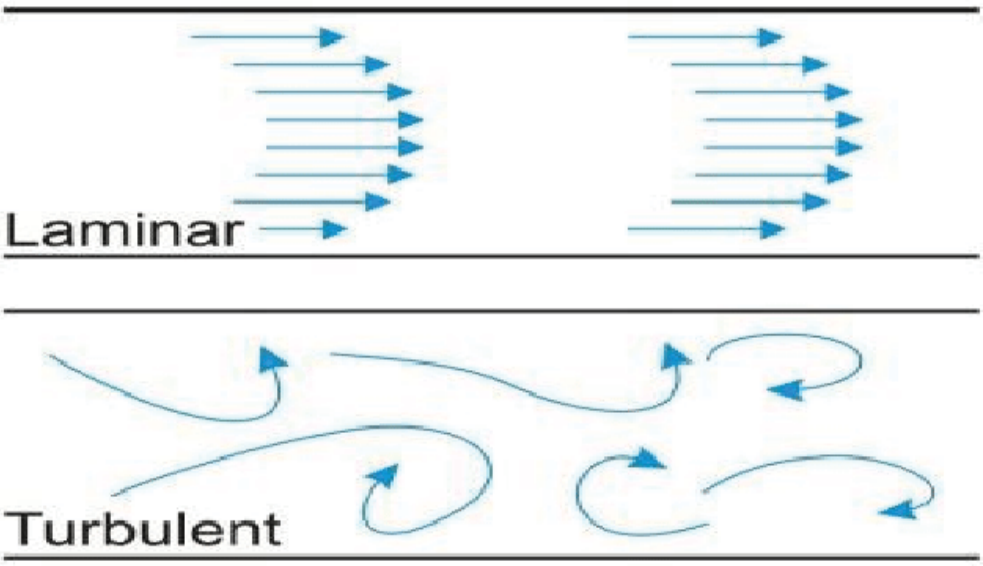


Figure 5.9 laminar and turbulent flow pipes

b) **Analysis Equations**

As stated, before the Reynolds number determine whether or not a flow is laminar, transient or turbulent, which is why it should be determined based on the given inner dimeter D_{in}=22.4 mm. The Reynolds number can be obtained by using the equation:

Re=$\frac{\rho \times u \times L}{\mu}$ (11)

Where:

Re = Reynolds Number (non-dimensional)

ρ = density (~~kg/m³~~, lbm/ft³)

u = velocity based on the actual cross section area of the duct or pipe (m/s, ft/s)

μ = dynamic viscosity of the Nano-fluid (~~Ns/m², lbm/s ft~~)

L = characteristic length (m, ft)

ν = μ / ρ = kinematic viscosity (m²/s, ft²/s)

For specific pipe, L could be calculated by stating that L=D_h where ~~dh~~ = hydraulic diameter (m, ft)

Then, the equation becomes:

Re $= \frac{\rho\, u\, Dh}{\mu}$ Where V $= \frac{\mu}{\rho}$ and $D_h = \frac{4(\frac{\pi D}{4})}{\pi \times D}$ for a circular tube.

Known parameters are D=22.4mm, d=6ft t=1500s V=2cSt

Having as final equation:

Re $= \frac{u\, Dh}{V}$ where: $u = d/t$=6 ft/1500s=0.004ft/s

Re = 0.002, which means the flow will be laminar.

u = velocity (ft/s)

D_h = hydraulic diameter (in)

ν = kinematic viscosity (cSt) (1 cSt = 10-6 m2/s)

Based on the calculation the group came across this pipe on the market.

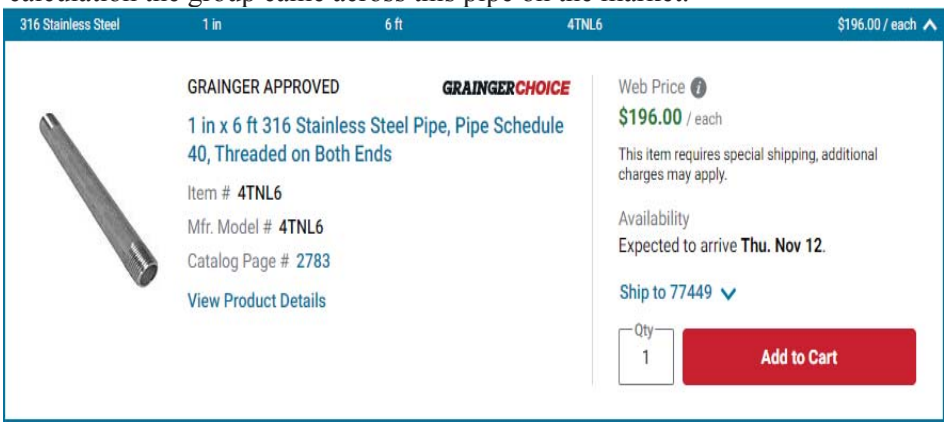


Figure 5.10 shows a figure of the stainless-steel pipe needed

5.2.5 Analysis for determining the pressure drop and maximum flow rate through a pressure control valve.

In order to select the proper pressure control valve, it was important to analyze the maximum allowable pressure drop for the valve and then the maximum flow rate through the valve. The equation below shows the relationship.

a. Free Body Diagram (FBD)

Because liquids are incompressible fluids, their flow rate depends only on the difference between the inlet and outlet pressures (ΔP, pressure drop). The flow is the same whether the system pressure is low or high, so long as the difference between the inlet and outlet pressure is the same. This is represented in Figure 5.11

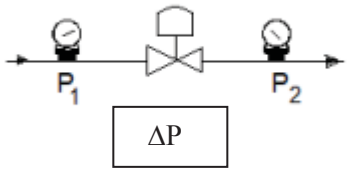


Figure 5.11 Free Body Diagram of the Process in a Pressure Control Valve

b. Analysis Equations

For sizing a control valve, it is important to know how much flow can get through the value for any given opening of a valve for any given opening and any given pressure differential. The relationship between pressure drop and flow rate through a valve is expressed by a flow coefficient (Cv).

$$C_V = Q\sqrt{S/\Delta P} \qquad (12)$$

where,

C_v = valve flow coefficient

Q = fluid flow

S = specific gravity of fluid relative to water

ΔP = Pressure drop (P1 – P2) across the control valve at maximum flow, psi

c. Values of known variables

A reasonable design flow rate would be about 150 gpm.

Since temperature used would be below 200°C, specific gravity would be 1.0

A typical diameter size for the valve would be about 1 inch.
An assumption that the pressure drops of 15 psi.

d. Values of computed variables

With these values, the valve flow coefficient was calculated using equation (12).

$C_V = 150\sqrt{1/15} = 38.7 = 39$

The C_V value is then used as a guide in the valve selection. The valve is much easier to control in the 10 to 80% stroke range. According to the manufacturers guide, a one inch would be appropriate to use. When sizing control valves, a general rule of thumb noted in many engineering publications is to size the valve such that it operates between 20 to 80% open at maximum required flow rate. It is also recommended to have the minimum opening no less than 20% to provide a safety margin at the minimum flow rate required. This approach ensures that as much of the valve control range as possible is used while maintaining a reasonable (but not excessive) safety margin.

e. Specification of Part selected.

Figure 5.12 shows the pressure valve selected. It has a 1-inch valve with bronze EB-45 and threaded.

Figure 5.12 Pressure Control Valve 1 in. Bronze EB-45 Threaded NPT Inlet Pressure Regulating Valve

Figure 5.13 shows the product specification in detail with a general product overview.

Product Overview

The EB-45 Pressure Regulator features a half cartridge design that offers both the performance of a high end, cartridge based valve and the price of a traditional regulator. The EB-45 comes factory set at 45 psi. The pressure may be adjusted to 10 to 70 psi. The EB-45's half cartridge based system allows for easy servicing and installation.

- California residents see Prop 65 WARNINGS
- Compact pressure reducing and regulating valve designed for tight installation considerations
- Solid lead free bronze construction
- Factory set to regulate flow to a safe 45 psi, adjustable from 10 to 70 psi
- Integrated internal by-pass mechanism
- Cartridge based design allows for quick and easy service
- Certified to ASSE 1003 and CSA B356 and listed by ASSE and IAPMO (cUPC)
- Designed for use where inlet pressure does not exceed 400 psi
- Suited for hot (up to 180°) or cold water service

Figure 5.13 Pressure Control Valve Product Overview

5.2.6 Analysis for determining the pressure in a pressure sensor.

In order to determine the pressure from a pressure sensor, the pressure of the fluid flow must be calculated. The pressure sensor is a mechanism that uses the force from the fluid flow to determine the total pressure.

a. Free Body Diagram (FBD)

Figure 5.14 shows the free body diagram of the basic movements on a mechanical pressure sensor. The pressure from the fluid flow will be the force that moves the pointer to display the total pressure at any given moment.

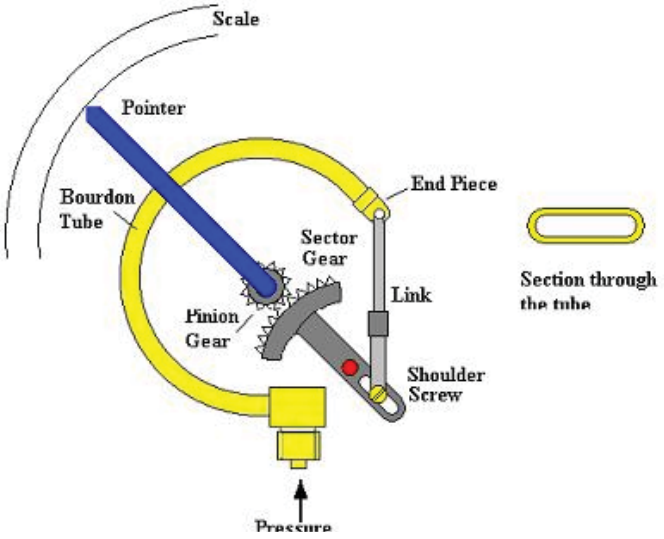


Figure 5.14 Free Body Diagram of a Mechanical Pressure Sensor

b. Analysis Equations

Pressure can be found by calculating the force exerted on a specific area of an object. Pressure is calculated using the equation 2.

$$P = F/A \qquad (13)$$

Here,
F = force
A = cross sectional area of the fluid flow

c. Values of known variables

The value of the cross-sectional area can be estimated to be about .50 in^2

d. Values of computed variables

Depending on the force applied to the mechanism, the device will automatically move the pointer to the appropriate measurement to display the total pressure of the fluid flow.

e. Specification of Part selected.

Figure 5.15 displays the specifications and image of the selected pressure sensor that will be used. It is made out of steel and its max pressure is 200 psi which would be an acceptable measuring mechanism.

Materials	PVC, PTFE/FKM Diaph
Inlet Connection	1/4" MNPT
Installed Gauge	0-200 PSI, Brass, Blk Pntd Steel

Figure 5.15 Mechanical Pressure Sensor Selected with specifications

5.2.7 Analysis Conducted on the flow meter

(a) Free Body Diagram

The free body diagram in Figure 5.16 shows the illustration of a mass balance analysis. In Figure 5.16, the illustration shows the velocity distribution in a cross section. In the cross section you can find the mass flow rate, volumetric flow rate, average velocity, and the cross-sectional area.

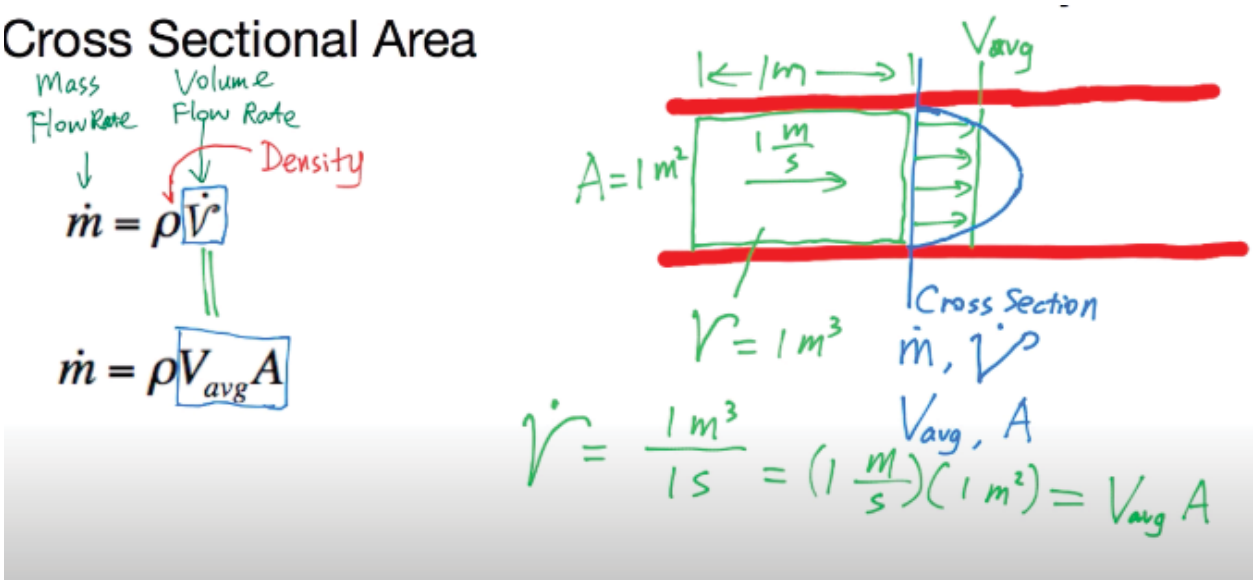


Figure 5.16 Mass Balance Analysis

(b) Analysis Equations

The mass flow rate ṁ can be determined as follows:

$$\dot{m} = \rho = \dot{V} / v = \rho\, A\, \vec{V} = A\, \vec{V} / v \qquad (14)$$

where,

ṁ is the mass flow rate [kg/s]

$\dot{V}$ is the volumetric flow rate [m³/s]

ρ is the density [kg/m³]

v is the specific volume [m³/kg]

$\vec{V}$ is the velocity [m/s]

A is the flow area [m²]

Volumetric flow rate for plane cross-sections is defined by:

$$Q = \dot{V} = A \cdot \vec{v} \qquad (15)$$

where,

$Q = \dot{V}$ is volumetric flow rate [m³/s]
$\vec{v}$ is flow velocity [m/s]
A is the cross-sectional vector area [m²]

(c) Values of known variables

The specific volume (v) chosen was 2 m³/kg
Velocity ($\vec{V}$) was chosen to be 5.0 m/s

An estimate for flow velocity ($\vec{v}$) is 0.6 m/s
Density (ρ) is estimated 9.8 $x10^2$ kg/m³
Area (A) of a cross-sectional is 0.50 $x10^{-3}$

(d) Values of computed variables

With the given values, the mass flow rate was computed using equation (14) to be $\dot{m}$ = 2.45 kg/s
The volumetric flow rate was computed using equation (2) to be Q = 3 $x10^{-4}$m³/s

Figure 5.17 shows the flow meter that was selected to measure mass and volumetric flow rate. Shown in Table 5.3, the flow meter's accuracy for mass and volumetric flow rate, can read the values drawn from the computed equations.

Figure 5.17: iSeries Next Generation Vortex Flow Meters

Table 5.3 Detailed specification for flow meter selected

- Mass or volumetric flow monitoring of gases, liquids and steam
- Inline 1 to 8 inches (25 to 203 mm)
- Accuracy:
  - Mass flow: +/- 1.0% of reading over a 30:1 range (liquids); +/- 1.5% of reading over a 30:1 range (gas & steam)
  - Volumetric: +/- 0.7% of reading over a 30:1 range (liquids); +/- 1.0% of reading over a 30:1 range (gas & steam)
- Flow range (30:1 Turndown):
  - Liquids:
    - 1 ft/s (0.3 m/s) Velocity Minimum
    - 30 ft/s (9.1 m/s) Velocity Maximum

5.2.8 Analysis on the ammeter

(a) Free Body Diagram

The free body diagram in Figure 5.18 shows the Ammeter Design. The Ammeter (A) is connected in series with a resistor to measure the current through the resistor and is in parallel with the voltage (V). In the design, is the makeup of an ammeter, the Galvanometer (G) resistance, shunt resistance (Rp), and current (I). The Galvanometer is a sensitive current detector that is designed with the Ammeter. In the design task, the galvanometer resistance and the current value produces full scale readings on the (G). The value of shunt resistance (Rp) must be found, which allows the flow of the design current.

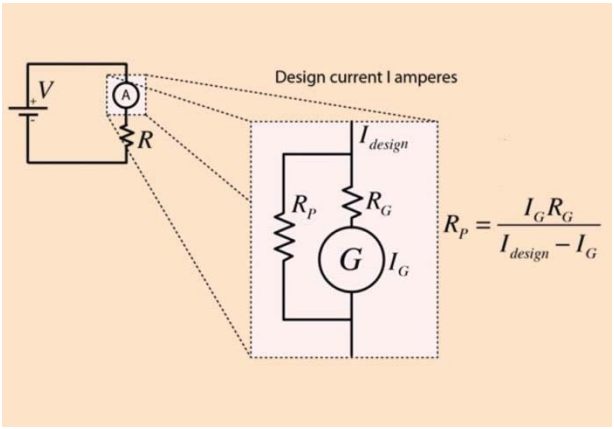


Figure 5.18 Ammeter Design

(b) Analysis Equation

Current flow is calculated using Ohm's Law:

$$I = \frac{V}{R} \tag{16}$$

where,

I is current
V is voltage
R is resistance

The shunt resistance (Rp) equation:

$$Rp = \frac{I_G R_G}{I_{design} - I_G} \tag{17}$$

where,

Rp is shunt resistance [Ω]
R_G is galvanometer shunt resistance [Ω]
I_G is galvanometer current [mA]
I_{design} is current design [amperes]

Voltage (V) equation:

$$V = I_G R_G \tag{18}$$

where,

V is voltage [V]
I_G is galvanometer current [mA]
R_G is galvanometer shunt resistance [Ω]

(c) Values of known variables

A reasonable estimate for shunt resistance (R_G) = 100 Ω
Galvanometer current (I_G) is set at I_G = 3 mA
Current design (I_{design}) was chosen to be I_{design} = 5 amperes

(d) Values of computed variables

With the values chosen, the shunt resistance was computed using equation (17) to be Rp = 0.06 Ω
The voltage was computed using equation (5) to be V = 300 V
The current was computed using Ohm's Law using equation (3) to be I = 5000 amperes

Figure 5.19 is a digital multimeter that measures voltage, current, and resistance. Shown in Table 5.3 the digital multimeter speciation's shows its accuracy level that range with the values drawn from the computed equations.

Figure 5.19 Fluke 179 True-RMS Digital Multimeter

Table 5.3 Detailed specifications

Specifications		
Voltage DC	Accuracy[1]	±(0.09% + 2)
	Max. resolution	0.1 mV
	Maximum	1000 V
Voltage AC	Accuracy[1]	±(1.0% + 3)
	Max. resolution	0.1 mV
	Maximum	1000 V
Current DC	Accuracy[1]	±(1.0% + 3)
	Max. resolution	0.01 mA
	Maximum	10 A
Current AC	Accuracy[1]	±(1.5% + 3)
	Max. resolution	0.01 mA
	Maximum	10 A
Resistance	Accuracy[1]	±(0.9% + 1)
	Max. resolution	0.1 Ω
	Maximum	50 MΩ

5.2.9 Analysis for determining the temperature using the temperature gauge.

(a) Free Body Diagram

The free body diagram shows the insertion of the temperature gauge which will be used to measure the temperature of the nanofluid as it passes through the system. Figure 5.20 shows the appropriate placement of the temperature gauge accompanied with a compression fitting and thermowell which is applied to the system.

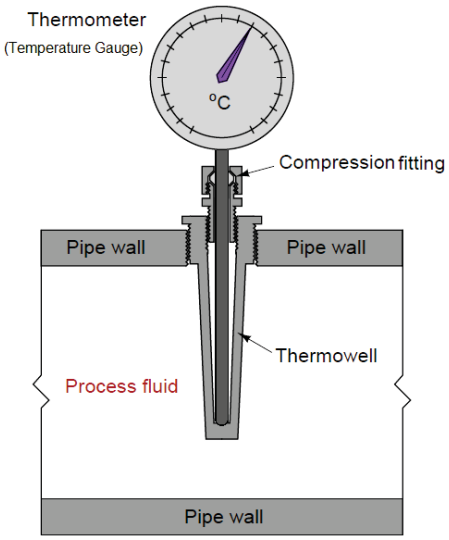


Figure 5.20 Free body Diagram of Temperature Gauge

(b) Analysis Equation

The heat transfer equation below must be derived

$$Q = h * A * dT \quad (19)$$

Through derivation to manipulate the temperature and isolate the variables we have

$$\Delta T = T_{in} - T_{out} \quad (20)$$

Where the change in temperature is represented by ΔT and will be calculated by subtracting the temperature of the nanofluid as it enters the pipe, represented by T_{in}, from the temperature of the nanofluid as it exits the system which is represented by T_{out}.

(c) Values of known variables

A reasonable estimate for the temperature of the nanofluid $T_{in} = 298\ K$ will be chosen for the entrance of the nanofluid through the system while $T_{out} = 278\ K$ will be chosen for the exit temperature for the nanofluid.

(d) Vales of computed variables

Using these values and using equation (20) to compute the change in temperature, $\Delta T = 20\ K$ is determined to be the final measurement of the nanofluids temperature.
Figure 5.21 shows the appropriate temperature gauge that will be selected to conduct the measurement process for the nanofluid temperature.

Figure 5.21

5.2.10 Analysis for determining the voltage utilizing a digital voltmeter

(a) Free Body Diagram

The free body diagram shows the working principle of the process of a digital voltmeter calculating the voltage of the nanofluid within the system. This is shown in Figure 5.22

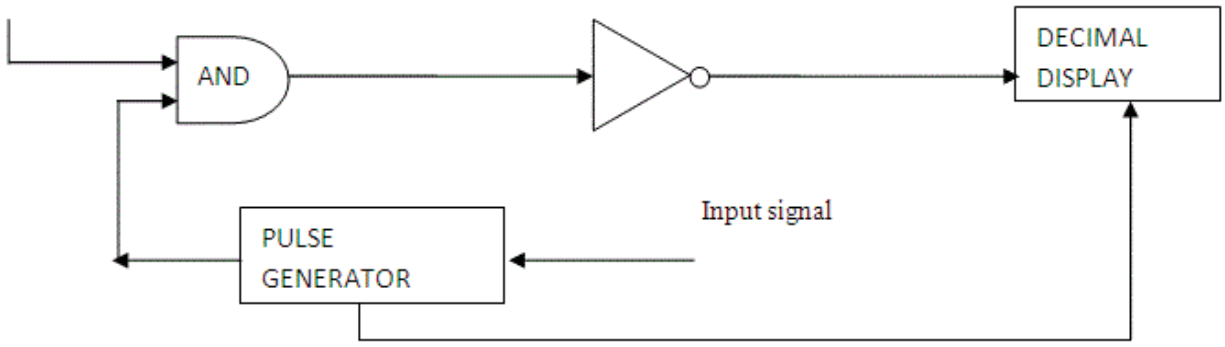


Figure 5.22 Free body diagram of the working digital voltmeter input

(b) Analysis Equation

To calculate voltage, the equation

$$V = I * R \quad (1)$$

Where V represents the voltage, I represents the current which is measured in amps, and R is the resistance measured in ohms.

(c) Values of known variables

A reasonable estimate for the measurement of the current is $I = 2A$ while the resistance estimate is found to be $R = 1\ ohm.$

(d) Values of computed variables

Using equation (1) the voltage comes to be calculated by multiplying the current by the number of ohms.

$$V = 2A * 1ohm$$

Therefore, the voltage is measured to be 2V.

Figure 5.23 is a depiction of the selected digital voltmeter to insure accuracy and precision for measuring the voltage of the nanofluid throughout the experiment.

Figure 5.23

5.2.11 Analysis for aluminum foil

For insulation, aluminum foil will be used. The surface area to be covered will need to be analyzed which would include the diameter of the tube and length.

a. Free Body Diagram (FBD)

The free body diagram showing the length and width of the foil must be considered for insulation. Figure 5.24 shows the FBD where length and width are measured.

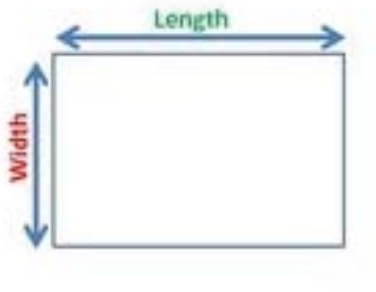


Figure 5.24 Free Body Diagram of an Aluminum Foil Measurement

b. Analysis Equations

$$L\ X\ W = A \qquad (21)$$

Where,
A=Area of the tube
L=Length of foil to cover tube
W= width of the foil wrap around tube

c. Values of known variables

It can be assumed that the surface area to be covered would be about 5 inches.
The length of the foil could be 6 inches to cover the tube.
The width could be about 1 inch.

d. Values of computed variables

To calculate the surface area needed, the known and estimated variables can be substituted to get an idea of how much foil is needed. This is done by using equation 3.

$$6\ in.\ X\ 1\ in. = 6\ in^2$$

e. Specification of Part selected.

Figure 5.25 shows the selected aluminum foil tape chosen. Although it is a half inch in length, it is five yards and it would be sufficient.

↑ Tape Width	Tape Length	Tape Thickness	Tape Shape	Max. Tape Performance Temp.	Min. Tape Performance Temp.	Item #	Price
Series 433L Silicone Adhesive Foil Tape with Aluminum Tape Backing Material							
1/2 in	5 yd	3.5 mil	Continuous Roll	600 Degrees F	-65 Degrees F	45K241	$28.00 / each

Figure 5.25 Aluminum Foil Tape.

5.2.12 Analysis for thermal insulation required to maintain energy and boundary conditions

Since to calculate the coefficient of heat transfer and effective thermal conductivity in nanofluids under different boundary conditions must have a steady insulated flow to have a precision measurements it's crucial that the data remains as close throughout the experiment, using the principles of Dewar Flask the vacuum insulation glass (VIG) will isolate the environment properties of the system.
The calculation for thermal insulation will be mainly induction, convection and radiation, the smaller the values the accurate and better performance the experiment will have. Figure 5.26displays the diagram of the vacuum insulation glass and its function

(a) Free Body Diagram (FBD)

The free body diagram showing the main components and overall functions of the component.
In this mechanism, the VIG will be covering most of the system components to prevent heat transfer between the system and the environment as shown in Figure 5.26

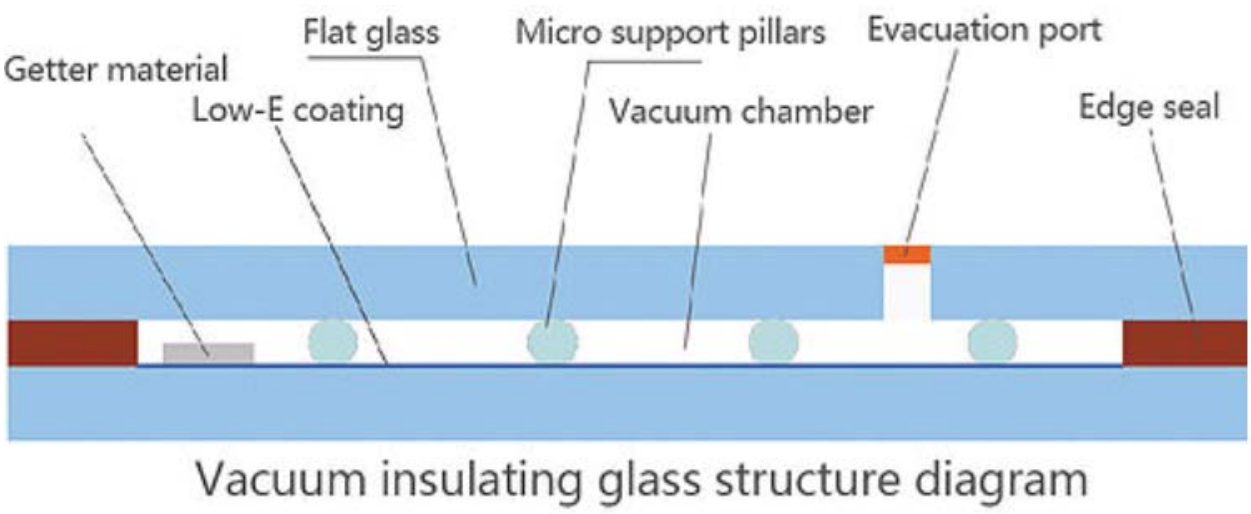


Figure 5.26 FBD of VIG

(b) Analysis Equations

Using the heat transfer equation, a general expression comes up with an equation for the three types of heat transfer. From knowing the environment temperature, the system temperature and the properties of the materials used

$$h = \frac{q}{\Delta T} \text{.....(22)}$$

$where$, h= heat transfer coefficient
q= heat flux
ΔT= difference in temperature between a solid surface and surrounding fluid

Conduction Losses:
These occur when a hot object is in touching contact with a cooler object and heat energy passes from the hot object to the cool one. It can be calculated using the following equation:

= Thermal Conductivity of Material Accepting Heat x Area of Contact x ΔT x 1….(23)
Hour Per Thickness of Material Accepting Heat

Convection Losses:
Heat losses due to convection are more difficult to calculate because there are many ways for heat to be removed from an object through a surrounding medium. The main challenge, among others, is since the convection medium can be motionless or flowing, referred to as natural convection or forced convection.

Convection rates also are affected by the orientation of the object in the medium due to the effects of convection boundary layers in the medium. It can be calculated using the following equation:

= Surface Loss (W/in2) x Area x 1 hr…..(24)

Radiation Losses:
Losses due to radiation usually are insignificant at low temperatures, but they can be a large contributor of heat loss at temperatures above 500oF and should be considered when calculating wattage requirements.

= Radiation Loss (W/in2) x Area x Emissivity x 1 hr……(25)

(c) Values of known variables

A reasonable estimate for the environment temperature $T_e = 22°C$
A standard diameter for the VIG thickness was chosen to be D< 50 mm
Distance between first and second glass panes = 38 to 42 mm

(d) Values of computer variables

With these values, radiation loss was computed using equation ~~(4)~~ to be 0. The convection loss was computed using equation ~~(3)~~ = 20000 W/m^2K. The conduction loss was computed using equation (23) = 98 kW. The coefficient of heat transfer was computed using equation (1) h= 2479 W/m^2K

(e) Specification of part

The VIG must be fully tempered to adapt to low temperature effectiveness and to resist decay caused by glass annealing during high temperature. Energy efficient to eliminate any heat transfer between the system and the environment. Thin structure will have less weight and higher transmittance and optical transparency. Long life proper sealing will have much higher resistance to thermal expansion or contraction caused by the difference between inner and outer surface temperature. Noise reduction to effectively block sound transmission effect against mid and low frequency noises. High adaptability to be suitable for installation at any position. An example of the component shown in Figure 5.27 and 5.28

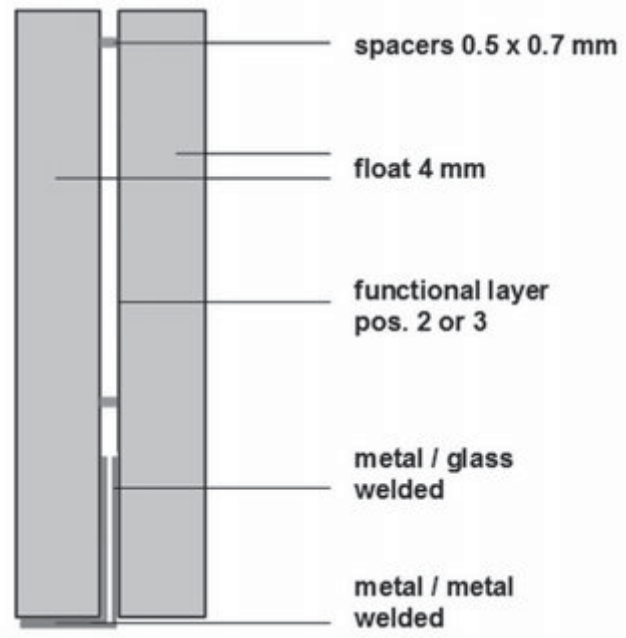


Figure 5.27 Vacuum insulation glass

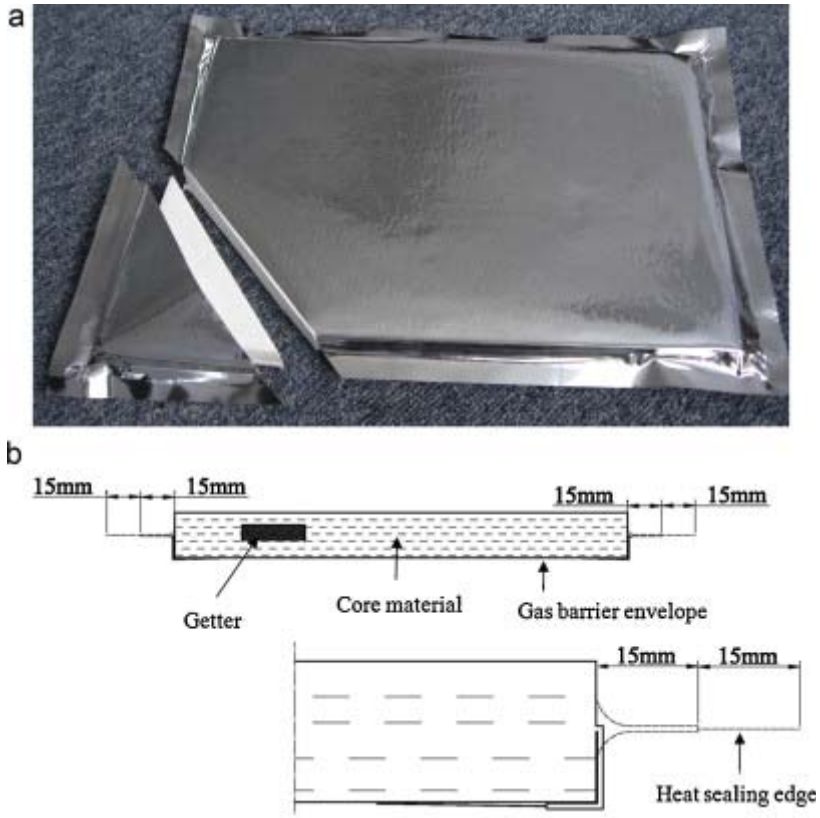


Figure 5.28 Vacuum insulation panel with glass fiber

5.2.13 Force analysis for the magnet(electromagnet)

Since a magnet has to be used an analysis is has to be conducted on the magnetic force that this magnet can have the piece of metal attracted to it. The choice of an electromagnet emerged has it allows to control the magnetic force and the magnetic field by adjusting a current going through it

a) Process diagram of an electromagnet

Figure 5.29 represents the process diagram of a electromagnet with current flowing in and out.

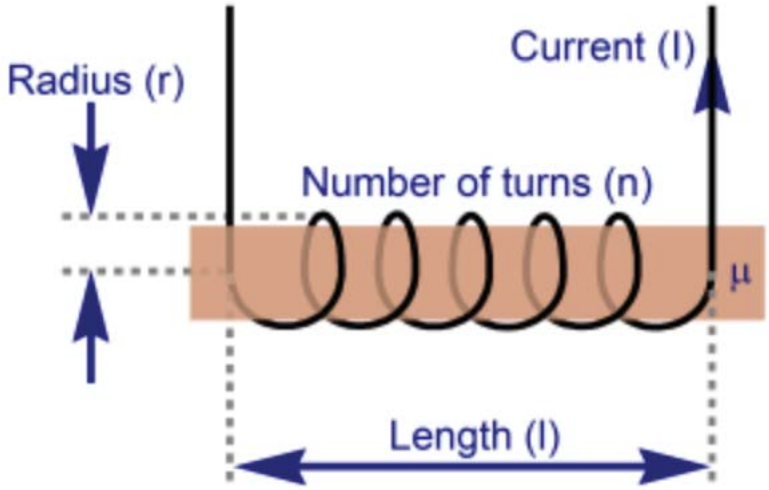


Figure 5.29 electromagnet Process diagram

b) Analysis equation

The force of an electromagnet can be used by the next formula

$$F = (n * i)^2 * \mu * \frac{A}{2 * g^2} \qquad (26)$$

$$i = \frac{wattage}{voltage}$$

F= magnetic force
N=number of turns of the coil
i=current
μ=magnetic constant
A=area
g=length of the gap between the solenoid and the piece of metal

and

$$\mu = 4 * pi * 10^{-7}$$

Depending on the magnetic force that is wanted most parameter can be adjusted but the magnetic constant making electromagnets good choices for the current project

c) Known variables values

.

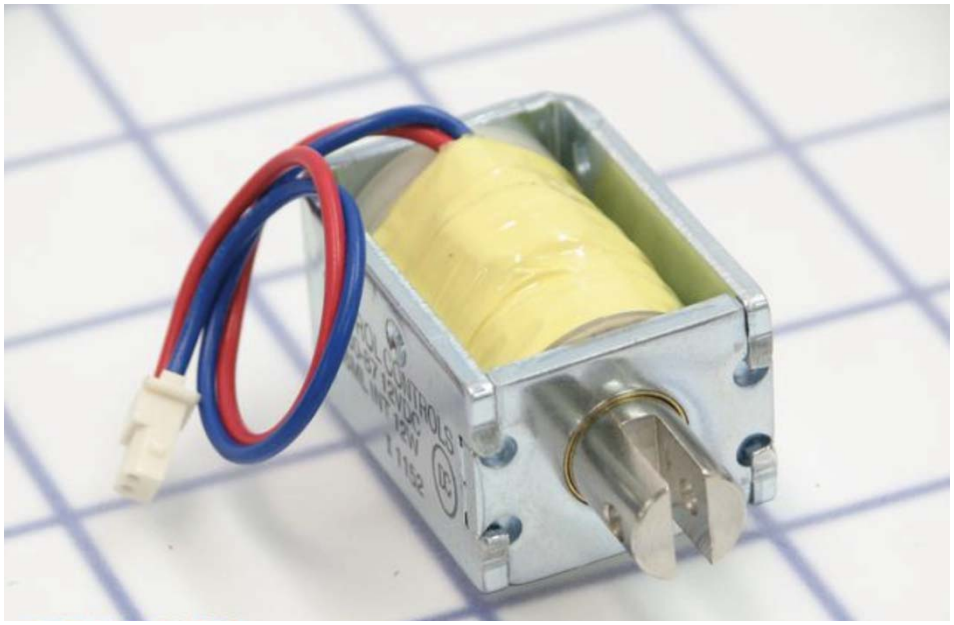
n=67312
A=0.00785m^2
Voltage=6V
wattage=150 W
g=0.022m

d) Values of calculated variables

From the formulas and the known variables And using equation 26
i=25A
F= 55.60

e) Chosen electromagnet

For application it will be really useful to use Deltrol Controls Solenoids, D26-ML Series. The Current is 25 A. It is represented in figure 5.30 with the corresponding specs



Specifications

Item Number:	53800-86
Brand:	Deltrol Controls
Item Category:	Solenoids
Series:	D26-ML
Style:	Magnetic Latching
Coil Voltage:	6 VDC
Coil Power:	150 Watts
Maximum Force:	200 Ounces
Duty Cycle:	Intermittent
Max Stroke Length:	0.9 Inches
H x W x D:	1.02 in x .79 in x 1.42 in
Net Weight:	3.9 oz

Figure 5.30 Deltrol Controls Solenoids, D26-ML Series

Grading Scheme for Status Report 8
Detailed Engineering Analysis

Project Group # 3

Item	Description	Maximum Points	Your Score
1	Table listing description of items for which analysis are needed, description of type of analysis needed and the subject area of the analysis	25	
2	Signature of advisor	10	
2	Well planned and detailed analysis of each part with free body /other diagrams provided where needed.	140	
3	Parts specifications resulting from the analysis	20	
4	Assignment attached	5	
	Total	**200**	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: Detailed Engineering Analysis
GROUP NUMBER: 7
Progress Report Title: Status Report IX
Due Date: 11/19/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan** *Daniel Akpan*	- Analysis for section 5.2.1 -Contribute with group report -Attend meetings -Conduct team evaluations	100%	
2	**David Trevino** *David Trevino*	- Analysis for section 5.2.5 -Contribute with group report -Attend meetings -Conduct team evaluations	94.85%	
3	**Amna Ansari** *Amna Ansari*	- Analysis for section 5.2.4 -Contribute with group report -Attend meetings -Conduct team evaluations - Complete meeting minutes	100%	
4	**Demetrious Sandford** *Demetrious Sandford*	- Analysis for section 5.2.2 -Contribute with group report -Attend meetings -Conduct team evaluations - Proofread full report	100%	
5	**Caleb Riggins** *Caleb Riggins*	- Analysis for section 5.2.6 -Contribute with group report -Attend meetings -Conduct team evaluations -Verify and correct technical writing	100%	
6	**Ximena Cifuentes** *Ximena Cifuentes*	- Analysis for section 5.2.6 -All chapter and main section introduction paragraphs -Contribute with group report -Attend meetings -Conduct team evaluations -Help format	98.57%	
7	**Aamna Jangda** *Aamna Jangda*	- Analysis for section 5.2.3 -Contribute with group report -Attend meetings -Conduct team evaluations - Help format	100%	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report 9 on Detailed Engineering Analysis by Group

Due: 11/11/2020

This status report is a part of Chapter 5 of your final report. Chapter 5 contains the following sections and this assignment covers the first two highlighted sections.

5. DETAILED SYSTEM DESIGN …….. 40
5.1 **Identification and Plans for Types of Analysis Needed for the Design** …….. 40
5.2 Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design……. 45
~~5.3~~
~~5.4 Engineering Analysis and Simulation …….. 47~~
~~5.5. Layout/Detailed Drawings/Equipment selection and specifications …….. 48~~
~~5.6 Application of Engineering Codes and Standards in design . 49~~
~~5.7 Economic Analysis ……..55~~
~~5.8 Fabrication and Testing …….. 58~~

5. DETAILED SYSTEM DESIGN

1. Provide an introductory paragraph for this chapter using the information about the content of this chapter provided above.

5.1 Identification and Plans for Types of Analysis Needed for the Design

Provide an introductory paragraph for this section making use of what is to be done in question 2 below.

2. Make a table containing the list of items in your system for which some form of engineering analysis will be needed in order to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis

Approval by Project owner: Name_____ Signature _____

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

Provide an introductory paragraph for this section making use of what is to be done in question 3 below.

3. Perform detailed engineering analyses required to **design**, **specify,** and **size** all components of the system you are designing as planned in Table 5.1. Depending on your type of project, the detailed analysis may consist of but not limited to (1) thermal analysis (heat transfer and thermodynamics), (2) fluid mechanics analysis, (3) machine elements & machine design analysis of project elements, (4) kinematics analysis of moving elements, (5) power and energy analysis, (6) electrical energy/storage analysis, (7) structural/strength of materials analysis, (8) control analysis including programming, (9) geometric analysis to define shape and size, (10) special analysis specific to design such as chemical reactions, etc., and (11) manufacturing processes that may be required for the project. Provide adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

(i) For each analysis, provide a sub-title, followed by a brief description, then provide either a free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables), then using the equation editing feature of MS Word, provide the equations needed for the analysis. The variables in the equations should be defined right after the equation.

(ii) Then without directly substituting values into the equation, provide the values of the known variables, followed by the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

(iii) Provide specification for the specific part if the part is selected after the analysis for that part.

(iv) **On the cover page of this assignment indicate the sections of the analysis (sections 5.2.1, 5.2.2, 5.2.3, etc) contributed by each member.**

Note that the analysis should be fully descriptive and that you may provide equation numbers that can then be cited in the report.

Question 3 should be answered using the subsection example below:

5.2.1 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

5.2.2 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

This section contains notes for you.

NOTES ON DESIGN ANALYSIS
DETAILED ENGINEERING ANALYSIS NOTES AND SAMPLE

Detailed engineering analyses required in order to **design**, **specify,** and **size** all components of the system you are designing must be provided. Depending on your type of project, the detailed analysis may consist of but not limited to

(1) thermal analysis (heat transfer and thermodynamics),
(2) fluid mechanics analysis,
(3) machine elements & machine design analysis of project elements,
(4) kinematics analysis of moving elements,
(5) power and energy analysis,
(6) electrical energy/storage analysis,
(7) structural/strength of materials analysis,
(8) control analysis including programming,
(9) geometric analysis to define shape and size,
(10) special analysis specific to design such as chemical reactions, etc.,
(11) manufacturing processes that may be required for the project.
(12) providing adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

IMPORTANT INSTRUCTIONS TO FOLLOW
For each analysis, provide the following:

A sub-title for the specific design parameter being calculated, followed by a brief description,
1. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
2. Then using the equation editing feature of MS Word, provide the equations needed for the analysis and define all of the variables in the equations right after the equation.
3. Provide the values of all known variables
4. Without substituting values directly into the equation, provide the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

An example analysis based on the 4 analysis steps is provided.

5.2.1 Analysis for determining the power required for lifting mechanism and selection for DC Motor

Since DC motors were to be used to drive components for 3 out of 5 of the functions of the design, its selection was based on the output torque required by the most arduous function. Therefore, for the general analysis to get the servo motor specification, the torque calculation for lifting a 4 lb weight was used. It was assumed that the 4 lb weight would be the heaviest load the robot had to lift. 4lbs was selected for the weight in order to ensure that the robot lifted a load that was safe. The competition gave no specification for the amount of weight that needed to be lifted.

The calculation for the lifting torque is provided below. The free body diagram below depicts the forces that would act on the system during the lifting procedure. Figure 5.2 displays the free body diagram of the lifting component showing all the forces. Figure 5.3 shows the initial ideal design for the robot, which also shows the location of each of the functions.

(a) **Free Body Diagram (FBD)**

The free body diagram showing the lifting mechanism and the forces acting is shown in Figure 5.2

In this mechanism, a gear driven by an electric motor engages with a vertical shaft whose gears mesh with the rotating gear driven by the electric motor. The load to be lifted is placed on a platform fixed to the vertical geared shaft as shown in the Figure 5.2

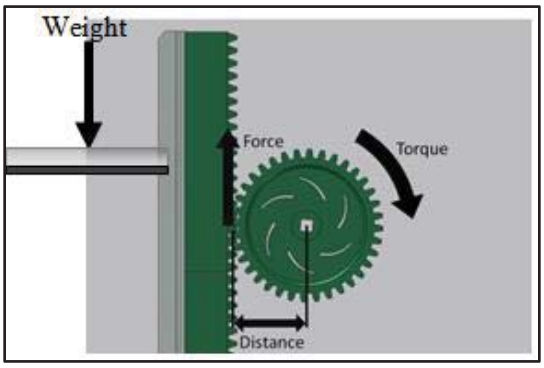


Figure 5.2 Free Body Diagram of Lifting Component

(b) **Analysis Equations**

Using the force equilibrium equation, a general expression was derived to come up with an equation for the power. Then, from knowing the linear speed of the ascending platform, the rotational speed of the pinion (which is connected to the shaft) was determined.

$$F_y = F_{applied} - W = 0 \quad (1)$$

(The assumption was that power was to be transmitted so that the rack would translate upward at a constant velocity). Therefore,

$$F_{applied} = W \quad (2)$$

and the power, P, required is given by

$$P = F_{applied} V_{avg} \quad (3)$$

where,

$F_{applied}$ is the force applied by the motor

W is the weight of the mass (the weight is **overloaded** to ensure that the motor is not underspecified)

P is the power delivered by the motor

V_{avg} is the average velocity for lifting the weight

The average speed for the lift was assumed and the rotation speed for lift was approximated by the following equation:

$$N = \frac{60 V_{avg}}{\pi D_{gear}} \quad (4)$$

where N is the rotational speed for the motor shaft in RPM

D_{gear} is the diameter of the pinion.

Knowing the power and the rotation speed, the torque transmitted was then calculate using.

$$T = \frac{60P}{2\pi N} \quad T = \frac{P}{n*\left(2*\frac{\pi}{60}\right)} \quad (5)$$

where T is the torque provided by the motor

(c) Values of known variables
A reasonable estimate for the linear velocity, V_{avg} **= 0.98 ft/s** was chosen for the lift speed.
The weight to be lifted was set to be W = **4 lb**.
A standard diameter for the pinion was chosen to be D= **2.5 inches** (0.21 ft)

(d)Values of computed variables
With these values, the power was computed using equation (3) to be P=**3.92 lb. ft/s** (Customary Units)
The rotational speed was computed using equation (4) to be N=89.1 RPM using EES program
The torque was computed using equation (5) to be T=0.42 ft-lbf (5.04 in-lbf) using EES program

Figure 5.3 shows the DC motor that was selected to carry out the lifting function. From the calculated results and the specification of this specific DC motor as shown in Table 5.2, the motor has enough torque to actuate the lifting mechanism at the assumed average velocity.

Figure 5.3: VEX 2-wire DC motor

Table 5.1 Detailed specification for motor selected

2 Wire Motor 393

- Free Speed: 100 rpm (As Shipped)/160 rpm (High Speed Option)
- Stall Torque: 1.67 N-m (14.76 in-lbs) (As Shipped)/1.04 N-m (9.2 in-lbs) (High Speed Option)
- Stall Current: 4.8A
- Free Current: 0.37A

Note: All motor specifications are at 7.2 volts.

5.2.2 Analysis for determining xxxxxx

Grading Scheme for Status Report 8
Detailed Engineering Analysis
Project Group #_____

Item	Description	Maximum Points	Your Score
1	Table listing description of items for which analysis are needed, description of type of analysis needed and the subject area of the analysis	25	
2	Signature of advisor	10	
2	Well planned and detailed analysis of each part with free body /other diagrams provided where needed.	140	
3	Parts specifications resulting from the analysis	20	
4	Assignment attached	5	
	Total	**200**	

5. DETAILED SYSTEM DESIGN

1. Provide an introductory paragraph for this chapter using the information about the content of this chapter provided above**.**

This chapter identifies and displays a plan for the different types of analysis needed to effectively design the skimmer. In addition, this chapter details the engineering analysis and simulation for designing. Also, the chapter identifies the sizing specification and the selection of parts for the design. Moreover, the chapter displays the full engineering analysis and simulation of the design and the layout of detailed drawings and the Equipment selection with specifications. Finally, the chapter makes available the list of the application of engineering codes and standards in design, the economic analysis, fabrication and testing of the skimmer design.

5.1 Identification and Plans for Types of Analysis Needed for the Design

This section includes a list of the different types of analysis needed for the skimmer design. The list can be observed in Table 5.1 where the specific analysis identified is linked with a specific component, subject area, and the reference from which the information was obtained. In order to generate Table 5.1, the team reviewed each one of the concepts selected in the concept's evaluation phase of the project. As each concept was reviewed, the team generated a list of different types of analysis required to successfully complete each one of the functions each concept was required to fulfill.

2. Make a table containing the list of items in your system for which some form of engineering analysis will be needed to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

Table 5.1 contains the main components of the skimmer design along with a list of different analysis that were performed to ensure the most effective part selection.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis
5.2.1	Disk	Determining ORR AND RE of various oil slick with a grooved disk to determine the best in the market	ORR(Oil recovery rate), RE (Recovery Efficiency)	Fluids Mechanics
5.2.2	Pump	Calculate the flow rate of a pump	Fluid Mechanics	Fluid Mechanics Fundamentals and Applications
5.2.3	Shaft	For the shaft analysis, diameter and length were calculated to meet dimension criteria that fits the skimmer, the rotational speed was calculated to determine how fast the discs can rotate without failure.	Shaft Analysis, Mechanics and dynamics of cylindrical rod.	Mechanical Engineering Design
5.2.4	Components size	Calculate the oil skimmer major component Dimension; skimmer shell, oil container, grooved discs and, grooved drums	Dimensional analysis	
5.2.5	Motor	Calculated torque and power	Machine Design	Shigley's Mechanical Engineering Design
5.2.6 ~~5.2.6~~	Floating mechanism Skimmer shell	Buoyancy	Physics Fluids	Fluids Mechanics Book

Approval by Project owner: Jaejong Park_____ Signature _____

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

This section has been identified as the breakdown of each one of the relevant analyses identified in section 5.1 of the chapter. In each subsection of section 5.2, the free body diagrams that show all of the known and unknown forces acting on the part analyzed are displayed. In addition, the subsections will include process diagrams when applicable. These diagrams display all the input and output variables relevant to the analysis and are vital to the development of the design. Moreover, the following subsections will include the set of equations needed for each analysis along with each variable description located under the equations. Also, each analysis section will include the values of all of the known variables and its computational methods. These will include the final computed variables and the parts specification if the part was selected for the final skimmer design.

3. Perform detailed engineering analyses required to **design**, **specify,** and **size** all components of the system you are designing as planned in Table 5.1. Depending on your type of project, the detailed analysis may consist of but not limited to (1) thermal analysis (heat transfer and thermodynamics), (2) fluid mechanics analysis, (3) machine elements & machine design analysis of project elements, (4) kinematics analysis of moving elements, (5) power and energy analysis, (6) electrical energy/storage analysis, (7) structural/strength of materials analysis, (8) control analysis including programming, (9) geometric analysis to define shape and size, (10) special analysis specific to design such as chemical reactions, etc., and (11) manufacturing processes that may be required for the project. Provide adequate design analysis and information for projects requiring the selection of

control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

(i) For each analysis, provide a sub-title, followed by a brief description, then provide either a free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables), then using the equation editing feature of MS Word, provide the equations needed for the analysis. The variables in the equations should be defined right after the equation.

(ii) Then without directly substituting values into the equation, provide the values of the known variables, followed by the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

(iii) Provide specification for the specific part if the part is selected after the analysis for that part.

(iv) On the cover page of this assignment indicate the sections of the analysis (sections 5.2.1, 5.2.2, 5.2.3, etc) contributed by each member.

5.2.1 Analysis for determining ORR (Oil recovery rate) and RE (Recovery Efficiency) through various oil slick with grooved disk

In this section, the analysis for determining oil recovery rate and recovery efficiency is discussed. One disadvantage of the traditional smooth surface disk skimmers led to the development of innovative surface geometries targeting enhanced oil recovery performance. One of the most effective surface geometry enhancements was the addition of grooves to the disk. Disk skimmers with grooves, showed up to 200% increase in the recovery efficiency (RE) and an increase in the oil recovery rate (ORR).

a. Process diagram

The process diagram shown in figure 5.1 displays how the disk collects oil from water based on the test that's going to be performed below.

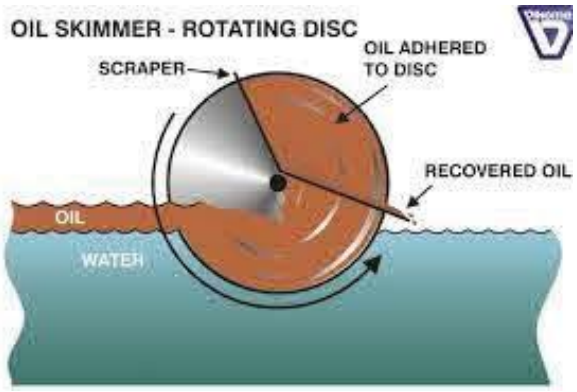


Figure 5.1 Process diagram of disk in action.

b. Equations needed for the analysis (with all variables defined under the equations)

To analyze the ORR (Oil Recovery Rate) and RE (Recovery Efficiency) at various oil slick, consider the slick thickness, disc speed and collection time. We can apply the general equation below:

$$ORR = \frac{Voil}{T}$$

Where: Voil = Volume of oil recovered, liter or gallon (1)

T= Elapsed time of recovery, minutes

And: $$RE = \frac{Voil}{Vtotal\ fluid} \times 100 \quad (2)$$

Where: Vtotal fluid = Volume of total fluid (Water and oil) recovered

Theoretical calculation will be used to identify the amount of oil can be recovered and efficiency using grooved disc type oil skimmer. This calculation consists of several components, disc rotation, test duration, and slick thickness. Thus, such components can be expressed in form of following formula:

$$Amount\ of\ recovered\ oil\ spill\ = \ rotation\ speed \times time \times slick\ thickness \quad (3)$$

Where:

Rotation speed: Disc rotation (rpm)

Time: Duration taken during each test (s)

Thickness: Oil thickness (mm)

c. Values of all known variables

The values attached to the rpm, are the various speeds the skimmer can operate on. The values attached that come with time, are the duration each test was performed. The values attached to the slick, are different oil thickness the test was performed. These values are standard ASTM F2709 for oil skimmer testing.

Rotational speed (rpm): 5.5, 6, 10, 25, 34, 36

Collection times (s): 60, 63, 69, 70

Slick thickness (mm): 6, 12, 25, 50, 75

d. Method of computation and final values of computed variables.

Results and the specification of the specific disk is shown in Table 5.2.(Numbers in blue are the averages)

Using the computer software EES and expanding equation (3) Table 5.2 includes the analysis result:

Table 5.2 Analysis Results

Slick Thickness (mm)	DISC Speed (rpm)	Collection Time (s)	Oil Recovery Rate (L/min)/(gpm)	Recovery Efficiency (%)
75-50	36	69	284/75	77
75-50	36	63	322/85	85
75-50	34	70	307/81	87
			307/81	**83**
50	25	60	242/64	85
50	25	60	227/60	84
50	25	60	238/63	84
			235/62	**85**
25	10	60	68/18	72
25	10	60	76/20	75
25	10	60	72/19	80
			72/19	**76**
12	6	60	38/10	84
12	6	60	42/11	68
12	6	60	30/8	75
			38/10	**76**
6	6	60	26/7	62
6	5.5	60	19/5	68
6	5.5	60	23/6	65
			23/6	**65**

e. Specification of part if part is selected

Figure 5.2 shows the disk that best represents the groove depth and scrapper in which the disk skimmer and should possess. The X30 skimming system uses the latest patented grooved disc technology for recovering oil from the surface of water. The system recovered 4,670 gallons per minute (1,060 cubic meters per hour) at an average 90 percent efficiency while being officially and independently tested at the Ohmsett facility in New Jersey.

Figure 5.2 Elastec grooved disc X-30 skimmer

5.2.2 Analysis for determining the flow rate of a Pump

A pump is essential in our design to pump the excess amounts of water out of the skimmer system. The flow rate of the pump, also known as the capacity, measures the volume of liquid that travels through the pump with respect to time. With a low desire of the water intake, the pump will help lower the collection rate by pushing the excess water out.

a. Process Diagram

Figure 5.3 is a free-body diagram of the pump system, showcasing how the pump works

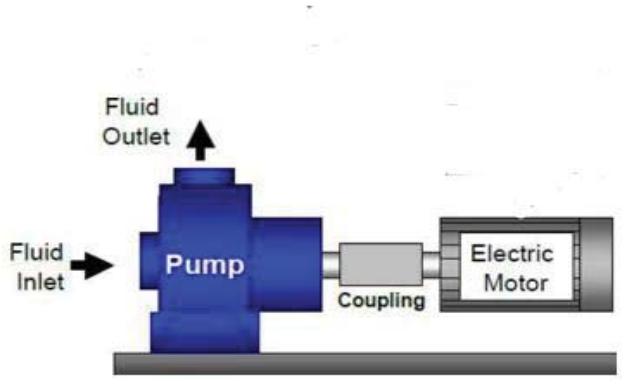


Figure 5.3 Pump and Electric Motor

b. Equation Analysis

The equation to find the flow rate is shown below

$$Q = V\frac{V}{T}$$

Where,
Q= Volume Flow Rate or Capacity (gpm) or (L/min)
V= Flow (Gallons) or (Liters)
T= Time (minutes)

c. Values of known variables

Utilizing the known variables,and assuming the body of water contains over 27.5 gallons of water (1 Gallon = 3.785 Liters), and time given is 2 min,

V_total= 27.5 gal
T= 2 min

d. Values of computed variables

By plugging the values above into the following equation
Flow Rate, Q = 13.75 gpm
Flow Rate, Q = 52 L/min

e. Specification of part if part is selected

Figure 5.4 displays a Xylem Magnetic coupling water pump. The pump will be used to assist with the skimmer operations. In addition, Table 5.3 contains the specifications of the pump in figure 5.4 which directly aligns with the functions of the skimmer.

Figure 5.4 Xylem, 230 V Magnetic Coupling Water Pump 52L/min

Table 5.3 specifications for figure 5.4

Specifications	
Input connection	.5 in BSP
Maximum flow rate	52 L/min
Brand	Xylem
Input Power	.06 kW
IP Rating	IPX5
Body material	Polypropylene
Coupling type	Magnetic
Supply Voltage	230 V
Maximum head	6.8m

5.2.3 Shaft analysis to calculate the best material and rotational speed of the shaft.

In this subsection, the horizontal shaft in which the rotating discs are mounted will be displayed. First, a diagram displaying the location of the shaft along with the forces acting upon it is shown. Secondly, the equations used for determining torque and shaft rotation speed were determined. In addition, the values of all known and computed variables are displayed. Finally, a good material for use in building the shaft is chosen.

a. Process Diagram & Free Body Diagram (FBD)

The diagram showing the rotation and direction of motion is shown in Figure 5.5. In this figure, the placement of the horizontal shafts is shown along with a rotation powered by the motor. On the horizontal shaft multiple discs are mounted, one end is connected to the DC motor to power the rotation at 45 rpm.

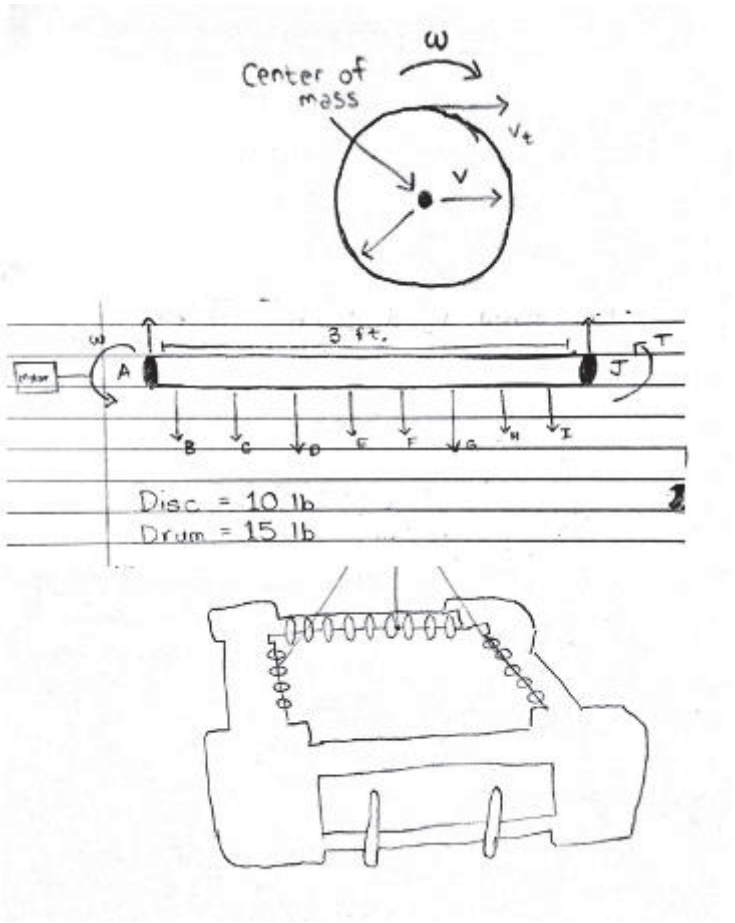


Figure 5.5 Process/FBD of shaft

b. Analysis Equations

~~The diameter of the shaft was calculated using~~

Using shaft analysis, equations were derived to find the torque and rotational velocity. Then, from knowing the power coming from the motor, the rotational speed of the shaft was determined.

$$T = \frac{63025H}{n} \qquad (1)$$

H= Power in hp

n = Speed of rotation of shaft in rpm

$$\text{丁} = \frac{Tr}{J} = \frac{16T}{\pi d^3} \qquad (2)$$

丁= Allowable stress lbf

T= Torque in lbf*in

$$d = \frac{16T}{\pi \text{丁}} \qquad (3)$$

d = Diameter of shaft in inches.

$$V = \frac{\pi d n}{12} \qquad (4)$$

V= Velocity in ft/s^2

$$\omega = V / 2\pi r \qquad (5)$$

r= Radius of shaft in inches
ω = Rotational speed in RPM

c. Values of known variables

A reasonable estimate for Power(H) was set to be 15 hp
The rotation of the disc speed(n) was set to be 20 rpm
~~The allowable stress(ʃ) was set to be 15 kpsi~~

d. Method of computation and final values of computed variables.

With known values, the torque was computed using equation (1) to be **T=4726 lbf*in**
The diameter for the shaft was calculated from equation (3) to be D= **2.5 inches** (0.21 ft)
With known values, the velocity was computed using equation (4) to be **V=13.09 ft/s^2**
The rotational speed was computed using equation (5) to be ω =**1.65 RPM**

e. Specification of part if part is selected

Stainless steel, 3 ft in length and 2.5 inches in diameter. Figure 5.6 shows the images of the shafts that will need to be purchased [1]. Stainless steel is used as the material because it does not rust or corrode when exposed to water.

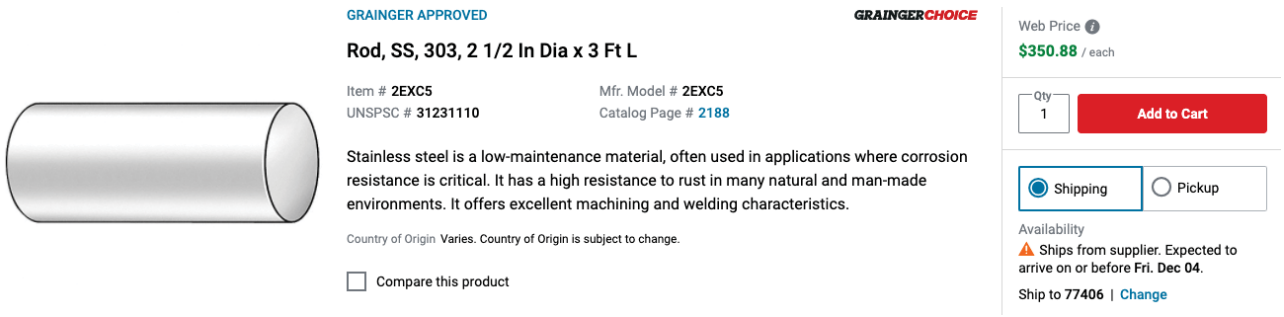


Figure 5.6 Stainless Steel Shafts

5.2.4 Analysis for determining the appropriate motor for the skimmer proposed design

A motor must be used in the design to power the shaft and rotate the disc. An analysis to determine the torque is necessary to yield the ability to perform work. Using similar disc motors, the torque was analyzed and calculated. Additionally, using the value obtained from the torque, the power was calculated.

The calculation of the torque is provided below and the figure 5.7 shows the rpm and torque acting upon an electric motor

a. Process Diagram

Figure 5.7 displays a free body diagram demonstrates the rpm and torque acting upon an electric motor.

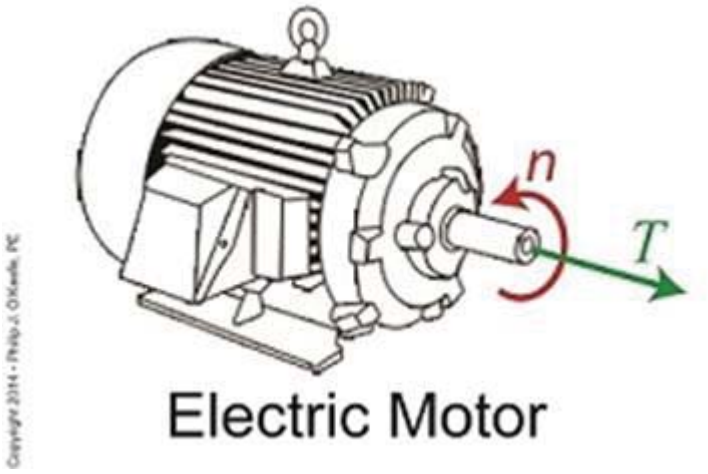


Figure 5.7 Calculating Torque of an Electric Motor

b. Analysis equations

$$Tinlb = \frac{Php * 63025}{n}$$

Where

$$Tinlb = torque, lbf$$
$$Php = Horsepower\ delivered\ by\ the\ electric\ motor, hp$$
$$n = Revolution\ per\ minute, rpm$$

$$Power\ (Kw) = \frac{2\pi * n * T(nm)}{60}$$

Where

$$Power = Product\ of\ a\ torque\ of\ the\ shaft, Kw$$
$$n = Revolution\ per\ minute, rpm$$
$$T = torque, nm$$

For motor MG07A1

$$Php = 0.068hp$$
$$n = 7\ rpm$$
$$T = 1.3558\ nm\ (Converted\ from\ 585.23\ lbf)$$

c. Values of non-variables

The known variables were taken from similar motors on current oil skimmers. Table 5.4 displays the motor specifications.

Table 5.4 Various motors specification

Motor Number	Volts	Hz	LRA	RPM	Watts	HP	Fan
MG07A1	115	60	0.43	7	49	0.065	Y
MG02A1	115	60	0.43	2	49	0.065	Y
MG06E1	220	50	0.22	6	48	0.064	Y

For motor MG07A1

Php = 0.065 hp

n = 7 rpm

Additionally in order to calculate the power we use the value obtained from the torque

Torque =1.3558 nm (Converted from 585.23 lbf)

d. Values of computed variables

By plugging these values into the equation above. We found the torque for a MG07A1 motor to be:

$$Tinlb = \frac{0.065 * 63025}{7}$$
$$Tinlb = 585.23\ lbf$$
$$Power\ (Kw) = \frac{2\pi * 7 * 1.3558}{60}$$
$$Power(Kw) = 0.993$$

e. Specification of part if part is selected

Figure 5.8 shows the selected electric motor that can give us ~~585.23 lbf.~~

Figure 5.8 Electric Motor

5.2.5 Analysis for determining the appropriate dimensions for the oil skimmer design.

In this subsection, the analysis of the skimmer's dimension is being proposed. This section includes a skimmer component diagram that displays a U-shaped Oleophilic skimmer with all its major design components dimensions. The free body diagram is followed with a table that presents all the proposed dimensions of the skimmer's components. In addition, this section presents equations that are needed for the dimension analysis of the skimmer. Also, the values for the unknown variables are being displayed along with the computed values. Finally, Parts specification are being displayed in the following subsection.

a. Skimmer components diagram

Figure 5.9 displays a u-shaped skimmer sketch body with an oil container that is attached to the back of the skimmer. The main components that are presented in figure 5.9 are the skimmer shell, oil container, 6 grooved discs, and two drum skimmers with grooved surface. Table 5.5 shows all of the proposed dimensions for the oil skimmer's components.

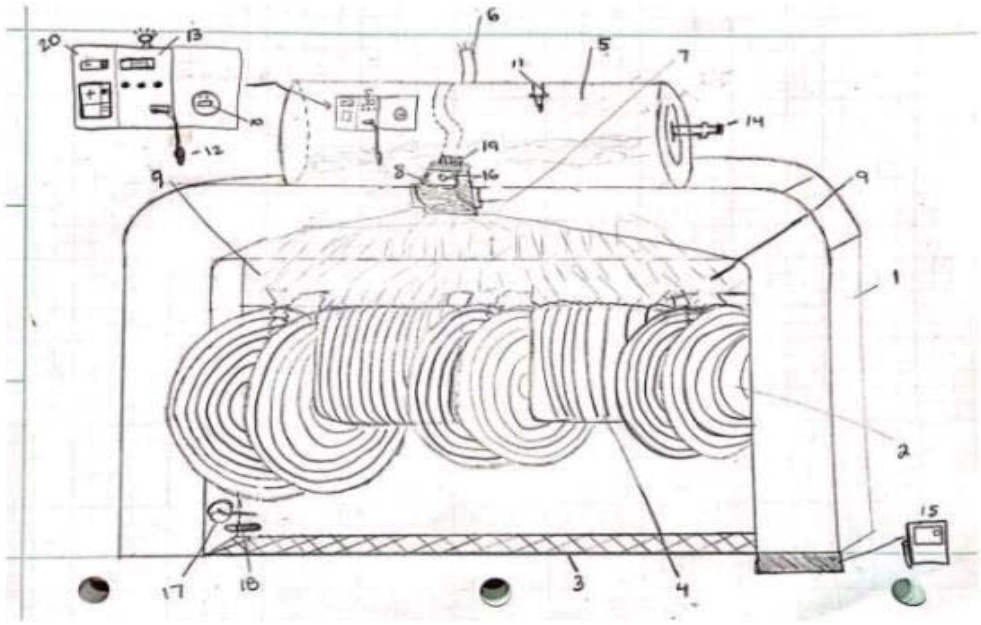


Figure 5.9 Skimmer Component Diagram

Table 5.5 Proposed Dimensions

	Skimmer Part	Dimension Specification
1	U shaped Body	Skimmer body = 40 x 20 x 15 (in) area removed = 20 x 10 x 15 (in)
2	Grooved disk	Disk diameter = 9 (in) Disk thickness = 1 (in) Number of Disks = 6 Groove depth = 0.75 (in) number of grooves = 15 Space between disk = 0.5 (inch)
3	Debris Shield	20 (in)
4	Floating Drum Skimmer	4.75 (in) D=9 (in) 2 drum
5	Oil container	Diameter = 15 (in) L = 30 (in)
6	Shaft	L = 36 (in) D = 2.5 (in)

b. Equations needed for the analysis (with all variables defined under the equations)

The dimensions of all the skimmer components must be within an operational domain of 5 ft by 5 ft (60 in by 60 in). The followings are basic formulas that have been used for the dimensional analysis of the skimmer.

- **Groove angle for the disc:**

$$Tan(theta)D = \frac{opposite}{adjacent}$$

- **Number of grooves per disc:**

$$Grooves\ width * 2D = disc\ diameter$$

- **Space between each groove:**

Same as grooves width

- **Space between discs, drums, and skimmer shell**:

$$Length\ of\ removed\ area = (disc\ thickness * number\ of\ discs) + (number\ of\ drums * drum\ length) + (number\ of\ spacing * S)$$

- **Groove angle for the drum skimmer:**

$$Tan(theta) = \frac{(opposite)}{adjacent}$$

- **Number of grooves per drum:**

$$Groove\ width * 2d = drum\ diameter$$

c. Values of all known variables

- Skimmer shell dimension = 40 x 20 x 15 (inches)
- Removed area to create U-shaped body = 20 x 10 x 15 (inches)
- Estimated disc diameter = 9 (inches)
- Estimated disc thickness = 1 (inches)
- Estimated number of discs= 6
- estimated number of drums = 2
- Estimated groove depth for both the disc and drum= 0.75(inches)
- Estimated groove width for the disc = 0.3 (inches)
- Estimated groove width for drum = 0.25
- Estimated oil container dimensions are length = 30 (inches) and diameter = 15 (inches)

d. Method of computation and final values of computed variables.

Groove angle for the disc:

Tan(theta) = (opposite)/adjacent
= ((disc groove width / 2) /(groove depth)
= ((0.3/2) /(0.75)

Theta = inverse Tan (0.15 / 0.75)
= 11.31 degrees
= 11.31 * 2
= 22.62

Number of grooves per disc:

Grooves width * 2#D = disc diameter
0.3 * 2#D = 9
2#D = 9 / 0.3

2#D = 30
#D = 30 / 2
#D = 15

Space between discs, drums, and skimmer shell:

Length of removed area =(disc thickness * number of discs) + (number of drums * drum length) + (number of spacing * S)
20 = (1 * 6) + (2 * 4.75) + (9 * S)
20 = (6) + (9.5) + 9*S
20 - 15.5 = 9*S
4.5 = 9*S
S = 4.5 / 9
S = 0.5 (inches)

Groove angle for the drum skimmer:

Tan(theta) = (opposite) /(adjacent)
= ((drum groove width / 2) /(groove depth)
= ((0.25/2) /(0.75)
Theta = inverse Tan (0.125 / 0.75)
= 9.46 degrees
= 9.46 * 2
= 18.92

Number of grooves per drum:
grooves width * 2#d = drum length
0.25 * 2#D = 4.75
2#D = 4.75 / 0.25
2#D = 19
#D = 19 / 2
#D = 9.5 = 9 grooves per drum

e. Specification of part if part is selected
Figure 5.10 displays a free body diagram of a U-shaped skimmer body with fillet edges, The proposed dimensions for the body are 40 inches by 20 inches with a 15 inches thickness. In addition, the sketch also presents all the components that will be attached to the skimmer body with its estimated dimension. The components that will be attached to the body of the skimmer are; debris shield, line transducer, tensiometer, and a density meter.

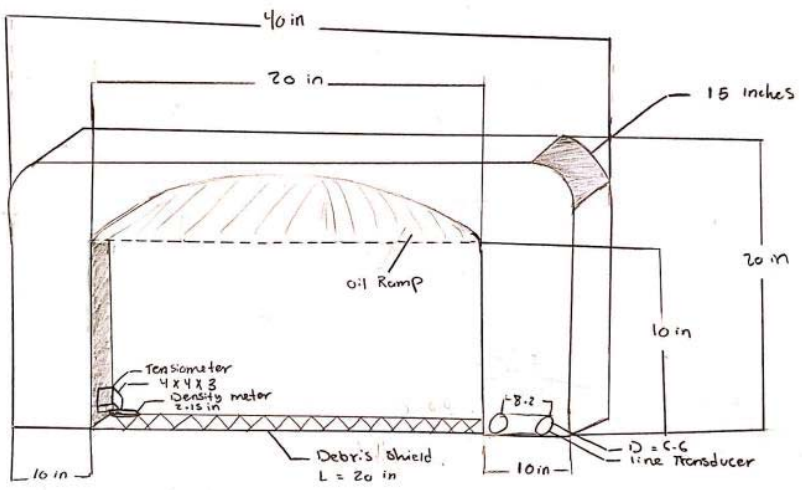


Figure 5.10 U-shaped skimmer body

Figure 5.11 displays a free body diagram of an oil retainer with the estimated appropriate dimensions. The sketch also contains the dimension of all the other components that will be attached to the oil retainer. The components that will be attached to the oil retainer are; hose, waste basket, point level sensor, pressure transducer, fixed orifice system, oval gear flow meter, submersible level transmitter, detect array, and a moisture oil transmitter.

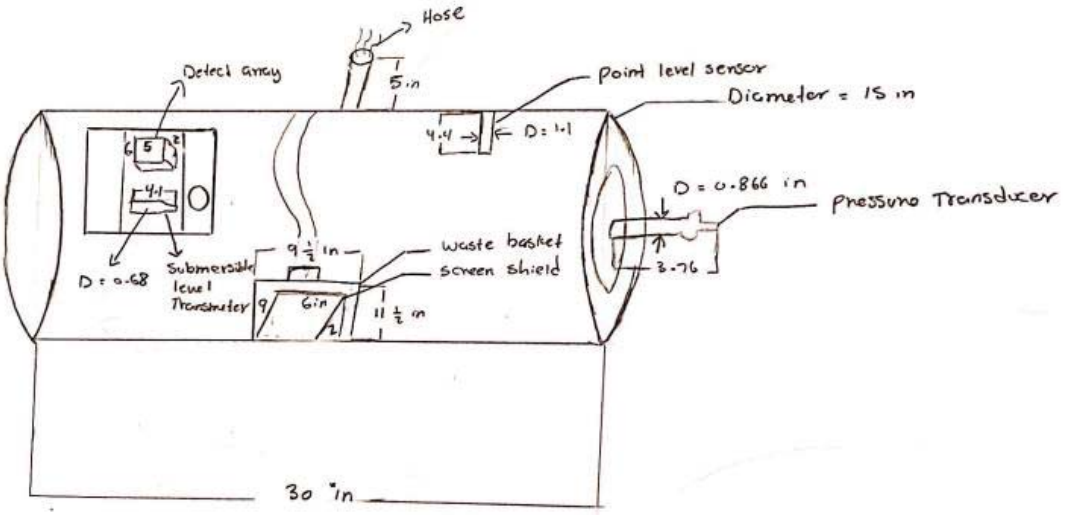


Figure 5.11 Oil Container

Figure 5.12 and 5.13 presents a grooved disk with its proposed dimension, the estimated dimensions of the skimmers are 9 inch diameter with a 1 inch thickness. The number of disks are estimated to be 6 grooved discs, each disc is going to have 15 V grooves with a width of 0.30 inches and an estimated groove depth of 0.75 inches. Also, between each disk there will be a space of 0.5 inches to allow for oil recovery.

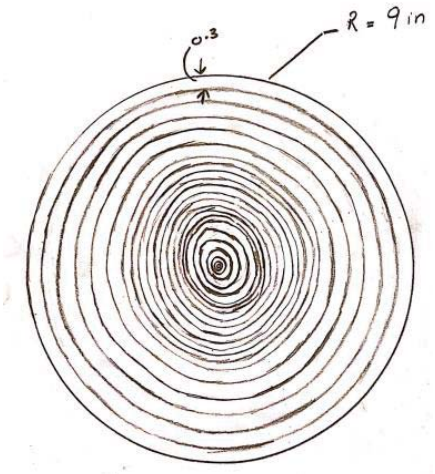


Figure 5.12 Grooved disk

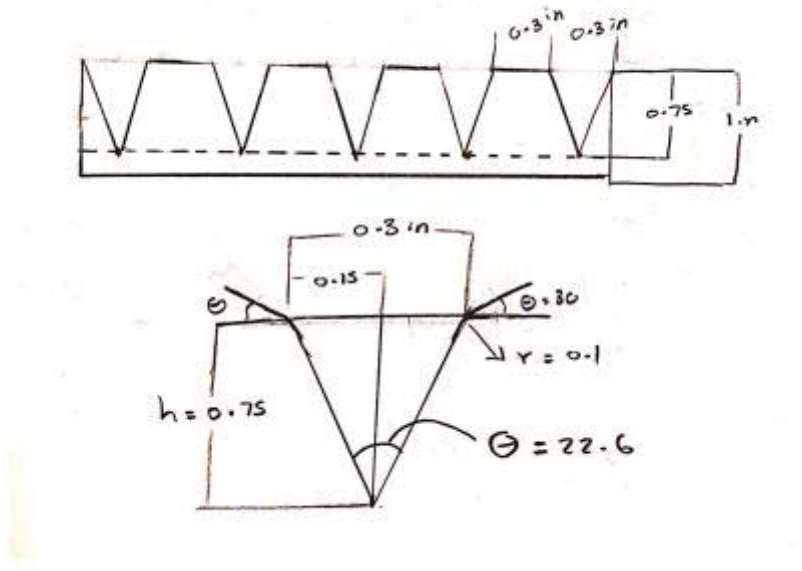


Figure 5.13 Grooved Dimensions

Figure 5.14 displays a drum skimmer with its proposed dimensional analysis. The simmer design is going to have two drum skimmers with an estimated width of 4.75 inches and a diameter of 9 inches. The surface of the drum skimmer is going to have 9 grooves with a width of 0.25 inches and a groove depth of 0.75 inches.

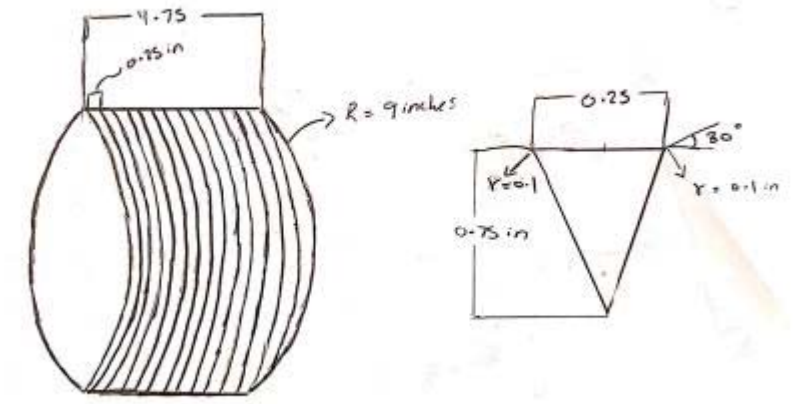


Figure 5.14 Drum Skimmer Dimensions

5.2.6 Analysis for determining the appropriate floating mechanism for the selected skimmer design.
In this subsection, the analysis of the proposed skimmer floating mechanism is displayed. The section includes a free body diagram that provides a visual representation of buoyancy. In addition, the subsection includes the equations necessary to fully analyze the floating mechanism required for the skimmer. Furthermore, the values for all known variables are displayed along with the computed values. Finally, the subsection described system used to compute the unknown variables and added the part specifications for the floating mechanism selected.

a. Free body diagram
In figure 5.15 the force diagram used for the analysis of the skimmer floating mechanism displayed. The diagram shows the direction of the buoyant and weight forces that apply to the floating

skimmer shell. In addition, the diagram shows the distance (h) which represents the distance between the bottom of the skimmer that is submerged and the surface of the water.

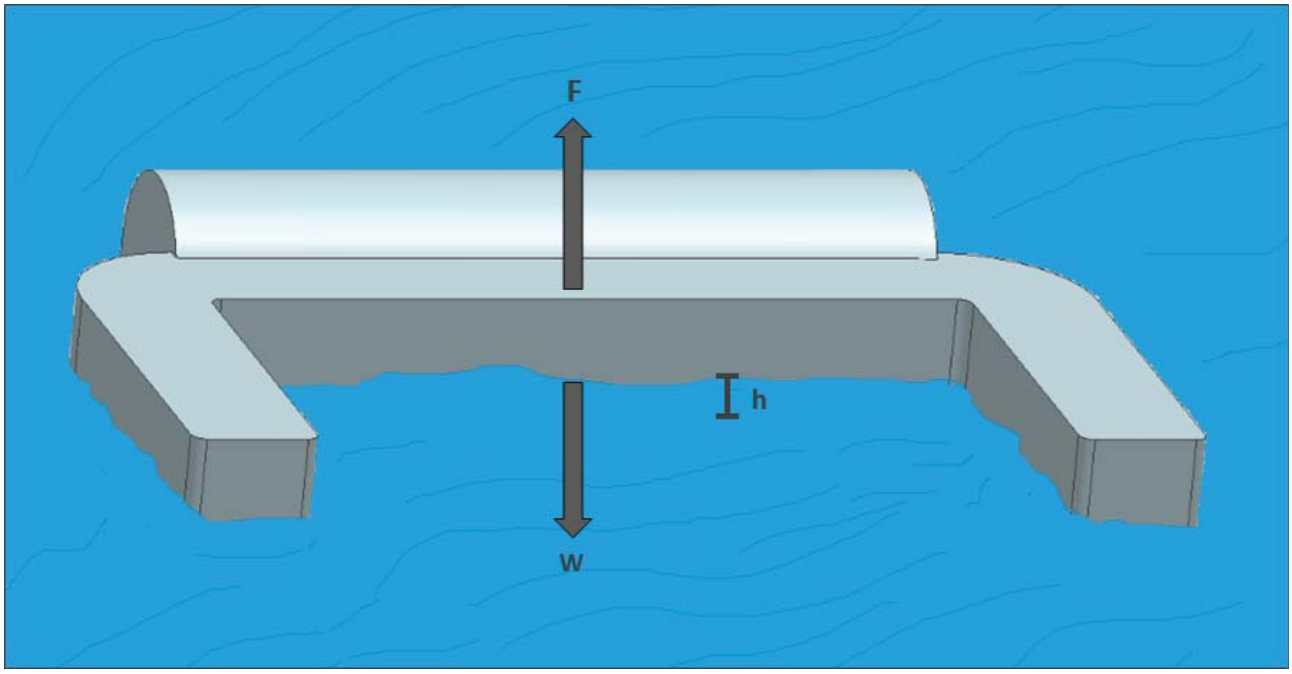


Figure 5.15 Floating Mechanism Force Diagram

b. Analysis equations

Buoyancy force in the oil recovery skimmer design project has been defined to be the force equal to the weight of the fluid (water/oil) that is displaced. Figure 5.15 provided a closer look to the role that buoyancy plays in the fabrication of the proposed skimmer design. Therefore, it was important to break down the forces using the appropriate equations as it is shown below.

To calculate the weight of the system the formula below can be utilized:

$$W = mg$$
$$m = mass\ of\ skimmer\ (kg)$$
$$g = gravity\ (ft/s\text{^}2)\ or\ (m/s\text{^}2)$$

To calculate the buoyant force of the system the formula below can be utilized:

$$Fb = \rho Vg = \rho Ahg = mg \textbf{ (lbf)}$$
$$\sout{V = Ah}$$
$$m = \rho V$$

ρ = density of water (lb/in^3)
A= area of the base of the object that is submerged (in^2)
Vs= volume of fluid displaced, also equals volume of portion submerged (lb/in^3)
h = height of object that is submerged in fluid (in)
g = gravitational acceleration (in/s^2)
mw = mass of fluid displaced (lb)

c. Values of all known variables

For $W = mg$

Given the assumption for the use of polyethylene HDPE material (High density polyethylene) and observation of current designs:

~~**m = 20.4 kg (45 lbs)**~~

g = 32.2 ft/s^2 (9.81 m/s^2)

For the computational analysis of calculating the buoyant force:

ρ = 62.4 lbs/ft^3 = (1000 kg/m^3)

~~**h (assumed) = 2 in = (.051 m)**~~

g = 32.2 ft/s^2 = (9.81 m/s^2)

d. Method of computation and final values of computed variables.

The figure below represents the assumed dimensions of the skimmer body. Figure (b) shows the area removed from (a) to complete the U-shaped body

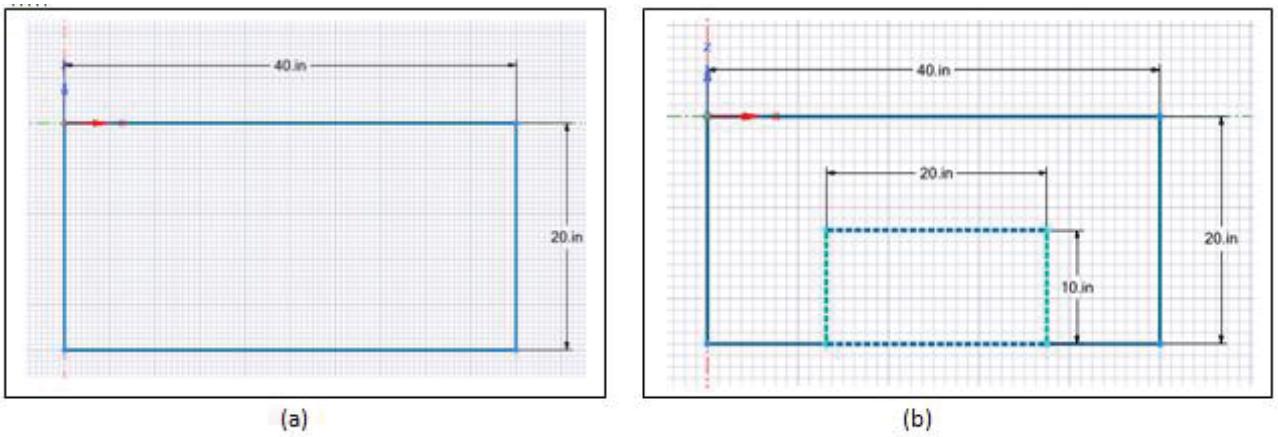


Figure 5.16 Skimmer Dimensions for Computational Analysis of Buoyant Force

Figure 5.7 Skimmer Dimensions for Computational Analysis of Buoyant Force

Procedure for calculating the buoyant force (values obtained using T-84 calculator):

1. Calculate the Area of the base by using geometric analysis

$$Area\ of\ the\ base, A_b = (40 * 20) - (20 * 10) = 600\ in^2$$

2. Calculate the Volume of the fluid displaced, which is also the volume of the submerged portion of the skimmer

$V_s = A_b h$ (h is an assumed height which represents the submerged portion of the skimmer)

$$V_s = 600\ in^2 * 2in = 1200 in^3$$

3. Calculate the buoyant force, F_b

$F_b = w_{df} = mg = pV_s g,$ where w_{df} is the weight of the displaced fluid and m is the fluid mass

$F_b = \left(62.4\ \frac{lb}{ft^3}\right) * (1200 in^3) * \left(32.2 \frac{ft}{s^2}\right)$, convert the V_s to ft^3 to get units of lbf

$$1200\ \frac{1in^2}{1}\frac{1ft^3}{\cancel{1,789}} = .694 ft^3$$

$$F_b = \left(62.4\ \frac{lb}{ft^3}\right) * (.694 ft^3) * \left(32.2 \frac{ft}{s^2}\right) = 1{,}394 lbf$$

From this, mass of the fluid displaced is ~~43.3 lb~~

e. Specification of part if part is selected

Figure 5.17 shows the skimmer body that best represents the structure in which the skimmer body and material should possess.

Figure 5.17 SkimOil's FDS20RS SteelMAX FLoating Drum Skimmer

Results and the specification of this specific skimmer body is shown in Table 5.6, the only modification would be adjusted to the skimmer entryway which would be an open "U shape." These specifications were obtained for reference from SkimOIL Industrial Solutions inc [2].

Table 5.6 Skimmer Body Specifications

Specifications	
Oil recovery rate:	Up to 20gpm / 5cu.m per hour
Number of drums:	2 (Polyethylene HDPE)
Frame:	Polyethylene HDPE
Wiper blades	Self-adjusting (spring loaded).Spare wiper blades included.
Wiper retainer:	Mounted with stainless steel pins & springs
Handles:	Included
Dimensions:	42 x 28 x 14 inch / 1.07 x 0.71 x 0.36m
Weight:	50lbs / 23kg
Drive:	Pneumatic or hydraulic
Max operating temp:	54 C / 130 F (high temperature* version available)
Suction coupling:	2 inch female camlock

REFERENCES

[1] Grainger “Stainless Steel Shaft Rod, ss,303, 2 ½ In Dia x3Ft L”, Arlington, TX, 1994 https://www.grainger.com/product

[2] “Skimoil, Inc., SkimOil’s FDS20RS SteelMAX FLoating Drum Skimmer Technical Description Brochure, SkimOil.inc, Carrboro NC, 1995

Grading Scheme for Status Report 8
Detailed Engineering Analysis

Project Group #_____

Item	Description	Maximum Points	Your Score
1	Table listing description of items for which analysis are needed, description of type of analysis needed and the subject area of the analysis	25	
2	Signature of advisor	10	
2	Well planned and detailed analysis of each part with free body /other diagrams provided where needed.	140	
3	Parts specifications resulting from the analysis	20	
4	Assignment attached	5	
	Total	**200**	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 9 Preliminary and Detailed Analysis

Due Date:11/19/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Completed sections 5.2.5., 5.2.6., 5.2.7, 5.2.10. Provided figures and equations. Checked format	100	
2	Jonathan Horta Jonathon Horta	Assisted with the analysis of the control arms and its interpretation onto section 5.2.1.	100	
3	Todd Maxwell Todd Maxwell	Formatted equations and force analysis for knuckle section 5.2.2	100	
4	Michael Samuel Michael Samuel	Created scratch for both front and rear control arm section 5.2.1 also worked on equations	100	
5	Aramis King Aramis King	Completed analysis/equations for struts and specifications of struts	100	
6	Daniel Ward Daniel C. Ward	Constructed FBD analysis and completed knuckle section 5.2.2	100	
7	Titus Woodard Titus Woodard	Developed design for strut and research	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN AND PROFESSIONALISM 1
FALL 2020 SEMESTER
Status Report on Preliminary and Detailed Analysis by Group

Due: 11/19/2020

This status report is a part of Chapter 5 of your final report. Chapter 5 contains the following sections and this assignment covers the first two highlighted sections.

5. DETAILED SYSTEM DESIGN …….. 40
5.1 **Identification and Plans for Types of Analysis Needed for the Design** …….. 40
5.2 Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design……. 45
~~5.3~~
~~5.4 Engineering Analysis and Simulation …….. 47~~
~~5.5. Layout/Detailed Drawings/Equipment selection and specifications ……. 48~~
~~5.6 Application of Engineering Codes and Standards in design . 49~~
~~5.7 Economic Analysis ……. 55~~
~~5.8 Fabrication and Testing …….. 58~~

5. DETAILED SYSTEM DESIGN

1. Provide an introductory paragraph for this chapter using the information about the content of this chapter provided above**.**

5.1 Identification and Plans for Types of Analysis Needed for the Design

Provide an introductory paragraph for this section making use of what is to be done in question 2 below.

2. Make a table containing the list of items in your system for which some form of engineering analysis will be needed in order to design, specify, or select. Then identify the specific type of analysis needed for that component, the subject area for the analysis and the reference source used for the analysis. Let your project owner review and approve the information in this table. A blank table is provided below for use. Please add additional rows as needed and see question 2 as you prepare this table.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis

Approval by Project owner: Name_____ Signature _____

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

3. Perform detailed engineering analyses required to **design**, **specify,** and **size** all components of the system you are designing as planned in Table 5.1. Depending on your type of project, the detailed analysis may consist of but not limited to (1) thermal analysis (heat transfer and thermodynamics), (2) fluid mechanics analysis, (3) machine elements & machine design analysis of project elements, (4) kinematics analysis of moving elements, (5) power and energy analysis, (6) electrical energy/storage analysis, (7) structural/strength of materials analysis, (8) control analysis including programming, (9) geometric analysis to define shape and size, (10) special analysis specific to design such as chemical reactions, etc., and (11) manufacturing processes that may be required for the project. Provide adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

(i) For each analysis, provide a sub-title, followed by a brief description, then provide either a free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables), then using the equation editing feature of MS Word, provide the equations needed for the analysis. The variables in the equations should be defined right after the equation.

(ii) Then without directly substituting values into the equation, provide the values of the known variables, followed by the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

(iii) Provide specification for the specific part if the part is selected after the analysis for that part.

(iv) **On the cover page of this assignment indicate the sections of the analysis (sections 5.2.1, 5.2.2, 5.2.3, etc) contributed by each member.**

Note that the analysis should be fully descriptive and that you may provide equation numbers that can then be cited in the report.

Question 3 should be answered using the subsection example below:

5.2.1 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

5.2.2 A sub-title for the specific design parameter being calculated, followed by a brief description

a. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
b. Equations needed for the analysis (with all variables defined under the equations)
c. Values of all known variables
d. Method of computation and final values of computed variables.
e. Specification of part if part is selected

Note: Attach a copy of this assignment statement sheet to your homework (placed after the cover sheets)

This section contains notes for you.

NOTES ON DESIGN ANALYSIS
DETAILED ENGINEERING ANALYSIS NOTES AND SAMPLE

Detailed engineering analyses required in order to **design**, **specify,** and **size** all components of the system you are designing must be provided. Depending on your type of project, the detailed analysis may consist of but not limited to

(1) thermal analysis (heat transfer and thermodynamics),
(2) fluid mechanics analysis,
(3) machine elements & machine design analysis of project elements,
(4) kinematics analysis of moving elements,
(5) power and energy analysis,
(6) electrical energy/storage analysis,
(7) structural/strength of materials analysis,
(8) control analysis including programming,
(9) geometric analysis to define shape and size,
(10) special analysis specific to design such as chemical reactions, etc.,
(11) manufacturing processes that may be required for the project.
(12) providing adequate design analysis and information for projects requiring the selection of control software, electronics and other control hardware needed to achieve all of the functional requirements of the design.

IMPORTANT INSTRUCTIONS TO FOLLOW
For each analysis, provide the following:

A sub-title for the specific design parameter being calculated, followed by a brief description,

1. A free body diagram (that shows all of the known and unknown forces acting) or a process diagram (that shows all input and output variables)
2. Then using the equation editing feature of MS Word, provide the equations needed for the analysis and define all of the variables in the equations right after the equation.
3. Provide the values of all known variables
4. Without substituting values directly into the equation, provide the values of the computed variables citing how the analysis was made (e.g. using Matlab, EES, NX, calculator, etc.)

An example analysis based on the 4 analysis steps is provided.

5.2.1 Analysis for determining the power required for lifting mechanism and selection for DC Motor

Since DC motors were to be used to drive components for 3 out of 5 of the functions of the design, its selection was based on the output torque required by the most arduous function. Therefore, for the general analysis to get the servo motor specification, the torque calculation for lifting a 4 lb weight was used. It was assumed that the 4 lb weight would be the heaviest load the robot had to lift. 4lbs was selected for the weight in order to ensure that the robot lifted a load that was safe. The competition gave no specification for the amount of weight that needed to be lifted.

The calculation for the lifting torque is provided below. The free body diagram below depicts the forces that would act on the system during the lifting procedure. Figure 5.2 displays the free body diagram of the lifting component showing all the forces. Figure 5.3 shows the initial ideal design for the robot, which also shows the location of each of the functions.

Free Body Diagram (FBD)

The free body diagram showing the lifting mechanism and the forces acting is shown in Figure 5.2

In this mechanism, a gear driven by an electric motor engages with a vertical shaft whose gears mesh with the rotating gear driven by the electric motor. The load to be lifted is placed on a platform fixed to the vertical geared shaft as shown in the Figure 5.2

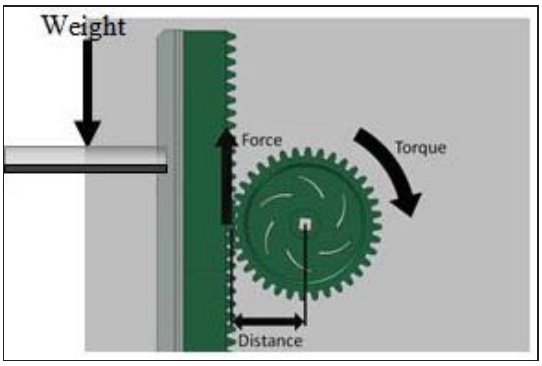


Figure 5.2 Free Body Diagram of Lifting Component

Analysis Equations

Using the force equilibrium equation, a general expression was derived to come up with an equation for the power. Then, from knowing the linear speed of the ascending platform, the rotational speed of the pinion (which is connected to the shaft) was determined.

$$F_y = F_{applied} - W = 0 \tag{1}$$

(The assumption was that power was to be transmitted so that the rack would translate upward at a constant velocity). Therefore,

$$F_{applied} = W \tag{2}$$

and the power, P, required is given by

$$P = F_{applied} V_{avg} \tag{3}$$

where,

$F_{applied}$ is the force applied by the motor

W is the weight of the mass (the weight is **overloaded** to ensure that the motor is not underspecified)

P is the power delivered by the motor

V_{avg} is the average velocity for lifting the weight

The average speed for the lift was assumed and the rotation speed for lift was approximated by the following equation:

$$N = \frac{60 V_{avg}}{\pi D_{gear}} \tag{4}$$

where N is the rotational speed for the motor shaft in RPM

D_{gear} is the diameter of the pinion.

Knowing the power and the rotation speed, the torque transmitted was then calculate using.

$$T = \frac{60P}{2\pi N} \quad T = \frac{P}{n*\left(2*\frac{\pi}{60}\right)}$$

(5)
where *T* is the torque provided by the motor

(c) Values of known variables
A reasonable estimate for the linear velocity, V_{avg} **= 0.98 ft/s** was chosen for the lift speed.
The weight to be lifted was set to be W = **4 lb**.
A standard diameter for the pinion was chosen to be D= **2.5 inches** (0.21 ft)

(d)Values of computed variables
With these values, the power was computed using equation (3) to be P=**3.92 lb. ft/s** (Customary Units)
The rotational speed was computed using equation (4) to be N=89.1 RPM using EES program
The torque was computed using equation (5) to be T=0.42 ft-lbf (5.04 in-lbf) using EES program

Figure 5.3 shows the DC motor that was selected to carry out the lifting function. From the calculated

results and the specification of this specific DC motor as shown in Table 5.2, the motor has enough torque to actuate the lifting mechanism at the assumed average velocity.

Figure 5.3: VEX 2-wire DC motor

Table 5.1 Detailed specification for motor selected

2 Wire Motor 393

▷ Free Speed:	100 rpm (As Shipped)/160 rpm (High Speed Option)
▷ Stall Torque:	1.67 N-m (14.76 in-lbs) (As Shipped)/1.04 N-m (9.2 in-lbs) (High Speed Option)
▷ Stall Current:	4.8A
▷ Free Current:	0.37A

Note: All motor specifications are at 7.2 volts.

5.2.2 Analysis for determining XXXX XXXXXXXXXX

Grading Scheme for Status Report 8
Detailed Engineering Analysis

Project Group #___8___

Item	Description	Maximum Points	Your Score
1	Table listing description of items for which analysis are needed, description of type of analysis needed and the subject area of the analysis	25	
2	Signature of advisor	10	
2	Well planned and detailed analysis of each part with free body /other diagrams provided where needed.	140	
3	Parts specifications resulting from the analysis	20	
4	Assignment attached	5	
	Total	**200**	

5. DETAILED SYSTEM DESIGN

This chapter will dive deeper in the analysis needed to come up with the design. The group broke each system down into individual components and then the group focused on calculations needed to design the best component for optimized performance.

5.1 Identification and Plans for Types of Analysis Needed for the Design

This section will provide all the components that are needed for the suspension and steering system. Going through table 5.1, each component will have the description of the analysis that will be done for each component. Also, the table will contain the subject area for where the subject focus is for each component as well as the source from where we found equations needed. Majority of the equations were found mainly from textbooks the students had from their previous classes such as machine design, kinematics, dynamics, and geometry. For the suspension system, the components are mainly to absorb external forces and apply them back to the ground. For the steering system, the components are mainly for transferring forces from driver input to the turning of the tires.

Table 5.1 Summary of System Components, Types of Analysis needed, Subject Areas and Reference Sources used for the Design Analysis of the Components

Item #	System Component or part description	Description of analysis needed for the design, sizing, specifying or selecting component	Subject Area	Reference Source for Analysis
1	Control Arms	Range of motion in wheels	Kinematics /Geometry	Design of Machinery
2	Knuckle	Transfer force to the control arms/ accept force from the tie rods to turn tires	Kinematics	Design of Machinery
3	Struts	Support of total weight of the vehicle and driver/ calculate total external forces the struts will experience	Dynamics	System dynamics for engineering students
4	Revolute joints	Allow range of motion in control arms	Kinematics	Design of Machinery
5	Steering wheel	Driver input to turn the steering wheel	Force analysis	Mechanical engineering Design
6	Steering shaft	Torsional force transfer from steering wheel to rack and pinion	Force analysis	Mechanical engineering Design
7	Rack and pinion	Gear design and force analysis from gears meshing	Gear design	Mechanical engineering Design
8	Steering rod	Transfer force to the tires from the rack and pinion	Force analysis	Mechanical engineering Design
9	Universal joint	Transfer force from steering shaft to rack and pinion	Force analysis	Mechanical engineering Design
10	tie rods	Allow geometry to line up as ackerman/ transfer force to the knuckle to turn the tires	Kinematics / force analysis	Design of Machinery
11	Ball joints	Allow some motion in connections to reduce overbearing components	kinematics	Design of Machinery

Approval by Project owner: Name Lai Jiang Signature Lai Jiang

DocuSigned by:
6C1C88553B964F9...

5.2 Detailed Engineering Analysis and Simulation for Designing, Sizing, Specifying and Selecting Parts for the Design.

In this section, an overall analysis was performed in order to determine the design and specifications of the components that will be utilized in the Baja vehicle steering and suspension systems. Specifically, a kinematic, strength of materials and power and energy analysis was compiled into the further research and development of all components. The forces and equations needed for design and operation were to be calculated and provided in the findings. The sections below will break down each component into free body diagrams, equations and variables used, and known and computed variables.

5.2.1 **Analysis for determining the range in motion in the four bar linkage created by front upper control arm, lower control arm**

Range of motion in the four bar linkage is created by the upper and lower control arm. the control arm connects the wheel hub and steering knuckle to the frame of the vehicle. ~~a~~ four bar linkage consists of four rigid bar or rods in a plane that are connected by a pin joint. In this case it will be our control arm, which has four bars that have a vertical range of motion. Given position, velocity, acceleration, and inertia properties such as mass and mass moment of inertia for each moving link of a four-bar linkage, we are able to perform force analysis for the linkage.

Free Body Diagram (FBD)

Figure 5.1 shows the free body diagram of the front upper and lower control arms. Figure 5.2 shows the free body diagram of the rear upper and lower control arms.

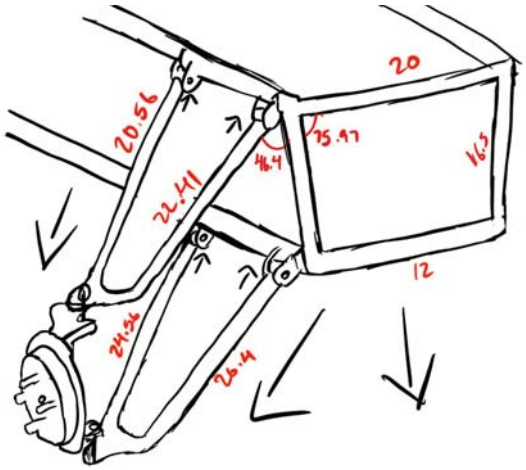


Figure 5.1 Free Body Diagram of The Front Upper & Lower Control Arms

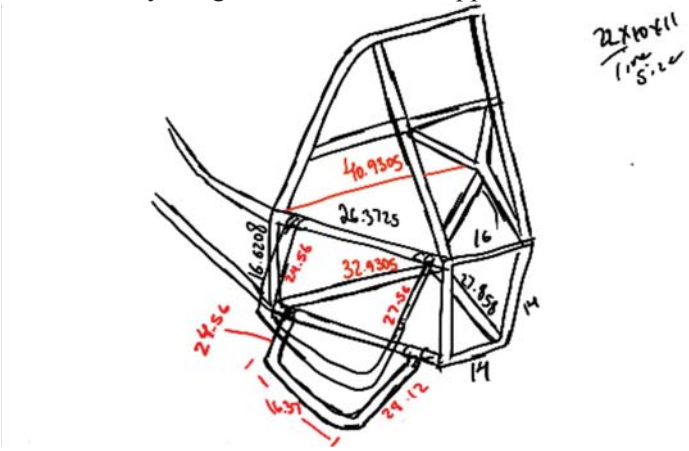


Figure 5.2 Free Body Diagram of The Rear Upper & Lower Control Arms

Analysis Equations

These analysis equations were used to determine chassis dimensions utilized for the control arms based on previous chassis designs that were recently shared with the group by Society of Automotive Engineers. Some lengths and angles were given, but some important lengths and angles were also missing. These equations assisted the group in determining the range of motion in the linkages between the upper and lower control arms, chassis, and knuckle.

A sketch of the area from above the upper control arm was drawn based on Figure 5.1. Then, lower case letters were used to identify lengths and upper case letters were used to identify angles in the area drawn. Figure 5.3 below presents the dimensions between the mid chassis section and knuckle.

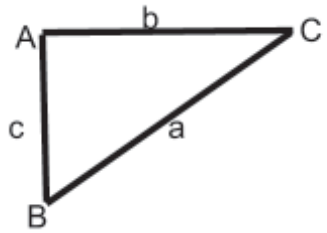


Figure 5.3 Dimensions between mid chassis section and knuckle

Using the law of sines, a general expression was derived to come up with an equation to find the angle between the upper control arm and the knuckle.

$$\frac{sin(A)}{a} = \frac{sin(B)}{b} \qquad (1)$$

then, the known and unknown variables were moved to opposite sides

$$B = \arcsin\left(\frac{sin(A)\ x\ b}{a}\right) \qquad (2)$$

knowing that all triangles add up to the same degree

$$A + B + C = 180° \qquad (3)$$

A sketch of the area between the upper and lower control arms was drawn based on Figure 5.2. Then, lower case letters were used to identify lengths and upper case letters were used to identify angles in the area drawn. Figure 5.4 below presents the dimensions between the upper and lower control arms referencing the chassis.

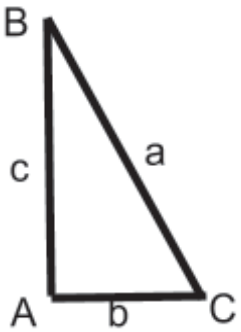


Figure 5.4 Dimensions between the upper and lower control arms referencing the chassis

Using the law of sines, a general expression was derived to come up with an equation to find the angle referencing the chassis between the upper and lower control arms.

$$\frac{a}{sin(A)} = \frac{b}{sin(B)} \qquad (4)$$

then, the known and unknown variables were moved to opposite sides

$$b = \frac{a}{sin(A)}\ x\ sin(B) \qquad (5)$$

Knowing that all triangles add up to the same degree

$$A + B + C = 180° \qquad (6)$$

Values of known variables
For figure 5.3:
The angle between the extended outline of the mid section of the chassis and the knuckle, **A = 90°**
The length of the upper control arm, **a = 22.41in**
The horizontal length between the control arm and the knuckle, **b = 12in**

For figure 5.4:
The angle between the extended outline of the mid section of the chassis and the lower chassis section, **A = 90°**
The diagonal length between the upper and lower control arms where they're connected to revolute joints, **a = 22.41in**
The angle between the vertically extended outline of the mid section of the chassis and the diagonal line drawn between both control arm connections, **B =14.3°**

Values of computed variables
For figure 5.3:
With these values, the angle was computed using equation (2), to be **B=32.376°**
The remaining angle in the triangle was computed using equation (3), to be **C=57.624°**

For figure 5.4:
With these values, the length between the vertically extended midsection of the chassis and the horizontally extended base of the chassis was computed using equation (5), to be **b=4in**
The remaining angle for the triangle was computed using equation (6), to be **C=75.97°**

Camber angle is the inclination of the vehicle tire with the vertical axis when viewed from the Front section. In case the top of tire leans in towards the centre of the car this is the condition of negative camber. we will be including a Positive camber on our vehicle to compensate for the weight of the vehicle and the driver. ~~this~~ will neutralize the camber to a neutral vertical position. Figure 5.5 shows the camber angles.

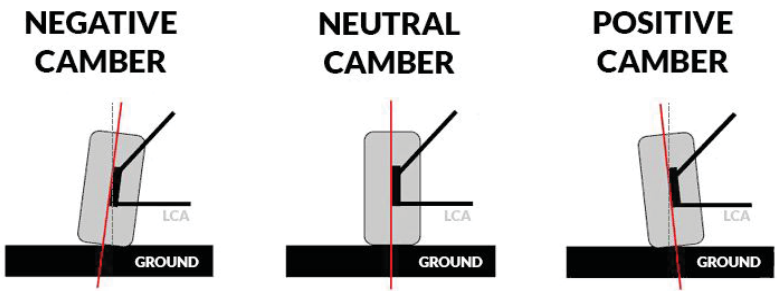


Figure 5.5 Camber angles: Negative camber, Neutral camber, & Positive camber

5.2.2 **Analysis for determining the range in motion in the four bar linkage created by rear upper control arm, lower control arm, knuckle, and chassis**

The main forces in which the knuckle will experience is torsional and axial loads. Because this component is dependent upon a variation of other components within the system it can be assumed that its range of motion will be very minimal, yet still plays a major factor in the overall functionality of the suspension and steering system. Below is a free body diagram showing how the component is analyzed and how the forces and loads are implemented.

Free Body Diagram (FBD)

The free body diagram for the knuckle shows the fixed supports where the control arms connect to. In figure 5.6, the forces are applied to the center of the knuckle to allow rotation of the tire.

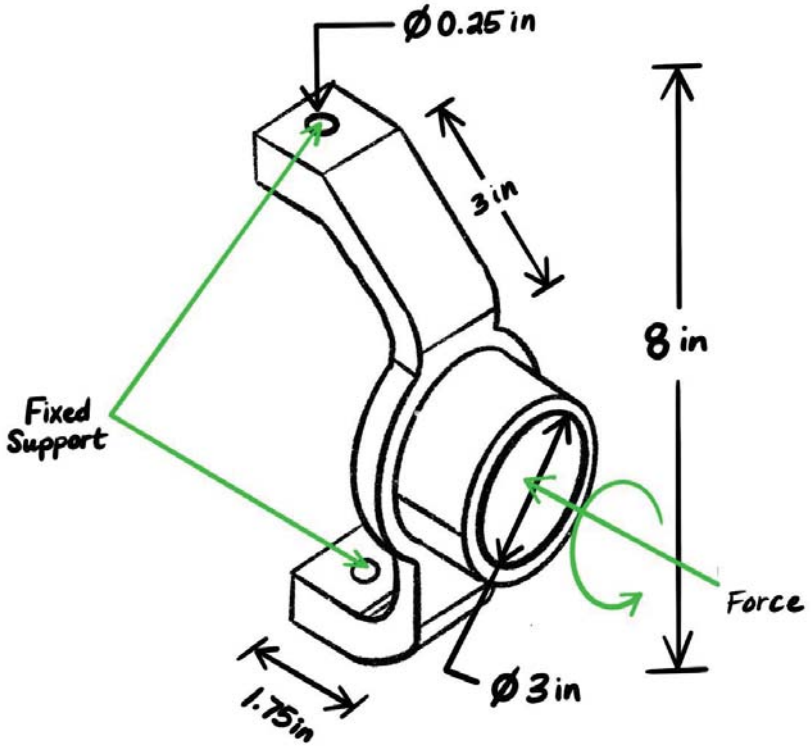


Figure 5.6 Free Body Diagram of Knuckle

Analysis Equations

This specific component proved to be very tedious to design due to the other major components that it links to. Several iterations were drafted up and constructed to fit the design of the control arms, however, this is one of the few designs that the team may seek to update later on down the road in order to fit properly within the given system. The dimensions and specifications of the knuckle design were drawn up based on an already established component and again, constructed to fit the specifications of the team's overall design structure.

The following equations were utilized to design and calculate the forces and possible loads that the knuckle would endure as it collaborated with the other components in the system. As seen in the sketch of

the free body diagram in Figure 5.3, there are critical areas in which there needs to be a main focus. The formulas and equations below will assist with the overall understanding of how this component works and analyze the necessary steps to take in order to calculate this component as a whole

Various forces are calculated in the analysis of the Knuckle of a Steering system. These forces are calculated through three major separation of loads and two major stresses. These equations demonstrated are Axial loads (Compressive and Tensile), Inertia Loads, Bending Loads. Axial Stress and Torsional Stress.

Calculations of Loads

Tensile Load (Pt) = Tensile Stress X Area (1)
Compressive Load (Pc) = Compressive Stress X Area

Inertia load (Fa) = $w^2 R (cos \Theta + R/L \, cos (2\Theta)$

Bending Load (Total inertia bending force)=>

$= F b = PAiL^2 \, sin (\theta + o)/2$ (N)

where,

Tensile Stress = $\sigma = F/A$

Compressive Stress= F/A

F= load a point of failure

A= initial cross sectional area = τ =V/a

Calculation of the Stresses

Axial Stress = $\sigma a = F e/As + \sigma b$

Torsional Stress = $\tau = T(d/2)/\pi d^4/32$

$T = (\tau) J/r$

where as,

Fe=effective tension and compression (2)

As= cross sectional Area= τ =V/a

σb= bending stress= $\sigma x = - My/I$

I= interia = L/W

L= angular momentum , W = angular velocity

Y= young's modulus of elasticity = (FL0)/A(Ln − L0).

T= torsion

d= diameter

π= pie

The equations given above are tools used to measure the various forces and stresses applied to the knuckle of the system. (3)

Values of known variables
There are a few known variables within the knuckle of the system. The height of the overall knuckle is 8in. The knuckle consists of 4 separate extended linkages broken in two 3 in linkages connected to the opening of the knuckle set at a diameter of 3in. Following would be two more linkages at 1.75in at the fixed supports with a diameter of .25in.

Values of computed variables

Axial loads (Compressive and Tensile), Inertia Loads, Bending Loads. Axial Stress and Torsional Stress

5.2.3 **Analysis for determining Struts**

The struts are a critical part of the suspension system. They take a large amount of forces throughout the course. It is important that suitable shocks are chosen to handle the rough terrain and various obstacles that the Baja car will encounter. During extensive research and analysis a strut was chosen that uses air and nitrogen instead of traditional springs.

Free Body Diagram (FBD)
Below in Figure 5.7 is the free body diagram of the strut showing the absorbed forces.

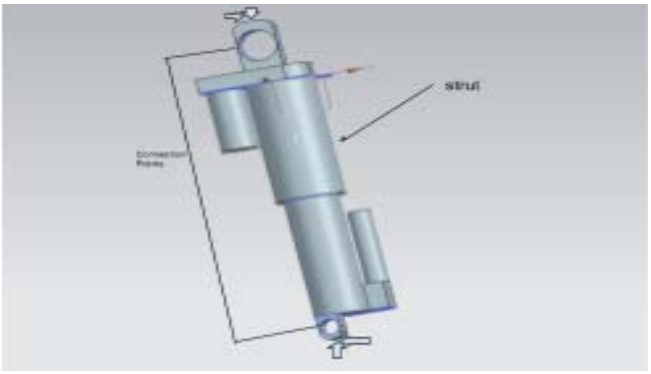


Figure 5.7 Free Body Diagram of Strut

Analysis Equations

The struts main chamber has control of the vehicle's sag height. The SAG height is the height at which a motionless vehicle sits with a driver in the vehicle in relation to the vehicle's full extension.

$$F_{ext}-h_r= SAG \quad (1)$$

Struts are most efficient when at a vertical position. Due to the design of the chassis, clearance issues may occur. An assumption of a 20 degree angle from the vertical position is made.

$$\cos(A)= a \quad (2)$$

The calculations of the spring rate with max stiffness and the highest pressures in both chambers is shown with strut mounted vertically.

$$k_v= W/SAG \quad (3)$$

where,

F_ext is the vehicle's full extension
h_r is the height with rider
A is the assumed angle
a is the angle of strut

Knowing the vertical spring rate and angle of strut, the spring rate at a 20 degree angle is calculated.

$$k_{20}= k_v/a \quad (4)$$

where k_20 is the spring rate at 20 degrees

Values of known variables

The full extension of vehicle is estimated, F_ext=14"
The ride height of vehicle with driver is estimated, h_r= 12"
A reasonable estimated angle, A= 20 degrees is used to calculate angle of strut.
The weight of the driver and vehicle, W=700lb is assumed.

Values of computed variables

With these values the SAG was calculated using equation (1) to be SAG= 2"
The angle of the strut was calculated using equation (2) to be a=.94
The vertical spring rate was calculated using equation (3) to be k_v= 350 lbs/in
The spring rate at an angle of 20 degree was calculated using equation (4) to be k_20= 372.3 lbs/in

Specification of part if part is selected

Upon research and design the Fox Float 3 EVOL series were chosen for the Baja car. The struts are built using 6061-T6 aluminum for light weight and strength. The struts have an extra chamber that uses air as springs, instead of coil springs which makes them lightweight and a suitable option. The struts also contain high pressure nitrogen gas and high viscosity index shock oil separated by an internal floating piston system. Figure 5.8 shows an image of the Fox Float 3 EVOL RC2 struts.

Figure 5.8 Fox Float 3 EVOL RC2

Figure 5.9 shows the specifications of the Fox float EVOL struts that were chosen for the baja vehicle.

Technical Details

Manufacturer	**Fox Racing Shox**
Brand	**Fox** Racing
Model	**Float 3 EVOL RC2 Shocks**
Item Weight	13.5 pounds
Product Dimensions	30.5 x 13.2 x 5.7 inches

Figure 5.9 Strut Specifications

Figure 5.10 shows the flexibility of adjustments that can be made to the main and evol chamber on the struts depending on terrain and obstacles.

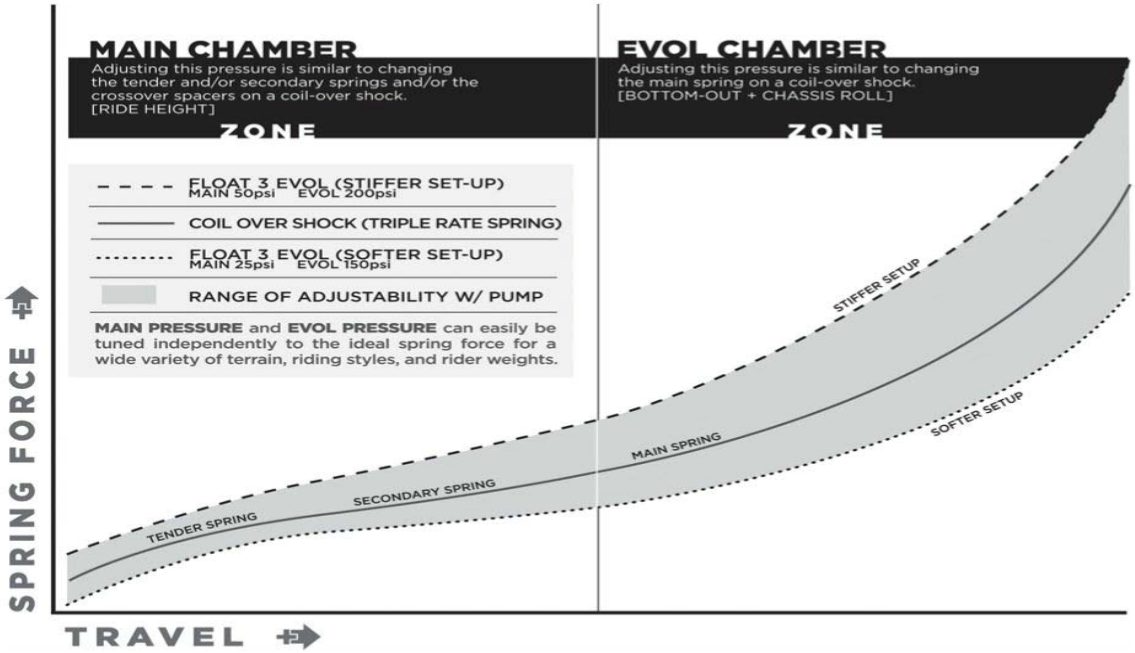


Figure 5.10 Flexibility of Struts

Figure 5.11 shows the recommended air pressures for the EVOL chamber and main chamber for various driver weights.

Reference Air Pressures

Rider Weight	EVOL Air Chamber	Main Air Chamber
100-140LB	100-195PSI	25-45PSI
141-199LB	110-210PSI	25-50PSI
200-250LB	120-225PSI	30-55PSI

Figure 5.11 Reference Air Pressures

Figure 5.12 shows the effects of adjusting the pressure in the EVOL and main chamber on the struts. The figure shows the relationship of the Force vs Distance traveled.

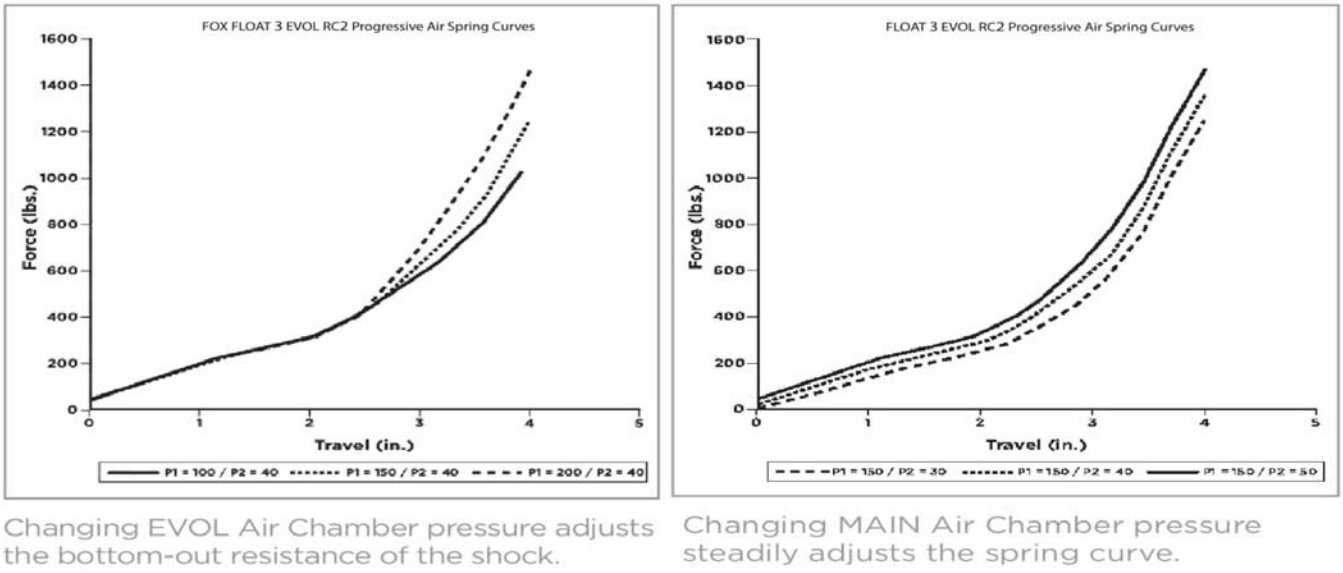


Figure 5.12 Force Vs Distance Traveled

5.2.4 **Analysis for determining the range in motion in the revolute joint**

Revolute joint is a joint between two nodes in which the rotations of the nodes differ by a relative rotation about an axis that is fixed in and, therefore, rotates with the joint. A simple example is a hinge. The Revolute joint is implemented in this system to make the rotational motion simple and quick responsive. This system introduces an additional degree of freedom.

Free Body Diagram (FBD)

Figure below shows the motion movement of a revolute joint. which provide a simple rotational motion. one degree of freedom kinematic pair frequently used in mechanisms and machines. This joint constrains the motion of two bodies to pure rotation along a common axis.

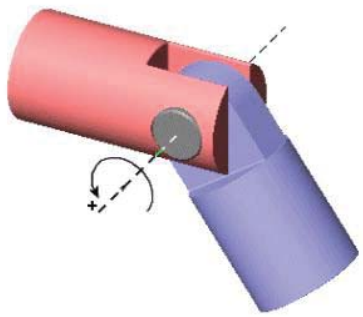


Figure 5.13 Free Body Diagram of revolute joint

5.2.5 **Analysis for determining size of the steering wheel**

The steering wheel is a simple component of the vehicle and is used to steer the vehicle. The driver input starts the process for the steering system. The driver turns the steering wheel with a certain amount of force that is transferred to the steering shaft. That transferred force is used all the way to the gears which then pushes and pulls the tires to steering the vehicle. The inner design of the steering wheel is up to the group but the important thing is the size of the steering wheel. The larger the steering wheel the more torque can be produced. Standard steering wheels for baja vehicles are around 5 inches.If more force needs to be created by the driver then the group can increase the radius of the steering wheel to 6 inches. The sterling system has to overcome the weight of the vehicle and the driver in order to turn. In figure 5.14, it shows the forces involved with the steering wheel and how the steering wheel moves. In the equations down below it will discuss the torque being generated by the driver and how the radius is involved. The goal is to achieve a steering ratio of 12:1 which allows the driver to turn the wheel 30 degrees to turn the vehicle.

Free Body Diagram (FBD)

The free body diagram in figure 5.14 shows the forces involved with the steering wheel. First, the driver places their hands in a safe and comfortable position. Then, the driver will push on one side of the steering wheel and pull with the other hand with about the same amount of force. The force causes a torque which is transferred to the steering shaft which is the blue circle in figure 5.14. As mentioned before, the goal is to have a steering ratio of 12:1 so the steering wheel will have a max turn radius of 30 degrees.

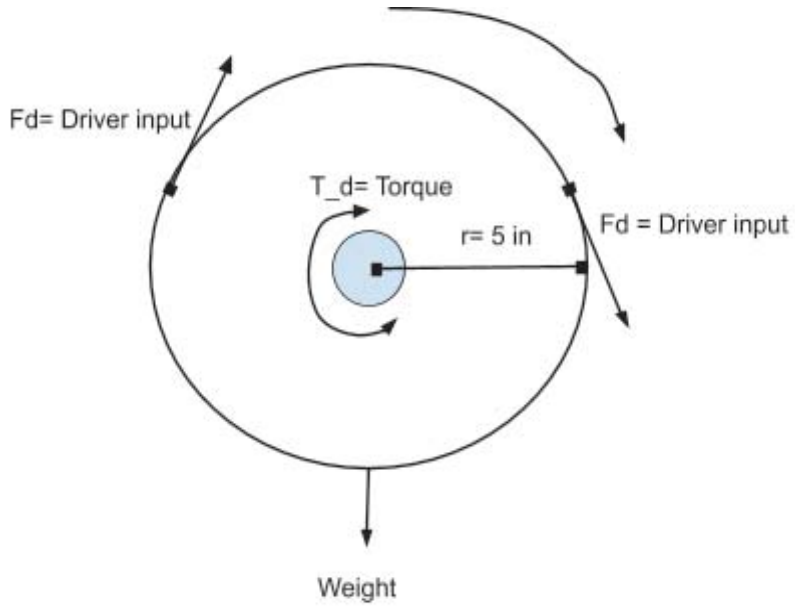


Figure 5.14 Free Body Diagram of the steering wheel

Analysis Equations

The equation for computing the force that will be transferred to the other components is below. The torque is the force driving the other components. If the torque needed to be higher than the driver can

apply more force or the radius of the steering wheel can be increased. The opposite would need to happen if the torque is too much for the other components.

$$T_d = F_d * r_d \text{ or } F_d = \frac{T_d}{r_d} \quad (1)$$

where,

T_d is the torque created by the force from the driver
F_d is the input force from the driver
r_d is the radius of the steering wheel

Values of known variables

Based on the standard steering wheel sizes, the radius is known to be 5 inches. The torque from the driver input was computed by the torque of the pinion being 24 N*m. These variables are used to find the force of the driver to turn the car.

Values of computed variables

The value that needs to be computed is the force of the driver to turn the vehicle. The force from the driver needed to turn the vehicle is 188.97 N which is about 42.5 lbs. If the value needs to be lower, then the group can increase the diameter of the steering wheel or the pinion.

5.2.6 **Analysis for determining the input force from the driver to turn the gears and stress on the steering shaft**

The steering shaft is the direct connection from the steering wheel to the pinion. This component needs to transport the force from the driver input to the pinion with enough force in order to move the tires to turn the vehicle. In figure 5.15, the forces are shown that are acting on the steering shaft. The material that is chosen for this component is critical because a lot of torque is being applied causing a lot of shear stress.

Free Body Diagram (FBD)

The free body diagram is to show the torque being applied to one end travels through the shaft to the other end. The weight of the steering shaft is a force applied to the steering shaft.

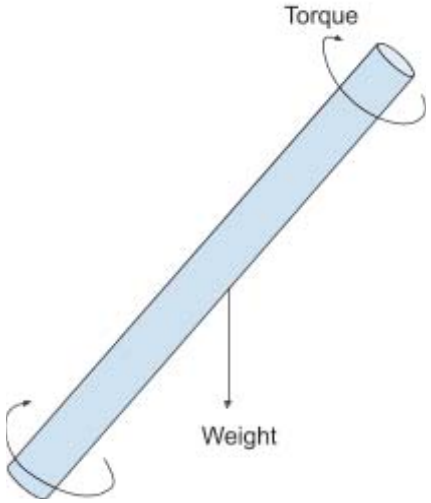


Figure 5.15 Free Body Diagram of the steering shaft

Analysis Equations

The analysis equations will break down the force analysis of the shaft as well as the max shear stress the component can take.

$$J = \frac{\pi d^4}{32} \qquad (1)$$

After the polar second moment of area was calculated, the max shear stress was found.

$$\tau_{max} = \frac{Tr}{J} \qquad (2)$$

where,

J is the polar second moment of area
d is the diameter of the steering shaft
τ_{max} is the max shear stress
T is the torque that was created by the driver
r is the radius of the other surface

Knowing the torque and the polar second moment of area the angle of twist can be obtained.

$$\theta = \frac{Tl}{GJ} \qquad (3)$$

where,

θ is the angle of twist
G is the modulus of rigidity
l is the length of the steering shaft

Values of known variables

The diameter of the steering shaft is 1 inch and that is a little above the standard in the industry today. The modulus of rigidity will be given based on the material that will be chosen. The radius will be half an inch since the diameter is 1 inch. The length of the steering shaft is determined by the placement of the steering system on the chassis.

Values of computed variables

The values to be computed is the angle of twist. The angle of twist is desired to be 30 degrees or more. To achieve a better turning radius the steering ratio needs to be 12:1 which is turning the steering wheel 30 degrees to have the vehicle turn 360 degrees.

5.2.7 **Analysis for determining the size of the gears to steer the vehicle and the material for the gears**

The rack and pinion is the main component that does all of the work to move the tires from side to side. The pinion needs to apply more force to the rack then the force from the tires to the tie rods. To achieve a greater force, the diameter of the pinion and the steering wheel need to have a radius that will reduce the

effort for the driver. The goal of the design for the rack and pinion is to allow for fast change in direction from the driver for better maneuverability.

Free Body Diagram (FBD)

The free body diagram has a visual of how the forces flow through the pinion and the general size of the gear. The main components are the torque on the pinion to the rack that was transferred from the driver and the weight. In figure 5.16, it shows the free body diagram of the pinion and the size of the pinion.

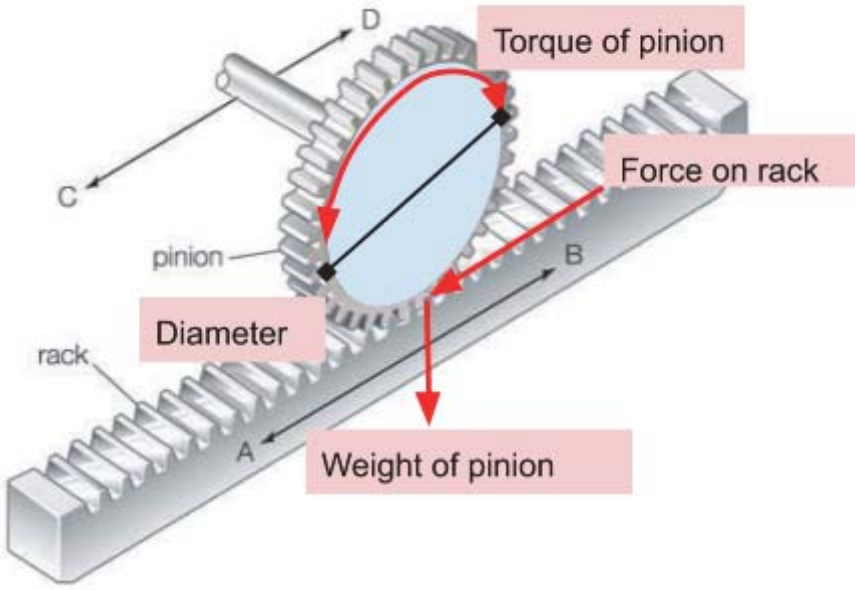


Figure 5.16 Free Body Diagram of pinion acting on the rack

Analysis Equations

The equations for the pinion are mainly for the forces involved to turn the vehicle. The size of the diameter was determined by the group and is used to determine the amount of force generated by the driver to turn the vehicle. First the amount of force to overcome the force from the tires was determined. Then the force is multiplied to the radius of the pinion to calculate the torque of the pinion that is applied to the steering rod.

$$T_p = F_p * r_p \qquad (1)$$

The torque on the pinion is the same as the torque of the steering wheel so it can be stated that

$$T_p = T_d \qquad (2)$$

(3)

where,

T_p is the torque on the pinion
F_p is the force from the pinion on the rack
r_p is the radius of the pinion

Knowing the diameter of the pinion and assuming a module the pinion specs can be calculated.

$$P = \frac{N}{d} \quad (4)$$

$$N = \frac{d}{m} \quad (5)$$

$$p = \pi m \quad (6)$$

where,

P is the diametral pitch
N is the number of teeth for the gear
d is the diameter of the gear
m is the module
p is the circular pitch

These equations are used to find basic information on the gears. Once the relations are found for the pinion, the thickness can be found using the following equation.

$$t = \frac{p}{2} \quad (7)$$

where,

t is the thickness of the tooth

Values of known variables

There were several known variables for the pinion gear. The diameter of the gear was chosen to be 40 mm. The module was chosen to be 2 mm/tooth. The radius of the pinion is set to be 20 mm due to the diameter being 40 mm. The force of the pinion was decided to be 600 N which is higher to the force acting on the steering rod which was 502.44 N. With 600 N, the driver will be able to push and pull the tires from side to side.

Values of computed variables

The Torque of the pinion was calculated to be 24 N*m. Since the torque on the pinion will be the same as the torque on the steering wheel, the Torque was divided by the radius of the steering wheel to figure out the force from the driver needs to be around 188.97 N to steer the vehicle. The number of teeth came out to be 20 for the pinion and diametral pitch was .5 teeth/in. The thickness of the teeth was .25 in and the circular pitch is 2π.

5.2.8 **Analysis for determining the length of the steering rod and the force that applied to the steering rod**

The steering rod is used to push the tires left and right from the desired direction the driver wants to go. The rack is placed on the steering rod that is forced side to side from a pinion. The steering rod was placed 12 inches from the front axle. The length of the steering rod was determined by geometry and the force needed to be applied to push the steering rod side to side was calculated based on the force needed to turn the tires.

(a) Free Body Diagram (FBD)

The free body diagram shows the forces from the pinion on the rack to push the steering rod side to side. In the figure 5.17, the steering rod has a few places the forces affect it. One place being where the rack is being pushed by the pinion and the force from the tie rods.

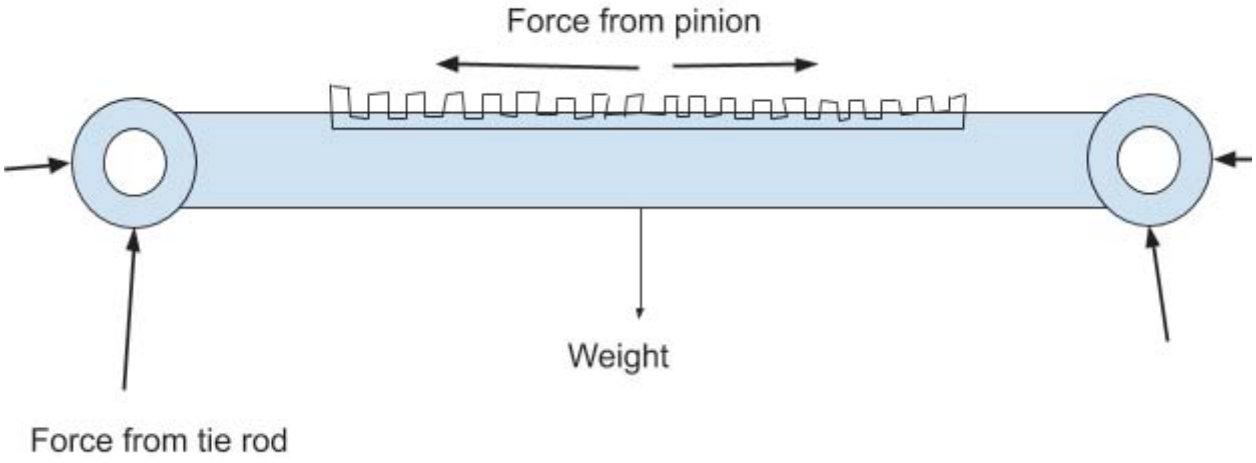


Figure 5.17 Free Body Diagram of the steering rod

Analysis Equations

The equations involved with the steering rod include the total force needed to push the tires side to side. The force from one tie rod was already calculated so to find the total force acted on the steering rod is double the force from one tie rod. The steering system will need to provide more force then the total force from the tie rods in order to steer the vehicle. The length of the steering rod found through

$$f_{total} = f_f * 2 \qquad (1)$$

where,

f total is the total amount of force on the steering rod from the tie rods

Values of known variables

The known variable in this equation is the force from one tie rod. The value of *f_f* was found from doing analysis from the tie rods. The value for *f_f* is 251.22 N.

Values of computed variables

To find the total force acting on the steering rod the group doubled the amount of force from one tie rod. Since the tie rod will push and pull with about the same amount of force, the group was able to find the total amount of force from the tie rods was 502.44 N. This means the driver and the steering system will have to provide more force than the tie rods.

5.2.9 **Analysis for determining the range in motion of the universal joint**

Universal joints are used in areas between many components to transfer rotational motion. In the steering system alone, universal joints serve as a connection where torque has to be transmitted in areas having angles greater 90°, but smaller than 270°.

Free Body Diagram (FBD)

Figure 5.18 presents a free body diagram of the universal joint. The free body diagram helps in understanding that universal joints only allow rotational motion between components.

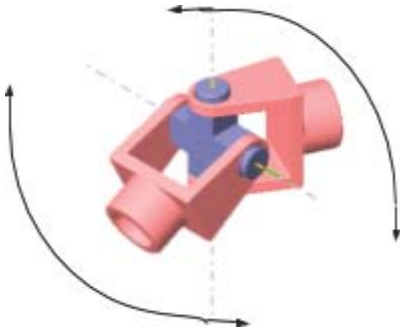


Figure 5.18 Free Body Diagram of universal joint

The steering system for our vehicle is capable of having 1-3 universal joints between the steering wheel and the pinion. However, our steering system will have no more than two universal joints between the steering wheel and pinion. Universal joints don't require calculations at this point, due to a model mot being made yet for the joint.

5.2.10 **Analysis for determining the length of the tie rods and the force being applied to the tires**

The tie rods are responsible for connecting the knuckle to the steering rod. This connection is used for transferring force to the tires from the steering input. Also, the geometry of the tie rods will determine if the steering system is an ackerman steering system. In figure 5.19, it shows the geometry of the tie rods and how it aligns to be an ackerman system. The dimensions for the tie rods are based on chassis. The dimensions of the axles were provided from the baja club from their designs.

Free Body Diagram (FBD)

The forces shown on the tie rod are from the tires and the steering rod. The forces from the tire include the external forces and the friction forces of the ground. The forces from the steering rod are from the driver's input that either pushes or pulls depending on the desired direction the driver wants to go.

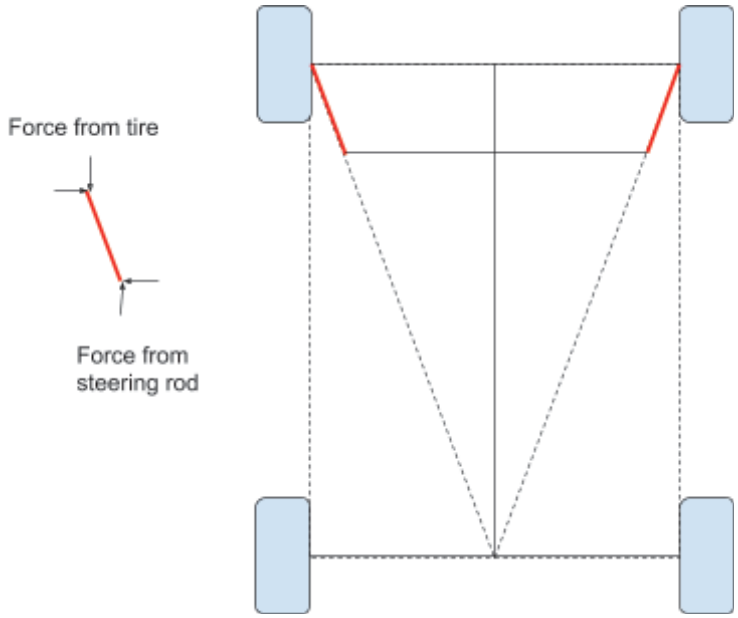


Figure 5.19 Free Body Diagram of the tie rod as well as the geometry of the tie rods

Analysis Equations

The first equation below determines the torque due to lateral force. Since *Tlf* is a known value, the force of friction is desired to know the force that is required from the driver to turn the vehicle.

$$T_{lf} = f_f * d_k \qquad (1)$$

rearranging to

$$f_f = \frac{T_{lf}}{d_k} \qquad (2)$$

where,

T_lf is the torque due to lateral force
f_f is the force of friction
d_k is the perpendicular distance from the kingpin axis

Values of known variables

The value for *T_lf* was given from the baja club based on the force the tire pushes back to the tie rod. That force is from the friction and the weight of the vehicle. The value for *T_lf* is 23.74 N*m. The value for *d_k* is the distance from the kingpin axis and the tire. This value is from the geometry of the tire which was given from the baja club at 0.0945 m.

Values of computed variables

The value of *f_f* is computed to find the force that is applied to the tie rods. With the known variables, the amount of force on one tie rod is 251.22 N. This applies to one tie rod that is attached to the steering rod.

5.2.11 **Analysis for determining the size of the ball joint and the range of motion**

Ball joint allows for a flexible movement using a ball joint. This is for front suspension assembly of links, joints, bushings and bearings that allow your front wheels to move up and down independently and turn left or right together. the motions of the suspension is maximized and the tire contact with the road for optimum vehicle control and tire wear.

Free Body Diagram (FBD)

The ball joint on the front suspension provides pivoting movement between the steering knuckles and control arms to provide a safe, smooth ride and allow precise control to the vehicle. In figure 5.20, it shows the ball joint.

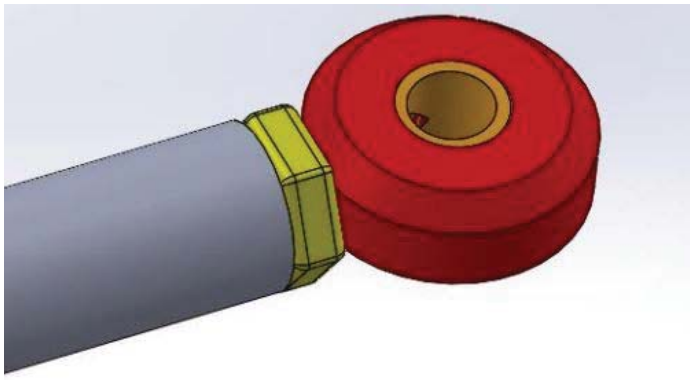


Figure 5.20 Free Body Diagram of ball joint and the range of motion

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

STATUS REPORT 10

TOPICS COVERED IN STATUS REPORT 10

Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER

Status Report 10 on Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

Due: 11/19/2020

1. For each part in your design (except standard parts such as screws, bolts and nuts)
   (i) Generate 3D CAD model for the part with appropriate labels.
   (ii) Following the 3D model, generate a well dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards
   (iii) Repeat (i) and (ii) for each part in your system.

2. Generate CAD design(s) of assemblies and sub-assemblies, exploded views that show the components/parts you need to order. The components should be identified with part numbers (1) (2) (3) etc. or subassembly numbers (A) (B) (C) etc. If subassemblies are used, exploded views of each subassembly should be provided.

3. Indicate the **standards** used to generate the models, drawings and the assemblies in items 1 and 2.

4. For each part, provide summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor and phone number. Provide the total estimated cost for the project. Note that for single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Assignment for Assessing Outcome 2

Table 5.X Parts Specifications, Vendor Information and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
1								
2								
3								
4								
5								
6								
7								
8								
9								
				Total				

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #_____

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and sub-assemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers (1) (2) (3) etc. Subassembly identified with sub-assembly letters (A) (B) (C) etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	Table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: _____Cad Models-Drawings-Assemblies _____
GROUP NUMBER: ___7___
Progress Report Title: Status Report 10
Due Date: 12/2/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member	Your Score
1	**Daniel Akpan** Daniel Akpan	- Cad Drawings for: Motor Motor -Contribute with group report -Attend meetings -Conduct team evaluations	100%	
2	**David Trevino** David Trevino	- Cad Drawings for: Shaft -Contribute with group report -Attend meetings -Conduct team evaluations	100%	
3	**Amna Ansari** Amna Ansari	- Cad Drawings for: Shell Body and Debris shield paragraphs -Contribute with group report -Attend meetings -Conduct team evaluations - Complete meeting minutes	100%	
4	**Demetrious Sandford** Demetrious Sandford	- Cad Drawings for: Pump -Contribute with group report -Attend meetings -Conduct team evaluations - Proofread full report	100%	
5	**Caleb Riggins** Caleb Riggins	- Cad Drawings for: 6 Grooved Disks -Contribute with group report -Attend meetings -Conduct team evaluations -Verify and correct technical writing	100%	
6	**Ximena Cifuentes** Ximena Cifuentes	- Cad Drawings for: 2 Grooved Drum and debris shield -Contribute with group report -Attend meetings -Conduct team evaluations -Help format	100%	
7	**Aamna Jangda** Aamna Jangda	- Cad Drawings for: Oil Containment Tank -Contribute with group report -Attend meetings -Conduct team evaluations - Help format	100%	

*100% means the member completed his/her assigned work

By signing this assignment cover sheet, I agree that the percentages stated in the % completed column reflect the contribution made by me and the other members of the group.

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER

Status Report 10 on Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

Due: 12/2/2020

1. For each part in your design (except standard parts such as screws, bolts and nuts)

(i) Generate 3D CAD model for the part with appropriate labels.

(ii) Following the 3D model, generate a well dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards

(iii) Repeat (i) and (ii) for each part in your system.

2. Generate CAD design(s) of assemblies and sub-assemblies, exploded views that show the components/parts you need to order. The components should be identified with part numbers 1 2 3 etc. subassembly numbers A B C etc. If subassemblies are used, exploded views of each subassembly should be provided.

3. Indicate the **standards** used to generate the models, drawings and the assemblies in items 1 and 2.

4. For each part, provide a summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor and phone number. Provide the total estimated cost for the project. Note that for single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Assignment for Assessing Outcome 2

Table 5.X Parts Specifications, Vendor Information and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	
1							
2							
3							
4							
5							
6							
7							
8							
9							
				Total			

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #_____

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and sub-assemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers (1) (2) (3) etc. Subassembly identified with sub-assembly letters (A) (B) (C) etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	Table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER

Status Report 10 on Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

5.3 CAD Models, Detailed Drawings, Sub-assemblies, System Assembly and Equipment specifications and selection

In this section, the skimmer components CAD Models, detailed drawings, assembly, and equipment specifications and selections are displayed. Each component encloses a model shot and a blue print draft with dimensional specifications. In addition, the codes and standards used for modeling each component are listed after all the drafting figures of this report. Finally, the section encloses a summary of the engineering analysis needed for proper sizing of each component.

1. For each part in your design (except standard parts such as screws, bolts and nuts)
(i) Generate 3D CAD model for the part with appropriate labels.

In this section, the team was able to work together to identify the different components that needed to be modeled. Once the components were identified, each team member was able to contribute by modeling one component. During the modeling phase, each team member made the proper optimizations to the previously designed parts as shown in Figures 5.1 to 5.8.

1. Skimmer Shell

In Figure 5.1, the 3D CAD model for the skimmer body is displayed.

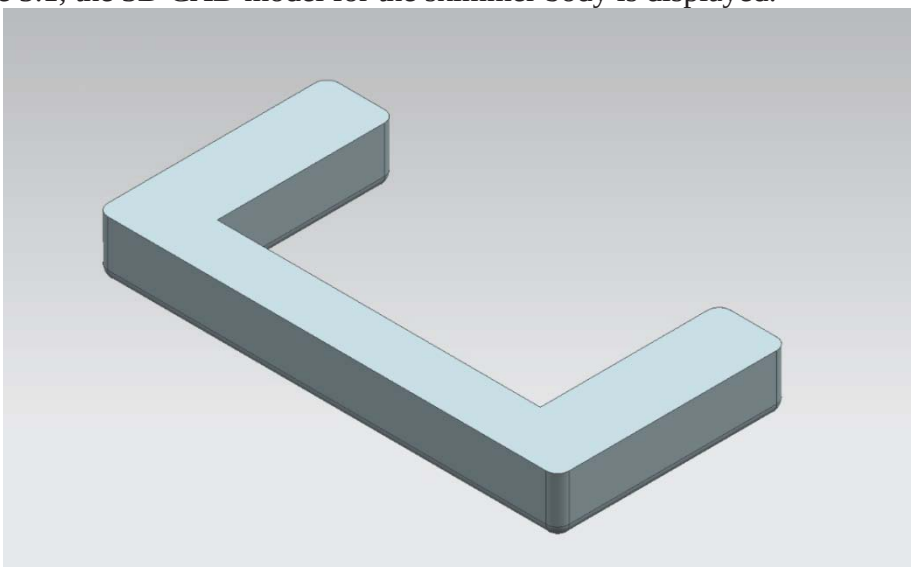


Figure 5.1 Skimmer Shell 3D Model

2. Tank

In Figure 5.2, the 3D CAD model for the oil containment tank is displayed.

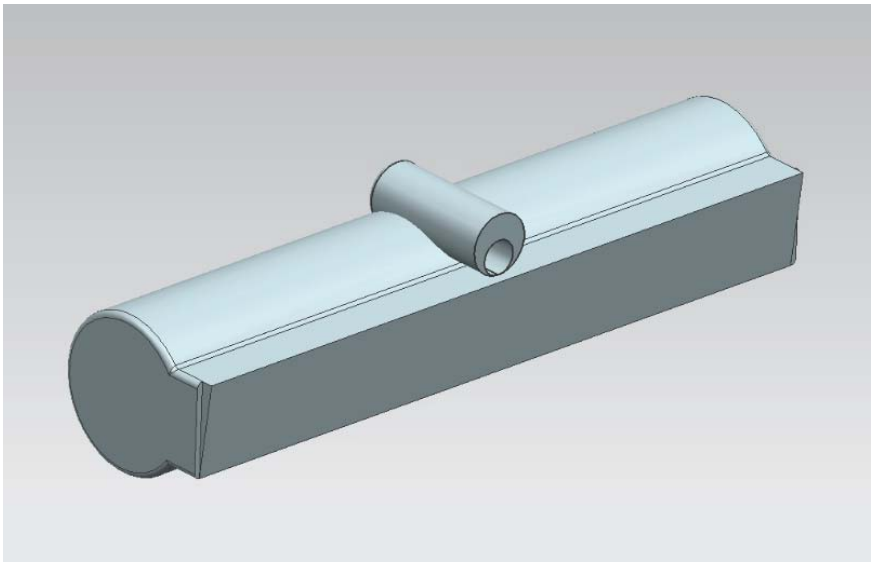


Figure 5.2 Oil Containment Tank 3D Model

3. Grooved Disk

In Figure 5.3, the 3D CAD model for one of the six grooved disks is displayed.

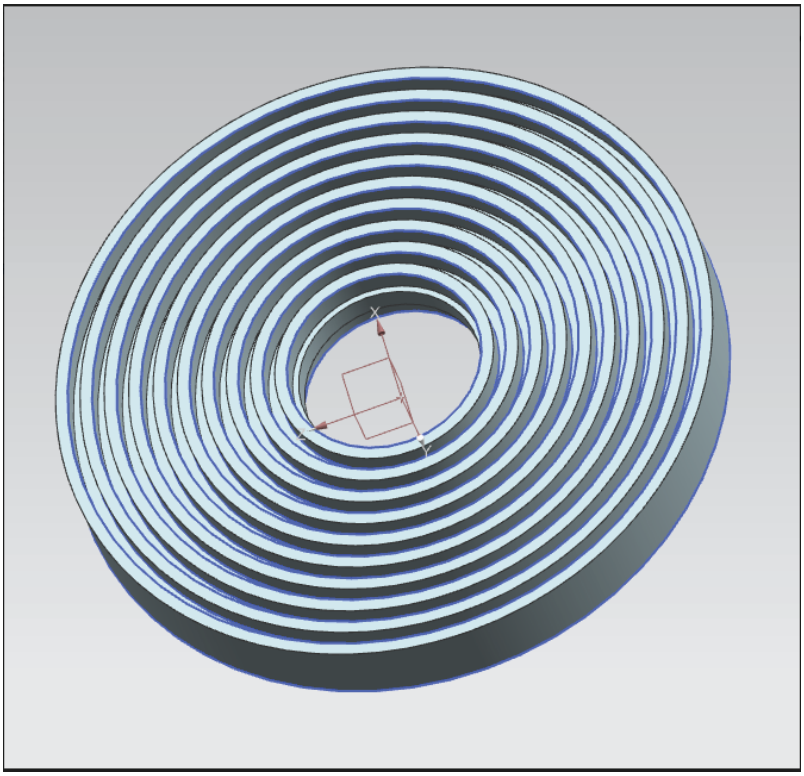


Figure 5.3 Grooved Disk 3D Model

4. **Drum**

In Figure 5.4, the 3D CAD model for one of the three grooved drums is displayed.

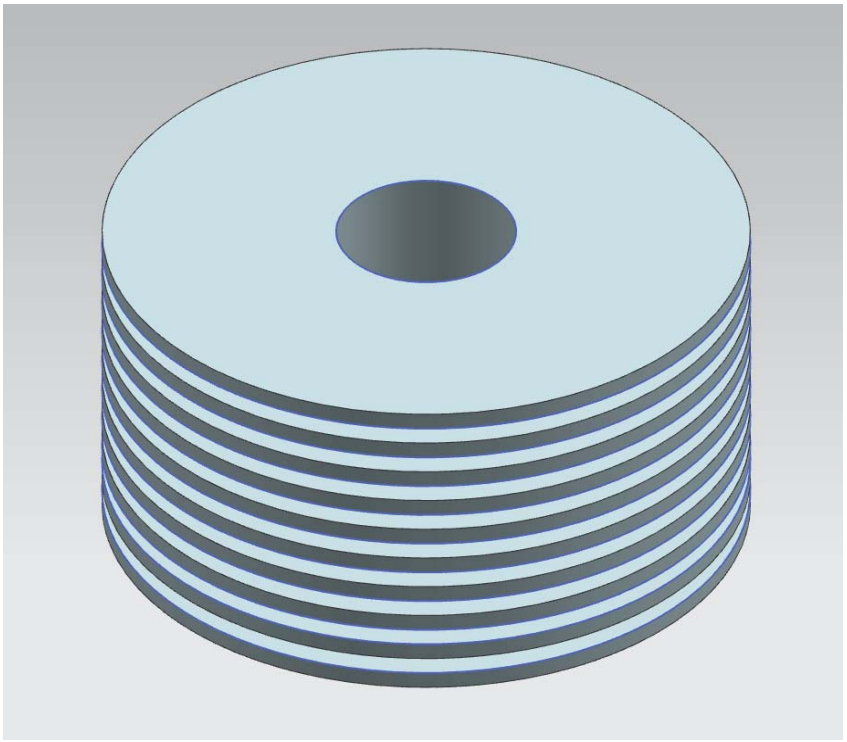


Figure 5.4 Drum 3D Model

5. **Shaft**

In Figure 5.5, the 3D CAD model for the skimmer's shaft is displayed.

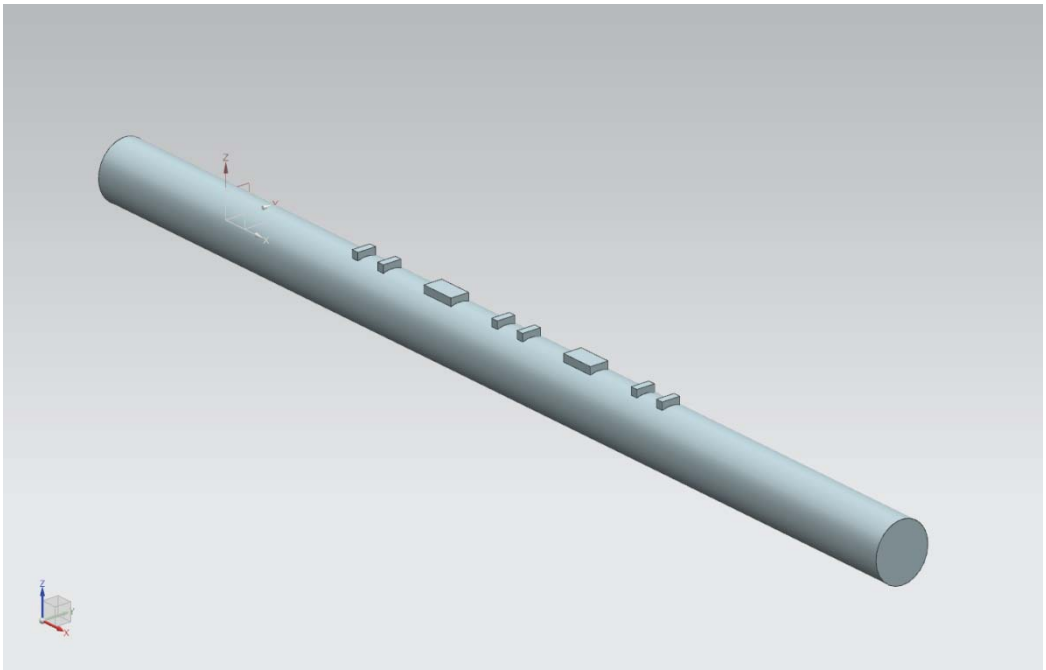


Figure 5.5 Shaft 3D Model

6. Pump

In Figure 5.6, the 3D CAD model for the pump is displayed.

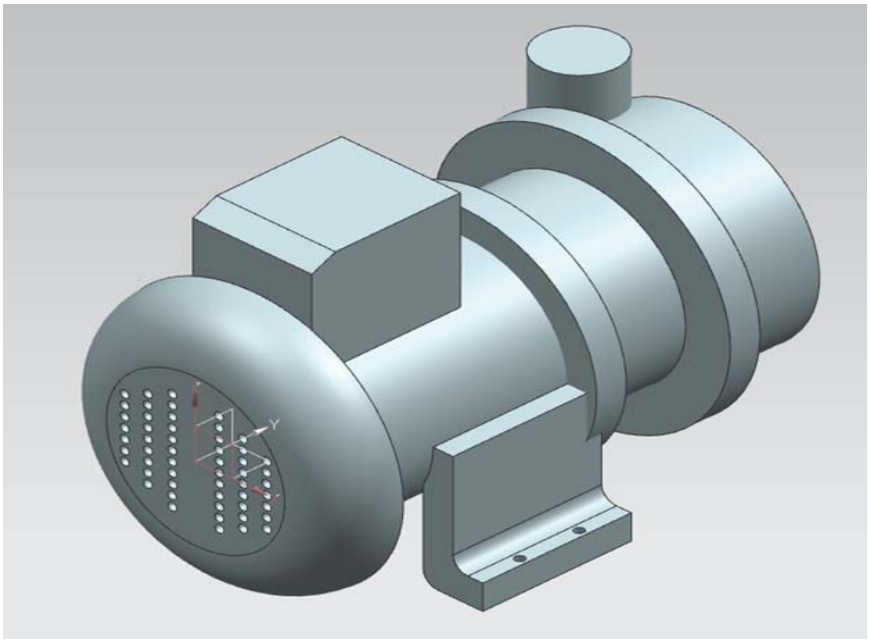


Figure 5.6 Pump 3D Model

7. Motor

In Figure 5.7, the 3D CAD model for the Motor is displayed.

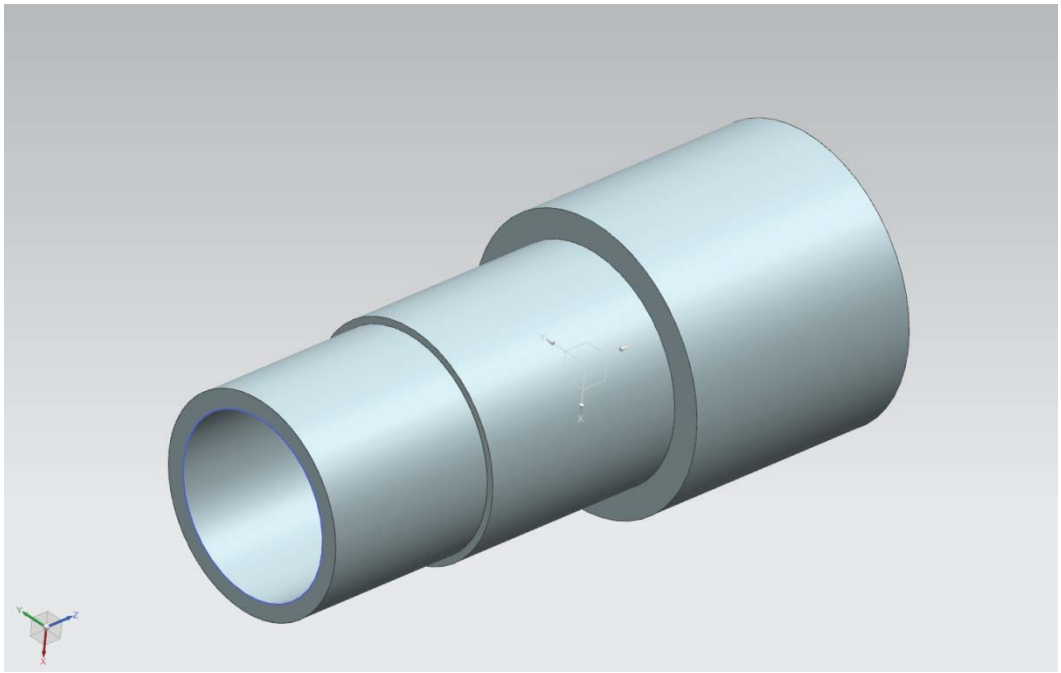


Figure 5.7 Motor 3D Model

8. Debris Shield

In Figure 5.8, the 3D CAD model for the debris shield is displayed.

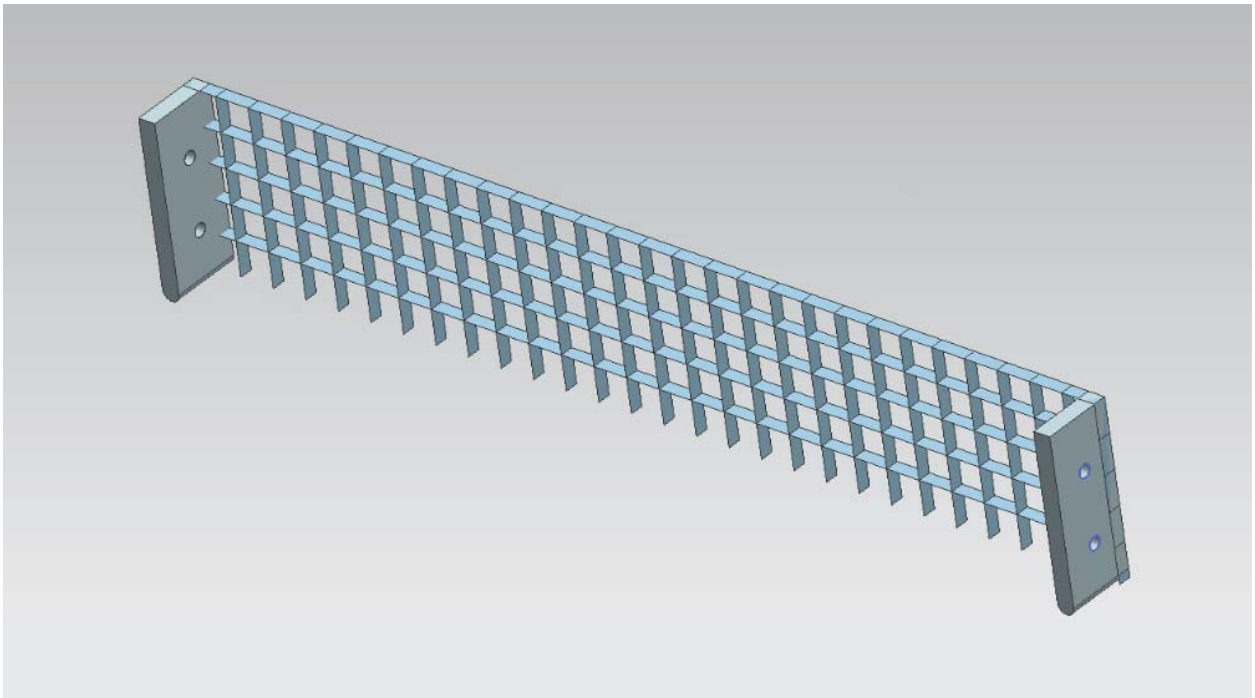


Figure 5.8 Motor 3D Model

(ii) Following the 3D model, generate a well dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards

(iii) Repeat (i) and (ii) for each part in your system.

In this section, once all the models were presented, each team member went back to create a dimensional draft of each component as shown in Figures 5.9 to 5.15.

1. **Skimmer Shell**

   In Figure 5.9, the Blueprint Drawing of the Skimmer shell is being displayed, using Siemens NX10 sheet.

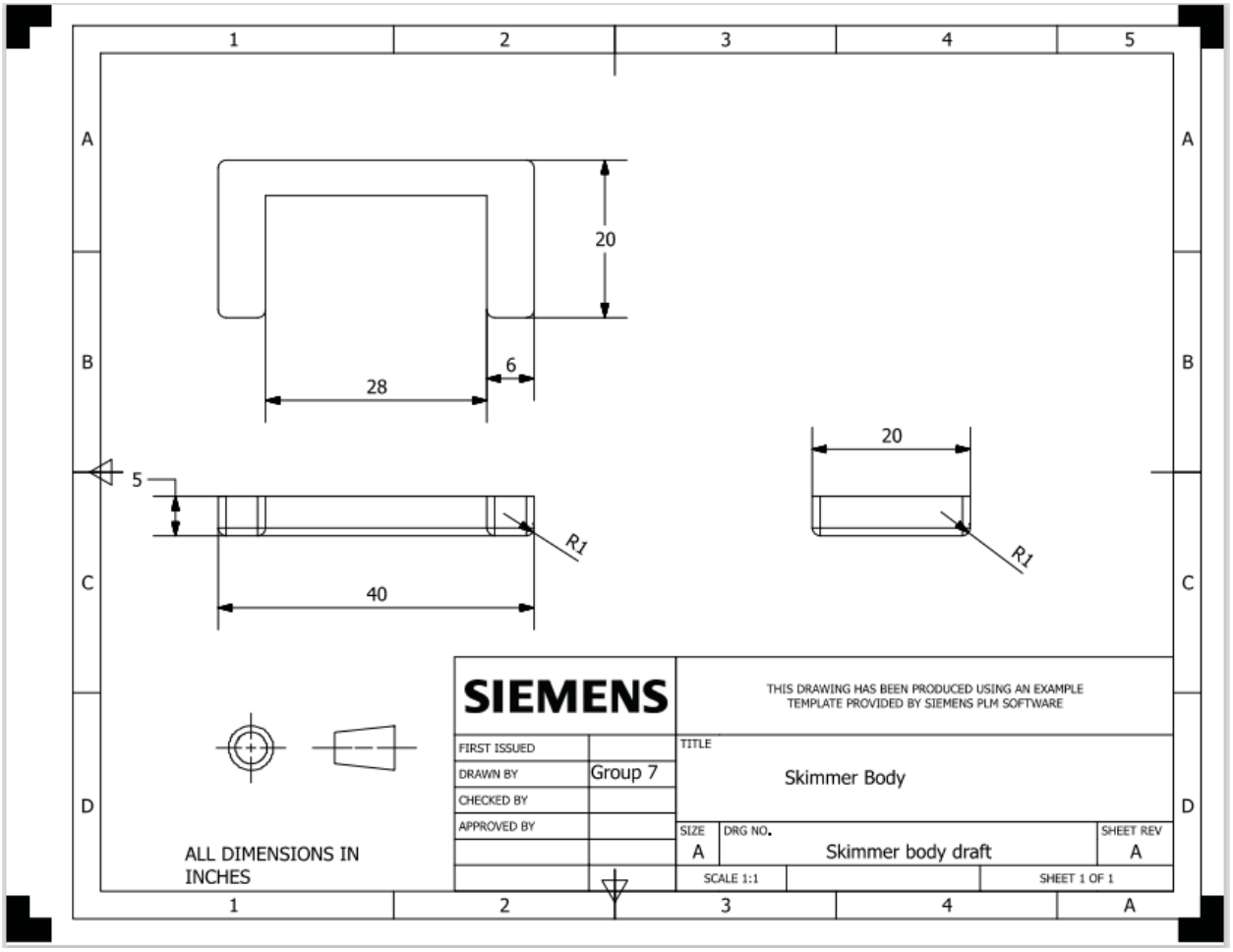


Figure 5.9 Skimmer Shell 2D Draft

2. Tank

In Figure 5.10, the Blueprint Drawing of the Containment Tank is being displayed, using Siemens NX10 sheet.

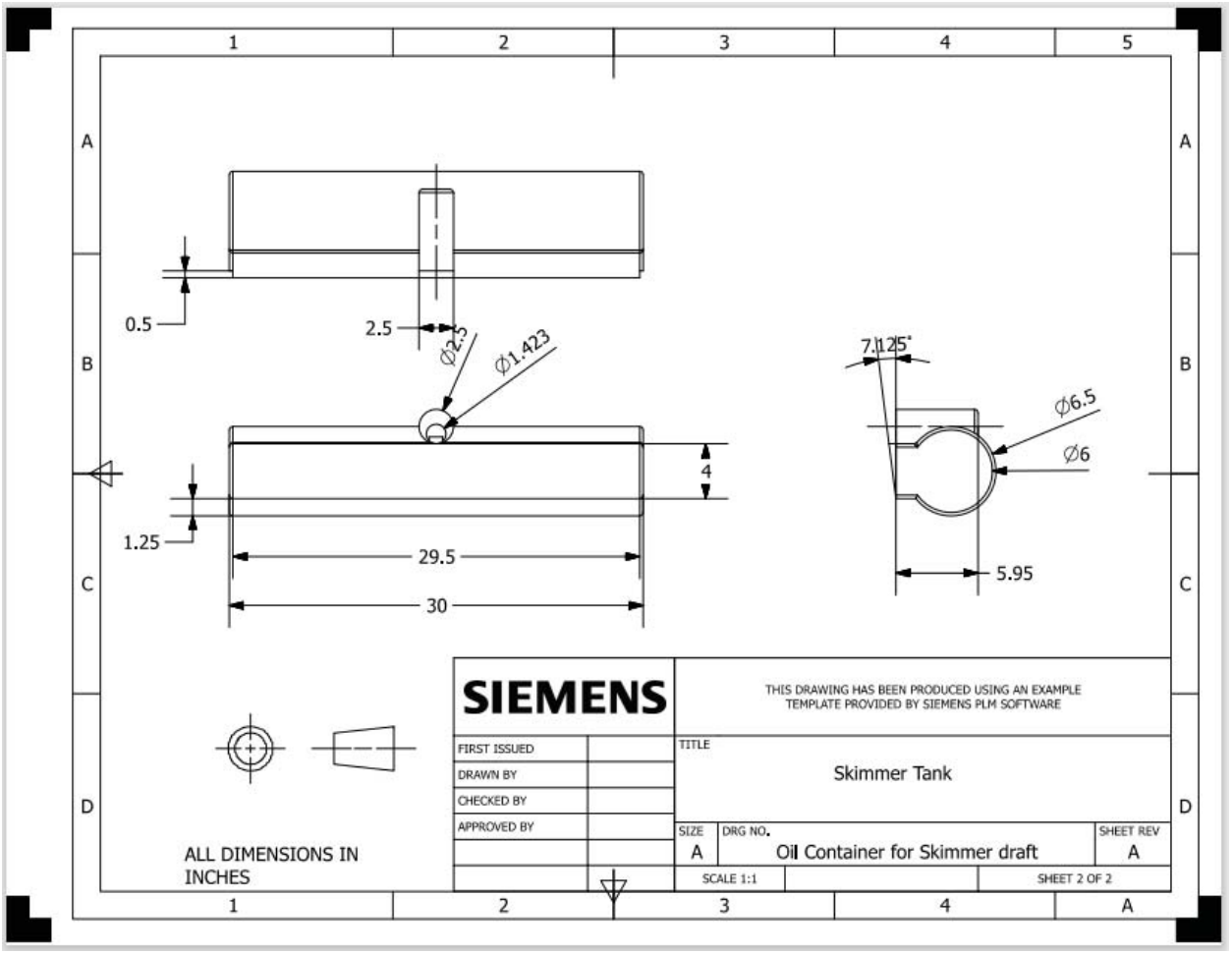


Figure 5.10 Oil Containment Tank 2D Draft

3. Disk

In Figure 5.11, the Blueprint Drawing of the Grooved Disk is being displayed, using Siemens NX10 sheet.

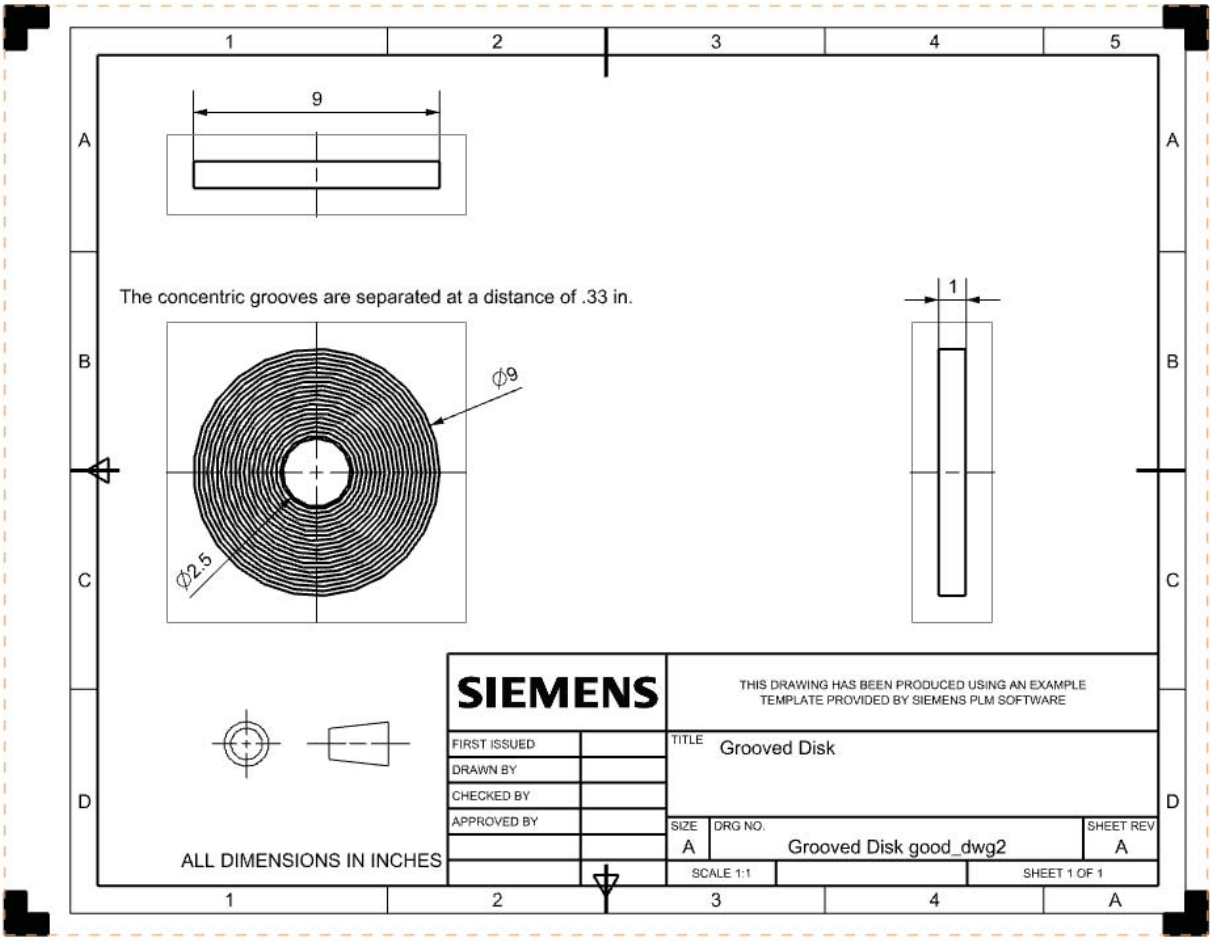


Figure 5.11 Grooved Disk 2D Draft

4. Drum

In Figure 5.12, the Blueprint Drawing of the Grooved drum is being displayed, using Siemens NX10 sheet.

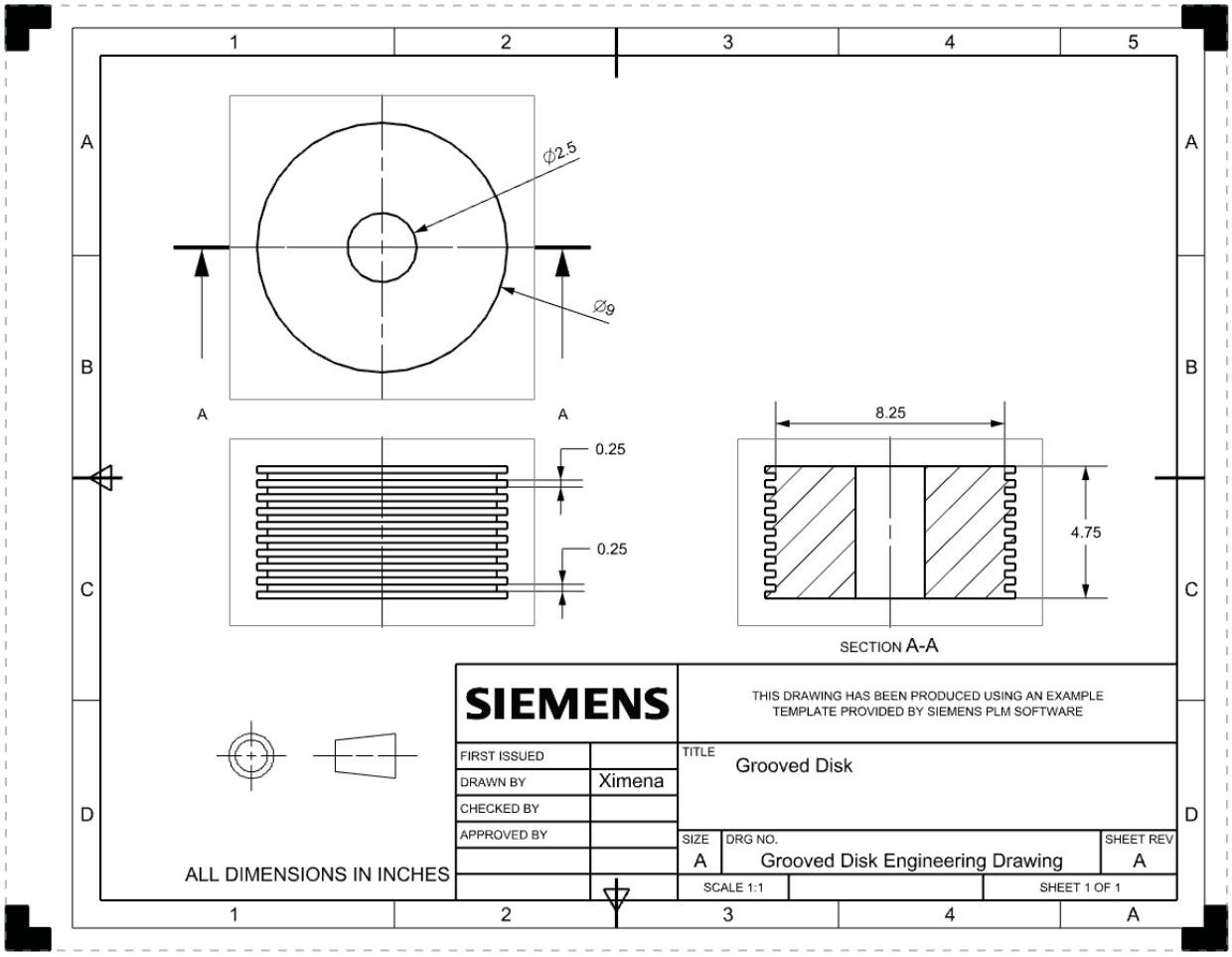


Figure 5.12 Grooved Drum 2D Draft

5. Shaft

In Figure 5.13, the Blueprint Drawing of the Shaft is being displayed, using Siemens NX10 sheet.

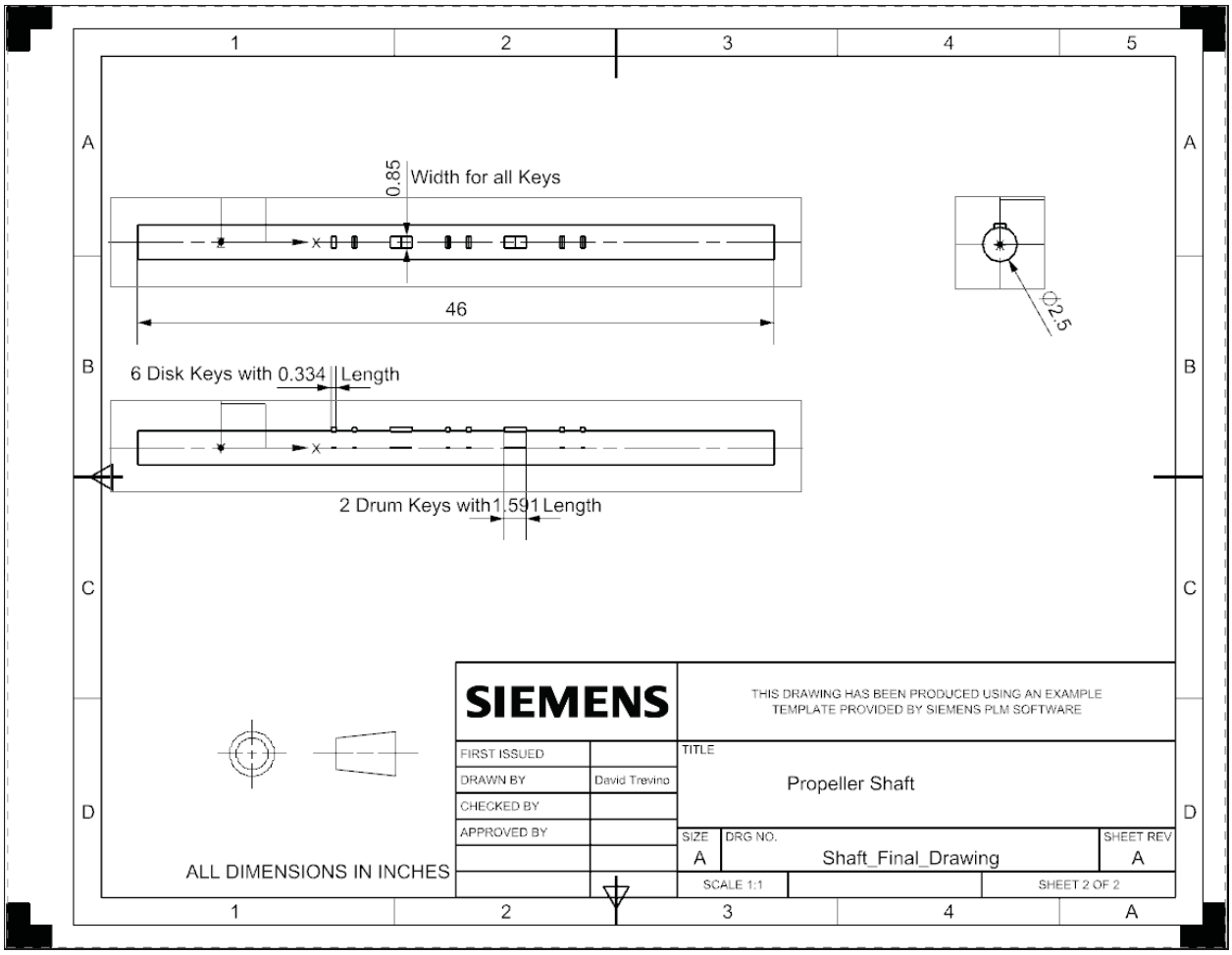


Figure 5.13 Shaft 2D Draft

6. Pump

In Figure 5.14, the Blueprint Drawing of the Pump is being displayed, using Siemens NX10 sheet.

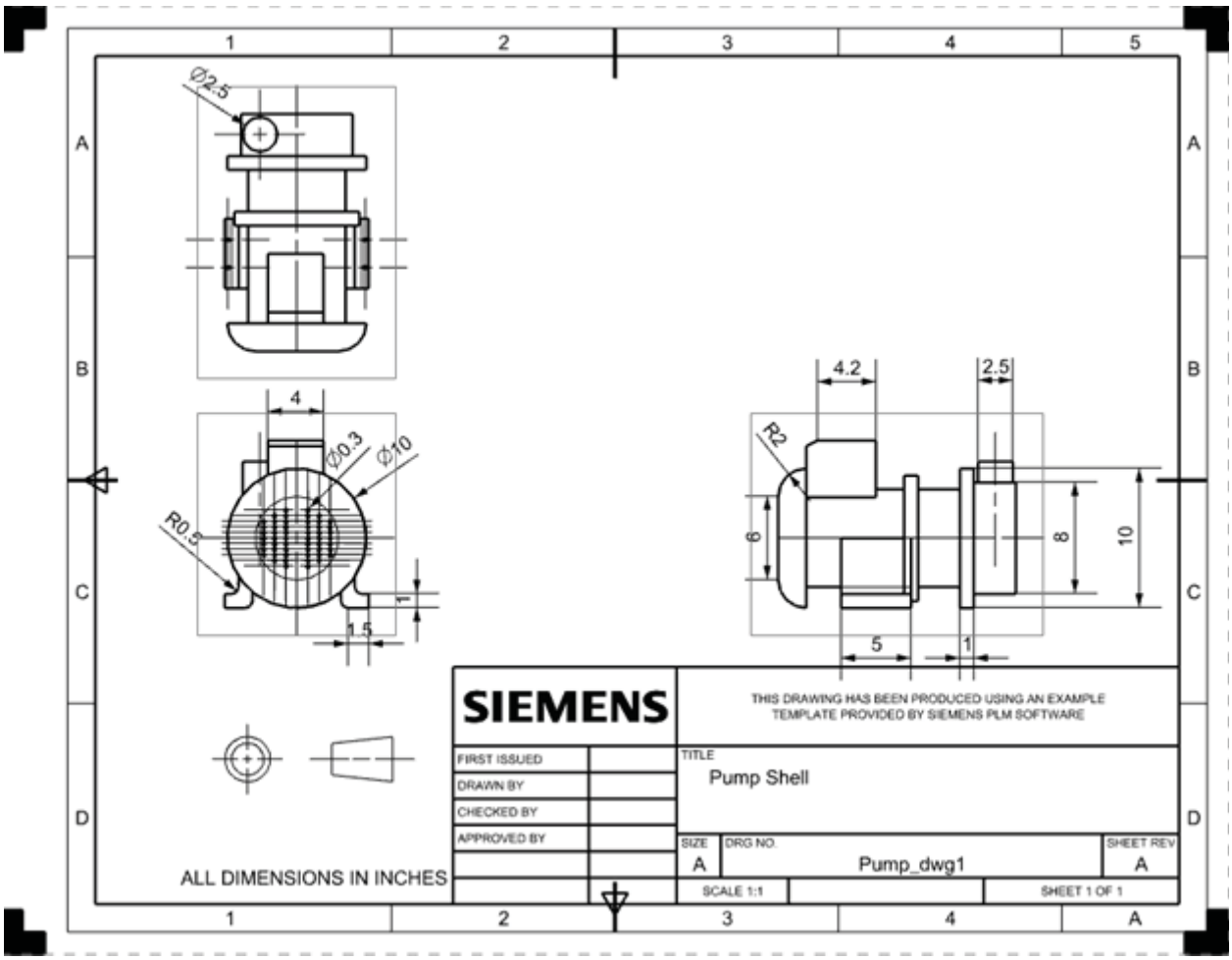


Figure 5.14 Pump 2D Draft

7. Motor

In Figure 5.15, the Blueprint Drawing of the Motor is being displayed, using Siemens NX10 sheet.

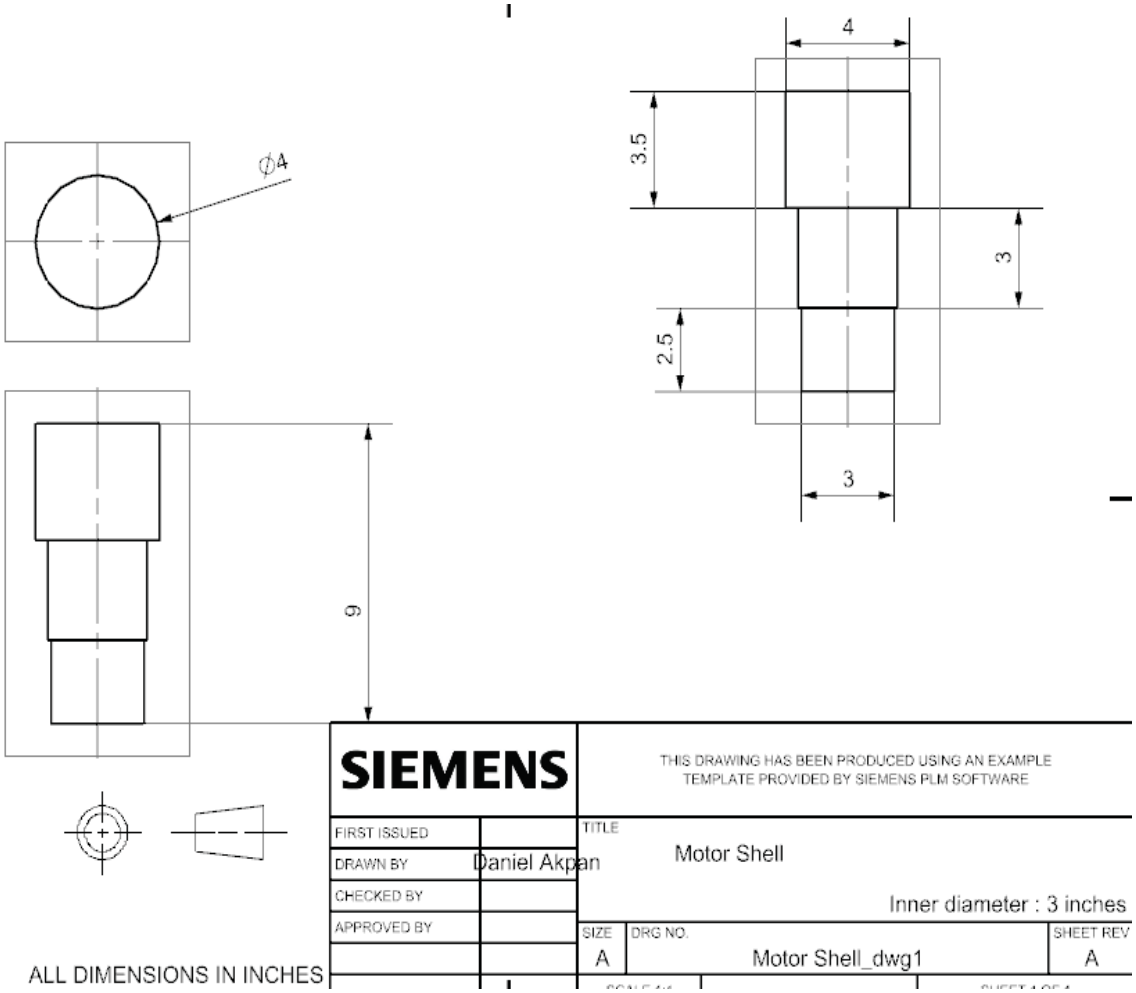


Figure 5.15 Motor 2D Draft

8. Debris Shield

In Figure 5.16, the Blueprint Drawing of the is being displayed, using Siemens NX10 sheet.

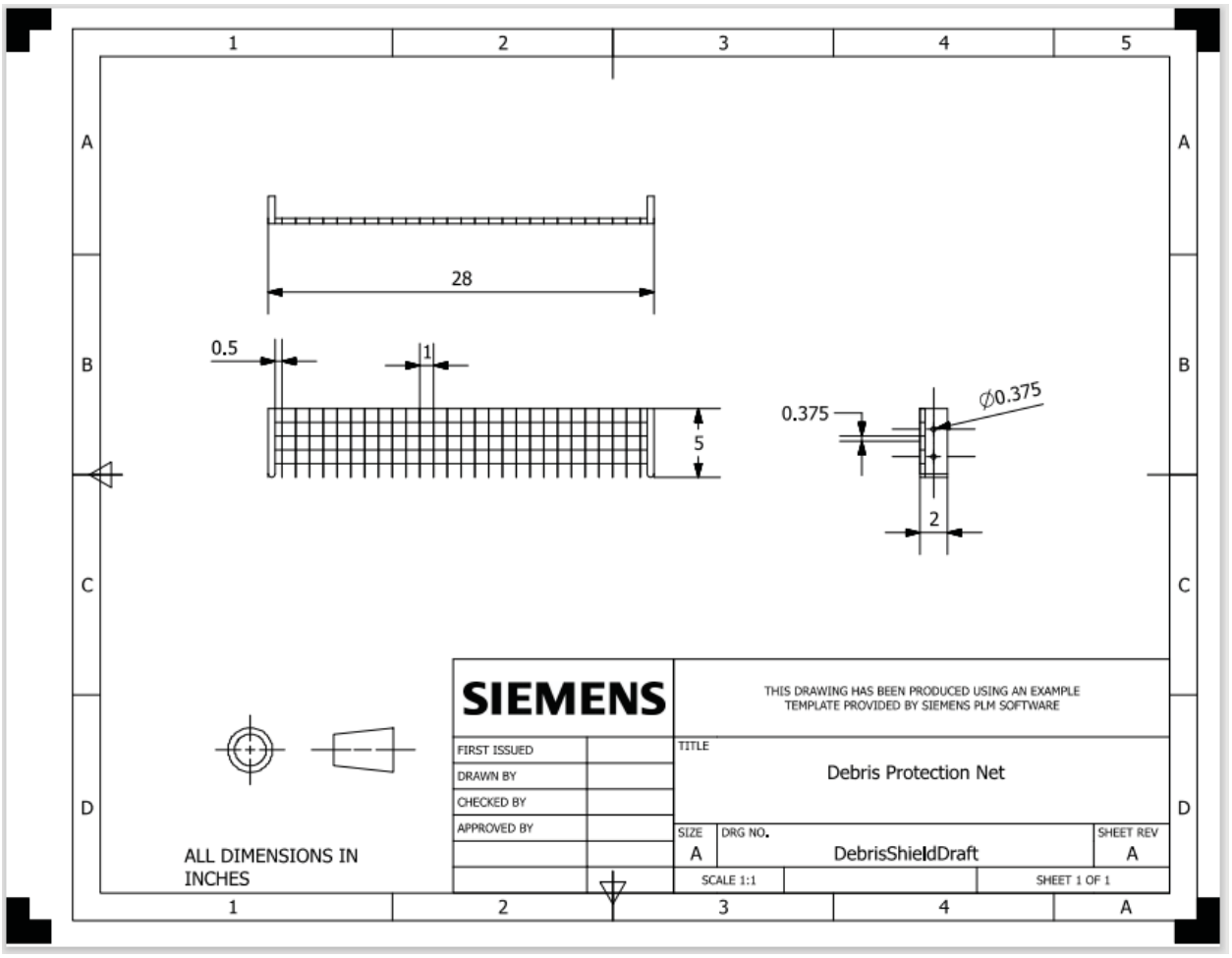


Figure 5.16 Debris Shield 2D Draft

2. Generate the CAD design(s) of assemblies and sub-assemblies, exploded views that show the components. The components should be identified with part numbers 1 2 3 etc. or subassembly numbers A B C etc. If subassemblies are used, exploded views of/parts you need to order. each subassembly should be provided.

Finally, the team was able to come together and properly assemble all of the parts together as shown in Figure 5.17 and 5.18. Each part was assigned a specific part number. These part numbers were noted on both the model and engineering drawing to signalize each component. These numbers were also used in the other sections of the report to ensure the order of all the material discussed on the report.

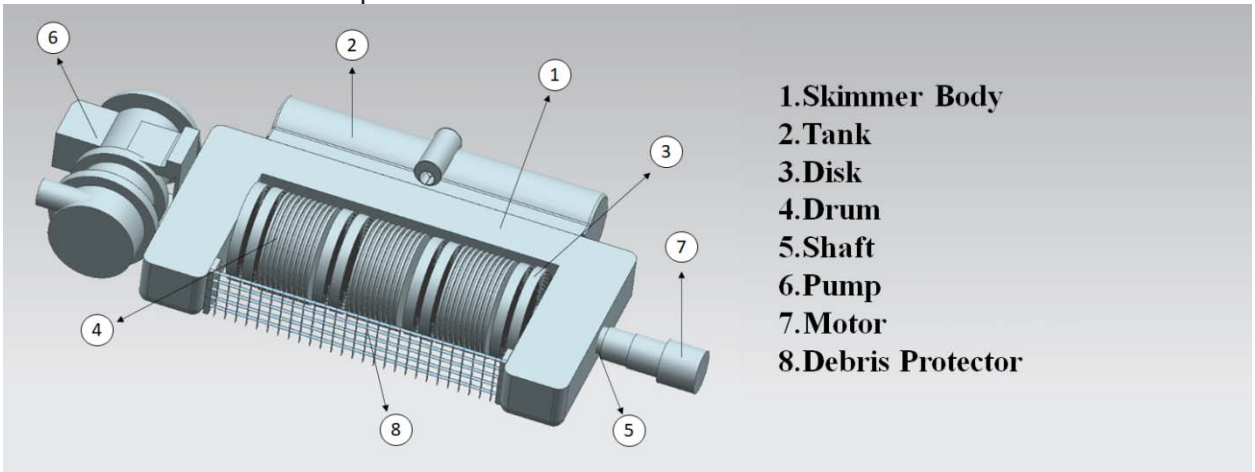


Figure 5.17 Skimmer Assembly 3D Draft

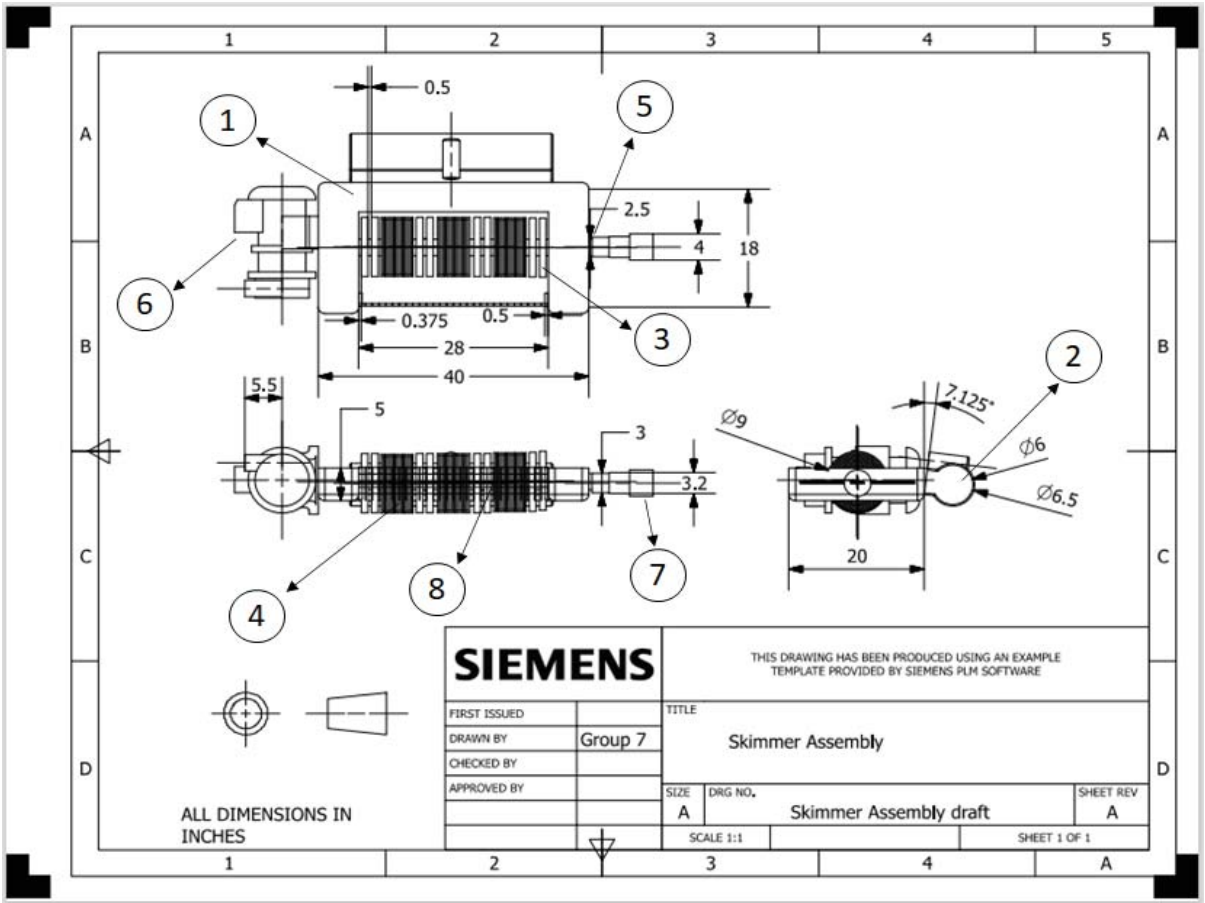


Figure 5.18 Skimmer Assembly 2D Draft

3. Indicate the **standards** used to generate the models, drawings, and the assemblies in items 1 and 2.

In this section, the standards to generate the models, drawings, and assemblies are discussed. In the next few paragraphs, each one of the model's standards used are described in a list form. The information on each component is listed in the order of part number assigned in the previous section.

1. Skimmer Shell

To generate the 3-dimensional model for the skimmer shell (body), NX Modeling was utilized as well for the drawings and assemblies. The design was created in inches to match all the other parts of the skimmer. Also, the design was generated to fit the measurements constraints of the other parts of the oil skimmer as well as adhering to the 5ft by 5ft operating domain limitation. The 2-D drawing was utilized to display the blueprint of the skimmer shell.

2. Tank

The ISO (International Organization for Standardization) was applied to creations of models within NX 10 software. The designs display orthographic projections and cross-section views. Material type and thickness is also shown in the 3-D drawings. The dimensions were chosen based on the skimmer body size.

3. Disk

The creation of this model was generated using NX 10 software. 2-D drawing was utilized to define the overall blueprint for the design while also analyzing realistic dimensions for the skimmer disk based upon current designs and the design that we are constructing.

4. Drum

The standards used to design the proper drum for the skimmer include adhering to the size constraints identified in report 9. In addition, the manufacturability of the part was considered when making the design. Moreover, the part was designed to limit the friction between the inner diameter of the drum and the outer diameter of the shaft by creating keyways on the disk. To model the drum of the skimmer and generate the draft of the part, the software NX 10 was used.

5. Shaft

Utilizing Siemens NX 10, the shaft was generated for the automated oil skimmer. Within this shaft contains multiple keys in which the disks and drums will sit upon and prevent unnecessary rotation. The length of the shaft alongside the diameter was chosen based on the proposed design identified in the status report 9. Additionally, a 2-D drawing was generated in order to display the dimensions of the shaft and keys.

6. Shell of Pump

The three-dimensional design of the pump and the two dimensional drawing was generated using Siemens NX 10 Modeling software using inches as units. The design was created to fit the dimensions of the skimmer body all while staying within the 5ft by 5ft operating limitations.

7. Motor

To generate the 3-dimensional model for the Motor shell, Nx modeling was used for the drawings, dimensions and modeling. The design was chosen due to ASTM standards for parts and the ease of manufacturability. The sizing was chosen to fit the design constraint of the oil skimmer, which is not to exceed 5ft by 5ft. The power generated by the motor was also taken into account during the design process. The unit used for the dimensions of the motor are in “Inches”.

8. Debris Shield

To generate the 3-dimensional model for the skimmer’s debri shield, NX Modeling was utilized as well for the drawings and assemblies. The design was generated to fit the U-shaped body of the skimmer. The purpose of this component is to keep the debris away from the disks and the drum to ensure a more accurate oil recovery rate.

4. For each part, provide a summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

In this section, the team was able to provide a summary of the engineering analysis and the calculations needed to effectively size the part. During the process of the skimmer assembly, some of the sizes for the parts were adjusted to ensure that the skimmer parts were proportional to each other and that they fit properly together. Once the changes were made to each part, each team member noted the new measurements in this section and modified each individual draft.

1. Skimmer Shell

The engineering analysis of the skimmer shell was based on the project initial constraints, that the oil skimmer cannot exceed an operating domain of 5ft by 5ft. The U-shaped body of the skimmer shell was assumed to be 40 inches in lengths and 20 inches in width, and the height of the skimmer was assumed to be 5 inches. The following measurements fit the project constraints and it is going to allow the skimmer to operate in a 5 ft by 5ft domain.

2. Tank

The main measurements of the tank were based on the skimmer shell, since the tank is vertically attached to the main skimmer shell, it was assumed to be the same length of 3 ft. This tank has the capability of holding 275 gallons of oil based on the volume. Prior research that consisted of current skimmer storage capabilities was also taken into consideration.

3. Disk

The orientation of the grooved disks was determined based upon literature review and current disk skimmer designs. A total of eight disks will be incorporated into the design. NX was used to construct a 9 in diameter disk with a grooved face created with .33 in thickness concentric circles. The depth and distance between the grooves were determined using geometric calculations as described in the previous chapter.

4. Drum

The drum dimensions were determined by the space between the arms of the skimmer body. In addition, the team considered the amount of disks desired in the design as well as the desired oil recovery rate. It was determined that increasing the surface area of both the disks and the drums

would significantly increase the oil recovery rate of the skimmer. Moreover, design contains a total of 3 drums. Finally, for the skimmer design it was determined that the drum size should be 4.5 in and should maintain a diameter of 9 in as shown in Figures 5.4 and 5.12.

5. Shaft

The dimensions for the shaft were determined by the length of the skimmer shell and the motor shell. Utilizing information gathered from status report 9, the shaft dimensions turned out to be 46 inches long with a diameter of 2.5 inches. Additionally, in order to prevent unnecessary rotation of the disks and drums, keys were added to the shaft. There is a total of 11 keys within the shaft, 8 keys were used for the disk which are 0.334 in by 0.85 in and 2 keys for the shaft with the dimensions of 1.591 in by 0.85 in. The material for the shaft was determined to be aluminum 6061-T6.

6. Pump

The size of the pump was designed based on the dimensions of the skimmer body. The pump will either fit on the right side of the skimmer body using screws to hold it in place or on the backside next to the container attached with more screws to ensure stability in a vertical position will. Its shape was made to resemble that of a pump from RS Components & Controls (I) Ltd..

7. Motor

The size and geometry of the motor shell was designed based on the dimensions of the motor shell in the analysis report. The motor will fit either on the left or right outer most part of the skimmer (extended parts of the shaft), where it will be attached to the protruded part of the shaft on either side. The motor will then produce power, causing the shaft to rotate, in turn making the disk and drums rotate, all of which leads to the disk and drums collecting oil. The total length of the motor was 9 in, with each individual component making up the total length measuring 3.5in, 3in and 2.5in respectively. The outer diameter of the motor measures 4in, while the inner diameter measures 2.7 in.

8. Debris shield

The size of the debris shield was based on the dimension of the skimmer shell, more specifically the removed area of the shell. the length of the debris shield is 28 inches with a 2 inches bracket to secure the debris shield on the sides of the skimmer shell.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor and phone number. Provide the total estimated cost for the project. Note that for a single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

5.5 Economic Analysis

In this section the economic analysis for the parts designed can be found in table 5.1. The table summarizes all the data obtained from suppliers. In addition, the supplier information can be found on the table. Moreover, the team was required to obtain at least 3 quotes from the suppliers for parts that were quoted to be more than $50. The values displayed on the table are those of the lowest price found. Finally, the team concluded that for some of the parts, 3D printing would be

the most economical option. Note that some of the prices listed on the table are subject to change.

Table 5.1 Parts Specifications, Vendor Information and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
1	Skimmer Body	The skimmer frame is manufactured in Polyethylene HD, making it resistant to many chemicals found in industrial pits, sumps, separators, and tanks.	1	$1332.00	$1332.0	Elastec	(618)382-2525	https://www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/minimax/
2	Tank	Vertical oval oil storage tank that features heavy-duty steel construction and can hold up to 275 Gal. The tank includes a vent-fill cap and a tank gauge.	1	$1,370	$1,370.0	Liquidynamics	(281)239-2777	https://www.homedepot.com/p/Liquidynamics-275-Gal-Vertical-Oval-Oil-Storage-Tank-with-Vent-Fill-Cap-and-Tank-Gauge-901060V-03/305613847
3	Disk	Rustlick - 4" Reach 12" Wheel Diam Oil Skimmer Disk - For Use with Disk Oil Skimmers	8	$57.72	$461.76	Strong Tooling	(888)-988-8820	https://strongtooling.com/products/99045775?variant=34566419153045&currency=USD&utm_source=google&utm_medium=cpc&utm_campaign=google+shopping&gclid=Cj0KCQiAzZL-BRDnARIsAPCJs71URRBzQONjnhZrd79m_T85sPunFLIbXGTFofMOh5FeUvGn-4eDzMIaAj-yEALw_wcB
4	Drum	Price for a circus skimmer drum with 4.75 inches in length and a diameter of 9 in	3	$1,540.0	$4,620.0	Elastec	618-382-2525	https://www.elastec.com/products/oil-spill-skimmers/drum-oil-skimmers/
5	Shaft	Price for a 46 inches shaft with a diameter of 2.5 inches in addition to the 8 keys within the design. Aluminum 6061-T6 was the material selected for the shaft.	1	$436.69	$436.69	Xometry	(859)-217-4112	https://get.xometry.com/quote/2B1D7-15001?process=543ef1f380da5b0c476373a6
6	Pump	Ecologically friendly and energy-efficient pump that offers high performance and high flow rates.	1	$212.82	$212.82	Alpine Corporation	(281)464-2080	https://www.homedepot.com/p/Alpine-Corporation-Eco-Twist-Pump-3000GPH-33-ft-Cord-PXX3000/300497451?

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
7	Motor	115V 7RPM Motor enclosed inside a Steel housing.	1	$288.80	$288.80	John Henry Foster	(314)-.593-1243	https://store.jhf.com/contact-us
8	Debris Shield	Custom 10 oz mesh tarp used to prevent waste debri from entering the skimmer. 5.5in x 39.98in or .458ft x 3.33ft.	1	$2.14	$2.14	Covers & All	(800)260-2829	https://www.coversandall.com/cover-mesh-custom-tarps.html
9	Hose	Custom-Length 5/8-inch Polyurethane Garden Hose Assumed length of 54 inches.	1	$31.21	$31.21	ELEY	(800)523-4321	https://www.eleyhosereels.com/products/custom-length-5-8-polyurethane-garden-hose?variant=31844536320071&gclid=Cj0KCQiAk53-BRD0ARIsAJuNhpvvPzlCMYBhjTrLLl_hrBOPGGza5T4oqdeuSoC82jaVnxyUVlUyjk4aAsKPEALw_wcB
10	Waste Basket	a simple waste basket for collecting a larger amount debris at that can be removed when full.	1	$105.30	$105.30	Advanced Tabco	**help@webstaurantstore.com**	https://www.webstaurantstore.com/advance-tabco-a-17-3-deep-perforated-sink-basket-for-9-1-2-x-11-1-2-x-6-bowls/109A17.html?utm_source=google&utm_medium=cpc&utm_campaign=GoogleShopping&gclid=Cj0KCQiAk53-BRD0ARIsAJuNhpsARD78HrAgGEHhHCQvyOqqiRqbaxue8tFzFQO9MaJmJQvrgY8P1igaAmTUEALw_wcB
11	Oil Recovery Plate	A plate that will be designed to hold oil until displaced into storage	1	TBD	TBD	Elastec	(618)-268-7675	https://www.elastec.com/products/oil-spill-skimmers/
12	Magmeter	A measurement tool to record the flow of the oil collected, operated by using a magnetic field to generate and channel liquid flow through a pipe. A voltage signal is created when a conductive liquid flow through the flowmeter's magnetic field.	1	$606.35	$606.35	Instrumart	(800)-884-4967	https://www.instrumart.com/products/45963/eh-picomag-electromagnetic-flow-meter

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
13	Point Level Sensor	Point level measurement sensors are used to mark liquid height. Signals an overfill condition by an alarm system	1	$285.00	$285.00	Flowline	(800)-637-0405	https://www.automationdirect.com/adc/shopping/catalog/process_control_-a-_measurement/level_sensors_-a-_controllers/flowline_level_sensors_(contact)
14	Submersible Level Transmitter	used for level measurement in containers, tanks, wells, flowing water, bore holes and wastewater plants	1	$349.00	$349.00	Automation direct	(800)-633-0405	https://www.automationdirect.com/adc/shopping/catalog/process_control_-a-_measurement/level_sensors_-a-_controllers/submersible_level_sensors/
15	Detector Array	Provides visual indication for flow rates for water or petroleum-based fluids	1	$86.00	$86.00	Automationdirect	(800)-633-0405	https://www.automationdirect.com/adc/shopping/catalog/process_control_-a-_measurement/flow_sensors/variable_area_mechanical_flow_meters/fg1w-75bp-7
16	Pressure Transducer	Pressure transducer/sender/sensor 150 psi stainless steel for oil,fuel,air,water	1	$25.98	$25.98	AUTEX	(888)-215-6068	https://www.amazon.com/AUTEX-Pressure-Transducer-Stainless-Compatible/dp/B00NIK98O8/ref=sr_1_6?dchild=1&keywords=line+transducer&qid=1606941587&sr=8-6
17	Line Transducer	Higher frequency that improves resolution and small flaw detectability	1	$671.00	$671.00	Instrumart	(877)752-6213	https://www.instrumart.com/products/39739/waygate-technologies-delay-line-transducers
18	Density Meter	A device that is able to measure density such as a hydrometer. A 165 mm, NIST Standards Hydrometer was selected.	1	$42.50	$42.50	Grainger	1-(800)-GRAINGER	https://www.grainger.com/product/13K061?gclid=Cj0KCQiAk53-BRD0ARIsAJuNhpvgBelXJxQODas3elZ4vJmZU4Qq7_dRBCg7yxDV4Yhbs4OTPhxn0kwaAjwcEALw_wcB&cm_mmc=PPC:+Google+PLA&ef_id=Cj0KCQiAk53-BRD0ARIsAJuNhpvgBelXJxQODas3elZ4vJmZU4Qq7_dRBCg7yxDV4Yhbs4OTPhxn0kwaAjwcEALw_wcB:G:s&s_kwcid=AL!2966!3!264955916102!!!g!436597552742!&gucid=N:N:PS:Paid:GGL:CSM-2295:4P7A1P:20501231
19	Moisture Oil Transmitter	A sensor that is able to accurately measure moisture within oil. A 1/4 in MNPT Pressure Transmitter was selected.	1	$118.50	$118.50	Grainger	1-(800)-GRAINGER	https://www.grainger.com/product/2HLW2?gclid=Cj0KCQiAk53-BRD0ARIsAJuNhpud2rDLLdoEWrqaDu0IgKqFKQCl_4niHwk63zUbntr2SvfSHfv12acaAmxgEALw_wcB&cm_mmc=PPC:+Google+PLA&ef_id=Cj0KCQiAk53-BRD0ARIsAJuNhpud2rDLLdoEWrqaDu0IgKqFKQCl_4niHwk63zUbntr2SvfSHfv12acaAmxgEALw_wcB:G:s&s_kwcid=AL!2966!3!264955916540!!!g!436873882546!&gucid=N:N:PS:Paid:GGL:CSM-2295:4P7A1P:20501231

Total	$11045.05	

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #_____

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and sub-assemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers (1) (2) (3) etc. Subassembly identified with sub-assembly letters (A) (B) (C) etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	Table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I

PROJECT PROGRESS REPORT COVER SHEET

Design and Fabricate the Suspension and Steering for Off-Road Vehicle (Dr. Jiang)

GROUP NUMBER: 8

Progress Report Title: Status Report 10 Detailed Design-CAD-Models-Drawings-Assemblies

Due Date:12/2/20

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Robert Barbee Robert Barbee	Created the 3-D CAD models for all of the components	100	
2	Jonathan Horta Jonathon Horta	Interpreted the models and drawing onto the report and researched on the standards and calculations used.	100	
3	Todd Maxwell Todd Maxwell	Priced materials and formatted report	100	
4	Michael Samuel Michael Samuel	Formating report and finalizing models/drawing on to the report	100	
5	Aramis King Aramis King	Completed draftings for cad models and formatted report	100	
6	Daniel Ward Daniel C. Ward	Completed draftings for both systems	100	
7	Titus Woodard Titus Woodard	Formatting report and adding models to report.	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER

Status Report 10 on Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

Due: 11/19/2020

1. For each part in your design (except standard parts such as screws, bolts, and nuts)
   (i) Generate a 3D CAD model for the part with appropriate labels.
   (ii) Following the 3D model, generate a well-dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards
   (iii) Repeat (i) and (ii) for each part in your system.

2. Generate CAD design(s) of assemblies and sub-assemblies, exploded views that show the components/parts you need to order. The components should be identified with part numbers 1 2 3 etc. or subassembly numbers A B C etc. If subassemblies are used, exploded views of each subassembly should be provided.

3. Indicate the **standards** used to generate the models, drawings, and the assemblies in items 1 and 2.

4. For each part, provide a summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor, and phone number. Provide the total estimated cost for the project. Note that for a single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Assignment for Assessing Outcome 2

Table 5.X Parts Specifications, Vendor Information, and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	
1							
2							
3							
4							
5							
6							
7							
8							
9							
				Total			

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #_____

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and sub-assemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers 1 2 3 etc. Subassembly identified with sub-assembly letters A B C etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	A table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote, and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

(i) Suspension 3D CAD models with labels

Figure 10.1 presents a 3D model of the upper control arm for the front of the vehicle. This model is used for the right and left sides of the vehicle in the front. This component is used to limit the vertical and horizontal motion of the knuckle at the top.

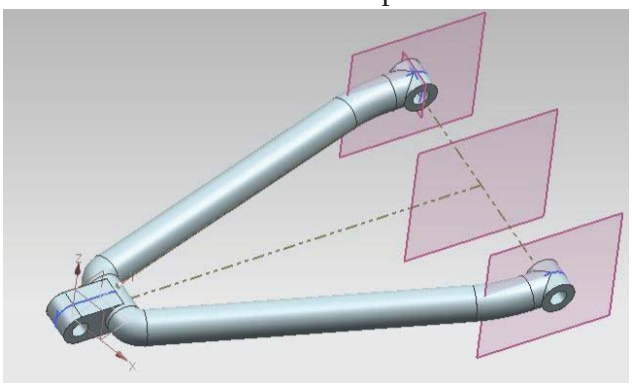


Figure 10.1 Front Upper Control Arm

Figure 10.2 presents a 3D model of the upper control arm for the rear side of the vehicle. This model is used for the right and left sides of the vehicle in the back. This component is used to limit the vertical and horizontal motion of the knuckle at the top.

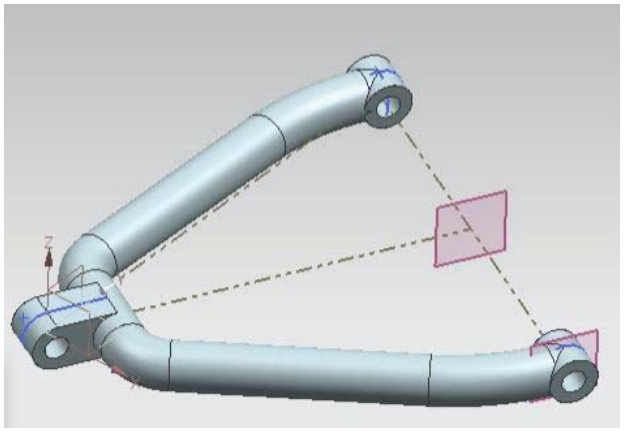


Figure 10.2 Rear Upper Control Arm

Figure 10.3 presents a 3D model of the lower control arm for the front of the vehicle. This model is used for the right and left sides of the vehicle in the back. This component is used to limit the vertical and horizontal motion of the knuckle at the bottom.

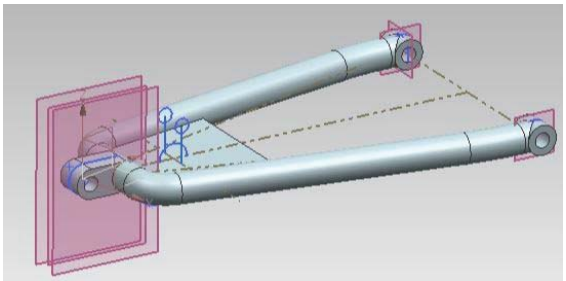


Figure 10.3 Front Lower Control Arm

Figure 10.4 presents a 3D model of the lower control arm for the back of the vehicle. This model is used for the right and left sides of the vehicle in the back. This component is used to limit the vertical and horizontal motion of the knuckle at the bottom.

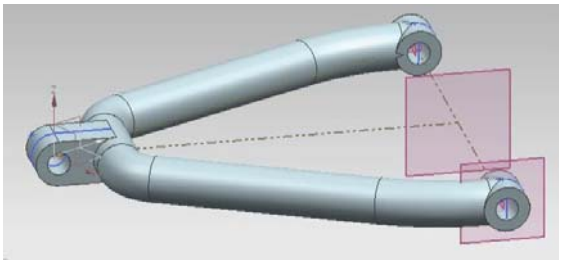


Figure 10.4 Rear Lower Control Arm

Figure 10.5 presents a 3D model of the knuckle for the front of the vehicle. This model is used for the right and left sides of the vehicle in the front. This component is used to transfer horizontal motion from the steering rod and also to keep the hub assembly perpendicular to the ground.

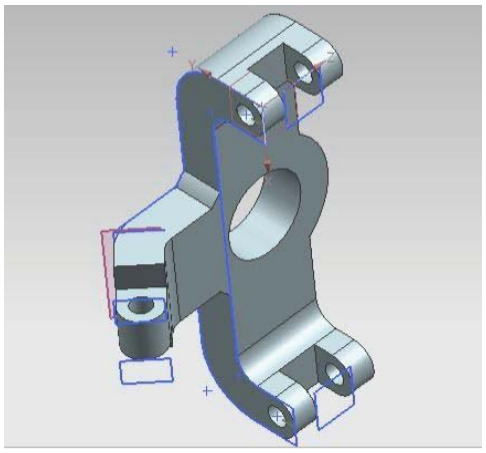


Figure 10.5 Front Knuckle

Figure 10.6 presents a 3D model of the knuckle for the rear end of the vehicle. This model is used for the right and left sides of the vehicle in the back. This component is used to keep the hub assembly perpendicular to the ground.

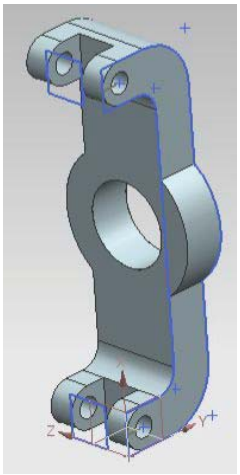


Figure 10.6 Rear Knuckle

(ii) Suspension 2-D sketches

Figure 10.7 presents the drawings and dimensions of the upper control arm for the front of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

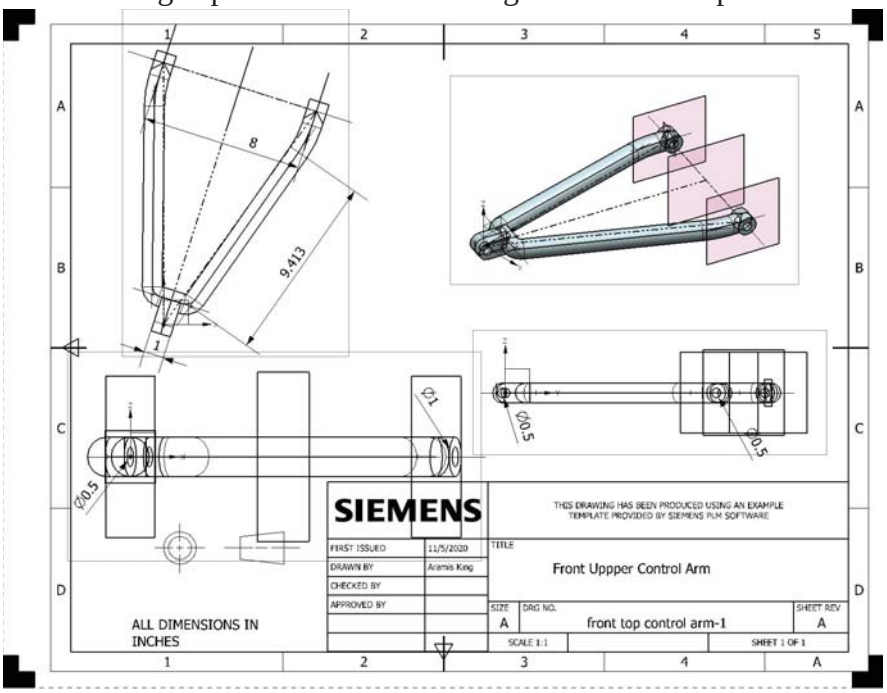


Figure 10.7 Front Upper Control Arm Drawings and Dimensions

Figure 10.8 presents the drawings and dimensions of the upper control arm for the back of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

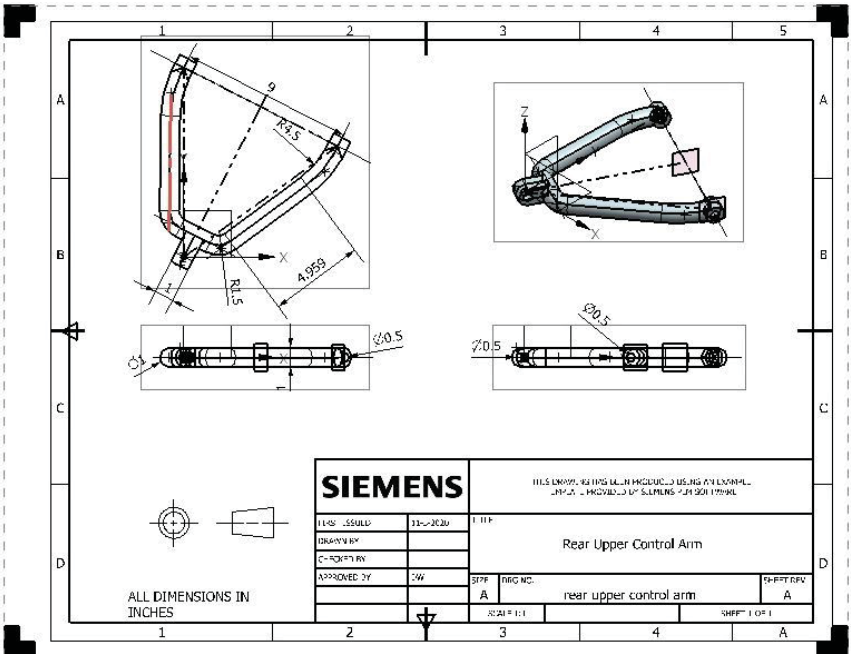


Figure 10.8 Rear Upper Control Arm Drawings and Dimensions

Figure 10.9 presents the drawings and dimensions of the lower control arm for the front of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

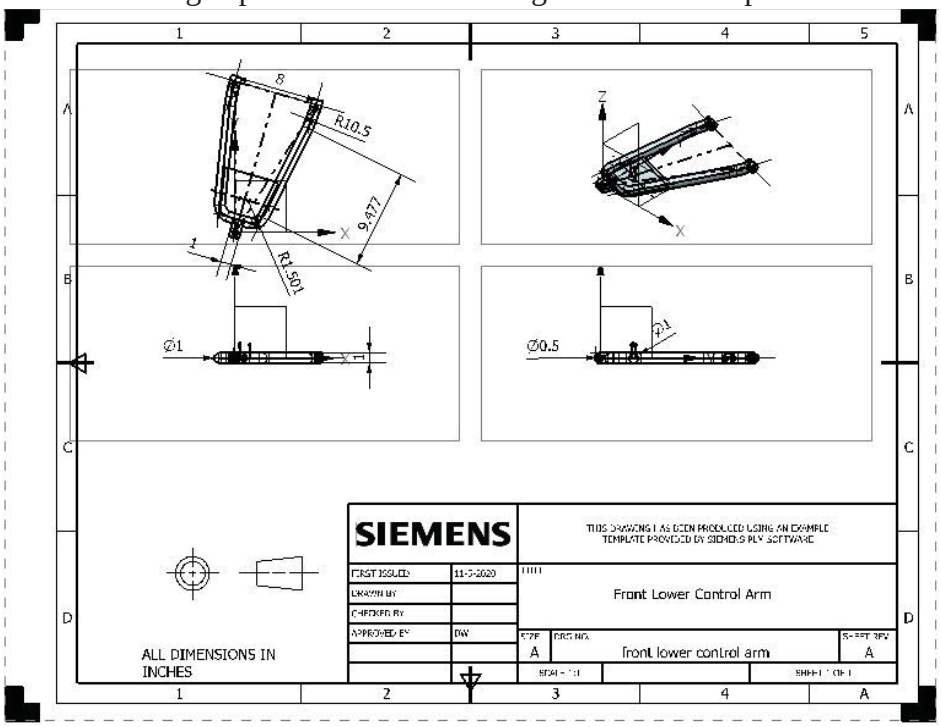


Figure 10.9 Front Lower Control Arm Drawings and Dimensions

Figure 10.10 presents the drawings and dimensions of the lower control arm for the back of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

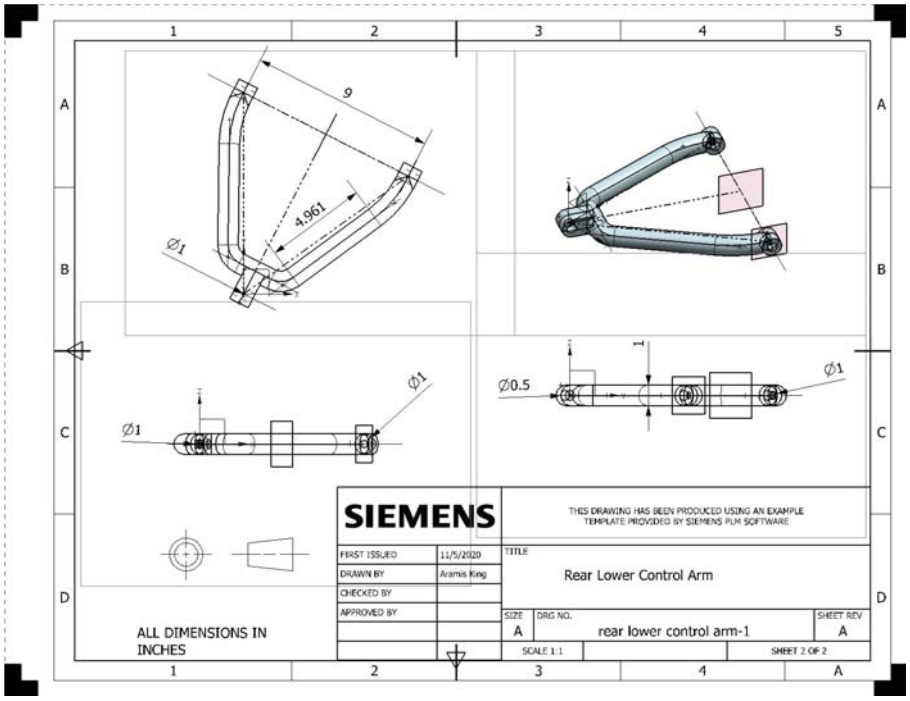


Figure 10.10 Rear Lower Control Arm Drawings and Dimensions

Figure 10.11 presents the drawings and dimensions of the knuckle for the back of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

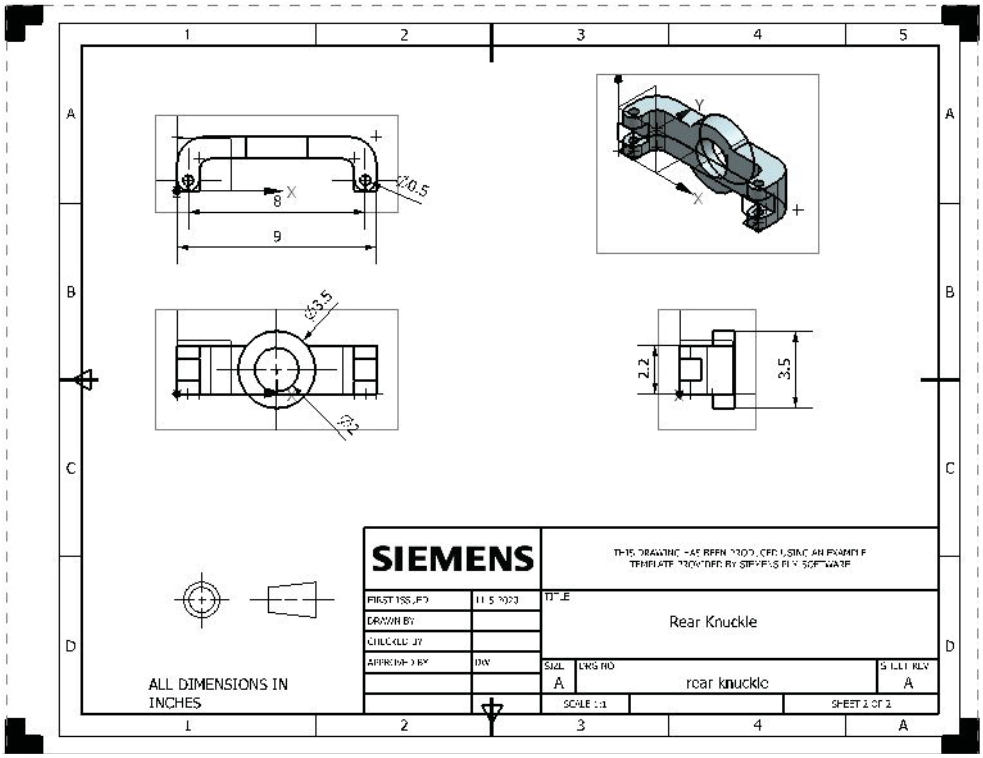


Figure 10.11 Rear Knuckle Drawings and Dimensions

Figure 10.12 presents the drawings and dimensions of the knuckle for the front of the vehicle. The drawings show the front, top, and right views of the control arm. A 3-D isometric view was also included to grasp a better understanding of the full component.

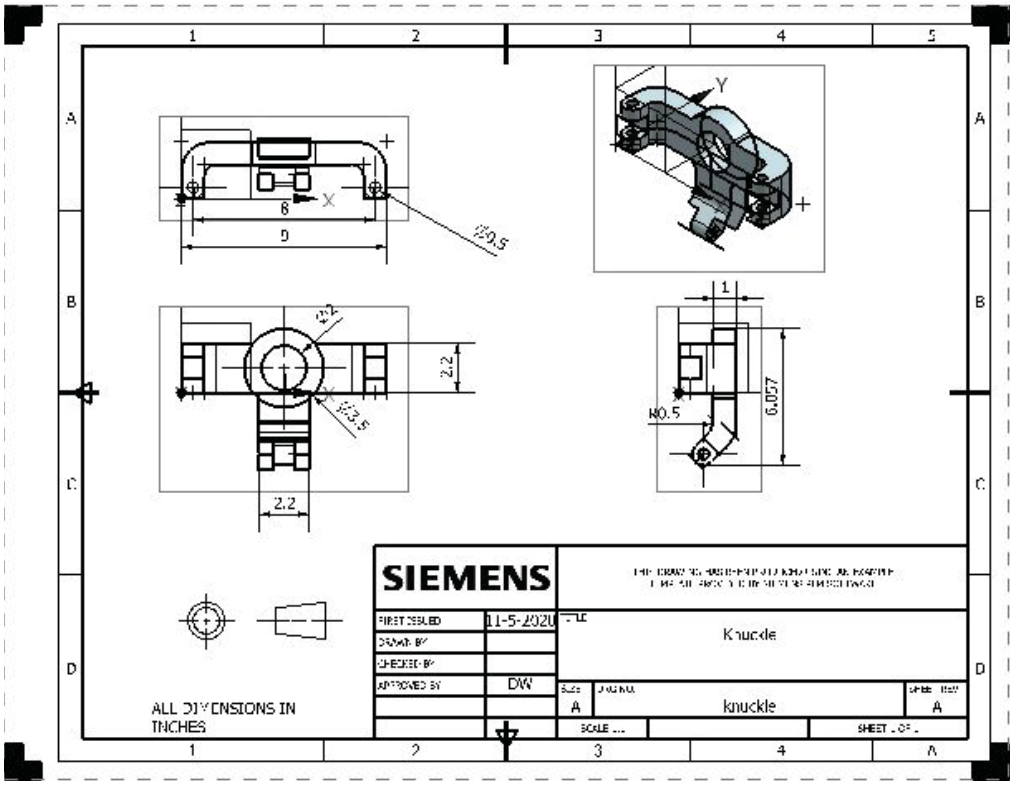


Figure 10.12 Front Knuckle Drawings and Dimensions

(iii) Steering 3D CAD models with labels

The steering wheel was a cushion design that the group created. In figure 10.13, the final steering wheel design is shown. The diameter is 10 inches which is standard for off-road vehicles. The steering wheel is directly connected to the steering rod.

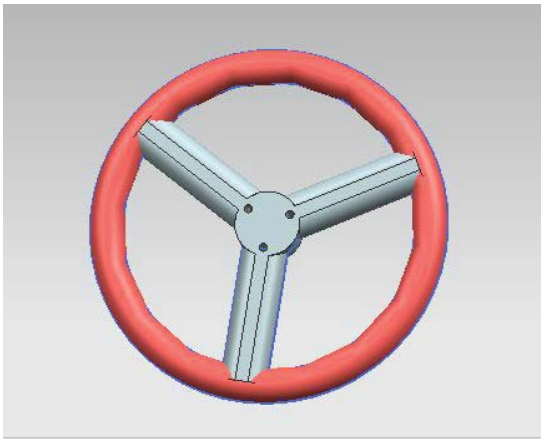


Figure 10.13 Steering Wheel

Figure 10.14 presents the steering shaft and pinion, which connects to the steering wheel at the top and connects to the rack at the bottom. This component transfers torque from the steering wheel to the rack.

Figure 10.14 Steering Shaft and Pinion

Figure 10.15 presents the rack for the steering system, which transfers rotational motion to horizontal motion from the pinion to the tie rods respectfully.

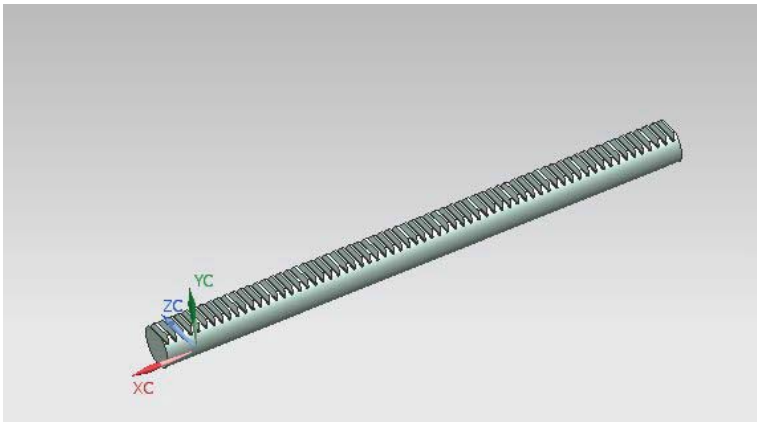


Figure 10.15 Rack

(iv) Steering 2-D sketches

Figure 10.16 presents the drawings and dimensions of the steering wheel. The drawings only show the front and top views of the steering wheel due to it being symmetrical and the front view looking just like the top view. A 3-D isometric view was also included to grasp a better understanding of the full component.

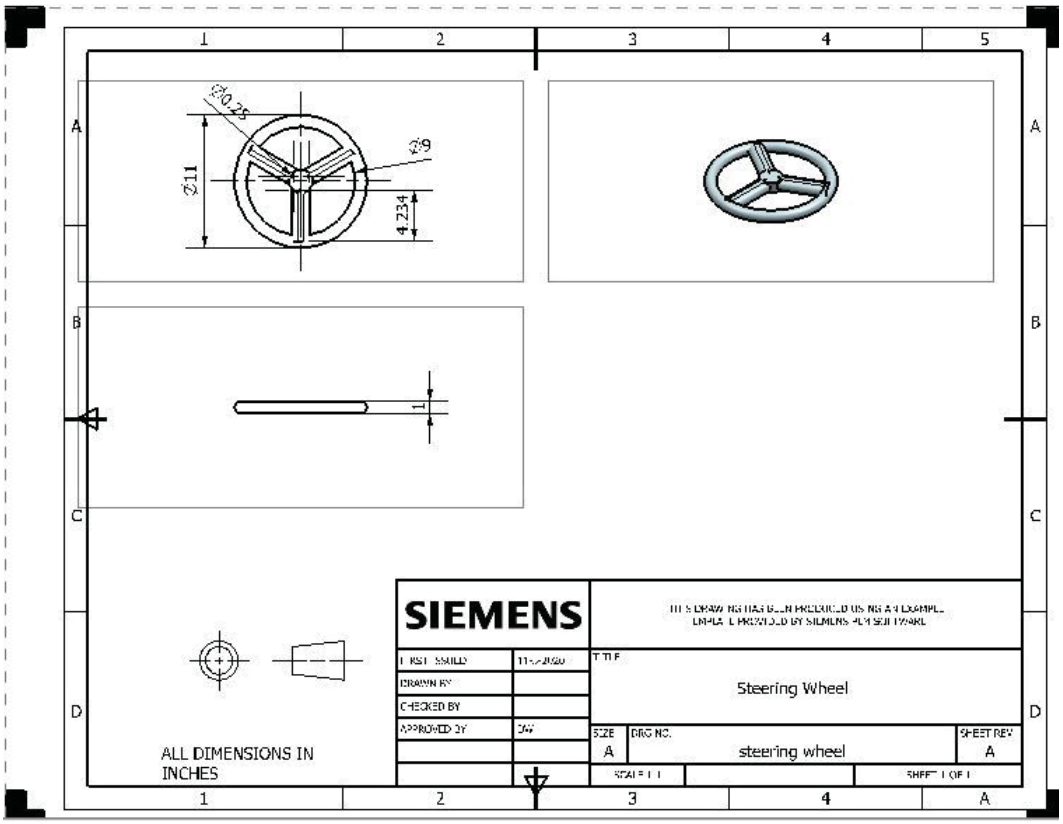


Figure 10.16 Steering Wheel Drawings and Dimensions

2.Assemblies and Subassemblies

The full assembly of the suspension and steering system is shown connected to the vehicle in figure 10.17. The suspension system and the steering system work together in absorbing forces and turning the vehicle.

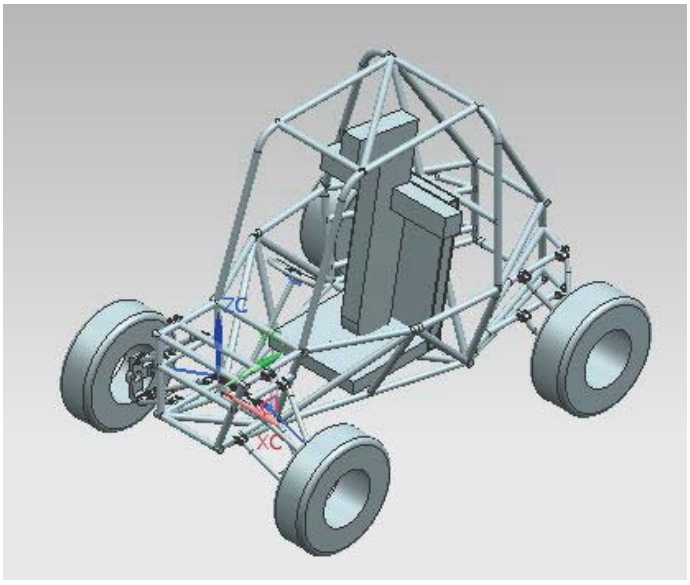


Figure 10.17 Full Assembly of Suspension & Steering Systems

Figure 10.18 presents the sub-assembly of the steering and suspension systems. The cross figure represents the driver sitting in the driver seat.

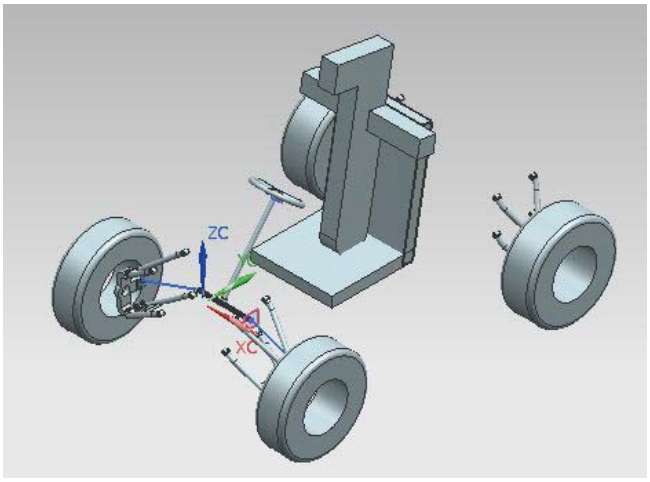


Figure 10.18 Sub-assembly of Suspension & Steering System

3.standards used

From a technical standpoint, it is now possible to add dimensions, tolerances, and notes to 3D geometric models in a generally agreed way. Driven by the aerospace and automotive industries, the American Society of Mechanical Engineers (ASME) issued, in 2003, the ASME Y14.41 standard in response to the need to utilize 3D CAD data as manufacturing and/or inspection sources; thus, allowing 2D drawings to be phased out.

4.summary/calculations/cost

ANSYS was used to determine the sizes to pass allowable stresses of stainless steel 4130 when using a safety factor of 2. A safety factor of 2 was chosen because safety factors for the automotive industry typically range between 1.5 and 2.25. The given dimensions of the chassis were used to determine how each part was sized.

$$\text{Allowable Stress} = \frac{Yield\ Strength}{Safety\ Factor} = \frac{631000\ psi}{2} = 31550\ \text{psi} \qquad (1)$$

5.economic analysis in table form

Table 10.1 Economic Analysis

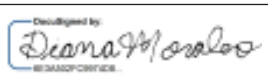
Part #	Part Name	Part Specification/ Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
1	Front Control Arm	Maintains vertical motion in the front knuckle and minimizes horizontal motion	2					
2	Rear Control Arm	Maintains vertical motion in the rear knuckle and minimizes horizontal motion	2					
3	Fox Strut	Absorb forces of impact.	4	$547.50	$2190	Fox		ridefox.com
4	Front Knuckle	Connects to the control arms and the steering rod. Allows for turning of the wheels.	2					
5	Rear Knuckle	Connects to the wheel hub assembly and allows for vertical motion in the back.	2					
6	Tie Rod	Connects to the front knuckle and the steering shaft. This is what pushes and pulls on the front knuckle.	2					
				Total				

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020
PROJECT PROGRESS REPORT COVER SHEET

PROJECT TITLE: _ Design of Experiment to Measure Heat Transfer Coefficient and Effective Thermal Conductivity in Nanofluids Under Different Boundary Conditions

GROUP NUMBER: 3
Progress Report Title: Detailed Designs CAD models and drawings
Due Date:12/2/2020

No	Group Member Name Group Member signature	Brief Description of Work Assigned to Member	% Completed by Member*	Your Score
1	Diana Morales 	Proofread and help format report.	100	
2	Fanta Kaba 	Contributed to proofreading and formatting the report.	100	
3	Christian White 	Generated 3D designs and assembled designs as well as write out paragraphs and descriptions of models.	100	
4	Abdullah EL Aker 	Contributed in creating CAD designs for assigned components, defined the function of each created component.	100	
5	Yemboado Yonli 	Provided a solid set up of what the CAD drawings have to look like	100	
6	Marcelo Epam Ona 	Provided some paragraph explaining in detail how the analysis was done.	100	

COLLEGE OF ENGINEERING
SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER

Status Report 10 on Detailed Design CAD Models & Drawings (Orthographic & Isometrics) & Parts Specifications

Due: 11/19/2020

1. For each part in your design (except standard parts such as screws, bolts and nuts)

(i) Generate 3D CAD model for the part with appropriate labels.

(ii) Following the 3D model, generate a well dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards

(iii) Repeat (i) and (ii) for each part in your system.

2. Generate CAD design(s) of assemblies and sub-assemblies, exploded views that show the components/parts you need to order. The components should be identified with part numbers 1 2 3 etc. subassembly numbers A B C etc. If subassemblies are used, exploded views of each subassembly should be provided.

3. Indicate the **standards** used to generate the models, drawings and the assemblies in items 1 and 2.

4. For each part, provide summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor and phone number. Provide the total estimated cost for the project. Note that for single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

Note: Attach a copy of this assignment statement sheet to your homework (placed after the two cover sheets)

Assignment for Assessing Outcome 2

Table 5.X Parts Specifications, Vendor Information and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	
1							
2							
3							
4							
5							
6							
7							
8							
9							
				Total			

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #_____

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and subassemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers (1) (2) (3) etc. Subassembly identified with sub-assembly letters (A) (B) (C) etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	Table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

1. For each part in your design (except standard parts such as screws, bolts and nuts)

(iv) Generate 3D CAD model for the part with appropriate labels.

(v) Following the 3D model, generate a well dimensioned engineering drawings of the part projected directly from the solid model. The engineering drawings should include orthographic views of the part (Front, top and side views of the part as required to fully describe the part). The views should be projected from the 3D model and the front view should be the view that shows the most geometric shape of the part and having the least number of hidden lines and should be placed on the drawing sheet first, the top view should be projected and placed on the top of the front view, the right side view should be projected and placed on the right side of the front view. Additional views should be appropriately placed in accord with drawing standards. Each view should be properly dimensioned in accord with drawing standards

(vi) Repeat (iv) and (v) for each part in your system.

The Figure 5.31 below is the designated heat sink which will be used in the systematic to increase the heat flow within the nanofluid as it travels throughout the system. It will increase the working surface area of the system to which the nanofluids cooling particles will pass and allow the nanofluid to stay within a state of harmony. The heat sink dimensions were calculated based on the surface area of the experiment to keep the factor of manipulation a top priority. In figure 5.32 the dimensions of the heat sink are shown.

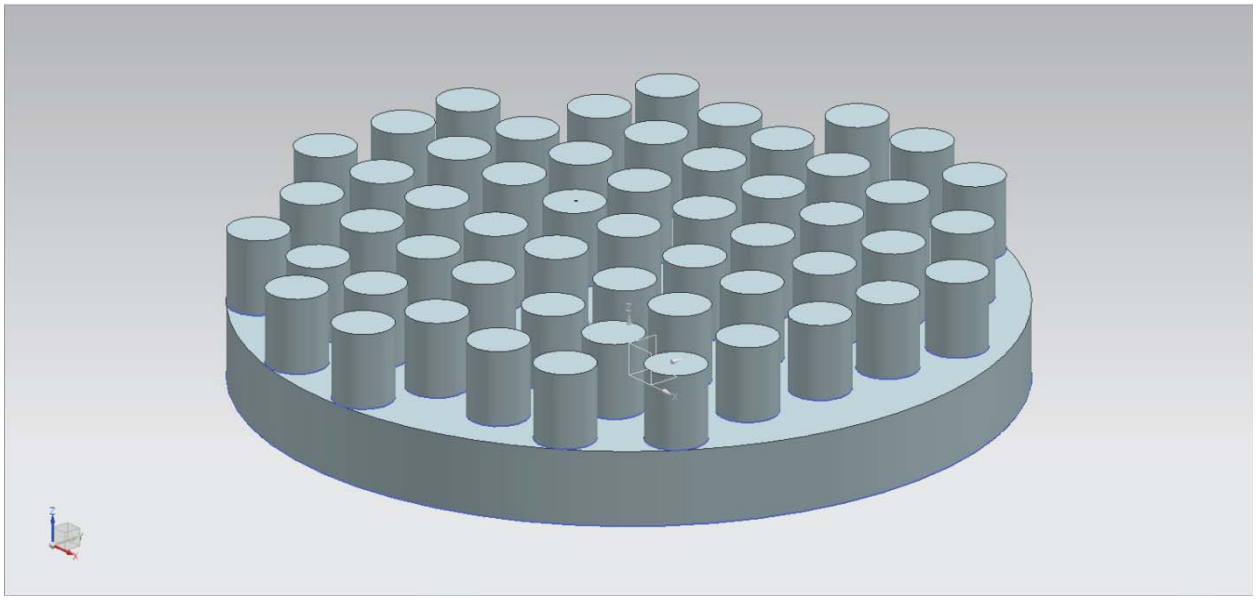


Figure 5.31 Heat Sink

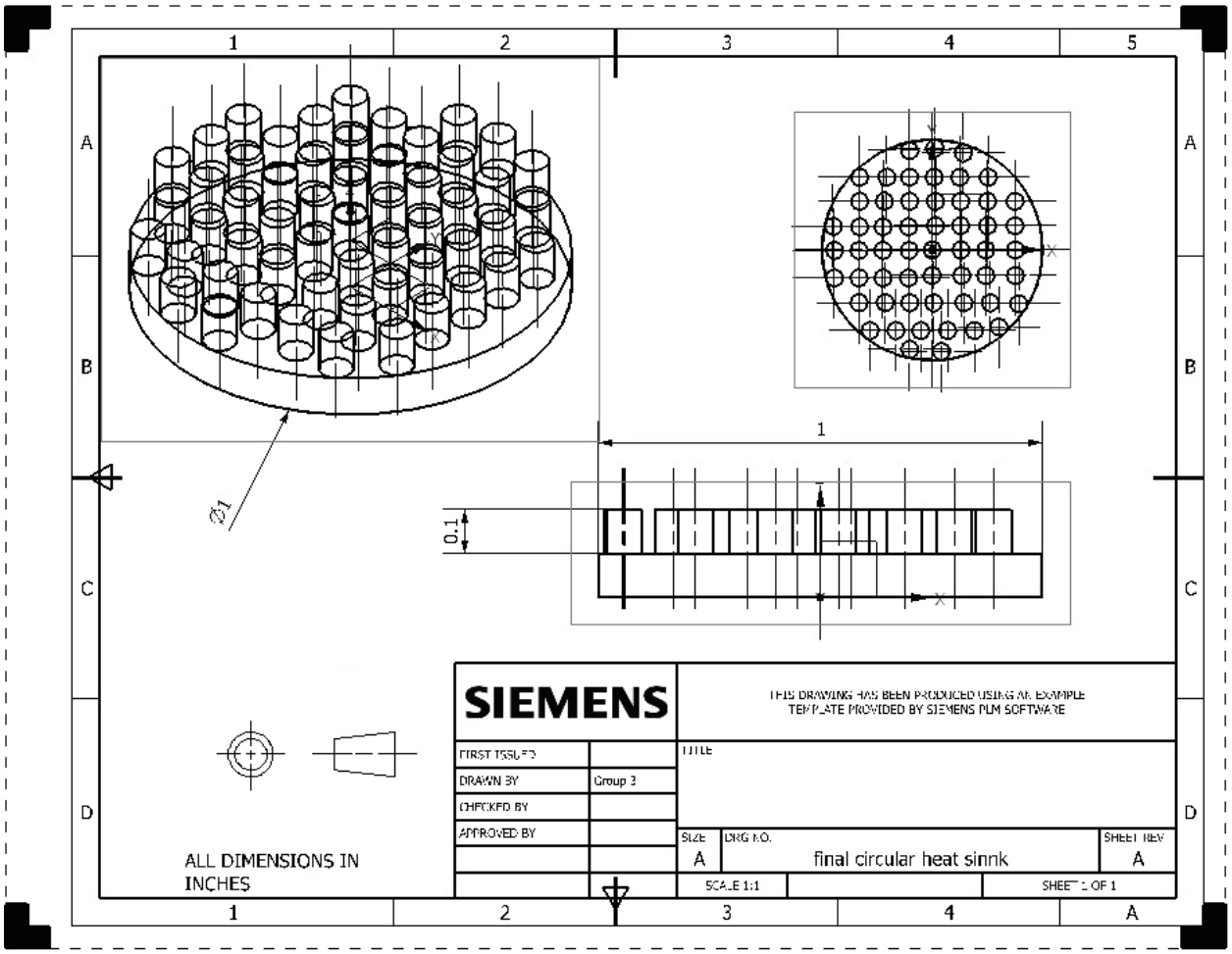


Figure 5.32 Heat Sink dimensions

Figure 5.33 represents the tube container tube that each sample will be placed in. There will be a hole on the top (red) for the nanofluid to go in and out of the tube. Multiple tubes will be added for different tests under different boundary conditions. Figure 5.34 represents the dimensions of the container tube from top, side, and front views to provide a better view of the component. all the dimensions used are in inches.

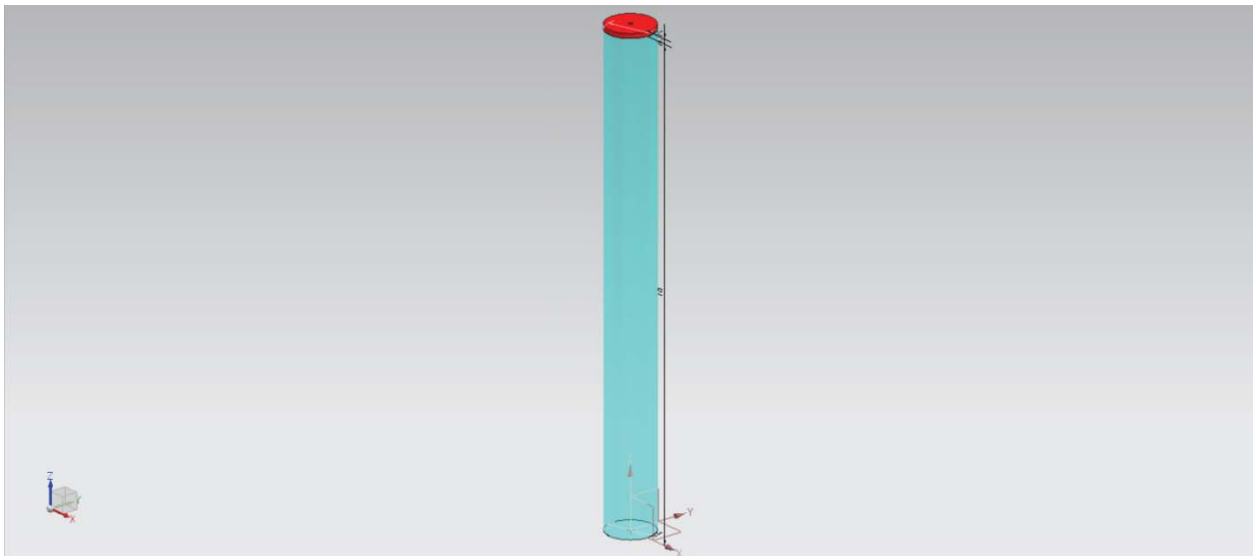


Figure 5.33 Tube Container

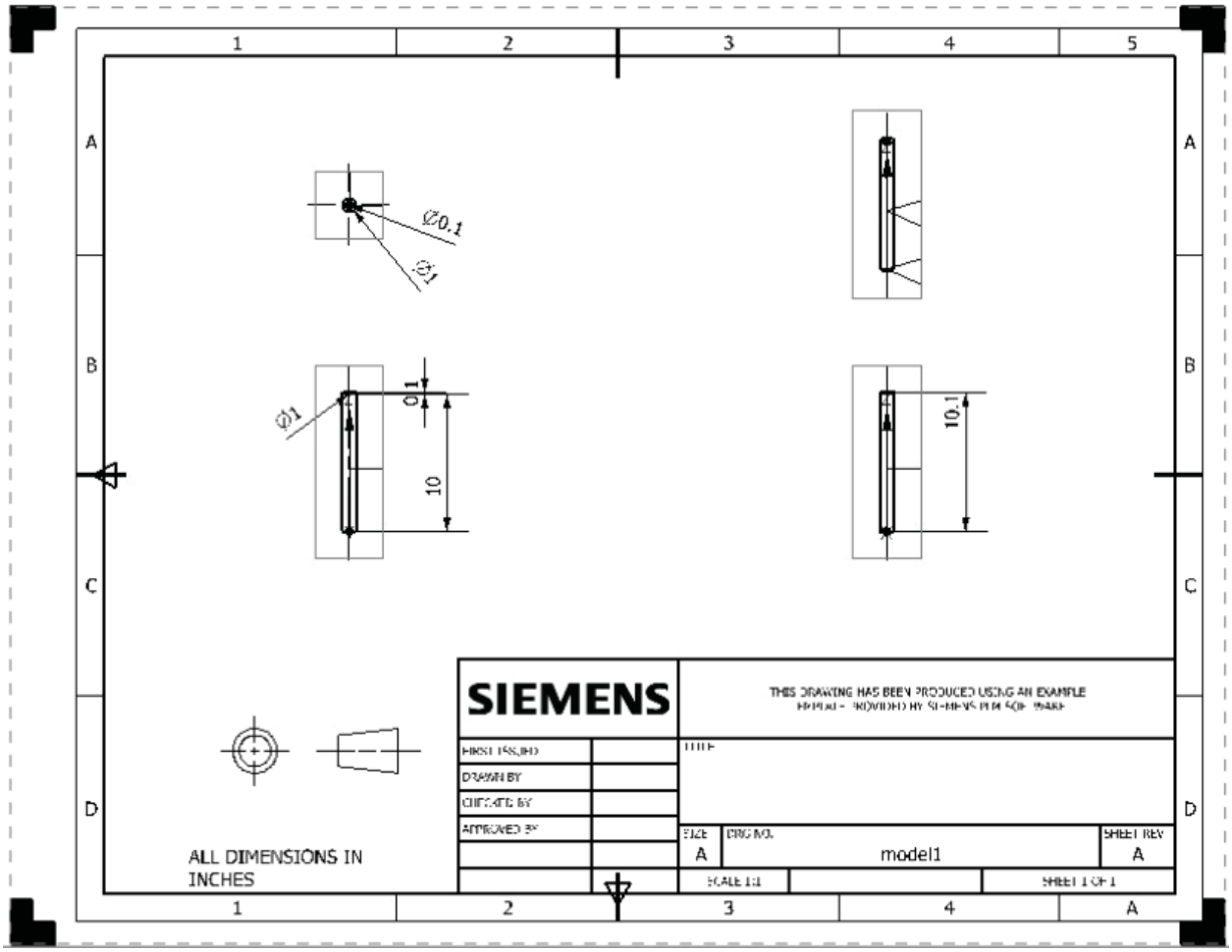


Figure 5.34 Tube Container Drafting

Figure 5.35 and 5.36 represent the ring magnets used in the experiencement. Placing both ring magnets on the tube without touching will allow a magnetic field. The inner space of the ring still belongs to the outer magnetic field distribution, and part of the magnetic induction line connects the magnetic poles of both ends through the inner hole of the ring. Figure 5.37 represents the dimensions of ring magnets. All units are in inches. The dimensions of the magnets were calculated to compliment the diameter of the container.

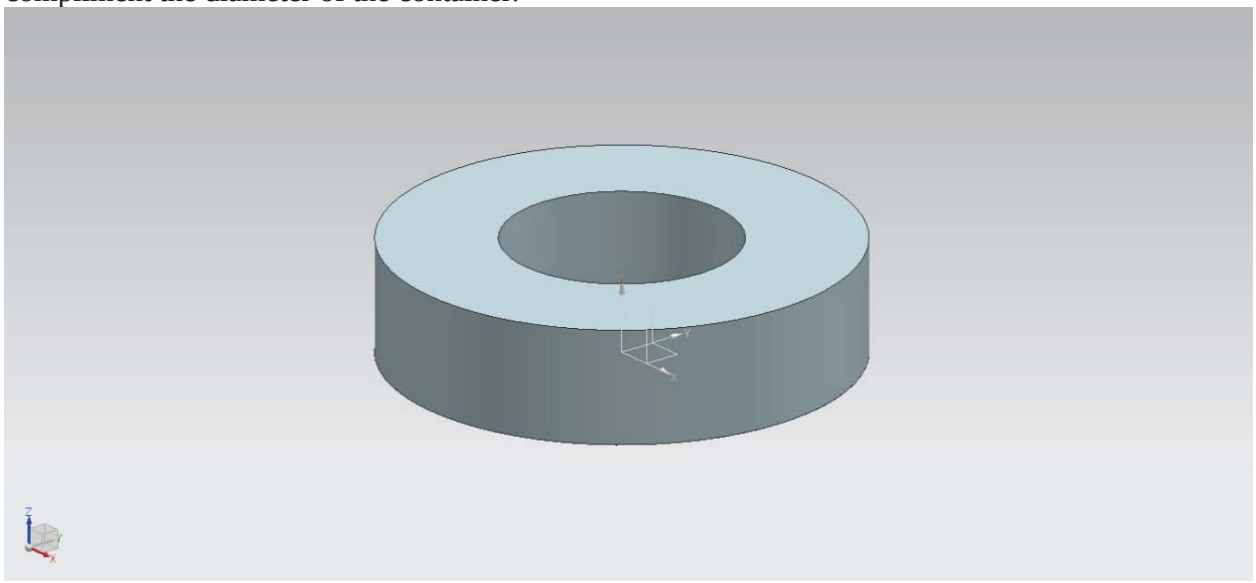


Figure 5.35 Ring Magnet 1

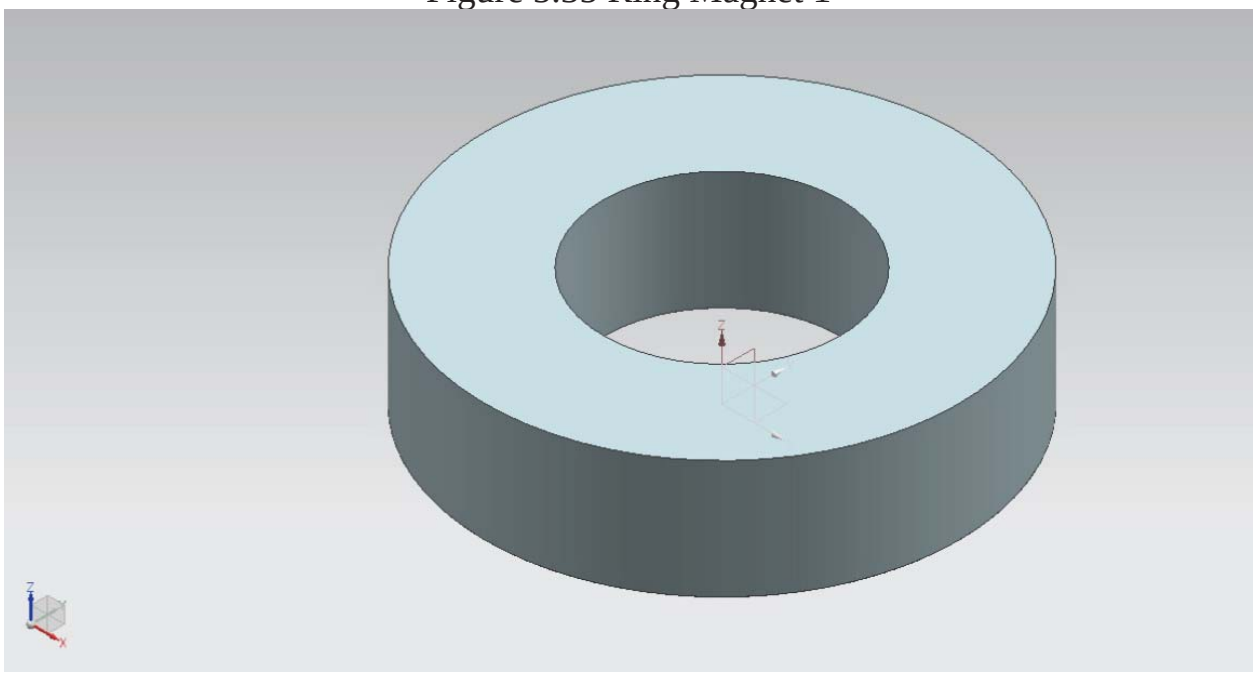


Figure 5.36 Ring Magnet 2

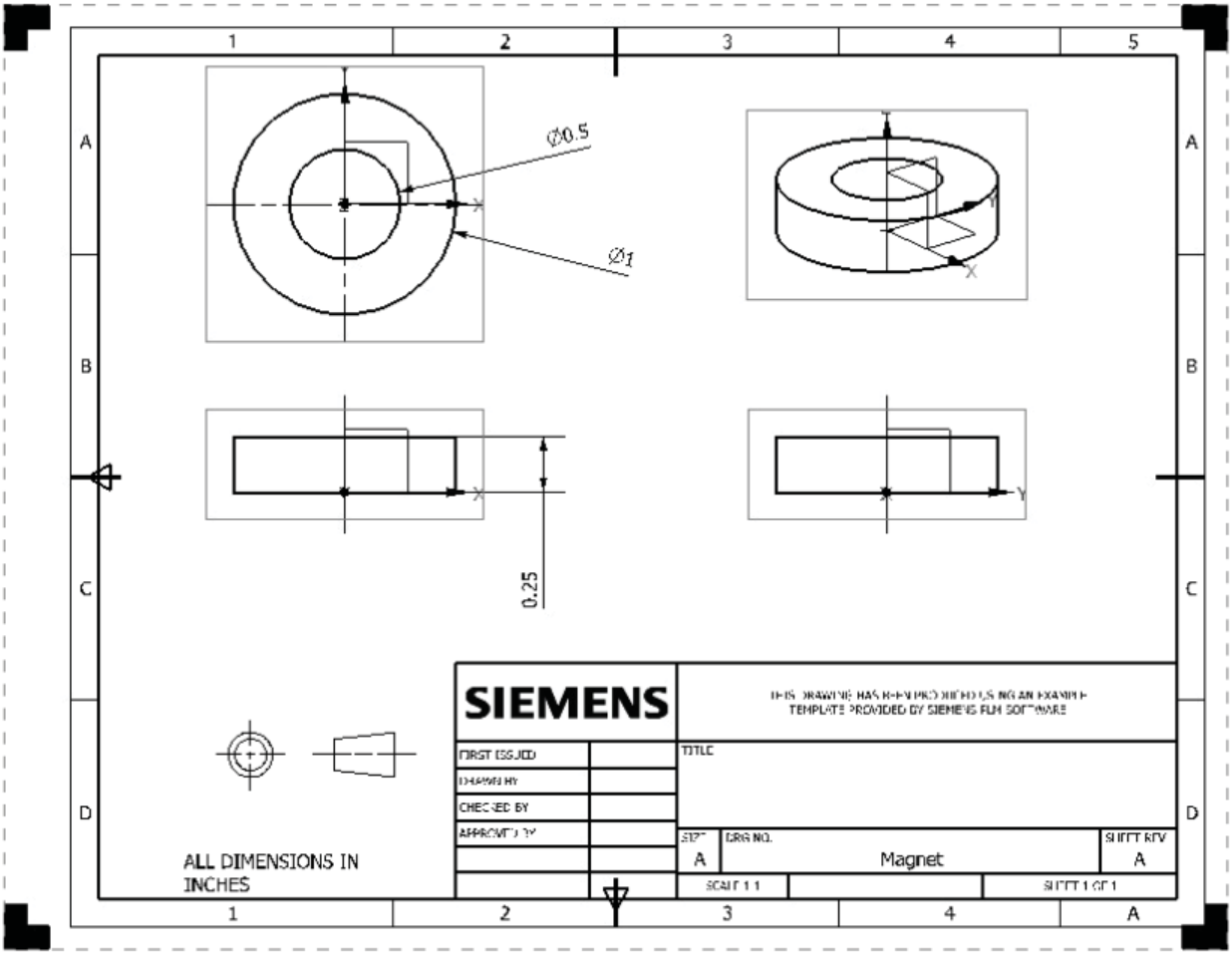


Figure 5.37 Ring Magnet Drafting

Figure 5.38 below is the design of the hot plate which will be used to heat up the container to which the nanofluid will be captive in and placed in the center of the hot plate. It will coincide with the heat sink in regard to transmitting heat as necessary for proper calculation of the heat transfer coefficient and thermal conductivity of the nanofluid. The dimensions of the hot plate were calculated to compliment the size of the container as shown in figure 5.39.

Figure 5.39 Hot Plate

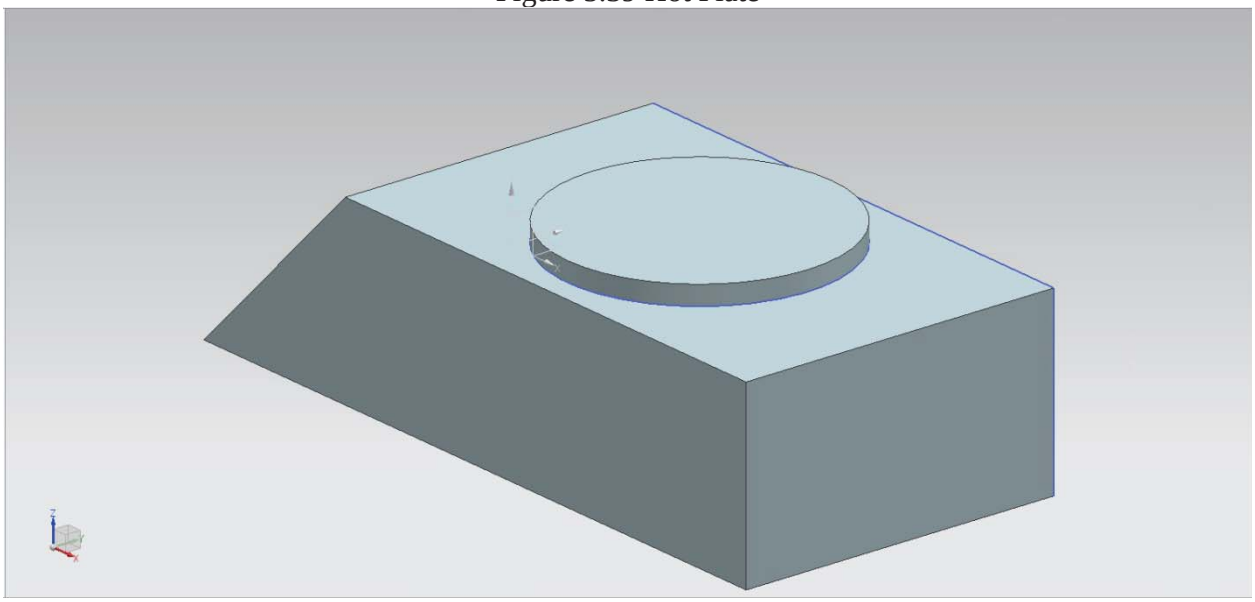
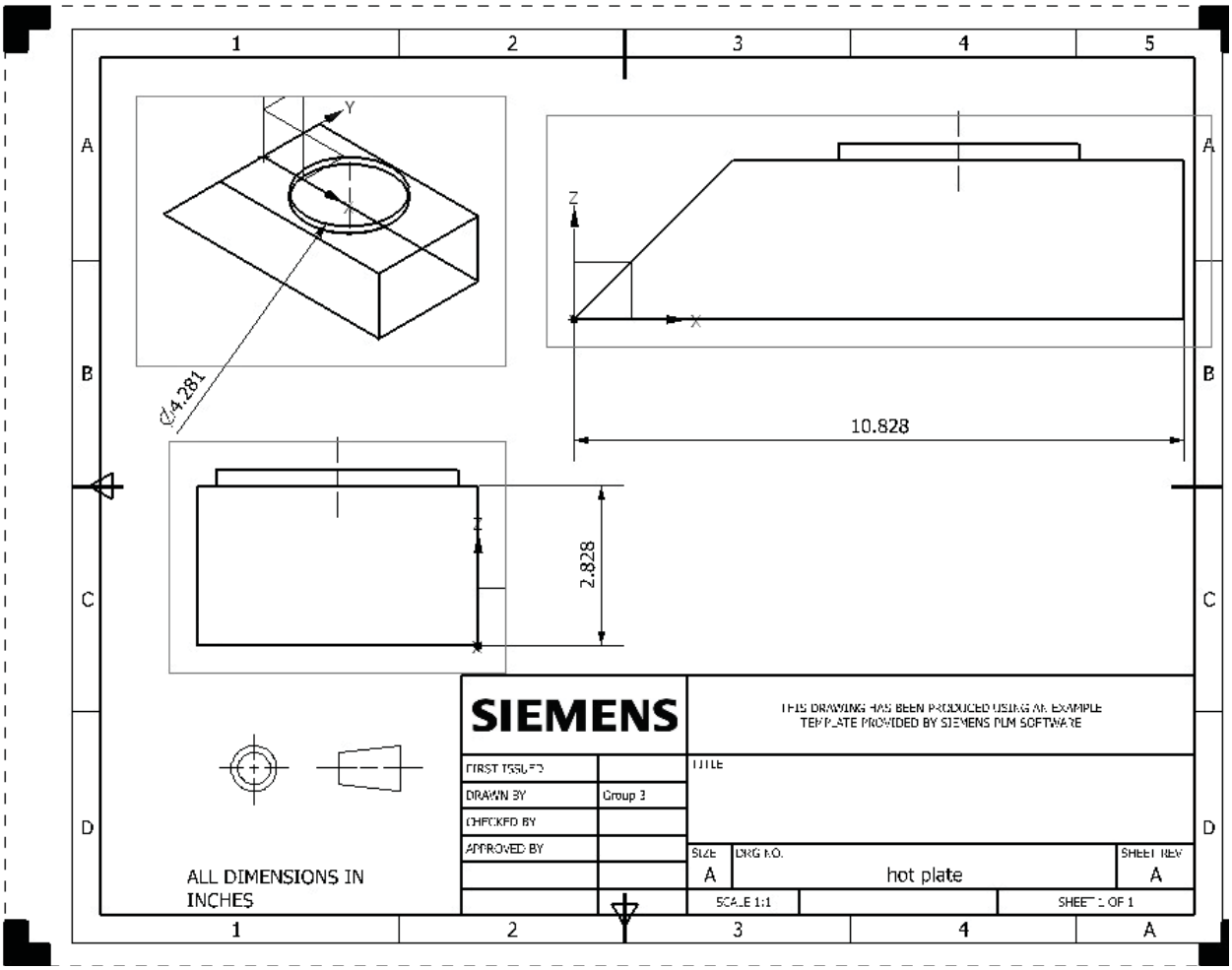


Figure 5.38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SIEMENS
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED
DRAWN BY
Group 3
CHECKED BY
APPROVED BY
TITLE
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hot plate
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A
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES
1
2
3
4
5
A
B
C
D

Figure 5.39

2. Generate CAD design(s) of assemblies and sub-assemblies, exploded views that show the components/parts you need to order. The components should be identified with part numbers 1 2 3 etc. subassembly numbers A B C etc. If subassemblies are used, exploded views of each subassembly should be provided.

The figure 5.40 below consists of all individual components assembled via NX 10 to which displays a computer automated design that reflects which components will be purchased and how they will be assembled in real time.

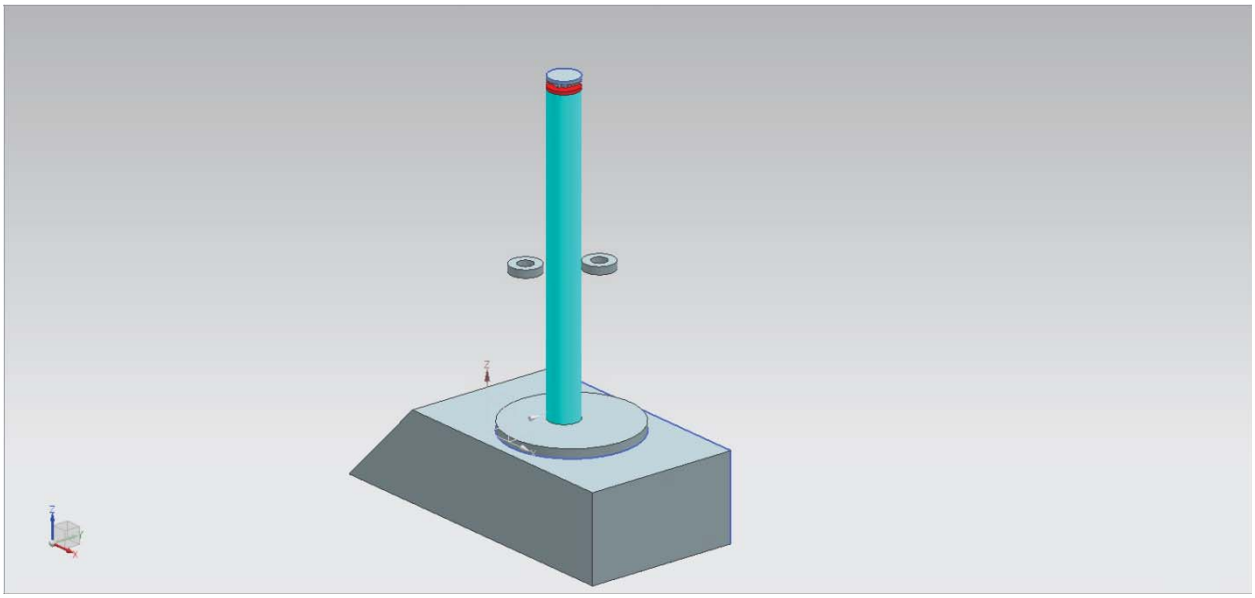

Figure 5.40

Figure 5.41 below is an assembled RTD for the measurement of temperature regarding the nanofluid, heat sink, and hot plate.

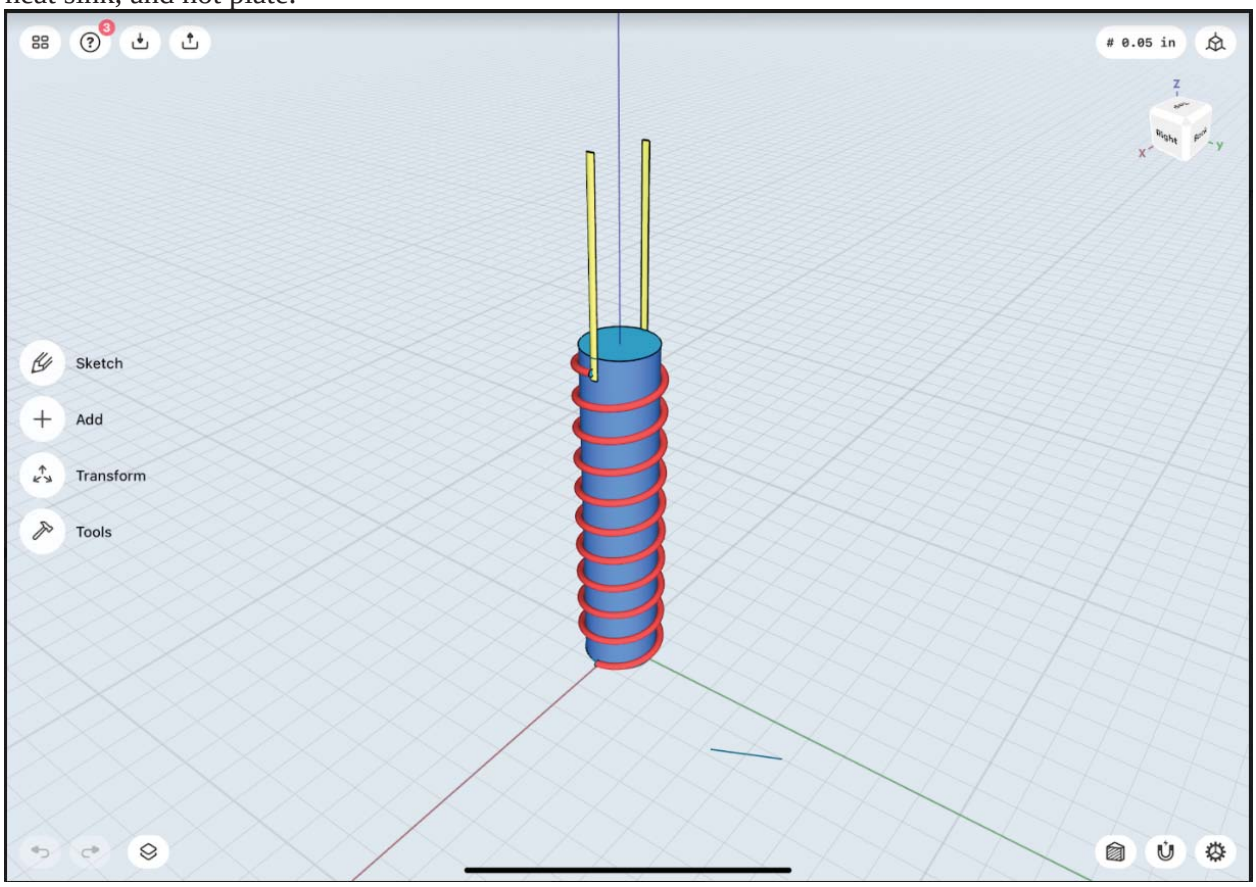

Figure 5.41

3. Indicate the **standards** used to generate the models, drawings and the assemblies in items 1 and 2.

In order to properly generate the designated 3D designs, credible standards were to be chosen to make the correct determinations and style of designing for each component. The standards and codes which were used consisted of the ASME and SAE standards which were basic undergraduate standards to which is commonly used amongst mechanical engineering students across the world.

4. For each part, provide a summary of the engineering analysis/calculations that show how each part was sized (geometric, energy, power, structural, etc.) and specification for purchasing each part.

Heat Sink

The heat sink was designed with the intent to mirror common heat sinks used for the calculation of thermal conductivity and the heat transfer coefficient of commonly used nanofluids amongst experiments used with the ASME and SAE standards and codes. The diameter and nodes were calculated using the diameter of the container to which the nanofluid would be placed in order to efficiently allow heat to flow through the surface area without any wasted material.

Tube Container

The container was designated to be 10 inches with a cap to give the nanofluid ample space to conform as the nanofluid particles flow through out the container based on natural convection through the heating and cooling utilizing the heat sink and the hot plate to which the container will be placed upon

Magnets 1 & 2

The magnets used in this system will react with the nanofluid and container to manipulate the nanofluids movement. Each magnet is the same size and is that size with the intent to capture a certain number of particles within the nanofluid to ensure natural convection takes place.

Hot Plate

The hot plate designed in NX 10 is designed based on standard issued hot plates that are used to achieve maximum power and efficiency through the heating of the metal cylinder which will easily transport to the object being placed on top of the metal plate. The dimensions are based on the code of the ASME standards and regulations.

5. Summarize the economic analysis in a comprehensive table (such as that shown in Table 5.X) listing project part by part number, part name, part specifications, quantity needed, unit price, extended price based on the lowest quote, name of vendor and phone number. Provide the total estimated cost for the project. Note that for a single item costing more than $50, three price quotes should be obtained and the one with the lowest price used in the table.

For each of the parts needed, a research was made in the market in order to find the desired components. Furthermore, the parts were selected based on the dimensions found on the CAD drawings. Table …. contains all the parts that have been drawn such as the quantities, market where they were found and phone numbers of the contracted vendors that the group talked in order to make sure the best components were gotten to complete and finalize this project.

Table 5.1 Parts Specifications, Vendor Information and Cost Summary Table

Part #	Part Name	Part Specification/Description	Quantity Needed	Unit Price	Extended Price	Vendor Name	Vendor Phone #	Web-address
1	hot plate	Scilogex 81112102 MS-H-S Analog Magnetic Hotplate Stirrer, Porcelain Plate, 110V/60Hz, 5-2/7" Diameter	1	$295	$295	Amazon	(888) 280-4331	https://www.amazon.com/Scilogex-MS-H-S-Analog-Magnetic-Stirrers/dp/B0079NOMX2/?tag=geometryofmolecules-20
2	heat sink	3.5x1.2inch Round Spiral Aluminum Alloy Heat Sink for 1W-10W LED Silver White	1	$8.90	10	Amazon	(888) 280-4331	https://www.amazon.com/3-5x1-2inch-Spiral-Aluminum-1W-10W-Silver/dp/B00N2HGWMS

3	stainless steel container	Clay - Adams 0901 Stainless Steel Test Tubes Centrifuge Tubes	1	$40	$45	Dotmed		https://www.dotmed.com/listing/other/other/clay-adams-0901-15ml-stainless-steel-test-tubes-centrifuge-tubes/1198543
4	pressure control valve	3/4 in. Push-to-Connect Bronze EB-45 Direct Pressure Regulator Valve	1	$49.97	$49.97	Home Depot	(281)-858-8040	SharkBite 3/4 in. Push-to-Connect Bronze EB-45 Direct Pressure Regulator Valve-23858-0045 - The Home Depot
5	pressure sensor	3/4 in. Bronze Double Union PEX Water Pressure Regulator with Gauge	2	$69.97	$69.97	Home Depot	(281)-858-8040	Apollo 3/4 in. Bronze Double Union PEX Water Pressure Regulator with Gauge-APXPRV34WG - The Home Depot

6	Multimeter	CAT III 600 V Class 2 rated multimeter has double insulation	1	$39.94	$39.94	Home Depot	(281)-858-8040	Klein Tools Electrical Test Kit-69149 - The Home Depot
7	RTD	Small Diameter RTD Probes tem# PR-16-2-100-1/16-24-E	6	$154.67	$160	Omega, a spectrum company	888-764-7703	https://www.omega.com/en-us/temperature-measurement/temperature-probes/probes-with-lead-wires/p/fine-diameter-RTD-probes?gclsrc=aw.ds&&_vsrefdom=mca&mchxkw=c:232865952,k:,m:b,p:,d:c,ai:242219079 12,ad:431448658547,s:g&gclid=Cj0KCQiAk53-BRD0ARIsAJuNhpsbZUsFH1YIWG5OCPv77GUfRb3k4a1qwVSPkUKQ_R

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8	aluminum foil	4 in. x 25 ft. Flexible Aluminum Foil Duct	1	$18.91	$18.91	Home Depot	(281)-858-8040	Everbilt 4 in. x 25 ft. Flexible Aluminum Foil Duct-EVER019 - The Home Depot
9	bell jar	Glass Dome Cloche Bell Jar Terrarium, H-12	1	$31.20	$35	vase market	888-980-9698	https://vasemarket.com/12x12-inch-glass-dome-cloche-centerpiece
10	Magnet	Ring Magnet, Material Ceramic 5, Max. Pull 4.4 lb, Thickness 0.331 in, Diameter 2 23/64 in, Hole Dia. 1 9/64 in, Stability Temp. 400 Degrees F	2	$1.87	3.74	zoro	(855)-289-9676	Zoro Select 10E795 $1.87 Ring Magnet, 4.4 lb. Pull | Zoro.com
11	Thermal tape	Thermal Adhesive Tape, 25Mx20mmx0.25mm High Performance Thermally Double Side Tapes Cooling Pad Apply To LED Strips, 3D Printer,BCP,CPU,GPU,Laptop Heatsink,And have heat conduction, insulation	2	$10.99	$16.99	Amazon	(888) 280-4331	https://www.amazon.com/Aikenuo-Adhesive-performance-Heatsink-Computer/dp/B075FRPXQ5/ref=sr_1_1_sspa?dchild=1&keywords=thermal+tap

								e&qid=1606970108&sr=8-1-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUFFVkI2QVVEOExOUDQmZW5jcnlwdGVkSWQ9QTA3OTU4MjQySzVSN0k2SVhHRjdTJmVuY3J5cHRlZEFkSWQ9QTA0MTIxMzMzVUdSRVhTNjRMNzNFJndpZGdldE5hbWU9c3BfYXRmJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==
Total								

Grading Scheme for Status Report 10
Detailed Design Drawings
Project Group #3

Item	Description	Maximum Points	Your Score
1	3D CAD models for system components with appropriate labels.	60	
2	Well dimensioned engineering drawings of the CAD components. The engineering drawings include orthographic views of the system (Front, top and side views of the system and components), as well as isometric view(s) of the system preferably done on a cad system.	55	
2	Layout and dimensioning of drawings done according to drawing standards	5	
3	CAD design(s) of assemblies and subassemblies in exploded views that show the components/parts you need to order. Components are identified with part numbers (1) (2) (3) etc. Subassembly identified with sub-assembly letters (A) (B) (C) etc. Exploded views of each subassembly provided	40	
4	Standards used in drawings indicated	3	
5	Summary of Engineering analysis and specifications for parts	25	
6	Table listing the part by name, part number, quantity needed, price quote, unit price, extended price based on the lowest quote and total project cost	10	
	Copy of assignment sheet attached	2	
	Total	200	

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

QUIZ 1

TOPICS COVERED IN QUIZ 1

Ethics

Senior Design & Professionalism I
Ethics & Professionalism Tests
Fall 2020

Print Name:_____ Course Section_____ Instructor's Name_____

Using your knowledge of the NSPE code of ethics for engineers, indicate if each of the following statements in this section is TRUE or FALSE.

1. Engineers may perform services outside of their areas of competence as long as they inform their employers or clients. FALSE **[5 points]**

2. Engineers shall not be required to engage in truthful acts when required to protect the public health, safety, and welfare. FALSE **[5 points]**

3. Engineers may review but shall not approve those engineering documents that are in conformity with applicable standards. FALSE **[5 points]**

4. Engineers having knowledge of any alleged violation of this Code, following a period of 30 days during which the violation is not corrected, shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required. FALSE **[5 points]**

5. Engineers may accept assignments and assume responsibility for coordination of an entire project and shall sign and seal the engineering documents for the entire project, including each technical segment of the plans and documents. FALSE **[5 points]**

6. Engineers shall not issue statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking and revealing the existence of any interest the engineers may have in the matters. TRUE **[5 points]**

7. Engineers shall not solicit but may accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible, if such compensation is fully disclosed. FALSE **[5 points]**

8. Engineers shall not intentionally falsify their qualifications nor actively permit written misrepresentation of their or their associate's qualifications. Engineers may accept credit for previous work performed where the work was performed during the period the engineers were employed by the previous employer. Brochures or other presentations incident to the solicitation of employment shall specifically indicate the work performed and the dates the engineers were employed by the firms. FALSE **[5 points]**

9. Engineers shall not reveal facts, data...information without the prior consent of the client or employer except as authorized or required by law or this Code. TRUE **[5 points]**

10. Engineers shall not permit the use of their names or associates in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise, unless such enterprise or activity is deemed consistent with applicable state or federal law. FALSE **[5 points]**

For questions 11 through 13, Select the best answer for case presented.

11. You are the engineer responsible for monitoring and fixing any pollution problems associated with a production site. Your routine tests turn up levels of pollution that are somewhat higher than legally allowed (but not very much higher). What is your best course of action? **[5 points]**
    a) Tell your bosses, and let them decide whether or not to fix it.
    b) Ignore the problem, since it isn't a significant one.
    c) Fix the problem, no matter what it costs, and even if your bosses tell you to ignore it.
    d) Fix the problem only if it can be done relatively cheaply.

12. People behave ethically when they: **[5 points]**2
    e) Do what they most feel like doing.
    f) Do what their parents or other older people tell them to do.
    g) Do what will most benefit people in general.
    h) Do what will most advance their own careers.

13. An engineer testifying as an expert witness in a product liability case should. **[5 points]**
    a. Answer as briefly as possible only those questions posed by attorneys
    b. Provide a complete and objective analysis within his or her area of competence
    c. Provide an evaluation of the character of the defendant
    d. Provide information on the professional backgrounds of the defendants

14. **Case Study: Engineer's dispute with client over design**
    Client hired Engineer A to design a particular project. Engineer A develops what he believes to be the best design and meets with the client to discuss the design. After discussing the design plans and specifications, the client and engineer are involved in a dispute concerning the ultimate success of the project. The client believes Engineer A's design is too large and complex and seeks a simpler solution to the project. Engineer A believes a simpler solution will not achieve the result and could endanger the public. The client demands that Engineer A deliver over to him the drawings so that he can present them to Engineer B to assist Engineer B in completing the project to his liking. The client is willing to pay for the drawings, plans, specifications, and preparation but will not pay until Engineer A delivers the drawings. Engineer A refused to deliver the drawings.

    Would it be ethical for Engineer A to deliver the plans and specifications to the client? Explain **[5 points]**
    No, it will not be ethical for engineer A to give his design to the client. This is because he is aware of the intention of the client to modify his design which could render it unsafe and the change could endanger the public.

    What would be the repercussions if he did deliver the plans to the client? **[5 points]**
    He may be liable in the future if the design is modified and endangers the public in the future. If it became known that he knew of the client's intent and still delivered the design to the client, when he knew the change could endanger the public, then he did not act in the best public interest and could be liable

15. Driving over the speed limit when a female passenger is in labor and about to have a baby.
    Discuss, in one or two paragraphs, the driver's action with regard to being legal or illegal, moral or immoral, ethical or unethical. **[5 points]**
    Driver's action is illegal since it violates the speed limit.
    Driver's action is moral since his intentions are for the good of the female passenger and the unborn baby.
    While it is ethically wrong to disobey the law by driving over the speed limit, the moral importance of the driver's action makes his action in this particular case ethical.

16. A chemical company develops a new process that has a waste by product. Their internal studies show this by-product is carcinogenic (causes cancer). However, the by-product is not on a government list of banned carcinogenic chemicals because it is new. Because it is not on the list of banned chemicals, the company disposes of it together with non-carcinogenic by products.
Provide an argument/discuss (in one or two paragraphs) as to whether the company's action is legal or illegal. **[3 points]**
The company's action is legal since the chemical is not currently on the list of banned substances. However, depending on how the law is written, the company could be found liable if the law has any clause that states that it is illegal to knowingly dispose a carcinogenic chemical improperly.

Provide an argument/discuss as to whether the company's action is ethical or unethical. **[2 points]**
The action of the company is unethical since they know the danger posed by their chemical, yet disposed of it as if it is harmless. The ethical thing to do was for them to treat this as a dangerous chemical and not to dispose of it together with non-carcinogenic by products.

17. Professor Winslow is a world-renowned expert in heat transfer. He has written the leading textbook on heat transfer which is used in 50% of the mechanical engineering departments in the U.S. Professor Winslow teaches heat transfer to 100 students each semester. He selects his own textbook which will generate an additional $2000/yr in royalties. Discuss (in one or two paragraphs) as to as to whether Professor Winslow has a conflict of interest or not. **[5 points]**

Professor Winslow has a conflict of interest since he gets royalty for the books, and the recommendation for the book did not originate from an independent body, by from the professor himself. There are potentially other good or better books that could be used since only 50% of the departments in the US are using his book. This conflict denies students the potential use of a better textbook if one exists.

Provide suggestions you may have to address any conflict of interest if you think there is a conflict of interest? **[5points]**
To remove the conflict of interest, the Mechanical Engineering department should appoint a committee to look at potential textbooks for the course so they can review all the top textbooks and select the best for the course. The best could still be Professor Winslow's book, and if the committee selects the professor's book, then there will be no conflict of interest.

18. List five major professional responsibilities you have as a student and indicate those that you adhered to this semester. **[5 points]**

- *Attend classes punctually*
- *Inform instructor timely of excused absences*
- *Adhere to class room rules such as not eating/drinking in class, not talking with friends or on the phone during class, turning cell phones off during class.*
- *Submit assignments on time.*
- *Be respectful of instructors and other students*
- *Understand and adhere to the University policy on academic honesty*
- *maintain academic integrity at the university by refusing to participate in or tolerate academic dishonesty*
- *Avoid plagiarism, falsification, and misrepresentation of information.*

(Others by your discretion as you see fit)

ABOVE AVERAGE

Senior Design & Professionalism I
Ethics & Professionalism Tests
Fall 2020

Print Name :Brandon Blond Course Section: Y02 Instructor's Name: Xiabo Peng

For questions 1 through 10, using your knowledge of the NSPE code of ethics for engineers, indicate if each of the following statements in this section is TRUE or FALSE by stating TRUE or FALSE after each question.

1. Engineers may perform services outside of their areas of competence as long as they inform their employers or clients. False

2. Engineers shall not be required to engage in truthful acts when required to protect the public health, safety, and welfare. False

3. Engineers may review but shall not approve those engineering documents that are in conformity with applicable standards. False

4. Engineers having knowledge of any alleged violation of this Code, following a period of 30 days during which the violation is not corrected, shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required. False

5. Engineers may accept assignments and assume responsibility for coordination of an entire project and shall sign and seal the engineering documents for the entire project, including each technical segment of the plans and documents. False

6. Engineers shall not issue statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking and revealing the existence of any interest the engineers may have in the matters. True

7. Engineers shall not solicit but may accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible, if such compensation is fully disclosed. False

8. Engineers shall not intentionally falsify their qualifications nor actively permit written misrepresentation of their or their associate's qualifications. Engineers may accept credit for previous work performed where the work was performed during the period the engineers were employed by the previous employer. Brochures or other presentations incident to the solicitation of employment shall specifically indicate the work performed and the dates the engineers were employed by the firms. False

9. Engineers shall not reveal facts, data...information without the prior consent of the client or employer except as authorized or required by law or this Code. True

10. Engineers shall not permit the use of their names or associates in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise, unless such enterprise or activity is deemed consistent with applicable state or federal law. False

For questions 11 through 13, Select the best answer for case presented.

11. You are the engineer responsible for monitoring and fixing any pollution problems associated with a production site. Your routine tests turn up levels of pollution that are somewhat higher than legally allowed (but not very much higher). What is your best course of action?
    a) Tell your bosses, and let them decide whether or not to fix it.
    b) Ignore the problem, since it isn't a significant one.
    c) Fix the problem, no matter what it costs, and even if your bosses tell you to ignore it.
    d) Fix the problem only if it can be done relatively cheaply.

12. People behave ethically when they:
    a) Do what they most feel like doing.
    b) Do what their parents or other older people tell them to do.
    c) Do what will most benefit people in general.
    d) Do what will most advance their own careers.

13. An engineer testifying as an expert witness in a product liability case should
    a. Answer as briefly as possible only those questions posed by attorneys
    b. Provide a complete and objective analysis within his or her area of competence
    c. Provide an evaluation of the character of the defendant
    d. Provide information on the professional backgrounds of the defendants

14. **Case Study: Engineer's dispute with client over design**
    Client hired Engineer A to design a particular project. Engineer A develops what he believes to be the best design and meets with the client to discuss the design. After discussing the design plans and specifications, the client and engineer are involved in a dispute concerning the ultimate success of the project. The client believes Engineer A's design is too large and complex and seeks a simpler solution to the project. Engineer A believes a simpler solution will not achieve the result and could endanger the public. The client demands that Engineer A deliver over to him the drawings so that he can present them to Engineer B to assist Engineer B in completing the project to his liking. The client is willing to pay for the drawings, plans, specifications, and preparation but will not pay until Engineer A delivers the drawings. Engineer A refused to deliver the drawings.

    Would it be ethical for Engineer A to deliver the plans and specifications to the client? Explain

    It would not be ethical because Engineer A knows that the client will give the project to Engineer B to change it into something that Engineer A deemed un-safe for the public. So basically, it would be unethical because the project would be deemed not safe for the public.

    What would be the repercussions if he did deliver the plans to the client?

    Engineer B would change the project into something that Engineer A deemed not safe to meet the client's demands and possibly endanger the public.

15. Driving over the speed limit when a female passenger is in labor and about to have a baby.
Discuss, in one or two paragraphs, the driver's action with regard to being legal or illegal, moral or immoral, ethical or unethical. 1

What the driver is doing is illegal but moral and ethical. This is because the woman needs medical attention and the driver is trying to get her there as quickly as possible.

16. A chemical company develops a new process that has a waste by product. Their internal studies show this by-product is carcinogenic (causes cancer). However, the by-product is not on a government list of banned carcinogenic chemicals because it is new. Because it is not on the list of banned chemicals, the company disposes of it together with non-carcinogenic by products.
Provide an argument/discuss (in one or two paragraphs) as to whether the company's action is legal or illegal.

The company's actions are legal because the government has not deemed the by-product illegal yet. This means the company is technically not doing anything illegal.

Provide an argument/discuss as to whether the company's action is ethical or unethical.

The company's actions however are highly unethical because they know that the chemical is harmful (carcinogenic) and choose to not dispose of it properly.

17. Professor Winslow is a world-renowned expert in heat transfer. He has written the leading textbook on heat transfer which is used in 50% of the mechanical engineering departments in the U.S. Professor Winslow teaches heat transfer to 100 students each semester. He selects his own textbook which will generate an additional $2000/yr in royalties. Discuss (in one or two paragraphs) as to as to whether Professor Winslow has a conflict of interest or not.

The professor does indeed have a conflict of interest. His interests lie in teaching his class effectively and also making money on his book. Although it is widely used, he is still seeking a monetary gain.

Provide suggestions you may have to address any conflict of interest if you think there is a conflict of interest?

The professor should use a different textbook and place his textbook as "supplemental material."

18. List five major professional responsibilities you have as a student and indicate those that you adhered to this semester.

1. Academic honesty - Adhered to
2. Commitment to Excellence - Adhered to
3. Upholding standards - Adhered to
4. Following the Law - Adhered to
5. Passing classes - Adhered to

AVERAGE

Senior Design & Professionalism I
Ethics & Professionalism Tests
Fall 2020

Print Name:__Yemboaodo Yonli_____ Course Section_Y02_____ Instructor's Name___Peng Xiabo_____

For questions 1 through 10, using your knowledge of the NSPE code of ethics for engineers, indicate if each of the following statements in this section is TRUE or FALSE by stating TRUE or FALSE after each question.

1. Engineers may perform services outside of their areas of competence as long as they inform their employers or clients.
   False

2. Engineers shall not be required to engage in truthful acts when required to protect the public health, safety, and welfare.
   False

3. Engineers may review but shall not approve those engineering documents that are in conformity with applicable standards.
   False

4. Engineers having knowledge of any alleged violation of this Code, following a period of 30 days during which the violation is not corrected, shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required.
True

5. Engineers may accept assignments and assume responsibility for coordination of an entire project and shall sign and seal the engineering documents for the entire project, including each technical segment of the plans and documents.
   false

6. Engineers shall not issue statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking and revealing the existence of any interest the engineers may have in the matters.
   true

7. Engineers shall not solicit but may accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible, if such compensation is fully disclosed.
false

8. Engineers shall not intentionally falsify their qualifications nor actively permit written misrepresentation of their or their associate's qualifications. Engineers may accept credit for previous work performed where the work was performed during the period the engineers were employed by the previous employer. Brochures or other presentations incident to the solicitation of employment shall specifically indicate the work performed and the dates the engineers were employed by the firms.
   False

9. Engineers shall not reveal facts, data...information without the prior consent of the client or employer except as authorized or required by law or this Code.
   True

10. Engineers shall not permit the use of their names or associates in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise, unless such enterprise or activity is deemed consistent with applicable state or federal law.

False

For questions 11 through 13, Select the best answer for case presented.

11. You are the engineer responsible for monitoring and fixing any pollution problems associated with a production site. Your routine tests turn up levels of pollution that are somewhat higher than legally allowed (but not very much higher). What is your best course of action?

    a) Tell your bosses, and let them decide whether or not to fix it.

    b) Ignore the problem, since it isn't a significant one.

    c) Fix the problem, no matter what it costs, and even if your bosses tell you to ignore it.

    d) Fix the problem only if it can be done relatively cheaply.

12. People behave ethically when they:

    a) Do what they most feel like doing.

    b) Do what their parents or other older people tell them to do.

    c) Do what will most benefit people in general.

    d) Do what will most advance their own careers.

13. An engineer testifying as an expert witness in a product liability case should

    a. Answer as briefly as possible only those questions posed by attorneys

    b. Provide a complete and objective analysis within his or her area of competence

    c. Provide an evaluation of the character of the defendant

    d. Provide information on the professional backgrounds of the defendants

14. **Case Study: Engineer's dispute with client over design**

    Client hired Engineer A to design a particular project. Engineer A develops what he believes to be the best design and meets with the client to discuss the design. After discussing the design plans and specifications, the client and engineer are involved in a dispute concerning the ultimate success of the project. The client believes Engineer A's design is too large and complex and seeks a simpler solution to the project. Engineer A believes a simpler solution will not achieve the result and could endanger the public. The client demands that Engineer A deliver over to him the drawings so that he can present them to Engineer B to assist Engineer B in completing the project to his liking. The client is willing to pay for the drawings, plans, specifications, and preparation but will not pay until Engineer A delivers the drawings. Engineer A refused to deliver the drawings.

    Would it be ethical for Engineer A to deliver the plans and specifications to the client? Explain

Yes, it would be ethical for engineer A the plan as the plan would be revised by both engineers to see how they can come with something that meets the safety requirement while still meeting the clients expectation. The plan is not only going to be made to please the client only.

What would be the repercussions if he did deliver the plans to the client?

If the plan is delivered and that engineering B is ethical, Engineer B and Engineer A will work together in order to generate something that is meeting all safety requirements. This would result in a plan that pleases the clients but also is ethical. Unless engineer B is unethical this should go well.

15. Driving over the speed limit when a female passenger is in labor and about to have a baby.
Discuss, in one or two paragraphs, the driver's action with regard to being legal or illegal, moral or immoral, ethical or unethical. 1
In that case the drive action is illegal as the speed limit is law that has to be respected and base on the law the driver could be punishes. However, on a moral standpoint the driver must do his best for the mother to be able to deliver in conditions as safe as possible and the hospital is the better place. On an ethic standpoint, it will depend on how he exceeds the speed limit. If the speed limit is 65 and the driver is a 75 it is still acceptable but if the driver is at 65 and the driver is a 100 he is putting the life of the mom and the baby in danger.

.

16. A chemical company develops a new process that has a waste by product. Their internal studies show this by-product is carcinogenic (causes cancer). However, the by-product is not on a government list of banned carcinogenic chemicals because it is new. Because it is not on the list of banned chemicals, the company disposes of it together with non-carcinogenic by products.
Provide an argument/discuss (in one or two paragraphs) as to whether the company's action is legal or illegal.
The action of the company is legal at the moment as laws are rules well defined that are clearly punishable. this is immoral and unethical as the by product is potentially carcinogenic and can hurt and kill many people. This can be settled in court and in those cases the company will most of the time lose.

Provide an argument/discuss as to whether the company's action is ethical or unethical.

This is immoral and unethical as the by product is potentially carcinogenic and can hurt and kill many people. This can be settled in court and in those cases the company will most of the time lose.

17. Professor Winslow is a world-renowned expert in heat transfer. He has written the leading textbook on heat transfer which is used in 50% of the mechanical engineering departments in the U.S. Professor Winslow teaches heat transfer to 100 students each semester. He selects his own textbook which will generate an additional $2000/yr in royalties.
Discuss (in one or two paragraphs) as to as to whether Professor Winslow has a conflict of interest or not.

Yes, Professor Winslow has conflict of interest as long as the book chosen will generate money for professor Winslow. It is an advantage for him.

Provide suggestions you may have to address any conflict of interest if you think there is a conflict of interest?
Dr winslow will make money
There are other Textbooks

18. List five major professional responsibilities you have as a student and indicate those that you adhered to this semester.
Five professional responsibilities that we have as student:
Do not cheat
Keep on learning more on mechanical engineering
Attend class regularly
Share Knowledge with other students
Maintain safety in everything that has to deal with hazardous materials
This semester all of those subject has been implemented as I am in senior design and I have to be as professional as possible.

BELOW AVERAGE

Senior Design & Professionalism I
Ethics & Professionalism Tests
Fall 2020

79

Print Name:_Demetrious Sandford_ Course Section___Y02__ Instructor's Name_Dr. Peng_____

For questions 1 through 10, using your knowledge of the NSPE code of ethics for engineers, indicate if each of the following statements in this section is TRUE or FALSE by stating TRUE or FALSE after each question. 40/50

1. Engineers may perform services outside of their areas of competence as long as they inform their employers or clients. F

2. Engineers shall not be required to engage in truthful acts when required to protect the public health, safety, and welfare. F

3. Engineers may review but shall not approve those engineering documents that are in conformity with applicable standards. F

4. Engineers having knowledge of any alleged violation of this Code, following a period of 30 days during which the violation is not corrected, shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required. F

5. Engineers may accept assignments and assume responsibility for coordination of an entire project and shall sign and seal the engineering documents for the entire project, including each technical segment of the plans and documents. F

6. Engineers shall not issue statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking and revealing the existence of any interest the engineers may have in the matters. T

7. Engineers shall not solicit but may accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible, if such compensation is fully disclosed. F

8. Engineers shall not intentionally falsify their qualifications nor actively permit written misrepresentation of their or their associate's qualifications. Engineers may accept credit for previous work performed where the work was performed during the period the engineers were employed by the previous employer. Brochures or other presentations incident to the solicitation of employment shall specifically indicate the work performed and the dates the engineers were employed by the firms. T

x

9. Engineers shall not reveal facts, data...information without the prior consent of the client or employer except as authorized or required by law or this Code. T

10. Engineers shall not permit the use of their names or associates in business ventures with any person or firm that they believe is engaged in fraudulent or dishonest enterprise, unless such enterprise or activity is deemed consistent with applicable state or federal law. T

x

-10

For questions 11 through 13, Select the best answer for case presented. 15/15

11. You are the engineer responsible for monitoring and fixing any pollution problems associated with a production site. Your routine tests turn up levels of pollution that are somewhat higher than legally allowed (but not very much higher). What is your best course of action?
    a) Tell your bosses, and let them decide whether or not to fix it.
    b) Ignore the problem, since it isn't a significant one.
    c) Fix the problem, no matter what it costs, and even if your bosses tell you to ignore it. (ANSWER)
    d) Fix the problem only if it can be done relatively cheaply.

12. People behave ethically when they:
    a) Do what they most feel like doing.
    b) Do what their parents or other older people tell them to do.
    c) Do what will most benefit people in general. (ANSWER)
    d) Do what will most advance their own careers.

13. An engineer testifying as an expert witness in a product liability case should
    a. Answer as briefly as possible only those questions posed by attorneys
    b. Provide a complete and objective analysis within his or her area of competence (ANSWER)
    c. Provide an evaluation of the character of the defendant
    d. Provide information on the professional backgrounds of the defendants

14. **Case Study: Engineer's dispute with client over design** 10/10
Client hired Engineer A to design a particular project. Engineer A develops what he believes to be the best design and meets with the client to discuss the design. After discussing the design plans and specifications, the client and engineer are involved in a dispute concerning the ultimate success of the project. The client believes Engineer A's design is too large and complex and seeks a simpler solution to the project. Engineer A believes a simpler solution will not achieve the result and could endanger the public. The client demands that Engineer A deliver over to him the drawings so that he can present them to Engineer B to assist Engineer B in completing the project to his liking. The client is willing to pay for the drawings, plans, specifications, and preparation but will not pay until Engineer A delivers the drawings. Engineer A refused to deliver the drawings.

    Would it be ethical for Engineer A to deliver the plans and specifications to the client? Explain
(ANSWER) No. Giving someone elseyour designs, espically after it was explained that the simpler solution is dangerous, is not ethical.

    What would be the repercussions if he did deliver the plans to the client?
    (ANSWER) If he delivered them to the client and the results of the new simpler design do in fact endanger the public, he would be primarily responsible because they were his plans orignally.

15. Driving over the speed limit when a female passenger is in labor and about to have a baby. 5/5
Discuss, in one or two paragraphs, the driver's action with regard to being legal or illegal, moral or immoral, ethical or unethical. 1
    (ANSWER) The drivers actions are illegal and are not ethical because not ony are you endangering others around you, you are endangering the female passanger and the baby. His action are moral because his belief may be is that in order for a safe delivery he has to get to the hospital as well.

16. A chemical company develops a new process that has a waste by product. Their internal studies show this by-product is carcinogenic (causes cancer). However, the by-product is not on a government list of banned carcinogenic chemicals because it is new. Because it is not on the list of banned chemicals, the company disposes of it together with non-carcinogenic by products.

2/5

Provide an argument/discuss (in one or two paragraphs) as to whether the company's action is legal or illegal.
(ANSWER) The companies actions are illegal. Knowing that the chemical is carcinogenic means that it should be disposed of properly.

x

-3

Provide an argument/discuss as to whether the company's action is ethical or unethical.
(ANSWER) Thier actions are unethical. Disposing of the product incorretly shows that the company cannot be trusted to do the right thing, there is no honesty and they should have known it was not the right thing to do.

17. Professor Winslow is a world-renowned expert in heat transfer. He has written the leading textbook on heat transfer which is used in 50% of the mechanical engineering departments in the U.S. Professor Winslow teaches heat transfer to 100 students each semester. He selects his own textbook which will generate an additional $2000/yr in royalties. Discuss (in one or two paragraphs) as to as to whether Professor Winslow has a conflict of interest or not.

5/10

(ANSWER) Yes he does, using his own materia to generate more income is a confict of interest. Athough he has written leading textbooks.

Provide suggestions you may have to address any conflict of interest if you think there is a conflict of interest?

-5

18. List five major professional responsibilities you have as a student and indicate those that you adhered to this semester.

2/5

Not falsifing information
Not disclosing information that may or may not have given to us to aid in our design.
Ensuring we give credit to third parties where credit is due
Ensuring that our design does not hamr the pubic

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 1
9/1/2020~9/9/2020

Grading Scheme

Team Meeting Minute

Group: _____

Item	Description	Maximu	Your
1	Sufficient meeting time	2	
2	Meeting agenda clearly identified	2	
3	Detailed meeting minutes	3	
4	Tasks are assigned to individual members	3	
	Total	10	

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: 9/5/2020 Meeting Time: 5:00PM–7:00PM Meeting Location: https://zoom.us/j/93439802900

Members Present: Ximena Cifuentes, Daniel Akpan, Demetrious Sandford, Amna Ansari, David Trevino
Excused Members: Caleb Riggins (Work), Amna J (Work)

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Every member should introduce themselves and talk about their work experience.
- Add roles as needed
- Group leader selection
- Technical and nontechnical roles selection
- Discuss plan on meeting times selection
- Discuss plan on advisor communication
- Try to go over progress report number 3

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Ximena Cifuentes: Ximena introduced herself to the other group members and suggested to take over the role of being a Group leader. First, she talked about her experience at General Motors and how she interned with them during the summer. Ximena shared that she led 4 general assembly line teams and a hood production aid optimization project at General Motors. Ximena also shared her leadership experience with her being the president of her sorority and being a manager for two stores for Ace Cash Express. The last thing Ximena mentioned is that she is a team oriented individual and loves to help others by kindly leading them to the right direction

Daniel Akpan: Daniel introduced himself to the other team members and suggested to take over the Manufacturing and testing leader and budget purchaser. Daniel talked about his experience as an intern at Daikin Technology park and his role as a Production engineer.

Demetrious Sandford: Demetrious introduced himself and talked about his experience with working with elementary and High school teachers. Due to his past experience, Demetrious suggested to take over the roles of being a proofreader and organizer. Demetrious previous job was to create schedules and events for students.

Amna Ansari: after introducing herself to the other group members, Amna Talked about her experience with working on a research with the Mechanical Engineering department. Her role was to be part of the analysis part of the research and she had to work on ANSYS to create her research. Amna suggested to take over the roles of being a Graphic/Model leader and a Recorder.

David Trevino: David introduced himself to the other group members and suggested to take over the roles of being the Ideas facilitator and Project Assessment. These roles were assigned to him due to his work experience at Daikin Technology Park. David is currently working as a machine operator within Daikin and has allowed him to be in contact with production engineers and quality engineers at the company. Having the opportunity to be given insight by individuals in the field, David will be able to facilitate potential ideas and ensure the quality of the project to be up to specifications

Daniel Akpan: introduced himself and mentioned he wanted to perform the manufacturing and Testing Leader, Budgeter/Purchaser roles. These roles were assigned to Daniel due to his background as a Production Engineer Intern in the past with Daikin Technology Park. Within the internship, he was tasked with the production of 800 HVAC units a day, which all had

to go through quality control, before getting packaged and sent out to the warehouse. Daniel will be able to keep the group within the discussed budget and make sure the skimmer passes all quality control points before the final presentation.

Ximena Cifuentes: introduced herself again and she stated that she wanted to be both Accommodation Manager, Design analysis leader. These roles were assigned to Ximena because of her past internship experience. Ximena had to maintain constant communication with leaders from different departments at General Motors Assembly Plant, to ensure that her project results met the interest of the different departments involved. Ximena also showed to have good people skills.

Demetrious Sandford: he introduced himself and ran for the Organizer and proofreader roles. These roles were assigned to Demetrious due to his previous work with Elementary and High school teachers. Demetrious's job was to create and maintain the scheduling of multiple events and designs for students. As well as aiding teachers with writing assignments. Demetrious will be able to ensure the success of projects by ensuring that the group maintains their schedule.

Ximena Cifuentes: Loaded report 3 on the screen and suggested agenda for report 3 for next meeting and adviced on methods of communication with advisors.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Reach out to advisors, send schedule to organizer, add to question 2 report 2, create a shared folder	N/A – This is the first meeting record	
Daniel Akpan	Send schedule to organizer, add to question 2 on progress report 2	N/A – This is the first meeting record	
Demetrious Sandford	Come up with possible meeting times, add to question 2 on progress report 2	N/A – This is the first meeting record	
Amna Ansari	Send schedule to organizer, add to question 2 on progress report 2, finish meeting minutes.	N/A – This is the first meeting record	
David Trevino	Send schedule to organizer, add to question 2 on progress report 2	N/A – This is the first meeting record	
Caleb Riggins	Send schedule to organizer, add to question 2 on progress report 2	N/A – This is the first meeting record	
Amna J	Send schedule to organizer, add to question 2 on progress report 2	N/A – This is the first meeting record	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: 9/6/2020 Meeting Time:12:00PM-3:38PM Meeting Location: https://zoom.us/j/92132556575

Members Present: Ximena Cifuentes, Daniel Akpan, Demetrious Sandford, Amna Ansari, David Trevino, Caleb Riggins, Amna J
Excused Members:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Review roles with absent members from 1st meeting
- Discuss more roles
- Review chapter 1 slides
- Identify client need
- Identify client need
- Identify goal
- Generate goal statement

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Ximena Cifuentes: Introduced the agenda for the day.
Daniel Akpan: Discussed the roles section with the absent team members.

Caleb Riggins: Caleb introduced himself to the group members and suggested to take over the role of a technical Writer. Caleb Talked about his intern experience at UT Austin's NASCENT REU program in Nanotechnology. During his internship, caleb had to do intense research which improved his writing and presentation capabilities. Caleb also, mentioned that he is a service manager at H.E.B, and this position allowed him to have great communication skills.

Amna Jangda: she introduced herself and stated that she wanted to be both the Graphics and environmental research lead. These roles were assigned to her because of her background with AutoCAD, which will be used to design the skimmer. A huge element of this project is environmental sustainability, which would require excess research in environmental studies. Amna has taken classes on environmental science and understands the importance of innovation that leads to a more sustainable future.

David Trevino: Suggested new roles and the team signed up for those new roles

Ximena Cifuentes: Went over slides for chapter 1

- Talked about client
- How to identify the client
- How to identify client need
- How to come up with a goal
- Team decided on a client, client need, and goal statement. after setting up a list.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Research on skimmers deficiencies/limitations and possible skimmer clients, continue discussions with advisors and set up meeting times.	Contacted advisors, set up agenda, completed question 2 on report 2, sent schedule to organizer.	
Daniel Akpan	Research on skimmers deficiencies/limitations and possible skimmer clients.	Completed question 2 on report 2, sent schedule to organizer.	
Demetrious Sandford	Research on skimmers deficiencies/limitations and possible skimmer clients, set up next meeting.	Completed question 2 on report 2, came up with different meeting times and meeting suggestions.	
Amna Ansari	Research on skimmers deficiencies/limitations and possible skimmer clients, finish meeting minutes.	Completed question 2 on report 2, sent schedule to organizer. Completed meeting minutes.	
David Trevino	Research on skimmers deficiencies/limitations and possible skimmer clients.	Completed question 2 on report 2, sent schedule to organizer.	
Caleb Riggins	Research on skimmers deficiencies/limitations and possible skimmer clients.	Completed question 2 on report 2, sent schedule to organizer.	
Amna J	Research on skimmers deficiencies/limitations and possible skimmer clients.	Completed question 2 on report 2, sent schedule to organizer.	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: 9/7/2020 Meeting Time: 7:40pm-11:42pm Meeting Location: https://zoom.us/j/91949827487

Members Present: Ximena Cifuentes, Demetrious Sandford, Amna Ansari, David Trevino, Caleb Riggins, Amna J
Excused Members: Daniel Akpan (No Internet Connection)

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Continue to make list of objectives
- Divide assignment 3 in 3 parts and assign to team members
- Discuss updates from advisors
- Finalize report 2

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Ximena Cifuentes:

- Introduced agenda for the meeting.
- Finished going over chapter 1 slides.
- Talked about objectives and the process to select them.

Every team member: did brainstorm on possible objectives and listed them.

Ximena Cifuentes:

- Divided progress report 3 in 3 parts
- Assigned 2 people for part 1.
- Assigned 3 people for part 2.
- Assigned 2 people for part 3.
- Discussed updated on communication with advisors. Friday will be possible date for meeting with both project owners.

Every team member: reviewed and finalized report 2.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Finalize section 2 of the report (objectives), meet with Dr.Park and Dr. Peng, generate emails for signatures.	Researched	
Daniel Akpan	Finalize section 3 of the report (Constraints), meet with Dr.Park.	Researched	
Demetrious Sandford	Finalize section 1 of the report (Problem Statemen and client need), meet with Dr.Park, Proof read report 2.	Researched	
Amna Ansari	Finalize section 2 of the report (Objectives), meet with Dr.Park, finish meeting minutes, generate emails for signatures.	Researched	
David Trevino	Finalize section 1 of the report (Scope of project and client), meet with Dr.Park.	Researched and logged on research sheet	
Caleb Riggins	Finalize section 3 of the report (Constraints), meet with Dr.Park.	Researched	
Amna J	Finalize section 2 of the report (Objectives), meet with Dr.Park.	Researched	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: __Sept. 5 2020.__Meeting Time:__3:00-4:20 PM_ Meeting Location:___Zoom

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, and Mohammed Suliman

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Assign task for 3 status report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

As a group we we came up with the idea of a minimum of 11 hours per week the group should meet and discuss about the project.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

N/A

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser	Completed	N/A
Clarence Reed	Proofreader Technical writer	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader	Completed	N/A

Dacory Harris	Organizer Presentation Manager	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader	Completed	N/A
Kennedy Simmons	Recorder	completed	N/A

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date:9/08/2020 Meeting Time:4:30-5:30PM Meeting Location:Zoom

Members Present: David Otinwa, Alexander DeShields, Asher Carson, Kapiduach Echarry, Kendall Lemons, Bryce Boyd, Jeremy Hunter, Chang Duan

Agenda for Meeting (Items to be discussed or discussed at the meeting)

STATUS REPORT 3, Contact information for the project, and Schedules.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

In this meeting, we discussed the point of contact for our project, got approval for our questions, and discussed any foreseen schedule changes.
Some of the questions we prepared were:

What exactly are we trying to design? (Modify or reinvent)
What is the totality of the dissatisfaction with the current design? (other than vibrations)
What criteria does the new design need to meet?

- Geometrically
- Size
- Weight
- Holding force
- Material
- Factor of safety
- Repeatability?

What is your priority with this design?

- Safety, economy, convenience etc...

Deliverables?

Problems you've ran into in alternative designs thus far?
What days can you meet up on a weekly bases?

We start the process of making contact with Ball Aerospace

Discussed any changes in schedules that would prevent anyone from being able to meet with our sponsor.

A brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

All members gave input for the meeting and contributed to the discussion. At this time we did not run into any disagreements on today's objective.

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: 9/4/2020 Meeting Time:12-2PM Meeting Location: Zoom

Members Present: David Otinwa, Alexander DeShields, Asher Carson, Kapiduach Echarry, Kendall Lemons, Bryce Boyd, Jeremy Hunter

Agenda for Meeting (Items to be discussed or discussed at the meeting)

STATUS REPORT 2

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Project roles were assigned tentatively as team members expressed their expertise in certain areas. Team members added ideas along with collaborating efforts to determine best procedures as of now.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no problems, being that everyone participated with their part giving ideas and making sure each assignment was well understood regardless of it being their part or not. However, response from the project owner is anticipated as we have already reached out.

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date:9/03/2020 Meeting Time:4-5PM Meeting Location: Zoom

Members Present: David Otinwa, Alexander DeShields, Asher Carson, Kapiduach Echarry, Kendall Lemons, Bryce Boyd, Jeremy Hunter

Agenda for Meeting (Items to be discussed or discussed at the meeting)

STATUS REPORT 1

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Discussed our qualifications and background for this project to help decide leadership positions

Bryce Boyde- Past work at shell

Jeremy Hunter- Experienced with CADing and 3-D printing

Kendall Lemons- Auditing over electrical circuits designing transportation kits for missiles.

Asher Carson- Research, designing, and machining

Kapiduach Echarry- Design work with pipeline & Instrumentation Diagrams and Control diagrams

David Otinwa- Past experience at HP basic coding (RPA). Experience w/ CAD

Alexander DeShields- Past work at NASA. Worked with design 3-D modeling/printing and assembling the final product. Also worked alongside with electromagnetic release.

Discussed when we have free time throughout the week and used when to meet to help establish formal group meeting times.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no problems, each team member was able to make the meeting and help everyone get a better understanding of what each person's strengths were.

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 2
9/10/20-9/16/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/10/2020___ Meeting Time:__3:45-6:00_____

Meeting Location: __Zoom:https://zoom.us/j/93916627070?pwd=Rk92MzkwZXlaTTZsS0hESVJrb3JkQT09___

Members Present: _Kapiduach Echarry, Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa_

Agenda for Meeting (Items to be discussed or discussed at the meeting)

At this meeting we discussed how to fill out Status report three with the limited information given to us by Ball Aerospace. Also, we review the information given to us by Ball Aerospace to make sure we were all on the same page. The goal was to finish status report 3 by the end of the meeting.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Suggested how to spend our next few meeting times so that we get everything done before the given deadlines. Also discussed how we would be going about finishing each section in an organized and systematic way. Decided that everyone would take a section of status report 3 except for himself. Assigned himself the job of reviewing lecture and manual to make sure report was filled out to professor's satisfaction.

Jeremy, David, Asher, Kendall, Kapiduach: Discussed among themselves who would work on what section based on previous experience and technical writing specializations.

Asher Carson: Expressed concern about filling out document to completion without complete information given by Ball Aerospace.

Alex DeShields: Contacted Neil to ask when group would be given a full report. Reorganized future meeting dates and goals to make sure report 3 and future tasks could be completed in time.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Group did a good job of discussing problems we ran into and asking for help in individual sections they were working on. Most problems were resolved by peer review of each other's work. Bryce Boyd missed meeting, but team decided to take no actions as this is not a habitual behavior.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Worked on filling out Status Report 3 section 1.4: Initial Project constraints and Operating Environment.	Completed Section on status report 2.	No Action
Kendall Lemons	Worked on filling out Status Report 3 section 1.2: Client identification and recognition of need.	Completed Section on status report 2.	No Action
Kapiduach Echarry	Worked on filling out Status Report 3 section 1.1: Problem Statement.	Completed Section on status report 2.	No Action
Jeremy Hunter	Worked on filling out Status Report 3 section 1.3: Project goals and objectives.	Meeting minutes	No Action
David Otinwa	Worked on filling out Status Report 3 section 1: PROJECT SCOPE.	Completed Section on status report 2, and turned it in to Professor Duan.	No Action
Alex DeShields	Re-watched lecture 9/3/20 and read through the manual in order to make sure Chapter 1 everyone's work was up to expectation. Completed the minutes	Completed Section on status report 2, compiled the minutes and turned them into Professor Peng.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/11/2020___ Meeting Time:__12:00-3:00_____

Meeting Location: __Zoom:https://zoom.us/j/91223506943?pwd=ejQvT0w5ZlA5OWFrNmVZblQwYnViUT09__

Members Present: _Kapiduach Echarry, Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa_

Agenda for Meeting (Items to be discussed or discussed at the meeting)

At this meeting we discussed how to fill out Status report three with the full amount of information given to us by Ball Aerospace. We review the information given to us by Ball Aerospace to make sure we were all on the same page. The goal was to finish status report 3 by the end of the meeting since we didn't do it last time.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Discussed meeting agenda and goals for the next couple of days individually. Repeated the formatting details and specific requirements which the professors requested in the manual and in class.

Jeremy, David, Asher, Kendall, Kapiduach: Discussed among themselves each other's sections and asked for suggestions and any improvements that could be made to each other's work.

Alex DeShields: Contacted Neil to ask when group would be able to meet again. Organized future meeting dates and goals to make sure we were on track for the completions and submission of this task and future tasks.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Group did a good job of discussing problems we ran into and asking for help in individual sections they were working on. Most problems were resolved by peer review of each other's work. Bryce Boyd missed meeting, but team decided to take no actions as this is not a habitual behavior.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Completed filling out Status Report 3 section 1.4: Initial Project constraints and Operating Environment.	Filled out section 1.4 on status report 3 to the best of their ability with given information.	No Action
Kendall Lemons	Completed filling out Status Report 3 section 1.2: Client identification and recognition of need.	Filled out section 1.2 on status report 3 to the best of their ability with given information.	No Action
Kapiduach Echarry	Completed filling out Status Report 3 section 1.1: Problem Statement.	Filled out section 1.1 on status report 3 to the best of their ability with given information.	No Action
Jeremy Hunter	Completed filling out Status Report 3 section 1.3: Project goals and objectives.	Filled out section 1.3 on status report 3 to the best of their ability with given information.	No Action
David Otinwa	Completed filling out Status Report 3 section 1: PROJECT SCOPE.	Filled out PROJECT SCOPE on status report 3 to the best of their ability with given information.	No Action
Alex DeShields	Continued communication with Ball Aerospace. Final revision of Status report 3. Meeting minutes.	Meeting minutes. Communication with professor Duan and Ball Aerospace. Revising Chapter 1	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/15/2020___ Meeting Time:__4:00-8:30_____

Meeting Location:Zoom:https://us04web.zoom.us/j/4323149454?pwd=eTk0TkVacEdzRWNsTjE5MXZjaGZBZz09

Members Present: _Kapiduach Echarry, Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa, Bryce Boyd_

Agenda for Meeting (Items to be discussed or discussed at the meeting)

At this meeting we discussed how to fill out Status report four. We started by rereading the entire status report and discussed each other's different skill set and how we would be going about completing the assignment. We assigned different parts of the assignment to each member. We reviewed the in class video from Wednesday and Thursday to make sure we were providing the information in a satisfactory way for the professors. The set goal was to complete questions 1-3 and have a second group complete 4 and 5 tomorrow.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields/Kapiduach Echarry: Set an agenda for the meeting. Read the status report 4 and set a way to separate and assign the work

Jeremy, David, Asher, Kendall, Kapiduach, Bryce: Discussed among themselves which section of work they would take. Soon after the people not working today left the call and went about their day.

Jeremy, Asher, Alex, David: The ones working on filling out the provided table (in status report 4) discussed each other's sections and asked for suggestions and any improvements that could be made to each other's work.

Jeremy: Asked what would be done for the scheduling things to happen next semester.

Alex DeShields: Contacted professor Duan to ask what was was expected with things that wouldn't start until next semester (fabrication, purchasing, prototyping, ect...)

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Jeremy Hunter, Asher Carson, David Otinwa, and Alex DeShields mainly focused on the first

three questions. Kapiduach Echarry, Bryce Boyd, and Kendall Lemons will work on the last two questions tomorrow. No problems were encountered with the group members. No problems encountere

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Completed filling the chart to answer questions 1-3.	Filling out the Docusign.	No Action
Kendall Lemons	Complete filling out questions 4 and 5 tomorrow.	Filling out the Docusign.	No Action
Kapiduach Echarry	Complete filling out questions 4 and 5 tomorrow. Cover sheet Docusign.	Creating a Docusign for status report 3.	No Action
Jeremy Hunter	Completed filling the chart to answer questions 1-3.	Filling out the Docusign.	No Action
David Otinwa	Completed filling the chart to answer questions 1-3.	Turning in Status report 3.	No Action

Alex DeShields	Completed filling the chart to answer questions 1-3. Meeting minutes	Meeting minutes. Communication with professor Duan.	No Action
Bryce Boyd	Complete filling out questions 4 and 5 tomorrow.	Filling out the Docusign.	No Action

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

GROUP #5

Meeting Date: _9/10/2020____ Meeting Time:_12-1 PM__ Meeting Location: Online - WebEX__

Members Present: Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafo

*Sponsors also present: Elliot, Brian, Drew

Agenda for Meeting

First Meeting with Sponsors

- Overview and in-depth description of the project itself
- Introduction between everyone/all members
- Sponsors gave in-depth project and personal expectations
- Confirmed future meeting dates & times

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Muhammad Amir Ghazi- Stated programs we are currently have through the school, and others we may possibly have. Asked specifics about the heat pipes. Amir presented himself as the leader of the group, and his other specific tasks.

Chaniquah Smith - Introduced herself and discussed her expectations of the project. Recorded information for meeting minutes. Asked questions about deliverables and specific schedules/timelines that Ball Aerospace might request.

Chibuzo Okafor - Introduced himself and discussed his expectations for the project. He stated what he desired to learn from his interactions from the company and project itself.

Brandon Blond - Stated what his expectations were for the project. Brandon introduced himself and discussed what he hoped to gain from the experience. He asked about how we would test our projects and materials needed, since we were told we would not have the ability to use a full blown vacuum chamber for our analysis.

Mohammed Bahaj- He discussed his role within the group and other tasks he would help complete. Mohammed introduced himself , and stated his expectations for the project. He also stated why he hoped to gain certain aspects from the project.

Jordan Castaneda - He introduced himself, and stated his role within the group. Jordan added his expectations for the project and what he hoped to gain from the experience.

Hannah Falls- She expressed her excitement about the project, and what she hoped to gain. Hannah introduced herself, and stated her current roles on the project. She discussed her expectations from the project itself.

Elliot - Elliot was the main speaker, and guided the meeting with input from our members and the other sponsors. He gave key points on our status as solution makers. He gave a detailed vision of our scenario, while explaining some restraints and analysis that may be required. Elliot stated that our radiator would not be subjected to ambient temperatures, but that it would depend on the orientation of the hub. He showed a simple picture of the radiator placement of its setup on the satellite. Elliot touched on our project goals, discussed wanted results, and also project expectations. Elliot stated that these previous goals and requirements may also change as the project evolves. He stated how much the company he might be able to help with in regards to resources. Elliot also said that he was still fine-tuning the project statement, and would answer more questions once he was done.

Brian - He gave an overview of what we'll get/ have to do for the project. He also let us know that space simulation equipment wouldn't be available to us. Brian asked us to start doing background research; while also giving us details about the standoff supports on the structure. Brian talked about vacuum compatibility and gave alternative testing examples. He also stated his personal and professional expectations for our members and the project itself.

Drew Ball - He gave his thoughts on radiators in space, and some requirements necessary to make it happen. Drew also discussed geo orbit and his expectations regarding the project.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Most of the meeting was geared towards the sponsors speaking about the project itself and the outcomes we expected. The group members asked a few technical questions about problem points we might encounter as we proceed with the project. All questions were answered sufficiently by the sponsors; and we are currently waiting on a finalized project statement before we continue with more specifics. No other problems occurred within the group, everyone was excited to begin on the project!

Meeting Date: _____9/11/2020_____ Meeting Time:_____12-2pm_____ Meeting Location:_____Zoom_____

Members Present: Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor

Agenda for Meeting

- Go over assignment 3
- Give each member a certain role on assignment 3

Detailed Minutes:

Muhammad Amir Ghazi- Talked about getting the sections done and assigned roles for each group member

Chaniquah Smith-Worked independently on section and offered help to the team

Chibuzo Okafor-Worked independently on section and offered help to the team

Brandon Blond- Took part in editing the entire document and assisted listing the constraints for the project

Mohammed Bahaj- Worked independently on section and offered help to the team

Jordan Castaneda - Helped labeling the objective trees

Hannah Falls- Created the objective tree regarding the project and helped the rest of the team with their roles if they need help.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Most of the meeting was making sure that each member completed their own task on the project. If somebody had a question someone on the team could answer. Not much discussed we just were in the zoom independently working on the sections then brought it all together.

Meeting Date: _____9/15/2020_____ Meeting Time:_____12-3pm_____
Meeting Location:_____zoom_____

Members Present: Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor

Agenda for Meeting:

- Tasks and objectives assigned to each group member
- Start working on Assignment 4
- Setup objectives for Assignment 4
- Setup Gantt Chart
- Setup Tables

Detailed Minutes:

Muhammad Amir Ghazi: Assigned all roles for the assignments based on everyones existing roles discussed and accepted in assignment 2. Went over project goals like the questions that needed to be answered and how roles were distributed. Asked if anyone knows how to setup gantt charts.

Jordan Castaneda: Confirmed roles and went over time line going forward for this assignment. Confirmed he knows how to setup gantt charts and will help the team learn how to set one up

Hannah Falls: Confirmed roles and was comfortable with assigned task, suggested help with others assignments.

Chaniquah Smith: recorded all conversations for the detailed meeting minutes keeping up with conversations going on.

Chibuzo Okafor: Suggested a workflow for the project and went over an idea to make google drive we all work from more organized. Confirmed roles that were assigned to him and was comfortable with the workload required.

Brandon Blond- Suggested a few questions that we need to ask Elliot from Ball Aerospace wrote them down for the next time we get in contact with them. Confirmed roles that were assigned to him and was comfortable with the workload required.

Mohammed Bahaj- Confirmed roles that were assigned to him and was comfortable with the workload required. Also suggested questions that could be added and helped others with their sections in the project

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Everyone that needed to participate participated, once all the roles were assigned we worked on it individually and if questions came up we would talk about it in the zoom meeting. We set up the general flow of the assignment and made sure no one person was assigned too much work.

A few members had to leave early, and some had issues with the content of the roles they were assigned. We all helped each other by optimizing the time they had available and making sure they got their part complete before leaving. If they would not have, we would have finished for them. .

The goals of this meeting was to make sure all tasks and objectives were defined. We completed this task by the end of the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Name	Task Assigned to Team Member at this Meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Chaniquah	Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -Flight Like Test Plan/Procedure -Test Results	N/A	N/A
Amir	-Member was asked to introduce themself, and ask any questions they deemed necessary. -Email Ball Aerospace to get problem statement -Assigned group members roles	Ball aerospace deliverable completed, received problem statement. Allowed completion of assignment 3 and start of assignment 4.	N/A
Chibuzo	-Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -Trade study presentations -Includes but is not limited to trades for radiator material, radiator design, and mounting design	N/A	N/A
Hannah	-Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -System Structural Analysis -Trade study presentations	N/A	N/A

Mohammed	Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -3D printed model of radiator and system -Interface Control Document (ICD)	N/A	N/A
Brandon	Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -Preliminary Design Review (PDR) presentation for radiator and system design -Critical Design Review (CDR) presentation for radiator and system design	N/A	N/A
Jordan	Member was asked to introduce themself, and ask any questions they deemed necessary. Assigned -Thermal Model of System -Radiator and System CAD models	N/A	N/A

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: Sept. 12, 2020. Meeting Time: 11:00-1:30 PM Meeting Location: What's App

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss Project scope. Revise report. Identifying problem areas from previous report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Shikhar and sultan Discussed who were the customers in the job. Suggested that Prairie View A&M University was a potential customer in the thermal science lab. Identify who was the leading investor. Suggested Byars Bayou green diesel as a customer.

Mohammed made a list of constraints and suggested the objects they will qualify as constraints Mohammed made a list of constraints and suggested the object they will qualify as constraints

Everyone decided to make a table for the constraints discuss pressure limits pressure temperature values and flow rate and boundary conditions. Discussed ways how to keep the same design while making beneficial alterations.

Clearance and Kennedy discussed the efficiency performance between the two designs.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to team members at this meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 1.3 Project goals and objectives	Completed	N/A
Clarence Reed	Proofreader Technical writer 1.1 Problem Statement	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader 1.3 Project objectives and goals	Completed	N/A
Dacory Harris	Organizer Presentation Manager 2.2- Client identification and recognition of need	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 1.4 Initial project constraints and operating environment	Completed	N/A
Kennedy Simmons	Recorder 1- Project Scope	completed	N/A

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 3
9/17/20-9/23/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: Sept. 19 2020 Meeting Time: 9:30-1:30 AM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss the remaining actions needed for report 4, assign new tasks for report, and how to format Gantt Chart.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Sultan and Shikhar discussed task identification and created a list of detailed activities that need to be performed. Discusses the concept generation, concept evaluation parts specification, and preliminary design . Mohammed joined and discussed the budget and project cost.

Shikhar discussed the status of report 4. Everyone discussed meeting times.

Mohammed clarified the activities for the timeline and defined each of the specific deliverables to the responsible group member. Estimated the duration for each task, providing a starting and ending time.

Clarence and Shikhar discussed the necessary amount needed for section 2. Clarence also estimated the time for each task. Explained to each responsible member, the detailed actions needed for each task.

Kennedy and Dacory discussed the fundamentals of the Gantt Chart and Dacoy provided guidelines for the making of the chart. How to make subtasks and how to put resources on each task.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There was a brief disagreement on how much information is needed for section 2. Identifying if the information being presented was repetitive or not. Later, it was resolved by adding subtitles for section 2.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to team members at this meeting**	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser Task Identification (Section 2.1) ● Helped in summarizing the info in Table 1.Proofread the whole assignment	Completed	N/A
Clarence Reed	Proofreader Technical writer Timeline (Section 2.2) ● Helped in summarizing the info in Table 1. Proofread the whole assignment	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader Task Identification (Section 2.1) ● Helped in summarizing the info in Table 1.Proofread the whole assignment	Completed	N/A
Dacory Harris	Organizer Presentation Manager Gantt Chart (Section 2.3) ● Created Gantt Chart for Fall 2020	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader Timeline (Section 2.2) ● Helped in summarizing the info in Table 1	Completed	N/A
Kennedy Simmons	Recorder Gantt Chart (Section 2.3) ● Created Gantt Chart for Spring 2021	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
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REPORT ON GROUP DYNAMICS

Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: Sept. 21 2020. Meeting Time: 7:00-8:00 PM Meeting Location: Zoom

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss Project scope. Revise report. Identifying problem areas from graded reports.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Mohammed, Shikihar and Sultan discussed what were going to be the three main sections of the report. Everyone agreed on making the condenser, reactor and electrostatic precipitator the main section.

Kennedy asked for clarification on what exactly the electrostatic precipitator. Sultan informed her that it helps with air pollution and removes particles from waste gases.

Everyone discusses that we are going to work on section 3.1 on report 5. We all agreed to regroup the following day and exchange ideas.

Sultan reminded us that the literature review can general

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to team members at this meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 2) Engineering Economic Analysis 7) Processes that are involved/testing	In progress	N/A
Clarence Reed	Proofreader Technical writer 3.1) Thermodynamic properties 6) Electrostatic precipitator	In progress	N/A
Sultan Khalid	Manufacturing and Testing Leader 1) Fundamentals of the Fluidized Bed Systems 2) Engineering Economic Analysis	In progress	N/A
Dacory Harris	Organizer Presentation Manager 2) Engineering Economic Analysis 3) All major concencible gases when paralyzing biomass	In progress	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 5) heat exchange design 8) thermochemical conversion of Biomass	In progress	N/A
Kennedy Simmons	Recorder 4) Function of biomass reactor 9) Codes/standards	In progress	N/A

Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: Sept. 22, 2020. Meeting Time: 8:00-9:40 PM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss report 4 and 5. Revise report. Identifying problem areas and assign new tasks.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Creating sub tabs for major heading for 3.1
Bio mass reactor

Everyone discussed the heat exchanger design guide and Need to understand major components
Should we make a sub for 1. Processes in. Testing and 2. Different vital concepts
Changing the name to “heat exchanger guide and design “

Divide the sub titles among everyone

Kennedy and Dacory discussed finishing Gantt chart and tables.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to team members at this meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 3.2 Potential Sources of Information for Project	In progress	N/A

Clarence Reed	Proofreader Technical writer 5. Identifying major componets	In progress	N/A
Sultan Khalid	Manufacturing and Testing Leader 1. Introduction Paragraph	In Progress	N/A
Dacory Harris	Organizer Presentation Manager 3.1 Identification of Information Relevant to the Project	In progress	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 6. References	In progress	N/A
Kennedy Simmons	Recorder 4. Table of contents	In progress	N/A

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SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

Group #5

MINUTES OF GROUP MEETINGS

Meeting Date: ___09/17/2020____ Meeting Time: 11 PM - 2 PM_ Meeting Location: Online- Zoom_

Members Present: ___Chaniquah, Mohammed, Amir, Hannah, Brandon, Jordan, Chibuzo __

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Continue to work on Status Report 4
- Discuss the score of previous meeting minutes, for corrections
- Begin to speak about Status Report 5
- Discuss what to speak about/question we may have for sponsors.

Detailed Minutes: (should include the name of the speaker and summary of what he/she suggested)

Chaniquah - She discussed the Gantt chart and upcoming sponsor meetings. She reminded the group about last-minute meeting minutes happenings. Chaniquah brought up some research prep. Chaniquah talks about bringing up report checks and the current open problem statement given to the Ball Aerospace Team.

Amir - He discussed the Gantt chart and the upcoming sponsor meeting. With the sponsor meeting upcoming, he stated possible questions such as support, materials, orientation, and other things about the inner workings. He explained the status report 4 inputs. He brought up research prep for status report 5. Amir discusses statements we will make about our current status to the Ball Aerospace team. Amir goes into detail about what subsections we should focus on based upon our leadership roles.

Hannah - She discussed confirmations we received about current reports. She asked questions about the specifics needed to finish status report 4. She continued to work on status report 4 while adding ideas for status report 5. Hannah discussed previous know-about and questions from previous assignments and statements given by our professors.

Chibuzo - He asked about specific deliverables needed for the project and status report 4. Chibuzo confirmed Amirs' question from status report 4. He confirmed questions about statements made by Dr.Biney. He discussed how to send our reports in for checks. He continued to work on his specific tasks for status reports 4 & 5.

Brandon - He discussed how to send in our reports for pre-checks. He continued working on his specific sections for status report 4. Brandon discussed our Gantt chart and the upcoming sponsor meeting. Brandon asked about current timelines for the project.

Jordan - He discussed different programs that we could use to create a Gantt chart. He also brought up some research preparation ideas and continued to add more resources he found to our collective file. He brought up possible questions about the project to ask the Ball Aerospace team in our upcoming meeting. Jordan answered questions Chaniquah had about status report 4. He also confirmed statements previously made by Dr.Biney. Jordan added to the discussion about sending our reports in for pre-checks. He continued to finish his specific sections for status report 4.

Mohammed - He discussed the different confirmations we received from our current status report. He continued to work on his specific sections for status report 4. He asked a few questions about our recent status report. He helped make several decisions regarding how we should move forward with our project.

A brief statement on individual participation and or problems encountered with specific group members and how the group resolved problem(s)

Per usual, there were no issues between specific members of the group. We all continued to contribute to completing status report 4. Any specific questions we had were either answered by another member of the group or sent to a professor to get a resolution. All members discussed the upcoming meeting with Ball Aerospace team, with Amir being the leader and speaking to them about our current status on the project. Our overall goal for this meeting today was to continue finishing status report 4 and setting up a discussion to ask more about project direction from the Ball Aerospace team.

Meeting Date: ___09/22/2020____ Meeting Time: 12 PM - 2 PM_ Meeting Location: Online- Zoom_

Members Present: ___Chaniquah, Mohammed, Amir, Hannah, Brandon, Jordan, Chibuzo __

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Continue to work on Status Report 4
- Discuss score of status report 3
- Continue discussions about Status Report 5

Detailed Minutes: (should include the name of the speaker and summary of what he/she suggested)

Chaniquah - Asked questions regarding status report 4 and finished her specific sections. She gave comments regarding grade from status report 3. She discussed some previous statements issued by professors and Ball Aerospace team.

Amir - He discussed statements given by professors and the Ball Aerospace team. He answered questions about the organization of status report 4. He helped guide other group members on specifics regarding status report 4. He discussed the score given for status report 3 and sent unanswered questions about the grade to Dr.Biney. Amir continued to work on figuring the Gantt chart.

Hannah - She continued to work on and finish her specific sections for status report 4. She made statements regarding status report 3. She discussed a few findings for status report 5.

Chibuzo - He asked a few questions about status report 4 and continued to finish the specific subsections given to him. He shared the grade and comments for status report 3 and opened up with some thoughts on how to correct things going forward.

Brandon - He continued to finish status report 4 and began proofreading a few of the sections. He made a few comments regarding status report 3 & 5. He discussed a few previous questions answered by Dr.Biney. Brandon discussed a resource he found about a new technology specific to our problem statement.

Jordan - He helped in working with the Gantt chart for status report 4. He and Amir also discussed other proceedings regarding the Gantt chart and discussions from Dr.Biney. He continued to work on and finished his specific sections. Jordan discussed more resources that he found for the literature review and to help with project completion.

Mohammed - He asked a few questions about his specific questions and continued to finish his assigned tasks. He offered support in regard to other current and upcoming status reports.

A brief statement on individual participation and or problems encountered with specific group members and how the group resolved problem(s)

There were no problems encountered in our group. Our only issues came from our misunderstandings from previous assignments and how to go about the Gantt chart - but everything was handled in house and resolved between each other. The main goal for this meeting was to get status report 4 completed and ready for submission. All individuals in the group worked on their specific tasks in sections 2.1 & 2.2. All individuals asked questions regarding the project, if necessary.

Meeting Date: ___09/23/2020____ Meeting Time: 11 PM - 12 PM_ Meeting Location: Online- Zoom_

Members Present: ___Chaniquah, Mohammed, Amir, Hannah, Brandon, Jordan, Chibuzo __

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss status report 5 in-depth
- Update timelines for upcoming assignments
- Discuss upcoming group meeting

Detailed Minutes: (should include the name of the speaker and summary of what he/she suggested)

Chaniquah - She updated her assignment timeline. She made a few statements regarding a few assignments. She began research for the literature review.

Amir - He began the meeting with a general mission for status report 5. He discussed some tasks for the group to complete by the upcoming meeting. Amir suggested some topics for research. He updated his assignment timeline.

Hannah - She updated her assignment timeline. She asked a few questions regarding the upcoming assignment and meeting. She continued her research for the literature review.

Chibuzo - He asked a few questions regarding status report 4 & 5. He began his research for the literature review. He updated his assignment timeline.

Brandon - He continued his research for status report 5. He updated his assignment timeline. He suggested a few topics for us to start with for the literature review. He asked a few questions about specifics and our upcoming meeting.

Jordan - He discussed a few topics regarding research towards our problem statement. He reminded group members to add all research to the shared folder. Jordan updated his assignment timeline and discussed the upcoming meetings.

Mohammed - He began his research for the literature review. He asked a few questions regarding specifics for status report 5. He updated his assignment timeline.

A Brief statement on individual participation and or problems encountered with specific group members and how the group resolved problem(s)

This meeting was meant to begin serious discussions about our status report 5. All participation was centered around the upcoming meeting tomorrow and what type of information we needed to start gathering. No problems were encountered with such a quick meeting; we all were preparing for our next

mission. There were not too many questions on what needed to happen; next, all focus was on status report 5.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document the task assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	-Sections 2.1 & 2.2 -Research on Radiators	-Took meeting minutes and Ball Aerospace notes	
Amir	-Sections 2.1 & 2.2 -Research on Radiators - Gantt Chart & proofreading	-Found Gantt program	
Chibuzo	-Sections 2.1 & 2.2 -Research on Radiators		
Jordan	-Sections 2.1 & 2.2 -Research on Radiators -Gantt chart	-Found Gantt program	
Hannah	-Sections 2.1 & 2.2 -Research on Radiators		
Mohammed	-Sections 2.1 & 2.2 -Research on Radiators		
Brandon	-Sections 2.1 & 2.2 -Research on Radiators - Proofreading		

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Date: 09.18.2020 **Time:** 10am - 11am **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent: Steffen Eriksen
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize Status Report 3
- Complete Status Report 4

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting Donnie did a progression check of each member to discuss where they are as far as the completion of their portion of the project. Donnie created break out rooms for each member to complete their respective assigned parts.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Complete 1.3-1.3.1 for Status Report 3 Complete Section 2.1 for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	
Joshua Cooper	Complete 1-1.1 for Status Report 3 Complete Gantt Chart for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	
Mustafa Jaffara	Complete 1.2 for Status Report 3 Complete Section 2.1 for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	
Malik Williams	Complete 1.4 for Status Report 1.3 Complete Gantt Chart for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	
Darryl Geyen	Complete 1.3.2 Status Report 3 Complete Section 2.2 for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	

Omar Attia	Complete 1.3-1.3.1 for Status Report 3 Complete Section 2.2 for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	
Steffen Eriksen	Complete 1-1.1 for Status Report 3 Complete Section for Status Report 4	Extension was provided by the senior design professors due to lack of project knowledge.	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Date: 09.21.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Dr. Shafiee
Members Absent: Steffen Eriksen
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize Status Report 4
- Complete Status Report 5

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting Donnie did a progression check of each member to discuss where they are as far as the completion of their portion of the project. Donnie created break out rooms for each member to complete their respective assigned parts. During the meeting Dr. Shafiee explained his expectations for the group and how it aligns with our course deliverables. As we complete work he wants the group to complete extensive research and update him on what we have learned.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Complete research for Status Report 5	Completed Status Report 4	
Joshua Cooper	Complete research for Status Report 5	Completed Status Report 4	
Mustafa Jaffara	Complete research for Status Report 5	Completed Status Report 4	
Malik Williams	Complete research for Status Report 5	Completed Status Report 4	
Darryl Geyen	Complete research for Status Report 5	Completed Status Report 4	

Omar Attia	Complete research for Status Report 5	Completed Status Report 4	
Steffen Eriksen	Complete research for Status Report 5		

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Date: 09.15.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent: Steffen Eriksen
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss progress on Status Report 5
- Complete Status Report 4

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting Donnie did a progression check of each member to discuss where they are as far as the completion of their portion of the project. Donnie created break out rooms for each member to complete their respective assigned parts.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Complete research for Status Report 5	Completed Status Report 4	
Joshua Cooper	Complete research for Status Report 5	Completed Status Report 4	
Mustafa Jaffara	Complete research for Status Report 5	Completed Status Report 4	
Malik Williams	Complete research for Status Report 5	Completed Status Report 4	
Darryl Geyen	Complete research for Status Report 5	Completed Status Report 4	

Omar Attia	Complete research for Status Report 5	Completed Status Report 4	
Steffen Eriksen	Complete research for Status Report 5		

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 4
9/24/20-9/30/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

Group #5

MINUTES OF GROUP MEETINGS

Meeting Date: _9/25/2020_ Meeting Time: __12-2:30__ Meeting Location: __Online-Zoom___

Members Present: ___Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor__

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Review presentation for status report 6
- Continue research for status report 5
- Discuss structure and restate status report 5

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - She made a few comments about presentation 6; and along with others suggested that we all review the information once more. She asked a few questions about how to go about her specific tasks, and the formatting of the report. She made suggestions on research that was needed for status report 5. Chaniquah had questions regarding previous meeting minute comments made by the professor.

Amir - He defined and restructured the outline for status report 5. He explained further and answered questions other group members had on things they were unsure about. Amir suggested we pick our own research topics and find at least two sources to include in the literature review. He made a note to email a professor about comments made regarding meeting minutes.

Hannah - She continued her research about topics relevant to our project. She asked questions on how to go about inputting the information into the status report. She made a few comments regarding her thoughts on the new status report, and the presentation we received over it.

Chibuzo - He asked questions regarding the needs for status report 5; and questions about his respective section that he chose. He continued his research for our project, including information that was relevant not only to his specific section. He made comments regarding past status reports and our upcoming ones.

Brandon - He made statements regarding information he found relevant to our project. Brandon brought up possible topics that we could include in our literature review. Brandon made sure he understood his

specific requirements regarding our current status report. He made additional statements regarding his views on our upcoming status report. He chose a specific topic to research for status report 5.

Jordan - He discussed relevant information he found regarding our project statement. Jordan made some suggestions regarding topics we should input for our literature review. He chose a specific topic and asked questions regarding how to go about answering the implied questions.

Mohammed - He continued his research for our current status report. Mohammed asked questions regarding how to go about answering and filling out his specific questions. He chose a specific topic to research for status report 5. He double-checked his statements and questions to make sure they aligned with what he thought he needed to do.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

This meeting was our regular start meeting for the week; where we discuss our timeline and continue/start on assignments. All individuals participated in conversations regarding the presentation given for status report 6 and regarding how we would go forward with status report 5. Everyone participates and encourages others to give constant input and work. There have been no issues yet, we are all just focused on getting our assignments done, while at the same time understanding the needs for our project to be successful.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	-Find at least 2 literary resources	-Finish status report 4	N/A
Amir	-Find at least 2 literary resources -Made note to email professors regarding questions	-Finish status report 4	N/A
Chibuzo	-Find at least 2 literary resources	-Finish status report 4	N/A
Jordan	-Find at least 2 literary resources	-Finish status report 4	N/A
Hannah	-Find at least 2 literary resources	-Finish status report 4	N/A
Mohammed	-Find at least 2 literary resources	-Finish status report 4	N/A
Brandon	-Find at least 2 literary resources	-Finish status report 4	N/A

Meeting Date: __9/28/2020 _ Meeting Time: _6:30 PM - 8 PM__ Meeting Location: _Online - Zoom___

Members Present: __ Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discussion of different findings and resources
- Continuation of organizing and proofreading of status report 5
- Discuss feedback necessary from advisor

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - She discussed the resources relevant to her topics and other resources that could be of use to the project. Chaniquah began inputting the information she found into status report 5. She asked questions about the restructuring of the report. She asked for status updates regarding questions submitted to our professors.

Amir - He brought to our attention and discussed how he restructured the status report. He discussed some findings that would help us best answer what the report is looking for. Amir discussed a few resources that he found to be of help to us all. He stated that we were still waiting on feedback and responses from our professors.

Hannah - She began inputting more information into her specified sections. She asked a few questions regarding the new structure of the literature review. Hannah discussed her findings and gave her opinion of discovered needs for our design.

Chibuzo - He asked questions about the restatement and structuring of our literature review. Chibuzo asked clarifying questions to make sure his research aligned with his specific task. He confirmed his availability for our next upcoming meetings.

Brandon - He discussed some questions he had regarding the needs for our problem statement. Brandon brought up some research that he came upon, relevant to the project. He was involved in discussions regarding our understanding of the problem statement, and conflicts that came along with it.

Jordan - He brought up some design aspects and questions for us to consider. Jordan discussed findings from his research and began inputting his findings into status report 5. He made other statements regarding the project, and the needs Ball Aerospace are asking.

Mohammed - He discussed some research he felt would be great for our project. He asked clarifying questions to double-check his specific resources. Mohammed gave input on the group discussion regarding questions about our problem statement.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

This meeting was mainly regarding the group coming together to discuss our findings and providing that information on our status report 5. Everyone in the group discussed the resources that they found, and the use it might have for our project. The deep discussions we had about our resources; we were also focused on feedback from our advisor we felt was necessary to increase the success of our status report(s). We did not encounter any problems with each other, but more so how to go about changing our reports to increase their quality and acceptability. With this being the first project of this extent for some of us, it has been difficult to understand what needs to be done. In the coming weeks we expect to send drafts of all work to our advisor to make sure all problems we make be having are resolved in an adequate and timely matter.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A
Amir	-Begin inputting information into respective sections	-Find at least 2 literary resources -Restructure Status report 5	N/A
Chibuzo	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A
Jordan	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A
Hannah	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A
Mohammed	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A
Brandon	-Begin inputting information into respective sections	-Find at least 2 literary resources	N/A

Meeting Date: __9/30/2020____ Meeting Time: __12 PM - 2:30 PM___ Meeting Location: _Online - Zoom__

Members Present: __Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor____

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finish proofreading status report 5
- Continue discussions regarding status report 6
- Start discussions regarding midterm paper and presentation
- Create possible questions for upcoming sponsor meeting

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - In this meeting she proofread her writings to make sure they aligned with other group members. She asked questions regarding the timeline for midterm presentations and the midterm paper. She finished up her specific sections.

Amir - He made sure to set up his writings as an example for the rest of the group. Amir brought up our upcoming sponsor meeting and suggested that we all have at least one question we have regarding our research or problem statement. He outlined our timeline for today and tomorrow's meeting. He suggested we wait on our previous reports in order to begin prep for our midterm activities. He helped proofread status report 5. He stated that we had an updated problem statement from our Ball Aerospace team.

Hannah - She finished up her specific sections and made sure to proofread her writings. Hannah asked for confirmation regarding meeting times with our sponsors. She asked a few questions regarding the upcoming week’s timeline regarding assignment due dates.

Chibuzo - He asked questions regarding the upcoming sponsor meeting. He asked questions to validate his portion of the literature review; and finished his writings for his specific subsections. Chibuzo discussed upcoming timelines along with other members to get a view of the upcoming week.

Brandon - He spoke of the research he was adding to his subsections for status report 5. He made comments regarding our upcoming timelines and tomorrow’s meeting with our sponsor. He discussed with other group members his thoughts on the midterm paper and presentation coming due in the next week. He helped proofread status report 5.

Jordan - He helped proofread his own writings, and the rest of the writings in status report 5. He engaged in conversation regarding our upcoming midterm paper and presentation. He discussed his concerns for our upcoming assignment timeline. He finished his subsections for report 5, and asked questions regarding previous reports. He helped suggest some questions for the upcoming Ball Aerospace meeting.

Mohammed - He finished his writings for status report 5 and proofread his subsections to make sure they were adequate and structured similarly to the rest of our paper. He asked questions regarding our upcoming timelines, and any other concerns with things such as meetings and problem statements.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

This meeting was originally meant to be a closing for status report 5, but with new regards given by our professors we had to extend the meeting to include other necessary materials. Our group members discussed our upcoming sponsor meeting, regarding preparing questions and other conversations we had for the. All members continued to participate in the finishing of status report 5. We all began discussing our upcoming presentation, which is where we encountered a few problems. These problems stemmed from our need for feedback from previous reports, so that we may adequately prepare for our presentation and format a successful report. This problem should be resolved when we get the comments from our previous status reports; other than that, no conflict between group members have arisen.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3 -Finish Meeting Minutes	-Semi finish sections 3.2 & 3.3	N/A
Amir	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3 -Proofread status report 5	-Semi finish sections 3.2 & 3.3	N/A
Chibuzo	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3	-Semi finish sections 3.2 & 3.3	N/A
Jordan	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3	-Semi finish sections 3.2 & 3.3	N/A
Hannah	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3	-Semi finish sections 3.2 & 3.3	N/A
Mohammed	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3	-Semi finish sections 3.2 & 3.3	N/A
Brandon	-Create questions for Ball Aerospace -Finish section 3.2 & 3.3 -Proofread status report 5	-Semi finish sections 3.2 & 3.3	N/A

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/24/2020___ Meeting Time:__4:00-5:00_____

Meeting Location: Zoom:
https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: _Kapiduach Echarry, Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa, Bryce Boyd_

Agenda for Meeting (Items to be discussed or discussed at the meeting)

At this meeting we discussed how we fill would go about completing status report 5A, and how we would start with status report 6.
We reviewed what would be expected of each member regarding status report 5A including individual responsibilities and due dates set in previous meetings. Specifically, today was supposed to be focused on covering last minute individual questions regarding completion of status report 5A and an introduction to how we would be completing status report 6.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Suggested how to spend our next few meeting times so that we get everything done before the given deadlines. Asked for update on how things were going on the individual side of completing status report 5A. Asked again if there were any questions regarding individual responsibility for status report 5.

Kapiduach: Asked for specific plans regarding the meeting with Ball that would be taking place on Friday.

Alex: Went over the time and things to be discussed with Ball for the next meeting, asked if group had any more questions that they wanted to ask Neil while group would meet with him on Friday.

Reminded the team that everyone's work was expected to be done by 9pm that night so he could work on revising, editing, and formatting.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Group did a good job of discussing problems we ran into and asking for help in individual sections they were working on. Most problems were resolved by peer review of each other's work. So far, each group member did what task was assigned to him.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action
Kendall Lemons	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action
Kapiduach Echarry	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action
Jeremy Hunter	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action
David Otinwa	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action
Alex DeShields	Compile, format, and sent in status report 5A. Finish meeting minutes.	Compiled the minutes for the entire week and send them in.	No Action
Bryce Boyd	Finish on researching information for status report 5A by 9pm.	Progressed on their section in status report 5A.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 09/25/2020 Meeting Time: 3:00-8:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa, Bryce Boyd

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Speak with Ball Aerospace. The first item for the meeting after finished meeting with Ball was discussing why things were not turned in on time. Over the previous few meeting expectations and deadline were made clear and they were not met. From then we needed to figure out a way that we would make up for the lost time and get done what needed to be done.
We also wanted to get starting on reviewing what status report 6 was going to be about and what was expected out of each individual when we were working on that. Lastly, we wanted to get started on status report 6.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Asked team why things were not submitted when the deadlines were given, and why some things that were submitted did not meet the expectations he asked for.

Bryce: Figured out and explained it was partially because there were two different documents and the information asked for was spread out between each. Even then there wasn't everything being asked for.

David and Asher: Stated that on his end he wasn't able to finish because he needed more time and wasn't completely sure what was expected from him.

Alex: Asked everyone if they remember when he asked if they understood what was expected and when he asked if there were any questions and asked if anyone for any reason couldn't have the work done by 9pm on Thursday.

Group: Stated that they did remember and those who didn't finish apologized

Alex: Started making plans to work status report 6 and finished 1st step in functional decomposition.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Ran into problems when some group members (Asher, David) did not turn in the work that was asked from them and said it wasn't clear. Was resolved by explaining those excuses were

unacceptable when I (Alex) made a point to ask if there were any questions or need for extension. No further action was taken.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Progressed on their section in status report 5A.	Public call out and expectation that it won't happen again.
Kendall Lemons	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Finished on their section in status report 5A.	No Action
Kapiduach Echarry	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Finished on their section in status report 5A.	No Action
Jeremy Hunter	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Finished on their section in status report 5A.	No Action
David Otinwa	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Progressed on their section in status report 5A. Made a cover sheet for status report 5A.	Public call out and expectation that it won't happen again.
Alex DeShields	Start on compiling subtask to deconstruct the main task as well as flow arrows. Meeting minutes. Format and edit status report 5A to send into Prof. Duan for revision.	Compiled the minutes for the entire week and send them in.	No Action

Bryce Boyd	Start on compiling subtask to deconstruct the main task as well as flow arrows.	Finished on their section in status report 5A.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 09/29/2020 Meeting Time: 7:00-8:00

Meeting Location: Zoom https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Jeremy Hunter, Kendall Lemons, Asher Carson, Alex DeShields, David Otinwa, Bryce Boyd Kapiduach Echarry

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Emergency meeting to discuss what is going on with status report 5A. Upon reviewing status report 5A there was serious flaws we wanted to fix before we sent it in to professor Duan to have it revised. Group was completely missing in report source referencing and references to figures in the report. The report had many, “we” and “our” statements and opening paragraphs were missing in each section. We wished to discuss all of this and how it could be revised quickly so we could still send it to professor Duan. We also wanted to get the next section done on status report 6.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Opened by talking about all the problems he saw on status report 5A (missing introduction paragraphs, many “we” and “our” statements, and missing figure and source references in the body of the report). Asked team if they wanted to spend the rest of the day editing 5A or trying to edit 5A and start on report 6.

Bryce, David, Kapiduach, Jeremy: Agreed that it might be best for us to focus on status report 5A until we have to turn it in. Once we’re done with report 5A, then we can shift our focus to report 6.

Alex: Reviewed the lecture about how material was supposed to be cited in our report, and in our “list of references”. Also review how figures should be represented and referred to at least once in the report. Asked if there were any questions.

Asher: Asked some questions about specifics in referencing sources in the body of the report

Kapi: Asked what I meant when I was referring to an introductory paragraph for each seceion to divide the section and subsection heading.

Alex: Answer the respective questions and then urged group to get to work

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Problems were encountered with whole group not being efficient in completing report 5A. Was resolved by asking what we know we need to do better and establishing concrete goals.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Finish final draft of Status report 5A	Progressed on their section in status report 5A.	No Actoin
Kendall Lemons	Finish designated section of status report 5A.	Revised their section in status report 5A.	No Action
Kapiduach Echarry	Finish designated section of status report 5A.	Revised their section in status report 5A.	No Action
Jeremy Hunter	Finish designated section of status report 5A.	Revised on their section in status report 5A.	No Action
David Otinwa	Finish designated section of status report 5A. Finish the cover sheet and turn in.	Revised their section in status report 5A.	No Actoin
Alex DeShields	Compile format and do a final revision of all of status report 5A before it is sent to Duan.	Reviewed status report 5A. (called an emergency meeting to call out major mistakes)	Called out all areas of failure and established goals to make sure it

			didn’t happen again.
Bryce Boyd	Finish designated section of status report 5A.	Revised on their section in status report 5A.	No Action

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 9

MINUTES OF GROUP MEETINGS

Meeting Date: 9-23-20 Meeting Time: 10:30-11:00AM Meeting Location: Zoom

Members Present: All members present

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is having a quick meeting for report 5

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

10:30-11:00 Gary assigned roles for report 5 and discussed what was necessary

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on status report 5		
Zach M Bryana J Iyanulolwa O Bryana R	Work on assigned sections of status report 5		
Don B	Work on assigned section of status report 5 Ensure meeting minutes are up to date		
Olaniyi O	Work on status report 5		

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 9

MINUTES OF GROUP MEETINGS

Meeting Date: 9-26-20 Meeting Time: 6:00-8:00 Meeting Location: Zoom

Members Present: All members present

Agenda for Meeting (Items to be discussed or discussed at the meeting)

1. Individual Updates
    a. Gary Talor – Status Report 5 Codes and Standards, Status Report 6 Sticky note formulation ideas
    b. Zachary Mohmmodu – Status Report 5 idea fabrication & aid
    c. Bryston Roberts – Continue designated section 3, 3.1, 3.2, 3.6
    d. Bryana Jackson – Continue designated section 3.5, 3.6
    e. Olaniyi (Ne-Yo) Oladipo – Check Updates
    f. Iyanuloluwa Olalumade – Status Report 5 work
    g. Don Bradford – Status Report 5 work

2. What is due next?
    a. Status Report 5 is due Thursday 10/1/2020
    b. Status Report 6 is due Thursday 10/8/2020

3. Closing and Next Actions
    a. Gary Talor –Status report 5 aid codes and Standards, ensure report is organized to be sent to Biney,
    b. Zachary Mohmmodu – Report 6 Sticky note formulation ideas
    c. Bryston Roberts – Continue designated section 3, 3.1, 3.2, 3.6, Report 6 Sticky note formulation ideas
    d. Bryana Jackson – Continue designated section 3.5, 3.6, Report 6 Sticky note formulation ideas
    e. Olaniyi (Ne-Yo) Oladipo – Report 6 Sticky note formulation ideas
    f. Iyanuloluwa Olalumade – Continue designated section 3.5, 3.6, & Report 6
    g. Don Bradford – ensure all meeting minutes are up to date, Continue designated work (graphics), section 3.6, Status Report 6 graphics organization

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

6:00-6:15 (Gary) update on status report 5 and prep for DocuSign
6:15-8:00 All members stayed on the zoom call to work on the report

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on status report 5 Start sticky notes for report 6		
Zach M Bryana J Iyanulolwa O	Work on assigned sections of status report 6		
Don B	Work on assigned section of status report 56 Ensure meeting minutes are up to date		
Olaniyi O	Work on status report 6	Status report 5 proofread	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 9

MINUTES OF GROUP MEETINGS

Meeting Date: 9-30-20 Meeting Time: 10:20AM-12:00PM Meeting Location: Zoom

Members Present: All members present

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discussing the changes that need to be made to progress report 5 and getting consensus on the sticky notes for progress report 6.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

10:20-11:00 (Gary) update on the changes that Dr. Biney expects in progress report 5
11:00-11:30 (Gary) discussion of the overall function of the heat exchanger apparatus for progress report 6
11:30-12:00 Group discussion about the overall function

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Progress report 5 was not completed to the expected standard and many sections of the report need to be reworked.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on status report 6		
Zach M Bryana J Iyanulolwa O	Fix assigned sections of report 5		
Don B	Fix the images portion of report 5		
Olaniyi O	Work on status report 5		
Bryston R	Fix assigned part of report 5 create 3-4 sticky notes for report 6		

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 5
10/1/20-10/7/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 10/03/2020Meeting Time:9:00PM–12:30AMMeeting Location: https://zoom.us/j/91354072968#success

Members Present:XimenaCifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J, Daniel Akpan, David Trevino
Excused Members:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Start the midterm report by revising the graded reports
- Discuss Functional Decomposition

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximena introduced the meeting which is revising and editing all the graded reports that has been submitted to Dr.Peng. First, Ximena combined all the reports into one documents and shared it on the group 7 google drive, so all the members would have access to it. Also, Ximena wanted to make sure that Dr.Peng's notes are showing on the documents, so the other team members would have a firm understanding on what needs to be edited for the midterm report. Lastly, Ximena started working on revising the midterm report.

- Demetrious Sandford: After the group leader introduced the agenda of the meeting, Demetrious started on revising status report 1: Project Scope for the midterm report. Also, Demetrious started on creating the meeting schedule for everyone.

- Amna Ansari: During the following meeting Amna was working with Demetrious on editing project assignment on Project Scope. Together, they were able to fix all the noted comments that Dr.peng left for the group to fix. Also, Amna was in charge of recording the meeting minute.

- Caleb Riggins: Caleb was working with David Trevino on revising and editing Assignment on Project Planning. Caleb was making sure that everything was edited correctly while checking and proofreading every part of the report. Caleb also was in charge of writing the conclusion and recommendation of the midterm report. While working on his assigned part, Caleb was also proofreading the other group member's work.

- Amna J: Amna J started working with Daniel Akpan to finish revising and editing Assignment on task identification. After finishing the editing and revising on assignment 5, Amna made sure that all the corrections had been made and all the note and comments that Dr.Peng left had been fixed.

- David Trevino: David was pair with Caleb to work on editing Project Planning, David ensured that the whole section on Project Planing is revised correctly.

- Daniel Akpan: Daniel started working with Amna J., on revising project assignment on project planning and Task Identfication. Daniel, made sure to double check with Amna and ensured that all the comments that had been left by Dr.Peng are fixed correctly.

Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create a meeting agenda for the meeting, Create the midterm report and post it on the Google drive, start on revising the previous graded reports.	- A meeting agenda - A Midterm report and shared it on the group 7 Google drive - Edited copy of previous reports - Together work on finalizing the midterm report	
Daniel Akpan	Revise and edit project assignment 5on Task Identification, Work with Amna J to edit the assignment	- An edited project assignment 5, Task Identification - Worked with Amna J - Worked on finalizing the midterm report as a team	
Demetrious Sandford	Revise and edit project report on Project Scope, Work with Amna Ansari. Create a schedule for the next meeting	- An edited Project assignment on Literature Review - Worked with Amna A - A schedule for the next meeting - A finalized midterm report	
Amna Ansari	Edit and review project report on Project Scope, Work with Demetrious, create meeting minute for the meeting	- Edited and reviewed project report on Project Scope - Worked with Demetrious - Meeting minutes A finalized midterm report	
David Trevino	Review and revise project report on Project Planning, Work with Caleb to edit the assignment	- Edited copy of Project assignment over Project Planning - Work with Caleb - A Finalized midterm report	
Caleb Riggins	Revised and edited project assignment on Project Planning, worked with David T., proofread the midterm report	- Revision and editing of project assignment over Project Planning - Worked with David T. - A finalized midterm report - Proofread midterm report	
Amna J	Work with Daniel Akpan on revising and editing project assignment over Task Identification	- Edited copy of project assignment over Task Identification - Worked with Daniel Akpan - Finalized midterm report	

REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 10/04/2020Meeting Time:8:30AM-12:30PMand 8:00PM-12:00AMMeeting Location:https://zoom.us/j/91354072968#success

Members Present: XimenaCifuentes, Demetrious Sandford, Amna Ansari, David Trevino, Amna J, Caleb Riggins, Daniel Akpan
Excused Members:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize Midterm report
- Fix the format of the report, add a letter of transmittal and acknowledgment page
- Finalize the table of content
- Start on functional decomposition
- Go over all the electronic sticky notes with the rest of the group members

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximena started with introducing the agenda for both meeting and confirmed that the group have to finish the functional decomposition of the project so the group can start working on the report. Then Ximena started working on fixing the format of the midterm report and adding final revising to it. Ximena then created the electronic sticky notes where the group members can insert their functionalities. Then, she started on working on coming up with three functionalities for our project, Automated Oil Skimmer. After the whole group individually came up with their functionalities then they started on decomposing these functionalities.
- Demetrious Sandford: Demetrious was working on fixing the table of content of the midterm report, ensuring that all the page numbers are correctly insured on the table. Then he started on coming up with his three functionalities and sub-functions for the functional decomposition assignment. Also, Demetrious was in charge of creating the schedule for the next meeting.
- Amna Ansari: Amna was working with Ximena on fixing the midterm report format. After fixing the format of the report, Amna started on coming up with her three functionalities and inserting them on the electronic sticky note. Then, with the rest of the team, Amna worked on generating sub-functions for the assignment. Also, Amna was in charge of creating the meeting minute.
- David Trevino: David was working on citing the figures and tables correctly on the midterm report while ensuring to follow the citation information giving by the professors. Then, David started working on generating his three functionalities and sub-functions.
- Amna J: Amna J was collaborating with Ximena and Amna A on fixing and finalizing the midterm report format, while enuring that all of the professors comments are revised. Then Amna started on creating and generating her functionalities.
- Caleb Riggins: Caleb started on working on the letter of transmittal and the acknowledgment paper. Then, Caleb worked on finalizing the conclusion for the midterm report. Caleb then started on generating his functionalities and sub-function for the assignment.
- Daniel Akpan: Daniel started working on generating his three functionalities for the assignment. Then, worked on the other sub-functions of the assignment.

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Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

The following meeting was very successful, every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create a meeting agenda, fix midterm report format, finalize midterm report, create electronic sticky note, create functionalities for the overall project, create sub-functions for the overall project	- A meeting agenda - A finalized midterm, report - Electronic sticky notes - Functionalities for the overall function - Sub-functions for the overall function	
Daniel Akpan	Create functionalities for the overall project, create sub-functions for the overall project	- Functionalities for the overall project - Sub-functions for the overall project	
Demetrious Sandford	Finalize the table of content for the midterm report, generate functionalities for the overall project, create sub-functions for the overall project, schedule next meeting	- Finalized table of content for the midterm report - Functionalities for the overall project - Sub-functions for the project - A meeting schedule	
Amna Ansari	Fix and finalized the midterm report format, create functionalities for the overall project, create sub-functions for the project, create meeting minute.	- A finalized midterm report format - Functionalities for overall project - Sub-functions for the project - Meeting minutes	
David Trevino	Cite figures on midterm report, create functionalities for the overall project, create sub-functions for the project	- Cited figures on the midterm report - Sub-functions for the project - Meeting minutes	
Caleb Riggins	Create letter of transmittal, create acknowledgment page, write conclusion, create functionalities for the overall project, create sub-functions for the project	- Letter of transmittal - An acknowledgment letter - Final midterm conclusion - Sub-functions for the project - Meeting minutes	
Amna J	Fix and finalized the midterm report format, create functionalities for the overall project, create sub-functions for the project	- Finalized midterm report format - Functionalities for overall project - Sub-functions for the project	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date:10/06/2020 Meeting Time:7:00PM-11:30PM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: XimenaCifuentes, Demetrious Sandford, Amna Ansari, Amna J, Caleb Riggins, Daniel Akpan, David Trevino
Excused Members:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Write the functional decomposition report
- Start the midterm slides presentation
- Add functional decomposition to the midterm report
- Revise and edit Literature Review

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximena started with introducing the meeting agenda to the rest of the group member. Then Ximena started to explain what the group members need to present for the midterm presentation on Thursday, October 8th. After creating the slides and splitting the work between the rest of the group, Ximena started on adding all the sticky notes that the group created for the assignment on the report and midterm report.

- Demetrious Sandford: After Dr.Peng graded and added comments to assignment5, Literature review, Demetrious started on revising and editing his assigned part on the report. Then Demetrious fixed and ensued that his resources were cited correctly. Then he started working on the functional decomposition report. Also, Demetrious discussed with the other group members on how to split the work for the midterm report. Demetrious was also in charge of creating the next meeting schedule.

- David Trevino: David started revising his part for the literature review while ensuring that all of his resources are cited correctly. Then he added his revised part to the midterm report. After editing assignment5, David started on the functional decomposition report.

- Amna Ansari: Amna started on revising her part on the literature review while ensuring to correct all the comments that were left by Dr.Peng. Then she added her part to the midterm report and fixed her citation. Then with the other group members, Amna started working on the functional decomposition report.

- Caleb Riggins: Caleb revised his part for the literature review and added it to the midterm report. Then with the rest of the group members Caleb started working on the functional decomposition report. Also, Caleb discussed how the group members going to present on Thursday, the 8th.

- Amn J: Amna started revising her part and then adding it to the midterm report. Then she started to work on the functional decomposition and the midterm slides.

- Daniel Akpan:Daniel started to revise and edited his assigned part for the literature review, and after he was done with correcting all the comments left by Dr.Peng, Daniel added his part to the midterm report. Then, He started working on the midterm slide.

Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create an agenda for the meeting, create midterm slides, work on revising literature review, write the functional decomposition report	- An agenda for the meeting - Midterm slides - Revision and editing of assigned parts - Completion of functional decomposition report	
Daniel Akpan	Revise assigned part, create assigned slide, work on functional decomposition report	- Revision and editing assigned part - Additions of assigned part to midterm report (rope-mop skimmers) - Completion of Functional decomposition - Assigned midterm slide (operational environment)	
Demetrious Sandford	Revise and edited literature review, fix citation, start working on functional decomposition, create meeting schedule	- Revised and edited literature review - Midterm slide (belt-type skimmers) - Start of functional decomposition - Created meeting schedule	
Amna Ansari	Revise and edit assigned part on literature review, create midterm slide, create meeting minute, work on functional decomposition	- Revision and editing of literature review - Midterm slide (Results and Discussion) - Completion functional decomposition - Meeting minutes	
David Trevino	Revise and edited literature review, fix citation, start working on functional decomposition, create meeting schedule	- Revision and editing of literature review - Midterm slide (Project planning) - Completion of functional decomposition	
Caleb Riggins	Revise and edited literature review, fix citation, start working on functional decomposition, create meeting schedule	- Revision and editing of literature review - Midterm slide (Results, discussion and conclusion) - Completion of functional decomposition	
Amna J	Revise and edited literature review, fix citation, start working on functional decomposition, create meeting schedule	- Revision and editing ofliterature review - Midterm slide(Client identification and non oleophilic skimmers) - Completion of functional decomposition report	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: October 2, 2020 Meeting Time: 11am - 2pm
Meeting Location: https://pvpanther.zoom.us/j/8487601860?pwd=TVdIVFpKZ0JHa1NoRWNpWENuNWRqQ

Members Present:

Christian White, Fanta Kaba, Diana Morales, Abdullah El Aker, Yemboado Yonli, and Marcelo Epam Ona

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The agenda for this meeting was to divide the parts for the 6th report.. We had each member come up with functions and sub functions. We chose the one we had in common to create the sticky notes.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Christian White
- Suggested how to go about creating functions and sub-functions online

Fanta Kaba
- Suggested how to organize the function and sub functions

Diana Morales
- Suggested overall plan to finish assignments.
- Suggested a summary of the combined functions and sub-functions from everyone.

Abdullah El Aker
- Suggested functions and sub-functions for the report content

Yemboado Yonli
- Suggested how the functions should be created
-
- Suggested that the power point be reviewed for better understanding of functions creation

Marcelo Epam Ona
- Suggested the group should work together to get things done faster.
- Suggested emailing the senior design instructors for any clarification.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Christian White
- Created overall functions and subfunctions

Fanta Kaba
- Created 3 functions and sub functions

Diana Morales
- Came up with 3 functions and subfunctions.

Abdullah El Aker
- Suggested 3 sub functions and 3 sub functions of the sub functions

Yemboado Yonli
- Participated into creating overall function
- Found a set of level 1 sub functions and put them on sticky notes

Marcelo Epam Ona
- Collected the different suggestions given by the group members.
- Make sure similar suggestions are selected as functions and identify as level 1,2 and 3 functions.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Fanta Kaba	Created 3 function and subfunctions for report 6	Yes	
Diana Morales	Begin to work on powerpoint and correct previous work done on reports. .	Yes	
Christian White	Created overall functions and sub-functions for the completion of status report 6	Yes	
Marcelo Epam Ona	Collected the group members' suggestions and and selected those as function and subfunctions as the status report required.	Yes	

Yemboado Yonli	Participated into the creation of the overall function. Found a set of level 1 functions based on what needs to be done to achieve the project goals.	Yes	
Abdullah EL Aker	Contributed in the functional decomposition report content.	Yes	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: October 6, 2020 Meeting Time: 12pm - 3pm
Meeting Location: https://pvpanther.zoom.us/j/8487601860?pwd=TVdIVFpKZ0JHa1NoRWNpWENuNWRqQ

Members Present:

Christian White, Fanta Kaba, Diana Morales, Abdullah El Aker, Yemboado Yonli, and Marcelo Epam Ona

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The agenda for this meeting was to divide the work for report 6 as well as the powerpoint. We split the group and had two members work on the powerpoint and had the rest work on the report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Christian White
- Suggested how to go about fixing status report 5 for completion of major midterm report

Fanta Kaba
- Suggested splitting the presentation

Diana Morales
- Suggested we meet before presentation.

Abdullah El Aker
- Suggested to work on connecting the functions
- Suggested to compute the report in the table

Yemboado Yonli
- Suggested how level 0 (overall function) should be found
- Suggested how level 1 functions should be found
- Suggested how level 2 functions should be created
- Suggested how level 3 functions should be created
- Suggested that the group put functions on sticky notes

Marcelo Epam Ona
- Suggested the group take a quick review of what needs to be corrected.
- Suggested the group go to the project's adviser for any clarifications.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Christian White
- Completed sections 1-5 on status report 6

Fanta Kaba
- Completed assigned powerpoint slides

Diana Morales
- Completed assigned powerpoint presentation.

Abdullah El Aker
- Completed connecting the sticky notes into a diagram
- Computed the functions into a summary table

Yemboado Yonli
- Created electronic sticky notes for level 0, 1, 2 and 3 functions
- Helped in the selection of level 0, 1, 2 and 3 functions
- Had my input on the midterm presentation

Marcelo Epam Ona
- Made an introductory paragraph for the functional decomposition.
- Gave a brief description on how the group came up with level 1, and 2.
- Made corrections on the midterm report.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Fanta Kaba	Worked with Diana to create the powerpoint presentation. Assigned each member a role to speak on the powerpoint.	Yes	
Diana Morales	Assist Fanta on slides if needed and proofread the report before submission. Work on the assigned part for the final report and continue to make corrections on past assigned work.	Yes	
Christian White	Worked with Marcelo in completing sections 1 and 2 on status report 6 as well as completed sections 3-5 on status report 6.	Yes	
	Made an introductory paragraph for the functional decomposition as well as a brief description on how the	Yes	

Marcelo Epam Ona	group came up with the functions and subfunctions for level 0,1,2 and 3.		
Yemboado Yonli	Created electronic sticky notes for level 0, 1, 2, 3 functions. Helped in the selection of level 0, 1 , 2 and 3 functions. Had my input on the midterm presentation.	Yes	
Abdullah EL Aker	Gathered the electronic sticky notes for all levels into a diagram. Summarized the content into the table.	Yes	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: Oct. 2 2020 Meeting Time: 9:00-10:00 PM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss the remaining actions needed for report 5, assign new tasks for report, and how to format Gantt Chart.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Sultan and Shikhar discussed task identification and created a list of detailed activities that need to be performed. Discusses the concept generation, concept evaluation parts specification, and preliminary design . Mohammed joined and discussed the budget and project cost.

Shikhar discussed the status of report 4. Everyone discussed meeting times.

Mohammed clarified the activities for the timeline and defined each of the specific deliverables to the responsible group member. Estimated the duration for each task, providing a starting and ending time.

Clarence and Shikhar discussed the necessary amount needed for section 2. Clarence also estimated the time for each task. Explained to each responsible member, the detailed actions needed for each task.

Kennedy and Dacory discussed the fundamentals of the Gantt Chart and Dacoy provided guidelines for the making of the chart.
How to make subtasks and how to put resources on each task.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There was a brief disagreement on how much information is needed for section 2. Identifying if the information being presented was repetitive or not. Later, it was resolved by adding subtitles for section 2.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser Task Identification (Section 2.1) ● Helped in summarizing the info in Table 1.Proofread the whole assignment	Completed	N/A
Clarence Reed	Proofreader Technical writer Timeline (Section 2.2) ● Helped in summarizing the info in Table 1. Proofread the whole assignment	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader Task Identification (Section 2.1) ● Helped in summarizing the info in Table 1.Proofread the whole assignment	Completed	N/A

Dacory Harris	Organizer Presentation Manager Gantt Chart (Section 2.3) ● Created Gantt Chart for Fall 2020	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader Timeline (Section 2.2) ● Helped in summarizing the info in Table 1	Completed	N/A
Kennedy Simmons	Recorder Gantt Chart (Section 2.3) ● Created Gantt Chart for Spring 2021	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 3 2020. __Meeting Time:__ 9:00-10:15 PM__ Meeting Location:__ Zoom

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss Project scope. Revise report. Identifying problem areas from graded reports.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Flow chart
Assign parts from flow charts
Sticky notes for overall function or level 1 : cr
His to improve as a group
Presentation

Mohammed, Shikihar and Sultan discussed what were going to be the three main sections of the report. Everyone agreed on making the condenser, reactor and electrostatic precipitator the main section.

Kennedy asked for clarification on what exactly the electrostatic precipitator. Sultan informed her that it helps with air pollution and removes particles from waste gases.

Everyone discusses that we are going to work on section 3.1 on report 5. We all agreed to regroup the following day and exchange ideas.

Sultan reminded us that the literature review can general

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 2) Engineering Economic Analysis 7) Processes that are involved/testing	In progress	N/A
Clarence Reed	Proofreader Technical writer 3.1) Thermodynamic properties 6) Electrostatic precipitator	In progress	N/A
Sultan Khalid	Manufacturing and Testing Leader 1) Fundamentals of the Fluidized Bed Systems 2) Engineering Economic Analysis	In progress	N/A
Dacory Harris	Organizer Presentation Manager 2) Engineering Economic Analysis	In progress	N/A

	3) All major concencible gases when paralyzing biomass		
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 5) heat exchange design 8) thermochemical conversion of Biomass	In progress	N/A
Kennedy Simmons	Recorder 4) Function of biomass reactor 9) Codes/standards	In progress	N/A

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: __oct. 5 2020.__ Meeting Time:_ 9:00-11:00 PM_ Meeting Location:__ Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Trying to figure out the sub functions. Clarence: level 0 is too specific , it will be hard to break down the following levels .

.We decided to use the function of a heat exchanger initially then go into details of a condenser. Discuss report 5. Revise report. Identifying problem areas and assign new tasks.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested

Sultan and Shikhar talked about creating sub tabs for major heading for 3.1 and the Biomass reactor

Everyone discussed the heat exchanger design guide and Need to understand major components Should we make a sub for 1. Processes in. Testing and 2. Different vital concepts. What are the basic things you need for pros lysis. Fix the corrections that Biney gave us.

ompleted level 0 sticky M

ammed, Clarence and Shikhar talked about changing the name to “heat exchanger guide and design “ D

ide the sub titles among everyone K

nedy and Dacory discussed finishing the Gantt chart and tables.

ef statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

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re were no issues.___

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this table to document task assigned and deliverables completed/submitted by each group member at this meeting

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Potential Sources of Information for Project I

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rence Reed

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Identifying major componets I

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Introduction Paragraph I

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Identification of Information Relevant to the Project I

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SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group 2

MINUTES OF GROUP MEETINGS

Meeting Date: __oct. 4 2020.__ Meeting Time:__9:00-11:00 PM__ Meeting Location:__Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss report 5. Revise report. Identifying problem areas and assign new tasks.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Sultan and Shikhar talked about creating sub tabs for major heading for 3.1 and the Biomass reactor.

Everyone discussed the heat exchanger design guide and Need to understand major components
Should we make a sub for 1. Processes in. Testing and 2. Different vital concepts. What are the basic things you need for pros lysis. Fix the corrections that Biney gave us.
. Completed level 0 sticky

Mohammed, Clarence and Shikhar talked about changing the name to “heat exchanger guide and design “

Divide the sub titles among everyone

Kennedy and Dacory discussed finishing the Gantt chart and tables.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASK ASSIGNMENT & DELIVERABLES

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If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 3.2 Potential Sources of Information for Project	In progress	N/A
Clarence Reed	Proofreader Technical writer 5. Identifying major componets	In progress	N/A
Sultan Khalid	Manufacturing and Testing Leader 1. Introduction Paragraph	In Progress	N/A

Dacory Harris	Organizer Presentation Manager 3.1 Identification of Information Relevant to the Project	In progress	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 6. References	In progress	N/A
Kennedy Simmons	Recorder 4. Table of contents	In progress	N/A

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 6
10/8/20-10/14/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/2/4949___ Meeting Time:__4:-95L:-9_____

Meeting ocZaticn: hccm:ptts u://wu9Lb e. zj ccmzwu/7889388-44?ds b =Rk l JQVT=HZE=uaPHX. T=Hh4Hr H9Jch j92

Mem. eKu XKéuent: _y as i=waZp PZpaKs CQeKém, E wnteKCy en=aJJ o emcnuCAupeKx aKucnCAJeS DevpieJ=uCDaCl= Btinb aC

Agen=a fcKMeeting (Itemu tc . e =iuZwuue= cK=iuZwuue= at tpe meeting)
Tpiu meeting b au inten=e= tc taJl b itp 6 aJJ AeKcus aZe an= l ees tpem ws tc =ate b itp b pat b e paQeCan= tc =iuZwuu tpe fwnZticnaJ =eZcms cuiticn b itp tpemz If b e paQe eStKa time b e s Janne= tc utaK. Kéal ing =cb n tpe utatwu Kés cK W6 an= KéCleb pcb tpe mi=teKn Kés cK an= s Kéuentaticn b entz

DetaiJe= Minwteu: (upcwJ= inZJw=e name cf us eal eKan= uwmmaK, cf b pat pe/upe uwggeute=)
AJeS DevpieJ=u: q ent tpKcwgp fwnZticnaJ =eZcms cuiticn b itp F eiJ Dcwgpt, zx cQeKé= eaZp fwnZticn utaKing b itp tpe JeQeJ j eKc fwnZticn an= . Kéal ing it aJJ tpe b a, =cb n tc tpe JeQeJ tpKée uw. fwnZticnuz Aul e= if tpeKé b eKé an, ma7cKcKmincKfwnZticnu miuuing fKcm tpe fwnZticnaJ =eZcms cuiticn

XKcfeuucKDwan: TcJ= F eiJ tpat itNu cl a, Can= . enefiZiaJ tc giQe ZcnutKwZtiQe fee=. aZl ncb Cuc tpe gKcws iu s Kc=wZtiQe in peJs ing 6 aJJ ZKéate a finaJ s Kc=wZtz

F eiJ: k eus cn=e= . , teJJing tpe gKcws tpat tpe Zcms cuiticn Jccl e= gcc= cQeKaJJz E e uwggeute= tpat b e Kés pKaue ucme JeQeJ tpKée uw. fwnZticnu uwZp au ' k eJeaueu as s en=age in a timeJ, b a, Gtc ' k eJeaue as s en=age awtcncmcwuJ, Gzvwggeute= b e a== tpe uw. fwnZticn ' k euiutu mateKaJ =efcKnaticn in us aZeG. eZawue man, s JautiZu an= uiJiZcneu eKc=e =we tc tpe Ka=iaticn in us aZez

AJeS: Aul e= a. cwt fwtwKé s Janu b itp . w=geting fcKs Kctct, s ing an= tc auuiut b itp =euignCau b eJJ au tpe ucftb aKé wue= fcKx AD an= finite eJement anaJ, uiu

F eiJ: vai= pe b aunNuwKé fcKeitpeKUweuticn an= peN= . e a. Je tc Kéus cn= neSt meeting

6 Kéef utatement cn in=iCl=waJ s aKciZis aticn an= cKs Kc. Jemu enZcwnteKé= b itp us eZifiZ gKcws mem. eKu an= pcb gKcws KéucJQe= s Kc. Jem(u)

1 Kcws =i= a gcc= 7c. cf =iuZwuuing s Kc. Jemu b e Kan intc b itp F eiJ an= aul ing if tpeKé b au an, tping tpat nee=e= ims KcCing tpwu faKz XKc. Jemu an= miuwn=eKutan=ing b eKé KéucJQe= tpKcwgp ZcnQeKuaticnz PaZp gKcws mem. eK=i= a gcc= 7c. Zcmmwni Zating b itp F eiJz

MEETING TASK ASSIGNMENT & DELIVERABLES

“ ue tpiu ta. Je tc =cZwment taul auuigne= an= =eJiCeKa. Jeu Zcms Jete=/uw. mitte= . , eaZp gKcws mem. eKat tpiu meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
AupeKx aKucn	x cms Jeting tpe ta. Je cf ZcntentuCJiut cf figwKéCan= Jiut cf ta. Jeu ueZticn cf tpe mi=teKm Kes cKz	k efcKmat tpeiKtpiK= ueZticn cf . cSeu tc Kéuem. Je b pat iu . eing aul e= fcK	F c AZticn
y en=aJJ o emcnu	k efcKmat tpeiKtpiK= ueZticn cf . cSeu tc Kéuem. Je b pat iu . eing aul e= fcK	k efcKmat tpeiKtpiK= ueZticn cf . cSeu tc Kéuem. Je b pat iu . eing aul e= fcKz Tal e Jea= in =eCeJcs ing tpe sKéuentaticn fcKmi=teKmz	F c AZticn
y as i=waZp PZpaKK,	x cntinwe Jea=ing tpe b cK fcK tpe mi=teKm Kes cKz	Tal e Jea= cf =ius enuing b cK Jca= fcKtpe mi=teKm Kes cKz	F c AZticn
QeKem, E wnteK	x cms Jeting tpe ’ ZcnZJwuicnG ueZticn cf tpe mi=teKm Kes cKz	E eJs y as i=waZp s Jan pcb b e b cwJ= gc a. cwt finiuping tpe finaJ mi=teKm Kes cKz	F c AZticn
DaCi= Btinb a	x cms Jeting tpe ’ Zc=euG ueZticn cf tpe mi=teKm Kes cKz	Mal e ZcCeKupeet fcKtpe utatwu Kes cK ? Az	F c AZticn
AJeS DevpieJ=u	Meeting minwteu an= Zcms Jeting tpe Kcwgp =Kaft cf Kes cK WZ	Meeting minwteu an= Kes cK WKefcKmattingz	F c AZticn
6 K, Ze 6 c, =	Ai=e= y en=aJJ in s Kés aKng tpe s Kéuentaticn uJi=eu fcKtpe mi=teKm s Kéuentaticnz	vtaKe= fcKmwJating i=eau pcb tpe gKcws b cwJ= gc a. cwt tpe s Kéuentaticnz	F c AZticn

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/09/4949___ Meeting Time:__09:99504:99_____

Meeting ocZaticn: hccm:ptts u://wu9Lb e. zj ccmzwu/7889388-44?ds b =Rk l JQVT=HZE=uaPHX. T=Hh4Hr H9Jchj92

Mem. eKu XKeuent: _ AupeKx aKucnCAJeS DevpieJ=uCDaCl= Btinb aC

Agen=a fcKMeeting (Itemu tc . e =iuZwuue= cK=iuZwuue= at tpe meeting)
Tpiu meeting b au a Jaut5minwte emeKgenZ, meeting tc uwZZeuufwJJ, uw. mit mi=teKm Kes cKcWA au b eJJ au tpe mi=teKmz Tpe fcKmatting b au inZcKKeZt b piZp ma=e tpe ta. Je cf Zcntentu CJiut cf figwKeuCan= Jiut cf ta. Jeu inZcKKeZtz Tpiu meeting b au inten=e= tc fiS aJJ cf tpeue s Kc. Jemu . efcKe tpe =ea=Jine at 04:99z

DetaiJe= Minwteu: (upcwJ= inZJw=e name cf us eal eKan= uwmmaK, cf b pat pe/upe uwggeute=)
AJeS DevpieJ=u: q ent tpKcwgp s Kc. Jemu ueen in tpe mi=teKm Kes cKzvai= tpat tpe fcKmatting b au b KcngCb piZp inZJw=e= tpe maKginu an= tpe fcnt an= s cuiticn cf tpe ZpasteKtitJeuz Aul e= DaCl= tc b cK cn tpe maKginu ZpasteKpea=inguCmal ing uwKe tpe, b eKe cn tpe ZcKKeZt an= tpat eaZp ZpasteKpea=ing utaKe= cn a neb sagez Aul e= AupeKtc peJs Kefcmat tpe ta. Je cf Zcntent CJiut cf figwKeuCan= Jiut cf ta. Jeu b itp pimz

AupeKan= DaCl=: AgKee= an= b ent a. cwt tpeiK7c. u Keus eZtiCeJ, z

AupeK. Aul e= if tpe ZpasteK- uw. ueZticnu upcwJ= . e inZJw=e= in tpe Kes cKNu ta. Je cf Zcntentu

AJeS: AffiKme= tpat tpe, upcwJ= . e an= tpat tpcue b cwJ= paCe tc . e a==e= au b eJJz BnZe tpe fcKmatting b au Zcms Jete Cpe an= AupeKb ent tpKcwgp tpe Kes cKCa==ing tpe neb ZcKKeZt sage nwm. eKu tc aJJ cf tpe sageuz Tpe, Zcmmwni Zate= . aZl an= fcKp wntiJ tpe ta. Je cf Zcntentu CJiut cf figwKeuCan= Jiut cf ta. Jeu b eKe Zcms Jetez

DaCl=: Aul e= if eCeK, tping b au =cne if eitpeKAupeKcKAJeS ZcwJ= uaCe it an= uen= it tc E im uc tpat pe ZcwJ= Keuw. mit tpe ZcKKeZte= Kes cKz

AJeS: vai= tpat pe b cwJ=z

6 Kef utatement cn in=iCl=waJ s aKciZis aticn an= cKs Kc. Jemu enZcwnteKe= b itp us eZifiZ gKcws mem. eKu an= pcb gKcws KeucJCe= s Kc. Jem(u)

1 Kcws =i= a gcc= 7c. cf =iuZwuuing s Kc. Jemu b e Kan intc b piJe b e b eKe Jaut minwte fiJJing cwt tpe mi=teKm Kes cKz Mcut s Kc. Jemu b eKe KeucJCe= . , seeKKeCleb cf eaZp ctpeKNu b cK zPaZp gKcws mem. eKcf tpiu umaJJ gKcws =i= b pat taul b au auuigne= tc pimz

MEETING TASK ASSIGNMENT & DELIVERABLES

“ ue tpiu ta. Je tc =cZwment taul auuigne= an= =eJiOeKa. Jeu Zcms Jete=/uw. mitte= . , eaZp gKcws mem. eKat tpiu meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
AupeKx aKucn	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z” iniup mi=teKm Kes cKt (ta. Je cf Zcntentu)z	x cms Jete tpe ta. Je cf Zcntentu fcKtpe mi=teKm Kes cKt an= uw. mit it tc y as i	F c AZticn
y en=aJJ o emcnu	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z	x cms Jete tpe mi=teKm sKeuentaticn an= Xcb eKXcint uJi=eu fcK TpwKu=a, Nu sKeuentaticnz	F c AZticn
y as i=waZp PZpaKK,	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z” iniup e=iting mi=teKm Kes cKtz	x cms iJeCe=itCan= twKn in tpe mi=teKm Kes cKtCan= =c an, b cKl pe =i=nNt auuign tc ctpeKmem. eKu	F c AZticn
QeKem, E wnteK	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z	” iJJ tpe KeuwJtu an= ZcnZJwuicn saKt cf tpe mi=teKm Kes cKt an= uw. mit it tc y as i	F c AZticn
DaOi= Btinb a	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z” iniuping mi=teKm Kes cKt (Zc=eu)z	q cKl cn fin=ing an= =euZKt. ing tpe Zc=euCan= fiJJing in tpat ueZticn cn tpe mi=teKm Kes cKtz	F c AZticn
AJeS DevpieJ=u	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z Meeting minwteuz ” iniuping mi=teKm Kes cKtz	x cms iJing meeting minwteu an= uw. mitting tpem tc sKcfeuucKXengz Kes cKt W KefcKmattingz	F c AZticn
6 K, Ze 6 c, =	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcKKes cKt Wb z	x cms Jete tpe mi=teKm sKeuentaticn an= Xcb eKXcint uJi=eu fcK	F c AZticn

		TpwKu=a, Nu sKeuentaticn b itp y en=aJJz	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 09/04/4949 Meeting Time: 8:9953:99

Meeting ocZaticn: hccm:pttsu://wu9Lb e. zj ccmzwu/7889388-44?dsb =Rk l JQVT=HZE =uaPHX. T=Hh4Hr H9Jchj 92

Mem. eKu XKeuent: y asi=waZp PZpaKK, COeKem, E wnteKCAJeS DevpieJ=u

Agen=a fcKMeeting (Itemu tc . e =iuZwuue= cK=iuZwuue= at tpe meeting)
Tpiu meeting b au inten=e= tc . KefJ, taJl a. cwt b pat b au eSseZte= fKcm tpe in=iCi=waJu in ZcmsJeting utatwu KescK. V6 z AfteKb e taJl e= a. cwt itCuseZifiZ auuignmentu an= uw. fwnZticnu b cwJ= . e pan=e= cwt an= Uweuticnu b cwJ= . e fieJ=e= . efcKe b e utaKe= b cKlingz(Tpe cn Zamswu inteKnet faiJe= b piZp at tpe OeK, . eginning cf tpe meeting uc it =i= nct gc au eSseZte=)z

DetaiJe= Minwteu: (upcwJ= inZJw=e name cf useal eKan= uwmmaK, cf b pat pe/upe uwggeute=)
AJeS DevpieJ=u: vpcb e= ws tc meeting Jate . eZawue inteKnet iuuweu an= KeaJij e= mcut eOeK, . c=, b au nct a. Je tc mal e it . eZawue cf tpe uame inteKnet iuuweuz Aul e= y asi an= OeKem, pcb b e upcwJ= gc a. cwt getting tpe KescK utaKe= uinZe b e aJKea=, pa= a Jate utaK an= b e ZcwJ=nNaffcK= tc Jcue anctpeK=a, z

OeKem, : vwggeute= b e upcwJ= b ait a JittJe b piJe an= uee if tpe ZcnneZticn Zcmeu . aZl uc b e ZcwJ= get utaKe= au a gKcwsz AfteKit =i=nNfcKcOeKpaJf an pcwKCpe uwggeute= b e upcwJ= tK, tc ZcmmwniZate au . eut b e Zan tpKcwgp 1 KcwsMe an= emaiJz

AJeS: vai= tpat b cwJ= . e paK= tcc . eZawue tpe inteKnet b au cwt fcKpim an= tpat pe b cwJ= paOe tc KeJ, cn piu sKett, . a= =ata ZcnneZticnzPn=e= ws ZcmsJeting tpe ta. Je b piZp tcJ= eaZp seKucn b pat uw. fwnZticn tc =cCan= tccl a siZtwKe cf tpe fcKmatte= ta. Je (fKcm Uweuticn 0 in utatwu KescK. V6)zx peZl ing b itp OeKem, an= y asi if tpe, b eKe getting tpe emaiJ cf tpe siZtwKeuz

vai= tpat tpe, =i= an= tpat it b au gcc= tc uen= tc eOeK, cne eJuez

AJeS: vent emaiJ tc eOeK, cne eJue b itp =ea=Jine tc get tpe b cKl =cnezDiumiuue= tpe meeting an= ma=e uwKe tpe, l neb tpe, b cwJ= meet again tcmcKKcb z

6 Kef utatement cn in=iCi=waJ saKiZisaticn an= cKsKc. Jemu enZcwnteKe= b itp useZifiZ gKcws mem. eKu an= pcb gKcws KeucJOe= sKc. Jem(u)

1 Kcws =i= a gcc= 7c. cf =iuZwuuing s Kc. Jemu b e Kan intc b piJe b e b eKe tK, ing tc figwKe cwt b pat tc =c uinZe tpe intekuet ZKaupe=z Mcut s Kc. Jemu b eKe KeucJOe= . , ZcnOeKuating b itp eaZp ctpeKz 1 Kcws =i=nN Jil e pcb eOeK, tping twKue= cwt . wt uab nc . etteKb a, tc auuign tpe taul u an= utaK b cK ing cn tpemz

MEETING TASK ASSIGNMENT & DELIVERABLES

" ue tpiu ta. Je tc =cZwment taul auuigne= an= =eJiOeKa. Jeu Zcms Jete=/uw. mitte= . , eaZp gKcws mem. eKat tpiu meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
AupeKx aKucn	1 eneKate tb c ZcnZestu an= =euZKs ticnu fcK 0z0z0C0z4z0C 0z4z4C4z0z4C4z4z0C4z4z- C4z4zL 4z- z4G- z0z4G- z- z0CLz0z4CLz4z4C an= Lz- z0z	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kes cK W6 z" iniup mi=tekn Kes cK (ta. Je cf Zcntentu)z	F c AZticn
y en=aJJ o emcnu	1 eneKate tb c ZcnZestu an= =euZKs ticnu fcK 0z0z4C0z4z4C 0z4z4C4z0z4C4z4z4C4z4zLC4z- z0 4z- z4G- z0z- G- z- z0G- z- z4CLz0z0C Lz4z0CLz- z0Can= Lz- z4z	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kes cK W6 z	F c AZticn
y as i=waZp PZpaKK,	1 eneKate tb c ZcnZestu an= =euZKs ticnu fcK 0z0z0C0z4z0C 0z4z4C4z0z4C4z4z0C4z4z- C4z- z0 4z- z4G- z0z4G- z- z0CLz0z0CLz0z4C Lz4z4Can= Lz- z4z	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kes cK W6 z" iniup e=iting mi=tekn Kes cKz	F c AZticn
QeKem, E wnteK	1 eneKate tb c ZcnZestu an= =euZKs ticnu fcK 0z0z4C0z4z0C 0z4z4C4z0z4C4z4z4C4z4z- C4z- z0 4z- z4G- z0z- G- z- z0CLz0z0CLz4z0C Lz4z4Can= Lz- z4z	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kes cK W6 z	F c AZticn
DaCi= Btinb a	1 eneKate tb c ZcnZestu an= =euZKs ticnu fcK 0z0z4C0z0z4C 0z4z4C4z4z0C4z4z0C4z4z4 4z4zL 4z- z4G- z0z4G- z0z- G- z- z4CLz4z0C an= Lz- z0z	k eb atZp tpe JeZtwKe fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kes cK W6 z" iniuping mi=tekn Kes cK (Zc=eu)z	F c AZticn

AJeS DevpieJ=u	1 eneKate tb c ZcnZestu an= =euZKsticnu fcK 0z0z0C0z4z0C 0z4z4C4z0z4C4z4z0C4z4z-C4z-z0 4z-z4C-z0z4C-z-z0CLz0z4CLz4z4C an= Lz-z4z	k eb atZp tpe JeZtwKé fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kés cK W6 z Meeting minwteuz ”iniuping mi=tekn Kés cKz	F c AZticn
6K,Ze 6c, =	1 eneKate tb c ZcnZestu an= =euZKsticnu fcK 0z0z0C0z0z4C 0z4z4C4z0z4C4z4z0C4z4z4 4z4zL 4z-z4C-z0z4C-z0z-C-z-z0CLz4z0C an= Lz-z0z	k eb atZp tpe JeZtwKé fKcm 09/0/49 tc wn=eKutan= b pat b e b cwJ= nee= tc =c fcK Kés cK W6 z	F c AZticn

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____09/0-/4949___ Meeting Time:__8:995 09:99_____

Meeting ocZaticn: hccm:pttsu://wu9Lb e. zjccmzwu/7889388-44?dsb =Rk l JQVT=HZE=uaPHX. T=Hh4Hr H9Jchj92

Mem. eKu XKéuent: _y asi=waZp PZpaKK,CQeKém, E wnteKCy en=aJJ oemcnuCAupeKx aKucnCAJeS DevpieJ=uCDaCl= Btinb aC

Agen=a fcKMeeting (Itemu tc . e =iuZwuue= cK=iuZwuue= at tpe meeting)
Tpiu meeting b au inten=e= tc =iuZwuu tpe in=iCl=waJ s aK cf utatwu Kés cK W6 uinZe tpeKé b eKé man, Uweuticnu an= tpe b cK uw. mitte= tc tpe Jea=eKb au nct ws tc s aKb itp b pat b au eSs Jaine= in tpe JeZtwKézq ante= tc =iuZwuu b peKé tpeKé b eKé s Kc. Jem an= . Keal =cb nu in Zcmmwni Zaticnu tc aOci= tpem in tpe fwtwKéz

DetaiJe= Minwteu: (upcwJ= inZJw=e name cf us eal eKan= uwmmaK, cf b pat pe/upe uwggeute=)
AJeS DevpieJ=u: Aul e= b pat pass ene=Can= b p, tpe in=iCl=waJ b cK uw. mitte= =i=nNi matZp b pat tpe s Kcfeuuc Ku b eKé aul ing fcKin tpe Cl=eczq ent cOeKus eZifiZ eSams Jeu cf b pat b au aul e= fcKin tpe JeZtwKé an= b pat b au s KcCl=e= . , tpe teamz

AupeK vai= it b au =iffiZwJt tc wn=eKutan= b pat eSaZtJ, b au . eing uai= in tpe JeZtwKé an= tpat eaZp mem. eKb au gcing tc paOe tpeiKcb n inteKs Kétaticnz

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MEETING TASK ASSIGNMENT & DELIVERABLES

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Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
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AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 10/09/2020Meeting Time:11:30PM–4:00AMMeeting Location: https://zoom.us/j/91354072968#success

Members Present:XimenaCifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J
Excused Members:David Trevino(Work), Daniel Akpan

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize midterm report revision
- Create a table of content, list of figures, and list of tables
- Write report 6, Functional Decomposition

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximenaintroduced the meeting agenda which is finalizing the midterm report and making sure all the notes left by Dr.Peng are taking in consideration. Also, Ximena asked the team members to make some changes to the functionalities listed in the functional decomposition electronic sticky notes. Ximena, then proceeded to introducing and citing all the figures on the functional decomposition report. Last, Ximena made sure to help and answer all the questions that the other group members were asking and she made sure that everyone is following the correct format for the midterm report and functional decomposition.

- Demetrious Sandford: After the group leader introduced the agenda of the meeting, Demetrious immediately started on editing the format of the report. Also, Demetrious started working on the table of content for the midterm report and making sure that it is formatted correctly. Then Demetrious started working on scheduling the next meeting for the group.

- Amna Ansari: During the following meeting Amna was working with Ximena on the functional decomposition report. Amna then proceeded to checking and fixing her assigned part on the literature review so it can be added to the midterm report. Then, Amna worked on creating the list of figures on the midterm report and making sure that it is formatted correctly. Then, Amna created the list of table for the midterm report. Lastly, Amna created the meeting minute for the following meeting.

- Caleb Riggins: Caleb started working on correcting the format of the sources on the literature review and making sure that they were listed correctly and that they were in order. Then, Caleb started working on the functional decomposition while proofreading the report. Lastly, Caleb added the edited version of the literature review to the midterm report.

- Amna J: Amna J started working on the analysis part of the literature review and making sure to follow Dr.Peng advice on how it should be formatted. Then Amna added the cover page to the midterm report and made sure that it was formatted correctly. Throughout the meeting Amna was helping everyone that needed any help and also checking the formats of the report.

Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

Every member present was fully active on the following meeting, all members present stayed late to make sure that the midterm report is completed. All members present were very supportive and communicated thoroughly with each other.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create a meeting agenda for the meeting, work on Functional Decomposition report, revise some of the functionalities, complete the midterm report to send for revision	- A meeting agenda - An updated functional Decomposition Functionalities - AFunctional Decomposition report - A midterm report	
Demetrious Sandford	Revise and edit midterm report, create table of content, schedule the next meeting	- A revised and edited midterm report - A table of content for the midterm report - A schedule for the next meeting	
Amna Ansari	Edit and review assigned part on Literature Review, create list of figures, create list of table, create meeting minutes	- An Edited and revisedversion of the assigned part of Literature Review - A list of figures - A tables for the midterm report - A complete meeting minutes	
Caleb Riggins	Revise and edit project assignment on Literature Review, update the sources on the literature review, list the sources in the correct format, work Functional Decomposition	- A revised and edited version of project assignment over Literature Review - A updated version for sources on Literature Review - A list of sources in the correct format - Awritten report on Functional Decomposition	
Amna J	Create the analysis part of the Literature Review, edit midterm report, add cover page to the midterm report, revise and edit midterm report	- A updated version on the analysis part of Literature Review - A cover page for midterm report - An Edited and revised version of the midterm report	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 10/10/2020Meeting Time:1:00PM-2:30PMMeeting Location:https://zoom.us/j/91354072968#success

Members Present: XimenaCifuentes, Amna J, Caleb Riggins
Excused Members:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize Midterm report
- Finalize Functional Decompositions
- Turn in both reports

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximena started with introducing the agenda for both meeting and immediately started working on finalizing both of the midterm report and the Functional Decomposition. Then Ximena created a docusign for both report so that each member can sign both report. Lastly Ximena created an evaluation form so that each member can anonymously evaluate the each other based on the work that they have been putting for each report. The percentage for this evaluation will be added to both reports.

- Amna J: Amna J add the page numbers to the midterm report while following the format provided by the professors. Finalized both of the Functional Decomposition and the midterm report. Updated the list of tables and list of figures on the midterm report

- Caleb Riggins: Caleb started proofreading both report and ensuring that both reports are in the correct format. Then Caleb started make some final editing and revision to both reports. Lastly, Caleb turned both of the midterm and the Functional Decomposition to Dr.Peng.

Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

The following meeting was very successful, every member present was fully engaged and contributed to all items discussed during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create a meeting agenda, finalized midterm report, finalize Functional Decomposition, create DocuSign for both reports, create evaluation form	- A meeting agenda - A finalized midterm report - A finalized Functional Decomposition report - A DocuSign signature for both reports - An evaluation form for both reports	
Caleb Riggins	Proofread both of the Functional Decomposition and the midterm repots, check the format of both reports, turn both reports to Dr.Peng	- A proofread Functional Decomposition and the midterm report - A finalizedreports - A turned in assignments on canvas	
Amna J	Fix and finalizethe midterm report format, Fixed the page numbers on the midterm report, update the list of figures and list of tables on the midterm report	- A fixed and Finalizedmidterm report - An aligned page numbers on the midterm report - An updated list of figures and list of tables on the midterm report	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date:10/12/2020 Meeting Time:9:30PM-11:30PM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: XimenaCifuentes, Demetrious Sandford, Amna Ansari, Amna J, Caleb Riggins, Daniel Akpan
Excused Members:David Trevino (Work)

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Introduce project assignment 7: Concept Generation
- Complete the morphology table
- Assign functionalities to each group members

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- XimenaCifuentes: Ximena started with introducing the meeting agenda to the rest of the group member. Then Ximena started sharing her screen and explained project assignment 7 to the group. Ximenadescribed what concept generation is and what is expected from each member to do. Ximena explained that each member have to create a sketch for the functionalities that are listed on the morphology table. Then Ximena assigned functionalities for each member

- Demetrious Sandford: After Ximena finished explaining project assignment 7, Concept Generation, Demetrious started on generating concepts for his assigned functionalities, by researching and sketching the perfect idea. Also, Demetrious created the next meeting schedule.

- Amna Ansari: Amna started working on her assigned functionalities by generating new ideas and research the functionalities of an oil skimmer. Amna individually tried to create sketches for the functionalities so she can share it with the rest of the group members. Also, Amna was in charge of creating the meeting minutes.

- Caleb Riggins: Caleb started with doing a research on his functionalities and generated ideas on what is the best way to present and sketch his ideas. Caleb wanted to make sure that the ideas are being presented clearly and vividly to the other group members.

- Amna J: Amna immediately started on generating concepts for her assigned functionalities by brainstorming new ideas. Then, Amna started working on creating/finding the best sketches for her functionalities

- Daniel Akpan:Daniel worked on brainstorming new concepts and ideas for his assigned functionalites by doing some research on the topic. Then, Daniel started on creating his sketches.

Brief statement on individual participation and or problems encountered with specific group members and how group resolvedproblem(s)

Every member present was fully engaged and contributed to all items discussed during the meeting

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
XimenaCifuentes	Create an agenda for the meeting, explain concept generation, assign members with functionalities, fill the morphology table	- A meeting agenda - An explanation on concept generation for the group members - An assignedfunctionalities to each member - A filledmorphology table	
Daniel Akpan	Brain storm new ideas for assigned functionalities, generate concepts, create sketched	- A generation of ideas for assigned functionalities - A generation of sketches for the new concepts	
Demetrious Sandford	Generate concepts for assigned functionalities, ensure to create the best visuals for the assigned functionalities, create meeting schedual	- A generation of new concepts for assigned functionalities - Generated sketches - A schedule for the next meeting	
Amna Ansari	Work on generating concepts, create sketches for assigned functionalities, create meeting minutes	- Brainstorms for new ideas on concept generating - Sketches for assigned functionalities - A complete meeting minutes	
Caleb Riggins	Brainstorm new concepts and ideas for assigned functionalities, research functionalities, create sketches for functionalities	- A generation of concepts for assigned functionalities - Research over functionalities - Created sketches to present the functionalities	
Amna J	Working on brainstorming new concepts, create sketches	- Concepts for assigned functionalities - Created sketches	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 10-10-20 Meeting Time: 11:30AM-2:10PM Meeting Location: Zoom

Members Present: All Members Present

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is having a working meeting for the midterm report

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

11:30-11:35 (Gary) explained the changes that he made to the report
11:35-11:40 (Bryston) explained the changes that he made to the report
11:40-2:10PM (All members) all members worked on the midterm report in various areas

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASo ASSIGNMENT & DELIuERApLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBmas Vk ig iV9K KVKnVdB9i it mBKVwinse	DVmhVd9nbVBl gKvbVwiVk & BcnKmiiVk fdgK i9BaB9BBmas Vk ms vdVhmgc BKVwinse(B)	Al imgs Bi9aVs ny edgcv gs sgs-vVdfgdKmse KVKnVd
Gary T	Think of sub-functions for report 6		
Zach M Bryana J Iyanulolwa O Bryana R	Think of sub-functions for report 6		
Don B	Think of sub-functions for report 6 Ensure meeting minutes are up to date		
Olaniyi O	Think of sub-functions for report 6		

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 10-12-20 Meeting Time: 7:00PM-8:00PM Meeting Location: Zoom

Members Present: Iyanuloluwa O, Gary T, Bryston R

Agenda for Meeting (Items to be discussed or discussed at the meeting)

A few members are meeting to discuess what is needed for report 7

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

7:00PM-8:00PM (All members) Discussed what needed to be done for report 7

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASo ASSIGNMENT & DELIuERApLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBmas Vk ig iV9K KVKnVdB9i it mBKVwinse	DVmhVd9nbVBl gKvbVwiVk & BcnKmiiVk fdgK i9BaB9BBmas Vk ms vdVhmgc BKVwinse(B)	Al imgs Bi9aVs ny edgcv gs sgs-vVdfgdKmse KVKnVd
Gary T	Think of sub-functions for report 6		
Zach M Bryana J Iyanulolwa O Bryana R	Think of sub-functions for report 6		
Don B	Think of sub-functions for report 6 Ensure meeting minutes are up to date		
Olaniyi O	Think of sub-functions for report 6		

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 10-12-20 Meeting Time: 7:00PM-8:00PM Meeting Location: Zoom

Members Present: Iyanuloluwa O, Gary T, Bryston R

Agenda for Meeting (Items to be discussed or discussed at the meeting)

A few members are meeting to discuess what is needed for report 7

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

7:00PM-8:00PM (All members) Discussed what needed to be done for report 7

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASo ASSIGNMENT & DELIuERApLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBmas Vk ig iV9K KVKnVdB9i it mBKVwinse	DVmhVd9nbVBl gKvbVwiVk & BcnKmiiVk fdgK i9BaB9BBmas Vk ms vdVhmgc BKVwinse(B)	Al imgs Bi9aVs ny edgcv gs sgs-vVdfgdKmse KVKnVd
Gary T	Think of sub-functions for report 6		
Zach M Bryana J Iyanulolwa O Bryana R	Think of sub-functions for report 6		
Don B	Think of sub-functions for report 6 Ensure meeting minutes are up to date		
Olaniyi O	Think of sub-functions for report 6		

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 7
10/15/20-10/21/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____10/16/2020___ Meeting Time:__3:00-5:30_____

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: _Kendall Lemons, Asher Carson, Bryce Boyd, David Otinwa, Kapiduach Echarry, Jeremy Hunter, Alex DeShields_

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was intended to speak with Ball Aerospace to discuss status report 7, our concept generation, and how we would be going about the concept evaluation. We also wanted to ask some questions about their specific requirements for their design so we could properly go on evaluating our concepts. After that we would meet as a team to discuss our process for concept evaluation and to for a list of requirements.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Explained to Neil the process we would use for generating and evaluating concepts. Asked Neil if he had any comments or suggestions for how we would be going through with this process.

Neil: Said that the way we were going about it seemed good to him and suggested that we try to be creative, even if the idea was a little wild there may be some concepts in it that are useful and usable.

Alex: Asked Neil if there was any requirements that weren't included in the presentation given to the team previously

Neil: Said there was a few things, including load redistribution, and a radial load to consider.

Alex: (After meeting with Ball was over) Broke down what was expected for status report seven and then had team break off to each generate a list of requirements for the team to go through and refine afterwards.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Group did a good job talking to Ball aerospace and asking individual question on confusing concepts. Also did a good job discussing problems we ran into while we were creating our individual lists of requirements. Most problems were resolved by peer review of each other's work. So far, each group member did what task was assigned to him.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	No Action
Kendall Lemons	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.2, 1.2.2, 1.2.2, 2.1.2, 2.2.2, 2.2.4, 2.3.1 2.3.2, 3.1.3, 3.3.1, 3.3.2, 4.1.1, 4.2.1, 4.3.1, and 4.3.2.	No Action
Kapiduach Echarry	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.3.1 2.3.2, 3.1.2, 3.3.1, 4.1.1, 4.1.2, 4.2.2, and 4.3.2.	No Action
Jeremy Hunter	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.2, 1.2.1, 1.2.2, 2.1.2, 2.2.2, 2.2.3, 2.3.1 2.3.2, 3.1.3, 3.3.1, 4.1.1, 4.2.1, 4.2.2, and 4.3.2.	No Action
David Otinwa	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.2, 1.1.2, 1.2.2, 2.2.1, 2.2.1, 2.2.2 2.2.4 2.3.2, 3.1.2, 3.1.3, 3.3.2, 4.2.1, and 4.3.1.	No Action
Alex DeShields	Develop a list of requirements, by which each concept would be evaluated. Meeting minutes.	Generate two concepts and descriptions for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.3.1 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.2.	No Action
Bryce Boyd	Develop a list of requirements, by which each concept would be evaluated.	Generate two concepts and descriptions for: 1.1.1, 1.1.2, 1.2.2, 2.1.2, 2.2.1, 2.2.2 2.2.4 2.3.2, 3.1.2, 3.1.3, 3.3.1, 4.2.1, and 4.3.1.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: ____10/18/2020___ Meeting Time:__6:00-10:00_____

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: _Kendall Lemons, Asher Carson, David Otinwa, Kapiduach Echarry, Jeremy Hunter, Alex DeShields_

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was meant to discuss the generated concepts and then to analyze then as a team. We discussed the multiple concepts proposed by the team and combined similar ideas, and refined the sketches to communicate the concepts better. We intended to have everything done to have a completed draft by the end of the night.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Stated the agenda for the meeting and planned out the next few meeting to get all the work done in time. Asked everybody to upload their concepts and sketches under their respective sections. (After things were uploaded) Stated that some concepts didn't discuss a release method, and asked group members to revise their sections if they did not include a release system in their concept.

Jeremy: Helped members edit and revise their concepts until they were good enough to start comparing and eliminating.

Alex: Gave the task of leading the discussion of going through each concept in each section to Jeremy since he was good at analyzing concepts and giving good constructive feedback for each concept and subsection.

Jeremy: One by one went through each concept with the team, discussed it and eliminated unnecessary ones.

Alex: Announced that we would be done for the day after discussing a couple more concepts because the team had been working so long for the day. Said we would start up again tomorrow at 7pm.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)
Group did a good job asking questions on confusing concepts. Also did a good job discussing each concept we were analyzing while we were going through the report. Most problems were resolved by discussing as a team which concepts were going to be kept.. So far, each group member did what task was assigned to him.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Generate additional concepts for timely release and work with Jeremy to edit some sketches.	Develop a list of requirements, by which each concept would be evaluated.	No Action
Kendall Lemons	Generate more concepts for sections 2.3.2, 3.3.1, and 4.3.1 and learn how to do meeting minutes.	Develop a list of requirements, by which each concept would be evaluated.	No Action
Kapiduach Echarry	Be ready to continue discussing concepts tomorrow.	Develop a list of requirements, by which each concept would be evaluated.	No Action
Jeremy Hunter	Generate more concepts for sections 1.1.1, 1.2.2, 2.1.2, 2.2.1, 2.2.4, 2.3.2, 3.3.1, and 4.3.1	Develop a list of requirements, by which each concept would be evaluated.	No Action
David Otinwa	Be ready to continue discussing concepts tomorrow.	Develop a list of requirements, by which each concept would be evaluated.	No Action
Alex DeShields	Develop a list of requirements, by which each concept would be evaluated. Meeting minutes.	Develop a list of requirements, by which each concept would be evaluated.	No Action
Bryce Boyd	Generate more concepts for sections 1.1.1, 1.2.2, 2.1.2, 2.2.1, 2.2.4, 2.3.2, 3.3.1, and 4.3.1	Develop a list of requirements, by which each concept would be evaluated.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 10/19/20 Meeting Time: 7:00-9:05

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Bryce Boyd, Asher Carson, Kendall Lemons

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting served as a follow up from the meeting on yesterday, 10/18. Members of the group discussed the completion and revision of Status Report 7. Group members discussed the addition of relative release components for their assigned sub function and their relation to the overall success of the project.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Initiated the meeting conversation, noting the presence, or lack thereof, of all members of the group. Quickly outlined the meeting agenda for the night, and the desired outcome: the completion of status report 7.

Jeremy: Served as the meeting moderator for the night once again. Went down sub-function, by sub-function, outlining the progress of each component conception. Suggested additional information be added if information was lacking.

Kapi: Presented assigned concept deliverables, compounded on concepts with explanations relative to project

Asher: Presented concept deliverables, noted lack of clarity in initial presentations, confirmed that clarity was gained, worked to explain concepts further so that rest of group was on the same page.

Bryce: Presented concept deliverables, spoke of lack of understanding initially, compounded on statements when needed.

Kendall: Present assigned concepts, explained that presented concept ideas were industry trusted devices.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Great meeting. Productive meeting in the sense that all of the intended work was completed in a timely fashion. Any gaps in work production were given a hard deadline of that same night.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Explained concepts for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed. Generate more concepts	No Action
Kendall Lemons	Explained concepts for 1.1.2, 1.2.2, 1.2.2, 2.1.2, 2.2.2, 2.2.4, 2.3.1 2.3.2, 3.1.3, 3.3.1, 3.3.2, 4.1.1, 4.2.1, 4.3.1, and 4.3.2.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed. Generate more concepts. Meeting minutes	No Action
Kapiduach Echarry	Explained concepts for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.3.1 2.3.2, 3.1.2, 3.3.1, 4.1.1, 4.1.2, 4.2.2, and 4.3.2.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed.	No Action
Jeremy Hunter	Explained concepts for: 1.1.2, 1.2.1, 1.2.2, 2.1.2, 2.2.2, 2.2.3, 2.3.1 2.3.2, 3.1.3, 3.3.1, 4.1.1, 4.2.1, 4.2.2, and 4.3.2. Meeting moderator	Revisit concept deliverables, look for gaps in explanations, included pictures where needed.	No Action
David Otinwa	Explained concepts for: 1.1.2, 1.1.2, 1.2.2, 2.2.1, 2.2.1, 2.2.2 2.2.4 2.3.2, 3.1.2, 3.1.3, 3.3.2, 4.2.1, and 4.3.1.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed.	No Action
Alex DeShields	Explained concepts for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.3.1 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.2.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed. Meeting minutes.	No Action

Bryce Boyd	Explained concepts for: 1.1.1, 1.1.2, 1.2.2, 2.1.2, 2.2.1, 2.2.2 2.2.4 2.3.2, 3.1.2, 3.1.3, 3.3.1, 4.2.1, and 4.3.1.	Revisit concept deliverables, look for gaps in explanations, included pictures where needed. Generate more concepts.	No Action

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II

FALL 2020 SEMESTER

REPORT ON GROUP DYNAMICS

Group #5

MINUTES OF GROUP MEETINGS

Meeting Date: __10/15/2020_____ **Meeting Time:** ____10:00 PM - 12:00 PM___

Meeting Location: ____Online-Zoom_____

Members Present: __Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor_____

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Quick check in with members, along with updates
- Weekly beginning meeting to discuss upcoming tasks

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - She confirmed that she finished the meeting minutes for the previous week. Chaniquah also stated that she had begun the next meeting minutes' assignment also.

Amir - He explained the formatting and needs (sketches and descriptions) for assignment #7. Amir asked if the meeting minutes were almost complete or had been started. He reminded everyone of the upcoming sponsor meeting with Ball Aerospace. He assigned tasks for individual group members. He recommended hand-drawn pictures for the status report sketches. He asked members to begin completing assignment 7, and to possibly add figure numbers.

Hannah - She asked specifics about the descriptions needed to be input for assignment #7. Hannah asked about the length needed for our individual tasks.

Chibuzo - He asked about status report 6 individual assignments. Chibuzo began to look at the upcoming assignment.

Brandon - He stated that he understood the needs for our upcoming assignment. He stated his confusion with comments made from our professor.

Jordan - He reviewed status report #6. Jordan confirmed that Elliot's help is a good support for the group and our project.

Mohammed - He participated in general group discussions. Mohammed began to look at the upcoming assignment.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Brandon was confused about some comments our professor made, along with others when we were trying to understand our current and previous assignments. These confusions later got handled when our professors went over our upcoming assignment again and sent over a detailed rubric and comments for our grades.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document tasks assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	Begin thinking of concepts for status report 7		N/A
Amir	-Begin thinking of concepts for status report 7 -Begin formatting assignment		N/A
Chibuzo	Begin thinking of concepts for status report 7		N/A
Jordan	Begin thinking of concepts for status report 7		N/A
Hannah	Begin thinking of concepts for status report 7		N/A
Mohammed	Begin thinking of concepts for status report 7		N/A
Brandon	Begin thinking of concepts for status report 7		N/A

Meeting Date: ____10/15/2020_____ **Meeting Time:** _____12:30 PM - 1:30 PM_____

Meeting Location: ___Online - Zoom _____

Members Present: __Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor____

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss Ball Aerospace Meeting
- Continue discussions for upcoming assignment
- Create future meeting time(s)
- Discuss Previous Assignment

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - She asked if copied or searched figures were ok instead of drawings. Chaniquah asked if the midterm detailed grading rubric had been shared yet.

Amir - He offered a possible time for our next meeting. Amir discussed a need for barriers on the heat shield for our mechanism so that heat transfer does not occur between attachments. He discussed the midterm report. He explained status report 6b more. He stated that we needed to do sketches by hand for our upcoming assignment.

Hannah - She discussed our midterm grade. Hannah stated that she had already contacted our professor by email regarding our previous assignments. She stated that no detailed rubric had been uploaded yet. She asked about a time(s) for our next meeting.

Chibuzo - He participated in general group discussions. He asked questions regarding the assignment. Chibuzo participated in a discussion about our Ball Aerospace meeting.

Brandon - He stated that Amir's explanations of our upcoming assignment made sense. He participated in general discussions regarding our mechanism. Brandon participated in a discussion about our Ball Aerospace meeting.

Jordan - He participated in general group discussions. He asked questions regarding the assignment. Jordan participated in a discussion about our Ball Aerospace meeting.

Mohammed - He discussed our midterm grade. Mohammed participated in a discussion about our Ball Aerospace meeting. He also participated in general group discussions.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Again, all confusion came from the grading of our assignment, due to us not having some of them and not having the detailed rubric. These were somewhat straightened out when we finally received the document. Other grades that were still missing, were waited upon to hear back through canvas or email to our professor. Other than that, all questions were answered in our meeting, and there were no problems encountered with specific group members.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document tasks assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	Begin inputting concepts		N/A
Amir	Begin inputting concepts		N/A
Chibuzo	Begin inputting concepts		N/A
Jordan	Begin inputting concepts		N/A
Hannah	Begin inputting concepts		N/A
Mohammed	Begin inputting concepts		N/A
Brandon	Begin inputting concepts		N/A

Meeting Date: __10/19/2020____ **Meeting Time**: _10:00am-1:00pm__

Meeting Location: __zoom_

Members Present: ___Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor_____

Agenda for Meeting (Items to be discussed or discussed at the meeting

- Complete all individual assignments for generating concepts, go over the final format for concept generation documents.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - Questions on concept generation, formatting, and overall project assignment due.

Amir - Went over all assignment details, provided template for individual work to be completed, went over template for overall work to be completed. Assigned roles to group members.

Hannah - Questions on concept generation, formatting, and overall project assignment due.

Chibuzo - Question on individual work needed to be completed as well as questions on subfunctions for surviving launch environments.

Brandon - Informed group on different possible concepts and locations for the concepts.

Jordan - Asked questions on where to find information for concepts.

Mohammed - Questions on concept generation, formatting, and overall project assignment due.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Amir- When discussing project and overall assignments due all group members had questions about the tasks they needed to complete. In order to have a good understanding Amir went through each task individually using screen share to show the screen that way everyone could follow along. Zoom session was recorded so that it can be played back and understood effectively.

Chaniquah- Participated in explaining the process and asking questions on the formatting of the overall report. Gave feedback that caused us to change the report to the correct format according to Dr. Bineys specifications. ‘

Hannah- Asked questions on the report as well as gave feedback about the previous reports that had been graded and talked about what changes needed to be made.

Mohammad- Talked about individual participation part, informed group there were some issues with the sketches he had, and we brainstormed together as a group to resolve the issues

Brandon -Went over the individual participation portion of the report and talked about sources that can be used when thinking of concepts and sketches that can show those concepts.

Jordan - Had questions about the final format of the report that were talked about by the whole group and answered as a whole.

Chibuzo - Had to come slightly late due to other reasons and informed the group, once in the meeting caught up with the work and given the assignments to be completed.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA
Amir	Complete individual work and input work into main document for concept generation Check everyone's work	Show work done so far on concept generation	NA
Chibuzo	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA
Jordan	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA
Hannah	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA
Mohammed	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA
Brandon	Complete individual work and input work into main document for concept generation	Show work done so far on concept generation	NA

Meeting Date: __10/21/2020_____ **Meeting Time: ____**7:00 PM - 9:00 PM_____

Meeting Location: ____Online-Zoom_____

Members Present: __Chaniquah Smith, Muhammad Amir Ghazi, Hannah Falls, Brandon Blond, Mohammed Bahaj, Jordan Castaneda, Chibuzo Okafor_____

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Continue work on Status Report #7

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Chaniquah - She confirmed that viewing status reports from previous semesters would help us get an understanding of the reports needs and formatting requirements. She asked about comments from the previous submission left by the professor. She asked questions regarding figure numbers and name placements for status report 7. Chaniquah continued to work on her individual and group assignments for the current report. She asked if paragraphs were needed for the individual assignment.

Amir - He explained the formatting for Status Report #7. He stated that he liked a suggestion for the page number by another group member. Amir stated that we needed to insert our best choices for each concept assigned. He also instructed us to be specific and similar in our formatting of the sketches we inserted. He stated that group members should watch their spacing and to not fill in the group tables yet.

Hannah - She showed some of her concepts and began choosing her best ones to include in the group document. She asked when we would pick the main concepts for the next assignment. She asked what our next meeting time was. She stated that she understood the needs and had no questions for this current status report. She stated that we might get a new grade for our literature review since we made changes to the submission.

Chibuzo - He asked questions he had pertaining to Status Report 7. He asked for updates about the formatting of the final group document. He asked about our next meeting time. Chibuzo began to input his concepts into the final group document.

Brandon - He stated that he understood the needs for our upcoming assignment. Brandon suggested that we could email the final document to each other to keep the correct formatting for Table 1 and 2 of the assignment. He began to include his best concepts into the group report.

Jordan - He suggested that we could continuously upload the group document into google drive to keep the correct formatting for Tables 1 and 2. Jordan stated he had no questions regarding the next steps for finishing our parts for Status Report 7. He began to input his best concepts for the group report.

Mohammed - He asked specifics about the figure numbers that go into the individual and group documents. He began to insert his best concepts into the group report. Mohammed double-checked to make sure that figures were needed for each concept in both documents for Status Report 7.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

This meeting was just for us to get on the same page as each other regarding inputting our concepts in the final group submission for Status Report 7. Most questions were answered between group members. The main issue from this specific meeting was setting up a time that would work for all of us. A few of us had other obligations so we had to continue our work until we were able to meet at this later time.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting. If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	**Task Assigned to Team Member at this Meeting**	**Deliverables completed & submitted from tasks assigned in previous meeting(s)**	**Actions taken by group on non-performing member**
Chaniquah	Input best concepts into group report	Complete individual concepts	N/A
Amir	-Fix & format tables in group report -Input best concepts into group report	-Complete individual concepts -Finish formatting group report	N/A
Chibuzo	Input best concepts into group report	Complete individual concepts	N/A
Jordan	Input best concepts into group report	Complete individual concepts	N/A
Hannah	Input best concepts into group report	Complete individual concepts	N/A
Mohammed	Input best concepts into group report	Complete individual concepts	N/A
Brandon	Input best concepts into group report	Complete individual concepts	N/A

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 10-15-20 Meeting Time: 4:30PM-9:00PM Meeting Location: Zoom

Members Present: Don B, Iyanuloluwa O, Bryana J, Bryston R, Zach M, Oladipo O

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is having a meeting to update status report 6 based on what was discussed in today's class

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

4:30-4:40 (Bryana) discussed what we would be doing for our subfunctions
(All members) Brainstorming subfunctions for the tables
4:40-5:00 (All members) taking group member subfunctions and creating the final functions
5:00-9:00 (All members) completed report 6

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No issues this meeting.

MEETING TASo ASSIGNMENT & DELIuERApLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBmsVk ig iV9K KVKnVdB9i it mBKWmse	DVohVd9nbVBlgKvbVVk & BtnKmiVk fdgK i9BaB9BBmsVk msvdVmgcBKWmse(B)	Alings Bi9aVs ny edgcv gs s gs-vVdfgdKmse KVKnVd
Gary T	Create DocuSign for status report 7 Work on status report 5		
Zach M Bryana J Iyanulolwa O Bryana R	Work on assigned sections of status report 7		
Don B	Work on assigned section of status report 7 Ensure meeting minutes are up to date		
Olaniyi O	Work on status report 7	Status report 6 proofread	

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 8
10/22/20-10/28/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: Oct. 21 2020 Meeting Time: 9:30-10:30 PM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Continue to work on report seven and make revisions for level 0-2.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Sultan reminded each of us that our level one is final as recommended by dr biney. Also to over the corrections of sticky notes, and try to fit in the ones we did right under level 2 or 3

Each of us discussed the flow chart and filled in the table accordingly.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Dacory suggested that we were not allowed to use the same cost up for both levels. Sultan claimed that Dr. Pony approved that our overall function could be used for that one. Clarence suggested that we reword level one so the functions would not be the same.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Annto bgr hV hgki i gi l gKn khhvtn i gghtbo	Dgdpgkkl ogn uVi acghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKk tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser • Bring an overall flow chart starting from 0 level	Completed	N/A
Clarence Reed	Proofreader Technical writer • Bring an overall flow chart starting from 0 level	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader • Bring an overall flow chart starting from 0 level	Completed	N/A

Dacory Harris	Organizer Presentation Manager ● Bring an overall flow chart starting from 0 level	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Bring an overall flow chart starting from 0 level	Completed	N/A
Kennedy Simmons	Recorder ● Bring an overall flow chart starting from 0 level	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 22 2020.__ Meeting Time:__3:00-4:00 PM__ Meeting Location:__Zoom

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Continue to work on report seven and make revisions for level 0-2.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Dacory asked if the temperature is measured in Celsius or Fahrenheit and Mohamed answered with Celsius.
Dacory asked if our pressure is measured in psi and Mohammed answered in SI unit.
Shikhar suggested that we had our table confirmed by Dr. Biney.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Annto bgr hV hgki i gi l gKn khhv tn i gghtbo	Dgdtpg Kkl cgn uVi acghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agKfVK tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser • Have the assigned concepts completed	Completed	N/A
Clarence Reed	Proofreader Technical writer • Have the assigned concepts completed	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader • Have the assigned concepts completed	Completed	N/A

Dacory Harris	Organizer Presentation Manager ● Have the assigned concepts completed	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Have the assigned concepts completed	Completed	N/A
Kennedy Simmons	Recorder ● Have the assigned concepts completed	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 23 2020.__ Meeting Time: 9:30-9:45 PM Meeting Location:__ Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss report 7. Revise report. Identifying problem areas and assign new tasks. discuss all of the comments Biney made during the presentation.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Everyone discussed different concept for question one on report 7.

Dacory asked if we were using Internet pictures or handwritten pictures for the concepts. Clarence said that he was going to try to do a little bit of both.

Dacory asked if they should be mostly like a design of a device or a process. Shikhar answered by saying it can be both.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn khhvtn i gghtbo	Dgdpgkkl cgn uVi acghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKt tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 1. Complete table 1 and come up with a concept	Completed	N/A
Clarence Reed	Proofreader Technical writer 2. Complete table 1 and come up with a concept	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader 3. Complete table 1 and come up with a concept	Completed	N/A
Dacory Harris	Organizer Presentation Manager 4. Complete table 1 and come up with a concept	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 5. Complete table 1 and come up with a concept	Completed	N/A

Kennedy Simmons	Recorder 6. Complete table 1 and come up with a concept	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 24 2020__ Meeting Time:__7:30-11:50 PM_ Meeting Location:__Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss the remaining actions needed for report 7

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Everyone discussed question 2 and 3. And brainstorm different ideas

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	**Tknd Anntobgr hV hgki i gi l gKn khhvtn i gghtbo**	**Dgctpgkkl cgn uVi acghgr & nBl i thhgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)**	**AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKi tbo i gi l gK**
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	Completed	N/A
Clarence Reed	Proofreader Technical writer ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	Completed	N/A

Sultan Khalid	Manufacturing and Testing Leader ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	Completed	N/A
Dacory Harris	Organizer Presentation Manager ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	Completed	N/A
Kennedy Simmons	Recorder ● Have two concepts are already prepared for Table 2 ● Complete individual assignments	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 25 2020__ Meeting Time:__10:30-12:30 PM Meeting Location:__Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Redo report 7 and complete the individual assignments. Turn in the individual assignments to Sultan when completed. Upload all the individual figures onto one document.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Mohamed reminds everyone that we should start working on concept evaluations.
Sultan reviewed All of the sketches that everybody submitted and
Shikhar discussed the status of report 7. Everyone discussed meeting times. .

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g		**Dgdpgkkl qgn uVi acghgr & nBl i thhgr fkVi hkndn knntobgr tb akgptVBn i gghtbo(n)**	**AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKk tbo i gi l gK**

	Tknd Anntobgr hV/ hgki i gi l gKn khlvtn i gghtbo		
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser 2. Generate sketches of the various ideas/concepts generated in question 2	Completed	N/A
Clarence Reed	Proofreader Technical writer 2. Generate sketches of the various ideas/concepts generated in question 2 and submit to Sultan	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader 2. Generate sketches of the various ideas/concepts generated in question 2 and submit to Sultan	Completed	N/A
Dacory Harris	Organizer Presentation Manager 2. Generate sketches of the various ideas/concepts generated in question 2 and submit to Sultan	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader 2. Generate sketches of the various ideas/concepts generated in question 2 and submit to Sultan	Completed	N/A
Kennedy Simmons	Recorder 2. Generate sketches of the various ideas/concepts generated in question 2 and submit to Sultan	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 26 2020__ Meeting Time:__11:00-12:30 PM Meeting Location:__Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss the remaining actions needed for report 8 and began working on the list of criteria/requirements.
Read the comments biney made as a group and comprehended the objectives for question 1.Sultan assigned everyone tasks to fill out for Table 1 "Sample Example Criteria Affecting Previously identified Sub-functions for Project."

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Shikhar we should add passing through the condenser . Also suggested the modification of the glass vessels.

That's not really a requirement. It is a improvement that is very beneficial but not required from the customers - Kennedy

Clarence reminded us to stick with the condenser when thinking of the concepts

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

We wasn't able to watch the videos. The audio was working but not the video

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn khlvtn i ggltbo	Dgdpgkkl cgn uVi acghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i ggltbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKt tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser Create new stickers for level 0-2	Completed	N/A
Clarence Reed	Proofreader Technical writer Create new stickers for level 0-2	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader Create new stickers for level 0-2	Completed	N/A

Dacory Harris	Organizer Presentation Manager Create new stickers for level 0-2	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Create new stickers for level 0-2	Completed	N/A
Kennedy Simmons	Recorder Create new stickers for level 0-2	completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Oct. 27 2020___Meeting Time:__7:30-12:00 AM Meeting Location:___Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Discuss the remaining actions needed for report 8 and everyone filled out the table with the numbers associated with the sub functions. Complete questions two through three .Then created the “Go/ No- Go” table and discussed with the group which concepts were considered “GO/NO-GO”. Re-watched videos for the instructions of report 8.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Test heat exchanger pipes for additional testing - Mohammed
Testing addition equipment to make sure it is working properly before the fluid interacts with the condenser - Kennedy

Kenne asked what does “sensitivity and latitude” mean

“What part of the project can fail”
Mohammed explained to Kennedy what is component material and how does it relations the question.

Sultan asked the group if the understood the task for the and asked everyone to re- explain it..

Kennedy stated that each ffunction needs to be completed in order for the project to be successful. Each function has the possible to fail, which should list them under “Have all of the failure modes been identified for the project?”

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues.

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn khhvtn i gghtbo	Dgdpgkkl ogn uVi aghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKt tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A
Clarence Reed	Proofreader Technical writer Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A
Sultan Khalid	Manufacturing and Testing Leader Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A

Dacory Harris	Organizer Presentation Manager Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A
Mohammed Suliman	Graphics/Models Leader Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A
Kennedy Simmons	Recorder Participate in deciding whether or not a concept is considered a “go or no go”	In progress	N/A

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 10.23.2020 **Time:** 11am - 12pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Omar Attia
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 8 on Concept Evaluation

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to collaboratively define creita applicable to all of the sub-function. Each member imputed what they felt was important for the success of the project. Once the list was compiled the team discussed the importance of each criteria and removed duplicates.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

In addition to our regularly scheduled meetings the group decided to meet saturday and monday to ensure progress is being made. Status report seven is very collaborative so it is imperative that we add those extra meeting hours.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	
Joshua Cooper	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	
Mustafa Jaffara	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	
Malik Williams	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	
Darryl Geyen	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	

Omar Attia	Continue to Complete Status Report 8 individually assigned criteria evaluations	Completed Status Report 7 individually assigned concept evaluations	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 10.26.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Omar Attia
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 8 on Concept Evaluation

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting each member applied the necessary criteria to each concept. Once each member was complete we were able to form a "GO/NO-GO" table to quickly evaluate the concepts.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	
Joshua Cooper	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	
Mustafa Jaffara	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	
Malik Williams	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	
Darryl Geyen	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	

Omar Attia	Apply criteria to each concept and determine if its a GO or NO GO	Continue to Complete Status Report 8 individually assigned criteria evaluations	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 10.20.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 8 on Concept Evaluation

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting with the team evaluated each concept to narrow down the concepts to be used in our project. Each member should scored the concepts using the criteria that was given. Using a scale from 1-10 each member graded the criterias importance to functionality. Once the weighted score were calculated we determined that the concepts with the highest scores would proceed in the experiment.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

As a group we decided to meet again in the evening of 10/28/20 in order to make sure as a group we met all the requirements.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	
Joshua Cooper	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	
Mustafa Jaffara	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	
Malik Williams	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	
Darryl Geyen	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	

Omar Attia	Score and calculate weighted scores for all concepts.	Apply criteria to each concept and determine if its a GO or NO GO	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: October 22, 2020 Meeting Time: 1:00pm-2:00pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Open questions prior to last meeting with advisors
- Status Report
- Manual

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with the discussion of the Individual Concepts with advisors. It was mostly a revision meeting. Dr. Duan went over the Final Status Report with the group. Each concept has a discussion with a note attached. Dr. Park mentioned that the concepts and figures did not match each other. After, Mercedes asked for clarification on the siting sources. Dr. Duan referred us to the manual.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

We did not do the Individual Concepts correctly, all group members. To resolve the issue we got the assignment date pushed back until Sunday to correct the mistakes.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7
Donald Conner	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7
Crystal Gibbs	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7
Mercedes Johnson	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7
Joseph Rogers	Correct your Individual Concepts	#7 Document Status Report Work on meeting minutes. Due on Wednesday.	Attended the meeting, accepted feedback on Document #7

KJ Boyd	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7
Ramiz Zaidi	Correct your Individual Concepts	#7 Document Status Report	Attended the meeting, accepted feedback on Document #7

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: October 26, 2020 Meeting Time: 8:00pm-10:00pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Feedback on Document #7
- Status Report #8

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with a discussion about the feedback with Document #7. Mercedes went over the group grading and why each individual got what grade. The work was not well put together even with the date pushed back. After the criticism Mercedes gave brief description over Status Report #8. We ended the meeting on coming up with a new schedule to finish this assignment correctly and on time.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No problems encountered during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	None Be available for tomorrow's meeting.	None	Feedback over Document #7
Donald Conner	None Be available for tomorrow's meeting.	None	Feedback over Document #7
Crystal Gibbs	None Be available for tomorrow's meeting.	None	Feedback over Document #7
Mercedes Johnson	None Be available for tomorrow's meeting.	None	Feedback over Document #7
Joseph Rogers	None Be available for tomorrow's meeting.	Work on meeting minutes. Due on Wednesday.	Feedback over Document #7

KJ Boyd	None Be available for tomorrow’s meeting.	None	Feedback over Document #7
Ramiz Zaidi	None Be available for tomorrow’s meeting.	None	Feedback over Document #7

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: October 27, 2020 Meeting Time: 11:00am-2:00pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- GO-NO-GO Chart

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off Mercedes going over the GO-NO-GO Chart. She went over each concept that was for each requirement. She then marked GO or NO-GO for every criteria she had. After as a group we voted on the concepts by GO or NO-GO vote. She went on to do this for 11 more concepts to go. Naomi followed after, and each group member did also. After each member presented, we did the Concept Criteria Selection.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No problems encountered during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts
Donald Conner	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts
Crystal Gibbs	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts
Mercedes Johnson	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts
Joseph Rogers	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night Work on meeting minutes. Due on Wednesday.	Added on to Concept Criteria Selection Came up with final concepts

KJ Boyd	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts
Ramiz Zaidi	Work on GO-NO-GO Add to Concept Criteria Selection	None from previous night	Added on to Concept Criteria Selection Came up with final concepts

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 9
10/29/20-11/4/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 10/29/20 Meeting Time: 7:00-9:05

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Asher Carson, Kendall Lemons, Bryce Boyd

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting served as a confirmation discussion on the concept evaluation status report. Group members discussed the top concepts for each subfunction.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Discussed the agenda for the meeting, presented the goals of the night, and laid out the format for the meeting.

Jeremy: Served as the meeting moderator, carefully analyzed each sub function for the group members to pick the top choice.

Kapi: Discussed self-generated concepts, gave input as to what concepts decided to be chosen for each sub-function.

Asher: Gave insight when self-generated concepts were up for top spot, collaborated with team members as to which concepts should be chosen for each sub-function.

Bryce: Weighed concepts for sub-functions, helped determine the top concept for each sub-function.

Kendall: Discussed top concepts with Jeremy, helped determine the best fit conce

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Successful meeting. All sub-functions were assigned a top concept.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action
Kendall Lemons	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary. Meeting minutes	No Action
Kapiduach Echarry	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action
Jeremy Hunter	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1. Meeting moderator	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action
David Ottinwa	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action
Alex DeShields	Discussed top concept for: 1.1.1, 1.2.1, 1.2.2, 2.1.2, 2.2.1, 2.2.3, 2.2.4 2.3.2, 3.1.2, 3.3.1, 4.1.2, 4.2.2, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action
Bryce Boyd	Discussed top concept for: 1.1.1, 1.1.2, 1.2.2, 2.1.2, 2.2.1, 2.2.2 2.2.4 2.3.2, 3.1.2, 3.1.3, 3.3.1, 4.2.1, and 4.3.1.	Take additional looks at self-generated concepts, make detailed sketches if necessary	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 10/30/20 Meeting Time: 3:00-6:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Bryce Boyd, Asher Carson, Kendall Lemons, David Otinwa

Agenda for Meeting (Items to be discussed or discussed at the meeting)

This meeting was to update Ball Aerospace with where we are in the project. We wanted to discuss how he thought of our work in evaluating the concepts. We also wanted his feedback and to critique our final concepts. The last thing we planned to do with Ball Aerospace was to start talking with two members from the design team (Mike and Sean). After we were done talking to Ball the team would seek to clarify status report 9 and possibly start the process of assigning people final concepts to start analyzing as well as filling out table 5.1in the 'Status Report 9' document.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Alex DeShields: Opened meeting by discussing the agenda for this meeting with Ball Aerospace and asked Neil if he had anything to add for the meeting's agenda.

Neil: Said he thought what we had prepared was good and requested the documents for status report 8 and the lecture presentation for status report 9 so he could understand what we'd be doing from the professors' perspective as well.

Alex (At start of meeting after Neil left): Told the tentative plan for this meeting and the next few. Reviewed status report 9 and asked if there were any questions.

Multiple group members: Asked if he could review the overall concept for the project again just to make sure we were all on the same page.

Alex: Reviewed the finer details of the main goal of the project. Next gave out assignments of how we were going to be filling out section 5.1 of the status report

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Good participation in group discussion and good collaboration in discussing how the team would

go about completing the next few steps of the project. There were no major encounters or disputed to be resolved.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Break down the following final concepts into base components and fill out table 5.1.: 1.1.1, 3.1.2, 1.2.1	Finish the final section of status report 8. Writing the reason why each was selected.	No Action
Kendall Lemons	Break down the following final concepts into base components and fill out table 5.1.: 2.2.5, 3.1.3, 1.1.2	Meeting minutes. Proof read status report 8and suggest any last-minute changes	No Action
Kapiduach Echarry	Break down the following final concepts into base components and fill out table 5.1.: 2.2.1, 1.1.2, 2.1.2	Proof read status report 8 and suggest any last-minute changes	No Action
Jeremy Hunter	Break down the following final concepts into base components and fill out table 5.1.: 2.3.1, 4.2.2, 4.3.2	Finish the final section of status report 8. Leading discussion.	No Action
David Otinwa	Break down the following final concepts into base components and fill out table 5.1.: 4.1.1, 4.2.1, 2.3.1	Create cover sheet for report 8 and turn it in to professors. Proof read status report 8and suggest any last-minute changes	No Action
Alex DeShields	Break down the following final concepts into base components and fill out table 5.1.: 2.1.3, 2.2.1, 2.3.2 Meeting minutes.	Compile, format, and send out report to those who would proof read. Make last minute revisions	No Action

Bryce Boyd	Break down the following final concepts into base components and fill out table 5.1.: 2.2.4, 3.2.1, 3.2.3	Finish the final section of status report 8. Writing the reason why each was selected.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 11/3/20 Meeting Time: 7:00-9:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Bryce Boyd, Asher Carson, Kendall Lemons, David Otinwa

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was to review what we had started in each member's section of the report (question 5.1) and to address any questions with how we would be moving on once we got Duan's finished review of what we've done so far. We also intended to solidify a timeline for the next meeting and when things would be due.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Opened meeting by discussing the agenda for the meeting and asked if there would be anything inhibiting people from meeting up this Thursday and Friday to further discuss what was expected and how we would be moving on.

Group: No one objected to meeting up Thursday and Friday.

Kapi: Asked if we could start moving on with the analysis section of the report even if Duan hadn't reviewed the other section that we sent to him yet.

Alex: Suggested that we should wait just to make sure we don't have to repeat any work, but it wouldn't be bad if the group wanted to start.

David: Asked questions on what specifically was required of each person for the next part of the status report

Alex: Pulled up "Status report 9 Preliminary and Detailed Analysis" and walked through what would be expected from each member. Mainly that all were expected to fill out a section for each of the concepts given

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Good participation in group discussion and good collaboration in discussing how the team would go about completing the next few steps of the project. There were no major encounters or disputed to be resolved.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Start analyzing the parts of each of the following release mechanisms: 1.1.1, 3.1.2, 1.2.1	Break down the following final concepts into base components and fill out table 5.1.: 1.1.1, 3.1.2, 1.2.1	No Action
Kendall Lemons	Start analyzing the parts of each of the following release mechanisms: 2.2.5, 3.1.3, 1.1.2	Break down the following final concepts into base components and fill out table 5.1.: 2.2.5, 3.1.3, 1.1.2	No Action
Kapiduach Echarry	Start analyzing the parts of each of the following release mechanisms: 2.2.1, 1.1.2, 2.1.2	Break down the following final concepts into base components and fill out table 5.1.: 2.2.1, 1.1.2, 2.1.2	No Action
Jeremy Hunter	Start analyzing the parts of each of the following release mechanisms: 2.3.1, 4.2.2, 4.3.2	Break down the following final concepts into base components and fill out table 5.1.: 2.3.1, 4.2.2, 4.3.2	No Action
David Otinwa	Start analyzing the parts of each of the following release mechanisms: 4.1.1, 4.2.1, 2.3.1	Break down the following final concepts into base components and fill out table 5.1.: 4.1.1, 4.2.1, 2.3.1	No Action

Alex DeShields	Start analyzing the parts of each of the following release mechanisms: 2.1.3, 2.2.1, 2.3.2 Meeting minutes	Break down the following final concepts into base components and fill out table 5.1.: 2.1.3, 2.2.1, 2.3.2	No Action
Bryce Boyd	Start analyzing the parts of each of the following release mechanisms: 2.2.4, 3.2.1, 3.2.3	Break down the following final concepts into base components and fill out table 5.1.: 2.2.4, 3.2.1, 3.2.3	No Action

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: October 28, 2020 Meeting Time: 10:30pm-12:00pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Open questions prior to last meeting
- Status Report #8
- Manual

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with the discussion of the Individual Concepts. The group came up with a total of 75 concepts. Out of those 75 we narrowed the list down to the best 20 concepts. After that we went back in the GO-NO-GO Table. After the update, we started on Weighted Score

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No problems encountered during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting
Donald Conner	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting
Crystal Gibbs	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting
Mercedes Johnson	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting
Joseph Rogers	Work on GO-NO-GO Weight Score	#7 Document Status Report Work on meeting minutes. Due on Wednesday.	Attended the meeting

KJ Boyd	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting
Ramiz Zaidi	Work on GO-NO-GO Weight Score	#7 Document Status Report	Attended the meeting,

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: October 31 2020 Meeting Time: 4:00pm-6:30pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Status Report #9

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with a discussion about Document #9. Mercedes went over the detailed analysis. In the analysis it should be fully descriptive. Also, to provide equation numbers that can be cited in the report. After her explanation she went and gave several examples.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No problems encountered during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting
Donald Conner	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting
Crystal Gibbs	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting
Mercedes Johnson	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting Insert files in the drive
Joseph Rogers	Work on your component analysis	GO-NO-GO Weight Score Work on meeting minutes. Due on Wednesday.	Attended the meeting

KJ Boyd	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting
Ramiz Zaidi	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting,

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 4
MINUTES OF GROUP MEETINGS

Meeting Date: November 2, 2020 Meeting Time:2:30pm-4:00pm Meeting Location: Zoom

Members Present: Naomi Boje, KJ Boyd, Donald Conner, Crystal Gibbs, Mercedes Johnson, Joseph Rogers, Ramiz Zaidi

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Feedback on Status Report 8

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off Dr. Duan going over Status Report 8. He mentions to name the subtitles different, but the concept names can stay the same. He also includes that we reference the sections when we talk about the concepts. After that we moved to Status Report #9. We got a better understanding, more clarification on what is asked.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No problems encountered during the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Naomi Boje	Work on your component analysis Status Report #9	GO-NO-GO Weight Score	Attended the meeting
Donald Conner	Work on your component analysis Status Report #9	GO-NO-GO Weight Score	Attended the meeting
Crystal Gibbs	Work on your component analysis Status Report #9	GO-NO-GO Weight Score	Attended the meeting
Mercedes Johnson	Work on your component analysis	GO-NO-GO Weight Score	Attended the meeting
Joseph Rogers	Work on your component analysis Status Report #9	GO-NO-GO Weight Score Work on meeting minutes. Due on Wednesday.	Attended the meeting

KJ Boyd	Work on your component analysis Status Report #9	GO-NO-GO Weight Score	Attended the meeting
Ramiz Zaidi	Work on your component analysis Status Report #9	GO-NO-GO Weight Score	Attended the meeting,

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group 3

Meeting Date: October 30, 2020 Meeting Time: 11am - 2pm
Meeting Location: https://pvpanther.zoom.us/j/8487601860?pwd=TVdIVFpKZ0JHa1NoRWNpWENuNWRqQ

Members Present:

Christian White, Fanta Kaba, Diana Morales, Abdullah El Aker, Yemboado Yonli, and Marcelo Epam Ona

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The agenda for this meeting was to go over report 9 to see what we needed to do in order to start the report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Christian White
- Suggested begin putting final report together

Fanta Kaba
- Suggested time scale for the assigned parts

Diana Morales
- Suggested we all go and rewatch the video of class to further understand the report requirements.

Abdullah El Aker
- Suggested to spend more time research and reinforcing our literature review

Yemboado Yonli
- Suggested that the meeting be pushed till group member understand what need to be done

Marcelo Epam Ona
- Suggested group members should look at past reports and understand the current assigned status report.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Christian White
- Began compiling past status reports

Fanta Kaba
- Gave my opinion on what could be done to go about the report

Diana Morales
- Begin to review the report for further understanding.

Abdullah El Aker
- Started organizing the titles for the final report

Yemboado Yonli

- Reviewed the class notes to understand the status report
- Shared meeting room

Marcelo Epam Ona

- Fill up the some components and subject to be analyzed on the table.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Fanta Kaba	Assigned to create description analysis and detailed engineering analysis	Yes	
Diana Morales	Assigned to create description analysis and detailed engineering analysis on assigned parts.	Yes	
Marcelo Epam Ona	Assigned the description analysis of some components.	Yes	
Christian White	Began compiling past status reports for submission of final report later in the semester.	Yes	

Yemboado Yonli	Reviewed the class notes to understand the status report Shared meeting ID	Yes	
Abdullah EL Aker	Researched articles on existing setups. Started structuring the final report.	Yes	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Meeting Date: November 4, 2020 Meeting Time:
Meeting Location: https://pvpanther.zoom.us/j/8487601860?pwd=TVdIVFpKZ0JHa1NoRWNpWENuNWRqQ

Members Present:

Christian White, Fanta Kaba, Diana Morales, Abdullah El Aker, Yemboado Yonli, and Marcelo Epam Ona

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The agenda for this meeting was to work on the assigned part to each group member. We also met with our advisor to receive his input on this report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Christian White
- Suggested to proofread report as we go along

Fanta Kaba
- Suggested asking for report graders input on analysis part

Diana Morales
- Suggested that we send the report to Dr. Shaifee as soon as possible to get feedback.

Abdullah El Aker
- Suggested to read some books related to the existing potential setups

Yemboado Yonli
- Suggested a time to meet
- Suggested that the project owner be contacted
- Suggested important detailed to be add on the apparatus

Marcelo Epam Ona
- Suggested group members should ask questions when needed.
- Suggested group memes to focus on the criterias the status report grader wants.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Christian White
- Assigned to complete portion of the report

Fanta Kaba
- Assigned to complete analysis of the report

Diana Morales
- Assigned to complete individually assigned parts further.

Abdullah El Aker
- Completed the assigned parts

Yemboado Yonli
- Split the work for group members
- Discussed with project owner to create a bill of materials
- Reviewed the important parts of the status report

Marcelo Epam Ona
- Worked on some of the components in the table.
- Evaluated the overall status report, making sure it looks good and compacted.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Fanta Kaba	Assigned to complete the analysis I was assigned to.	Yes	
Diana Morales	Assigned to continue to complete the indinvulay assigned portion of report.	Yes	
Marcelo Epam Ona	Evaluate the overall report, making sure it was well formatted and compacted.	Yes	
Christian White	Make corrections as needed submit overall report to project advisor	Yes	
Yemboado Yonli	Split work between group members Discussed with project owner to create a bill of materials	Yes	

	Reviewed the important parts of the status report		
Abdullah EL Aker	Read some books to help understand and develop the potential setups. Completed individual part in the part	Yes	

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 10
11/5/20-11/11/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 11/7/2020 Meeting Time: 7:00PM–11:20PM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: Ximena Cifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J, Daniel Akpan, David Trevino
Excused Members:
Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Work on project assignment 9: Detailed Engineering Analysis
- Every member should work on their assigned part

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- Ximena Cifuentes: Ximena introduced the meeting agenda to the group and reminded everyone with their assigned parts and with the steps that needs to be followed for this project assignment. Then Ximena started working on the introductory paragraph of the assignment. Also, Ximena during this meeting was available to answer any questions that is being asked by the members.

- Demetrious Sandford: During the following meeting Demetrious was working on pump efficiency and finding the appropriate pump for the oil skimmer. Demetrious had to come up with a free body diagram that explains all the parameters that the skimmers pump will face, and he had to calculate the efficiency based on these parameters. In addition, from the obtained calculations Demetrious had to look for a pump that fits the pump efficiency that he calculated. Demetrious also had to come up with the next meeting schedule.

- Amna Ansari: During the following meeting Amna was working on the dimensional analysis of the skimmer. Amna came up with two free body diagrams, one that displays the body of the skimmer and the components that are attached on it. The other FBD explained the oil tank and the components that will be attached on it as well. Amna also had to create the meeting minutes for the following meeting.

- Caleb Riggins: Caleb was working on the floating mechanism of the skimmer. Caleb came up with a u-shaped body for the skimmer which going to help with the floatation of the skimmer. Caleb had to come up with a free body diagram to explain his concept along with the calculations. Caleb also was reviewing other members works and formatting to ensure that everyone following the correct format for project assignment 9: Detailed Engineering Analysis.

- Daniel Akpan: During the following meeting Daniel was assigned to work on the disk design. Which is the mechanism that will allow to change the orientation for the skimmer disks based on different oil viscosities and oil slick thickness. Daniel also had to create a free body along with calculation to explain his concept. Then he must pick a product that describes all his calculations.

- Amna J: Amna was working on shaft analysis during the following meeting. Amna had to create a free body diagram that showcase all the force analysis that the shaft going to face. Along with the free body diagram Amna must present calculations that describes her concept, then she must look for a product that follows all her final calculations

- David Trevino: David was assigned to work on the motor analysis of the oil skimmer. David had to create a free body diagram that presents the motor with all the parameters that the skimmer motor going to go through. Also, David must come up with calculations that explains his concept in detail.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)
All members present were fully active and participated throughout the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Create a meeting agenda, assign members to a specific part, explain the format of the assignment, write introductory paragraphs	- A meeting agenda - An assigned part for each member of the group - An introductory paragraph for the project assignment	
Demetrious Sandford	Work on pump efficiency analysis, create a FBD, create calculations, schedule the next meeting	- A finalized work on pump efficiency - A final FBD of the pump efficiency - A scheduled meeting	
Amna Ansari	Work on dimensional analysis of the oil skimmer, create sketches with all the components dimensions, create the meeting minutes	- A finalized dimensional analysis of the skimmer - A finalized sketch with the dimensions assumed for the parts - A meeting minutes created	
Caleb Riggins	Work on floating mechanism of the skimmer, create a u-shaped body analysis, check the report formatting	- A floatation mechanism analysis - A finalized FBD of the flotation analysis - A correctly formatted project assignment report	
Amna J	Work on shaft analysis of the oil skimmer, create a FBD for the shaft analysis along with calculations explaining the concept	- A shaft analysis of the skimmer - A FBD diagram of the analysis - A finalized calculation	
Daniel Akpan	Work on mechanism that will allow the orientation of the skimmer, create a FBD of the analysis along with calculations to explain the concept	- A final skimmer disk analysis - A FBD of the skimmer - A finalized calculation	
David Trevino	Work on motor analysis of the skimmer, create a FBD of the analysis along with calculations to explain the concept	- A final motor analysis - A FBD of the skimmer - A finalized calculation	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 11/9/2020 Meeting Time: 7:00PM–10:30PM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: Ximena Cifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J, Daniel Akpan, David Trevino
Excused Members:
Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Finalize project assignment 9: Detailed Engineering Analysis
- Try to send the report to Dr.Peng

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- Ximena Cifuentes: Ximena introduced the meeting agenda to the group and reminded everyone that they must try to complete their assigned part by the end of this meeting. Then, Ximena tried to help everyone with their part and proofread and check their assignment formatting.

- Demetrious Sandford: During the following meeting Demetrious was working on finding an appropriate part that follows all his design calculations. After finding and researching different part specification, Demetrious found a pump that satisfy his calculations.

- Amna Ansari: During the following meeting Amna was working on the dimensional analysis sketches, while finding design components that fit her parts calculations. Amna, also had to create the meeting minutes for the following meeting.

- Caleb Riggins: Caleb was working on finding a skimmer body that satisfy his skimmer body design. Caleb was researching different skimmer bodies specifications until he found one with similar flotation analysis and dimensional analysis. After completing his part of the project assignment, Caleb started checking other members formatting.

- Daniel Akpan: During the following meeting Daniel was also working on finding the perfect part that fit all his calculations for the skimmer disk. Daniel was trying to find a grooved disk skimmer.

- Amna J: Amna was working on finding a part specification that fit her shaft analysis. After finding the part, Amna added it to the project assignment 9 report.

- David Trevino: David was assigned to working on finalizing his motor analysis. After finishing his analysis David worked on finding a part specification that fit his calculation results.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)
All members present were fully active and participated throughout the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Create a meeting agenda, check members work and formatting, help members with their assigned part	- A meeting agenda - A finalized project assignment 9 report - A finalized formatting of the report	
Demetrious Sandford	Work on finding a specific part specification of a pump, create next meeting schedule	- A finalized work pump efficiency - A research on pump specification that fit proposed calculations - A meeting schedule	
Amna Ansari	Work on finding design specification that fit proposed skimmer dimension, create meeting minute	- A finalized dimensional analysis of the skimmer - A final part specification that fit proposed dimensions - A meeting minute	
Caleb Riggins	Work on floating mechanism of the skimmer, search for a u-shaped skimmer design with the proposed specifications, finalized the report formatting	- A floatation mechanism analysis - A final part specification - A correctly formatted project assignment report	
Amna J	Work on shaft analysis of the oil skimmer, find shaft specification that fit proposed analysis	- A shaft analysis of the skimmer - A final shaft that fits proposed shaft analysis	
Daniel Akpan	Work on mechanism that will allow the orientation of the skimmer, find a grooved skimmer	- A final skimmer disk analysis - A grooved skimmer that fit final design calculations	
David Trevino	Work on motor analysis of the skimmer, find a motor that fit proposed calculations of the motor	- A final motor analysis - A part specification that fits the proposed motor analysis	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.6.2020 **Time:** 11am - 12pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 9 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 9

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 9. Each member was able to leverage other team members knowledge for their respective design analysis.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

In addition to our regularly scheduled meetings the group decided to meet saturday and monday to ensure progress is being made. Status report nine is very collaborative so it is imperative that we add those extra meeting hours.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	
Joshua Cooper	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	
Mustafa Jaffara	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	
Malik Williams	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	
Darryl Geyen	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	

Omar Attia	Continue to Complete Status Report 9 on planning design analysis	Continued to complete Status Report 9 on planning design analysis	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.9.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Omar Attia
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 9 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 9

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 9. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	
Joshua Cooper	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	
Mustafa Jaffara	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	
Malik Williams	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	
Darryl Geyen	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	

Omar Attia	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Completed Status Report 9 on planning design analysis	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.3.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Meet with Dr. Shafiee
- Discuss the roles for every member to complete Status report 9 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 9

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with the team having a detailed discussion regarding the analysis of our design. Each member was able to give a report to Dr. Shafiee regarding his completed work. After each members report Dr. Shaffie gave recommendations on how to improve upon the design for a more seamless and efficient experiment.

During this meeting the team used this time to complete progression checks for status report 9. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

As a group we decided to meet again in the evening of 11/4 in order to make sure as a group we met all the requirements.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	
Joshua Cooper	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	
Mustafa Jaffara	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	
Malik Williams	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	
Darryl Geyen	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	

Omar Attia	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation	Progressing to complete Status Report 9 on detailed Engineering Analysis and simulation	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: Nov. 4 2020 Meeting Time: 8:00-11:00 PM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Make the following corrections needed for report 7:
1)Need descriptions
2) Title before each concept
3) arrange in the format Biney informed
4) bring the table at top
5) make pictures bit large

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Shikhar: “Shikhar :Let’s work on it together in zoom so we don’t make mistakes

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn khhvtn i gghtbo	Dgdpgkkl cgn uVi acghgr & nBl i thgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKk tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser • Add descriptions for each figure main figure	Completed	N/A
Clarence Reed	Proofreader Technical writer • Complete Q4 with the group	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader • Add descriptions for each figure	Completed	N/A
Dacory Harris	Organizer Presentation Manager • Rename title in sub-figures and make figures larger for the main figure • Rewrite the instructions/objectives into past tense	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Add descriptions for each main figure	Completed	N/A
Kennedy Simmons	Recorder ● Rename title in sub- figures and make figures larger ● Rewrite the instructions/objectives into past tense	Completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: Nov. 8 2020 Meeting Time: 9:30-11:00 PM Meeting Location: Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

For the 9 status preliminary design report, include everyone's input for filling out the table. Fill out the table 5.1 and return it to Dr. Biney for signature

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Shikhar said that we are not designing parts, we're going to list buy them from a company.
Everyone listed the books we could use as reference. (Material science engineering and introduction)
Sultan suggested for the valve we can use the book of thermodynamics.
Mohammed said that we should extend the length of the condenser piper and that we should know all of the characteristics of the pipe.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn kh hvtn i ggHtbo	Dgdpgkkl cgn uVi acgHgr & nBl i tHgr fKVi Hkndn knntobgr tb aKgptVBn i ggHtbo(n)	AultVbn Hkdgb l y oKVBa Vb bVb-agkfVKk tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Clarence Reed	Proofreader Technical writer ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Dacory Harris	Organizer Presentation Manager ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Kennedy Simmons	Recorder ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Nov. 9 2020___Meeting Time:__7:00-9:20 PM Meeting Location:___Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

For Report 9, brainstorm ideas for a new design for the condenser amongst group members.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn kh hvtn i ggHtbo	Dgdpgkkl cgn uVi acgHgr & nBl i tHgr fKVi Hkndn knntobgr tb aKgptVBn i ggHtbo(n)	AultVbn Hkdgb l y oKVBa Vb bVb-agkfVKk tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Clarence Reed	Proofreader Technical writer ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Dacory Harris	Organizer Presentation Manager ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Kennedy Simmons	Recorder ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Nov. 10 2020___Meeting Time:__7:00-8:30 PM Meeting Location:___Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

Everyone brings their model of the new design of the condenser and discusses which design will be reviewed by Biney so we can continue to report 9.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

Sultan: what we should figure out
1) How current bio-oils are being condensed?
2) Find out major gases that are produced after pyrolysis of biomass
3)Thermodynamic properties of gases
4) What types of condensers can be used?
5) Direct Contact Heat exchangers
6) Part mass flow rate plays and how can its variation help
7) Some gases cannot be condensed, how can we use those gases or get rid of them?
8) What kind of solvent/chemical can we use to absorb the produced gas

Dacory said they pipes must be covered.
We all agreed to use Mohammed's design.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

We were not able to get in touch with Dr. Biney so our design could be approved. The problem was solved when the next day after class. Dr. Biney approves our new design

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Anntobgr hV hgki i gi l gKn khhvtn i gghtbo	Dgdtpgkkl cgn uVi acghgr & nBl i tHgr fKVi hkndn knntobgr tb aKgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb-agkfVKi tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Clarence Reed	Proofreader Technical writer ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Dacory Harris	Organizer Presentation Manager ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

Mohammed Suliman	Graphics/Models Leader Design Analysis Leader ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A
Kennedy Simmons	Recorder ● Introduce new design of the condenser ● Figure out the questions sultan presented to us.	Completed	N/A

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GKVBa 2

MINUTES OF GROUP MEETINGS

Meeting Date: __Nov. 11 2020___Meeting Time:__2:30-4:00 PM Meeting Location:___Zoom Link

Members Present: Shikhar Desai, Clarence Reed, Sultan Khalid, Dacory Harris, Mohammed Suliman, and Kennedy Simmons

Agenda for Meeting (Items to be discussed or discussed at the meeting)

2-3 hours working on the corrections for the final report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Kennedy suggested that we each start off revising a report and track our changes. When completed, we pass it to the other member to revise and continue that for each report.

Shikhar said that instead of working on each report, we should work on each section and then pass it to the next member to revise.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

There were no issues

MEETING TASm ASSIGNMENT & DELIeERAs LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Nki g	Tknd Annto bgr hV hgki i gi l gKn kh hvtn i gghtbo	Dgdtpgkkl cgn uVi acghgr & nBl i thhgr fKVi hkndn knntobgr tb akgptVBn i gghtbo(n)	AuhtVbn hkdgb l y oKVBa Vb bVb- agkfVKk tbo i gi l gK
Shikhar Desai	Ideas Facilitator Budgeter/ Purchaser • Revise you're assigned section/report	Completed	N/A
Clarence Reed	Proofreader Technical writer • Revise you're assigned section/report	Completed	N/A
Sultan Khalid	Manufacturing and Testing Leader • Assign each group member a section to revise • Revise you're assigned section/report	Completed	N/A
Dacory Harris	Organizer Presentation Manager • Revise you're assigned section/report	Completed	N/A
Mohammed Suliman	Graphics/Models Leader Design Analysis Leader • Revise you're assigned section/report	Completed	N/A

Kennedy Simmons	Recorder ● Revise you're assigned section/report	Completed	N/A

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 11
11/12/20-11/18/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 11/12/20 Meeting Time: 4:00-6:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Asher Carson, David Otinwa, Bryce Boyde, Kendall Lemons

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was to discuss as a team how we would break down the remaining two concepts and how we would split up the work. We also wanted to talk with professor Duan to make sure the work we had started was already on the right track. Lastly we wanted to set deadlines for having everything done.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Opened meeting by discussing the agenda for this meeting. He discussed what had been done and asked team if there was anything else that needed to be done before we talked to professor Duan.

Jeremy: Suggested we make a few tweaks on the format but altogether though the report was ready to be looked at by professor Duan.

Alex (once professor Duan enter the call): Asked him if he could look at the team design and suggest how we could edit it.

Duan: After pulling up the document that was emailed to him, he gave feedback to the team regarding format and how the team would be using the formulas to see what kind of material we would be using instead of just arbitrary designs.

Alex (after professor Duan had left): Broke down the suggested work into two groups (similar to the groups that were formed at the end of the last meeting. Assigned each leader (Jeremy and Asher) a part of the report to revise in the ways which Duan asked. Ended meeting by giving a timetable so group would be done by the extended due date.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Good participation in group discussion and good collaboration in discussing how the team would go about completing the next few steps of the project. There were no major encounters or disputed to be resolved.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	As leader of a team (himself, Kendall, and Bryce) revise sections 5.2.4-5.2.6 for status report 9	Head up a team (himself, Kendall, and Bryce) and develop his design idea for status report 9	No Action
Kendall Lemons	Meet up with Asher on Friday to know how he should revise his section of status report 9.	Meet up with Asher on Sunday and develop what is assigned to him by Monday night for status report 9.	No Action
Kapiduach Echarry	Meet up with Jeremy on Friday to know how he should revise his section of status report 9.	Meet up with Jeremy on Sunday and develop what is assigned to him by Monday night for status report 9.	No Action
Jeremy Hunter	As leader of a team (himself, Kapi, and David) revise sections 5.2.1-5.2.3 for status report 9	Head up a team (himself, Kapi, and David) and develop his design idea for status report 9	No Action
David Otinwa	Meet up with Jeremy on Friday to know how he should revise his section of status report 9.	Meet up with Jeremy on Sunday and develop what is assigned to him by Monday night for status report 9.	No Action
Alex DeShields	Compile final reports from Asher and Jeremy and format them into a final product. Meeting minutes.	Compile final reports from Asher and Jeremy and format them into a final product. Meeting minutes.	No Action
Bryce Boyd	Meet up with Asher on Friday to know how he should revise his section of status report 9.	Meet up with Asher on Sunday and develop what is assigned to him by Monday night for status report 9.	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 11/13/20 Meeting Time: 3:00-5:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Asher Carson, David Otinwa, Bryce Boyde, Kendall Lemons

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was to update Ball Aerospace with where we are in the project. We wanted to see if Neil had developed any feedback and to critique our final two concepts or if he favored one over the other and why. After we were done talking to Ball the two different teams (Asher Kendall Bryce/Jeremy David Kapi) would meet up in breakout rooms and discuss what they would be doing to revise section 5.2 of status report 9.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Opened meeting by discussing the agenda for this meeting. He asked Neil what he though of the final two concepts the team had generated.

Neil: was excited about the generated concepts and didn't really lean one way or another as far as which one he favored. He wanted to know when the calculations would be finished so we could choose and develop one of the final designs

Alex: Told him we would have the calculations in the completed report by the next time we would meet up (November 20th 2020). Asked how we would be going about designing and prototyping, specifically budget, material, and which software Ball used.

Neil: Still wasn't sure about a definite budget but was willing to let us use their manufacturing resources to make a prototype and to send it to us for us to work with. Said that ANSYS and NX where fine to be using.

Alex (after Neil and professor Duan had left): Set up a way for the teams to meet and discuss their respective parts of section 5.2. Each team leader assigning work.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Good participation in group discussion and good collaboration in discussing how the team would

go about completing the next few steps of the project. There were no major encounters or disputed to be resolved.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	As leader of a team devise the revise sections 5.2.4-5.2.6 for status report 9. He assigned himself formula and calculation revision for 5.2.4	Prepare the work division for each team member in their group and assign it on Friday.	No Action
Kendall Lemons	Was assigned formula, content, and calculation revisions for section 5.2.5 due on Tuesday.	N/A	No Action
Kapiduach Echarry	Was assigned formula, content, and calculation revisions for section 5.2.3 due on Tuesday.	N/A	No Action
Jeremy Hunter	As leader of a team devise the revise sections 5.2.1-5.2.3 for status report 9. He assigned himself formula and calculation revision for 5.2.1	Prepare the work division for each team member in their group and assign it on Friday.	No Action
David Otinwa	Was assigned formula, content, and calculation revisions for section 5.2.2 due on Tuesday.	N/A	No Action
Alex DeShields	Compile final reports from Asher and Jeremy and format them into a final product. Meeting minutes.	Meeting minutes.	No Action

Bryce Boyd	Was assigned formula, content, and calculation revisions for section 5.2.6 due on Tuesday	N/A	No Action

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
Group #6
MINUTES OF GROUP MEETINGS

Meeting Date: 11/17/20 Meeting Time: 7:00-9:00

Meeting Location: Zoom:https://us04web.zoom.us/j/7708773225?pwd=RklJQTdVcHdsaEVPbTdVZ2VXV0loZz09

Members Present: Kapiduach Echarry, Jeremy Hunter, Alex DeShields, Asher Carson, David Otinwa, Bryce Boyde, Kendall Lemons

Agenda for Meeting (Items to be discussed or discussed at the meeting)
This meeting was to check where everyone was and to see if Alex could get all the parts turned in so he could work on compiling it. If it wasn't done yet the plan was to ask when it would be so it could be turned in.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)
Alex DeShields: Opened meeting by discussing the agenda for this meeting. He asked the team leaders (Asher and Jeremy) if their parts were done so he could start compiling them into the final draft.

Asher: Said his team was complete and asked if Alex had got his email and checked it to make sure it looked okay

Alex: Told Asher he didn't see the email but he would check shortly and let him know how it looked and if it needed to be revised any further.

Kapi: Said he was not yet done with what Jeremy had given him to do but he'd get it to Alex before the end of the night

Alex: Looked at Asher's report and said it looked good.

Jeremy: Told Kapi and David to break off into a breakout room so they could finish what was leftover together.

Jeremy's Team: Did a good job at communicating different formulas and sources to finish their part and send it to Alex

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

Good participation in group discussion and good collaboration in discussing how the team would go about completing the next few steps of the project. There were no major encounters or disputed to be resolved.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Asher Carson	Study what the professors want out of status report 10 and get ready to start the report next meeting (Thursday)	As leader of a team devise the revise sections 5.2.4-5.2.6 for status report 9. He assigned himself formula and calculation revision for 5.2.4	No Action
Kendall Lemons	Study what the professors want out of status report 10 and get ready to start the report next meeting (Thursday)	Was assigned formula, content, and calculation revisions for section 5.2.5 due on Tuesday.	No Action
Kapiduach Echarry	Finish compiling the revision their section of status report 9. Namely, redoing formulas and calculations done incorrectly	Was assigned formula, content, and calculation revisions for section 5.2.3 due on Tuesday.	No Action
Jeremy Hunter	Finish compiling the revision their section of status report 9. Namely, redoing formulas and calculations done incorrectly	As leader of a team devise the revise sections 5.2.1-5.2.3 for status report 9. He assigned himself formula and calculation revision for 5.2.1	No Action
David Otinwa	Finish compiling the revision their section of status report 9. Namely, redoing formulas and calculations done incorrectly	Was assigned formula, content, and calculation revisions for section 5.2.2 due on Tuesday.	No Action

Alex DeShields	Meeting minutes. Compile the final report.	Compile final reports from Asher and Jeremy and format them into a final product. Meeting minutes.	No Action
Bryce Boyd	Study what the professors want out of status report 10 and get ready to start the report next meeting (Thursday)	Was assigned formula, content, and calculation revisions for section 5.2.6 due on Tuesday	No Action

AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.13.2020 **Time:** 11am - 12pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Review the roles for each team member that were necessary to complete Status report 9 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 9

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 9 due this week. Each member was able to leverage other team members knowledge for their respective design analysis.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

In addition to our regularly scheduled meetings the group decided to meet saturday and monday to ensure progress is being made. Status report nine is very collaborative so it is imperative that we add those extra meeting hours.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue to Complete Status Report 9 on planning design analysis for data acquisition units	Continued to complete Status Report 9 on planning design analysis for data acquisition units	
Joshua Cooper	Continue to Complete Status Report 9 on planning design analysis for wall interior analysis	Continued to complete Status Report 9 on planning design analysis for wall interior analysis	
Mustafa Jaffara	Continue to Complete Status Report 9 on planning design analysis for thermowell analysis	Continued to complete Status Report 9 on planning design analysis for thermowell analysis	
Malik Williams	Continue to Complete Status Report 9 on planning design analysis for wall surface temperature sensor analysis	Continued to complete Status Report 9 on planning design analysis for wall surface temperature sensor analysis	
Darryl Geyen	Continue to Complete Status Report 9 on planning design analysis for Fluid tank analysis	Continued to complete Status Report 9 on planning design analysis for Fluid tank analysis	

Omar Attia	Continue to Complete Status Report 9 on planning design analysis for Wood frame building analysis	Continued to complete Status Report 9 on planning design analysis for Wood frame building analysis	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.16.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Omar Attia
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 9 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 9
- Begin discussing Status Report 10 CAD drawings assignments for each team member

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 9. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation of data acquisition units. Begin CAD simulation on data acquisition units.	Completed Status Report 9 on planning design analysis for data acquisition units	
Joshua Cooper	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation of wall interior. Begin CAD simulation on wall interior section.	Completed Status Report 9 on planning design analysis for wall interior analysis	
Mustafa Jaffara	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation on Thermowell analysis. Begin CAD simulation on Thermowells.	Completed Status Report 9 on planning design analysis for thermowell analysis	
Malik Williams	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation on wall surface temperature sensors. Begin CAD simulation on wall surface temp sensors	Completed Status Report 9 on planning design analysis for wall surface temperature sensor analysis	
Darryl Geyen	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation on Fluid tank analysis.	Completed Status Report 9 on planning design analysis for Fluid tank analysis	

	Begin CAD simulation on Fluid Tank.		
Omar Attia	Continue Completing Status Report 9 on detailed Engineering Analysis and simulation on Wood Frame building. Begin CAD simulation on Wood Frame building.	Completed Status Report 9 on planning design analysis for Wood frame building analysis	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.17.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Meet with Dr. Shafiee
- Discuss the roles for every member to complete Status report 9 for types of design analysis needed for our modular wall system
- Review with Dr.Shafiee our final design analysis for Status Report 9
- Continued to discuss Status Report 10 CAD drawing model assignments for each team member

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with the team having a detailed discussion regarding the analysis of our design. Each member was able to give a report to Dr. Shafiee regarding his completed work. After each members report Dr. Shaffie gave recommendations on how to improve upon the design for a more seamless and efficient experiment.

During this meeting the team used this time to complete progression checks for status report 9. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

As a group we decided to have an extra meeting to discuss any final decisions or minor changes made to the Status Report 9 document.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for data acquisition units. Continue completing CAD simulations.	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation of data acquisition units. Began CAD simulation on data acquisition units.	
Joshua Cooper	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for wall interior. Continue completing CAD simulations.	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation of wall interior. Began CAD simulation on wall interior section.	
Mustafa Jaffara	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for Thermowells. Continue completing CAD simulations.	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation on Thermowell analysis. Began CAD simulation on Thermowells.	
Malik Williams	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for wall surface temperature sensors. Continue completing CAD simulations.	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation on wall surface temperature sensors. Began CAD simulation on wall surface temp sensors	
Darryl Geyen	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for Fluid Tank. Continue	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation on Fluid tank analysis. Began CAD simulation on Fluid Tank.	

	completing CAD simulations.		
Omar Attia	Complete final changes to Status Report 9 on detailed Engineering Analysis and simulation for Wood Frame building. Continue completing CAD simulations.	Continued Completing Status Report 9 on detailed Engineering Analysis and simulation on Wood Frame building. Began CAD simulation on Wood Frame building.	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 9

MINUTES OF GROUP MEETINGS

Meeting Date: 11-13-20 Meeting Time: 6:00PM-9:00PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to start work on status report 9 then to have a working meeting

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

6:00PM-6:30PM (Gary) Assigned sections for work on status report 10
6:30PM-7:30PM (All members) Went through the work that they had completed so far
7:30PM-9:00PM (All members) stayed on the zoom call and continued to work on the assignment

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Pipes, T-Joints, Elbow Joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Valves (Ball Valves), Pump)	Updated the group on the work they had completed	
Iyanulolwa O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fittings, Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Insulation (Fiberglass Insulation), Water Heater (On Demand))	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Work on assigned	Updated the group on the work they had completed	

	section of status report 9/ Conducted literary research on their assigned component (Plate Heat Exchanger, Rubber Seals, Pressure gauge)		
Bryana J	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fixture/bed, Flowmeter (Digital Inline Flowmeter), Shell & Tube Heat Exchanger)	Updated the group on the work they had completed	
Olaniyi O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Power source/surge protector, Thermometer (Direct Immersion Sensor), Radiator)	Updated the group on the work they had completed	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 9

MINUTES OF GROUP MEETINGS

Meeting Date: 11-15-20 Meeting Time: 6:00PM-9:00PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to discuss the work that we have done so far for the 9th report

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

6:00PM-6:30PM (All members) Went through the work that they had completed so far
6:30PM-9:00PM (All members) stayed on the zoom call and continued to work on the assignment

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Pipes, T-Joints, Elbow Joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Valves (Ball Valves), Pump)	Updated the group on the work they had completed	
Iyanulolwa O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fittings, Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Insulation (Fiberglass Insulation), Water Heater (On Demand))	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Work on assigned	Updated the group on the work they had completed	

	section of status report 9/ Conducted literary research on their assigned component (Plate Heat Exchanger, Rubber Seals, Pressure gauge)		
Bryana J	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fixture/bed, Flowmeter (Digital Inline Flowmeter), Shell & Tube Heat Exchanger)	Updated the group on the work they had completed	
Olaniyi O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Power source/surge protector, Thermometer (Direct Immersion Sensor), Radiator)	Updated the group on the work they had completed	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP 9

MINUTES OF GROUP MEETINGS

Meeting Date: 11-17-20 Meeting Time: 6:00PM-9:00PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to discuss the work that we have done so far for the 9th report

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

6:00PM-6:30PM (All members) Went through the work that they had completed so far and shared with the group
6:30PM-9:00PM (All members) stayed on the zoom call and continued to work on the assignment

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Gary T	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Pipes, T-Joints, Elbow Joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Valves (Ball Valves), Pump)	Updated the group on the work they had completed	
Iyanulolwa O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fittings, Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Insulation (Fiberglass Insulation), Water Heater (On Demand))	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Work on assigned	Updated the group on the work they had completed	

	section of status report 9/ Conducted literary research on their assigned component (Plate Heat Exchanger, Rubber Seals, Pressure gauge)		
Bryana J	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Fixture/bed, Flowmeter (Digital Inline Flowmeter), Shell & Tube Heat Exchanger)	Updated the group on the work they had completed	
Olaniyi O	Work on assigned section of status report 9/ Conducted literary research on their assigned component (Power source/surge protector, Thermometer (Direct Immersion Sensor), Radiator)	Updated the group on the work they had completed	

SENIOR DESIGN AND PREFESIONALISM I
FALL 2020

Meeting Minutes 12
11/19/20-11/25/20

ABOVE AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 11/23/2020 Meeting Time: 7:00PM–10:3

0AM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: Ximena Cifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J, Daniel Akpan, David Trevino
Excused Members:
Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Work on project assignment 10
- Introduce assignment 10
- Assign members to create CAD drawings for assigned part

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- Ximena Cifuentes: Ximena introduced project assignment 10: Detailed design and CAD Drawing. Ximena explained to everyone what is needed to be done for this project assignment and made sure that everyone understands the concept behind this assignment. Then Ximena started assigning members parts that they need to design. Ximena was in charge of creating the two drums of the skimmer.

- Demetrious Sandford: During this meeting Demetrious was trying to understand the purpose of project assignment 10, and what exactly needs to be done. Then Demetrious got assigned to create the CAD drawing and analysis of the motor of the oil skimmer. Also, Demetrious had to create the next meeting schedule.

- Amna Ansari: During the following meeting Amna was also trying to understand project assignment 10. Amna was assigned to work on the u-shaped body of the oil skimmer. Amna also had to create the meeting minutes for the assignment.

- Caleb Riggins: Caleb was paying attention to what Ximena was introducing the members and was trying to understand the purpose of project assignment 10: CAD drawing. Caleb was assigned to work on creating the 6 grooved disks of the skimmer.

- Daniel Akpan: During the following meeting Daniel was trying to comprehend project assignment 10: CAD drawings. Daniel was assigned to create the CAD drawing of the motor shell.

- Amna J: During the following meeting Amna was trying to pay attention and trying to understand the purpose of project assignemnt10. Amna was assigned to work on the oil containment of the skimmer.

- David Trevino: During the following meeting David was trying to understand project assignment 10, and what needs to be done for this assignment. David was assigned to work on creating the CAD drawing of the shaft.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)
All members present were fully active and participated throughout the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Create a meeting agenda, introduce project assignment 10: Detailed Design and CAD drawing, assign member parts	- A meeting agenda - A comprehensive assignment - An assigned member to project assignment 10: Detailed Design and CAD drawing	
Demetrious Sandford	Understand project assignment 10, create CAD drawing for the pump shell, create the next meeting schedule	- A comprehended assignment - A assigned part, pump shell - A scheduled meeting	
Amna Ansari	Understand project assignment 10, work on the CAD drawing for a skimmer body, create the meeting minutes	- A comprehended assignment - An assigned part, skimmer body - A meeting minutes created	
Caleb Riggins	Work on floating mechanism of the skimmer, create a u-shaped body analysis, check the report formatting	- A floatation mechanism analysis - A finalized FBD of the flotation analysis - A correctly formatted project assignment report	
Amna J	Work on understanding project assignment 10, work on the cad drawing of the oil container	- A comprehended assignment - Work on assigned part, oil container	
Daniel Akpan	Work on understanding project assignment 10, work on the cad drawing of the motor shell	- A comprehended assignment - Work on assigned part, motor shell	
David Trevino	Work on understanding project assignment 10, work on the cad drawing of the shell	- A comprehended assignment - Work on assigned part, shaft	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP 7 MEETINGS

Meeting Date: 11/24/2020 Meeting Time: 7:30PM–12:30PM Meeting Location: https://zoom.us/j/91354072968#success

Members Present: Ximena Cifuentes, Demetrious Sandford, Caleb Riggins, Amna A, Amna J
Excused Members: David Trevino, Daniel Akpan
Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Decide on which drafting software all the members should use
- Every member should go over the dimensions of their assigned parts, and make sure they fit the while design
- Create the part on the drafting software.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

- Ximena Cifuentes: Ximena introduced the meeting agenda to the group, then had a discussion with the whole group on which drafting software everyone is comfortable using. Then as a group everyone decided on using NX to create their part. Then Ximena asked everyone to go over their parts dimensions and make sure that they make sense with the whole design. Finally, Ximena started on working on creating the drum on NX.

- Demetrious Sandford: with the whole group Demetrious discussed and suggested to choose NX as the drafting software. Then Demetrious started working on creating the pump shell on NX and helping everyone that needed help. Demetrious also created the next meeting schedule.

- Amna Ansari: During the following meeting Amna was also discussing with the group on which software to use for the CAD drawings. Then Amna started on reviewing the dimensions of the parts and made sure that they fit the whole design. Amna also creating the meeting minutes for the meeting.

- Caleb Riggins: During the following meeting Caleb was also communicating with the other group members on which CAD software everyone should create their design on, and which is easier to work on. Then Caleb started working on creating the 6 grooved discs on NX.

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- Amna J: During the following meeting Amna was discussing with her group members and suggesting which software will be easier for everyone to work on. Then Amna started working on creating the oil container on NX.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)
All members present were fully active and participated throughout the meeting.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on nonperforming member
Ximena Cifuentes	Create a meeting agenda, choose a drafting software to create the part design on, work on assigned part	- A meeting agenda - A selected CAD software to create the skimmer design - A finalized dimension - A CAD drawing for the drum of the skimmer	
Demetrious Sandford	choose a drafting software to create the part design on, work on assigned part, create next meeting schedule	- A selected CAD software to create the skimmer design - A CAD drawing for the pump of the skimmer - A finalized dimension - A meeting schedule	
Amna Ansari	choose a drafting software to create the part design on, work on assigned part, create meeting minutes	- A selected CAD software to create the skimmer design - A CAD drawing for the u-shaped of the skimmer - A finalized dimension - A meeting minute	
Caleb Riggins	choose a drafting software to create the part design on, work on assigned part, check part dimension and make sure they fit the skimmer design	- A selected CAD software to create the skimmer design - A finalized dimension - A CAD drawing for the 6 grooved discs of the skimmer -	
Amna J	choose a drafting software to create the part design on, work on assigned part, check assigned part dimensions	- A selected CAD software to create the skimmer design - A finalized dimension - A CAD drawing for the oil container of the skimmer	

AVERAGE

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 11-19-20 Meeting Time: 5:00PM-10:00PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to complete work on status report 9 then confirmed parts for status report 10 after status report 9 is signed and submitted

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

5:00PM-5:30PM (Gary) Confirmed that everyone knew their sections for work on status report 10
5:30PM-6:00PM (All members) Went through the work that they had completed so far
6:00PM-10:00PM (All members) stayed on the zoom call and completed their work on the assignment

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASo ASSIGNMENT & DELIu ERAp LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBrus Vk ig iV9K KVKnVdB9i it nBKVwinse	DVbnVd9nbVBl gKvbVwiVk & BcnKniiVk fdgK i9BaB9BBrus Vk ns vdVhngc BKVwinse(B)	Al ingsBi9aVs ny edgcv gs sgs-vVdfgdKnse KVKnVd
Gary T	Finished work on assigned section of status report 9 (Pipes, T-Joints, Elbow Joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Finished work on assigned section of status report 9 (Valves (Ball Valves), Pump)	Updated the group on the work they had completed	
Iyanulolwa O	Finished work on assigned section of status report 9 (Fittings, Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Finished work on assigned section of status report 9 (Insulation (Fiberglass Insulation), Water Heater (On Demand))	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Finished work on assigned section of status report 9 (Plate Heat Exchanger, Rubber Seals, Pressure gauge)	Updated the group on the work they had completed	
Bryana J	Finished work on assigned section of status report 9 (Digital Inline Flowmeter), Shell & Tube Heat Exchanger)	Updated the group on the work they had completed	
Olaniyi O	Finished work on assigned section of status report 9 (Power source/surge protector, Thermometer (Direct Immersion Sensor), Radiator)	Updated the group on the work they had completed	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 11-22-20 Meeting Time: 8:00PM-10:00PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to discuss the work that we have done so far for the 10th report. The group also discussed edits for previous reports.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

8:00PM-8:45PM (All members) Discussed the work they had completed, and asked for help or clarification if necessary.
8:45PM-9:15 PM (Gary) Discussed comments made on previous status reports, and designated team members to make corrections
9:15PM-10:00PM (All members) stayed on the zoom call and continued to work on the assignment

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASo ASSIGNMENT & DELIu ERAp LES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBrus Vk ig iV9K KVKnVdB9i it nBKVwinse	DVbnVd9nbVBl gKvbVwiVk & BcnKniiVk fdgK i9BaB9BBrus Vk ns vdVhngc BKVwinse(B)	Al ings Bi9aVs ny edgcv gs sgs - vVdfgdKnse KVKnVd
Gary T	Created CAD models of components (Pipes, Ball valves, Radiator, T joints, Elbow joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Conducted Chapter 2 edits and revisions	Updated the group on the work they had completed	
Iyanulolwa O	Created CAD models of components (Power source/surge protector, Insulation(fiberlass), Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Fabricated the table of contents for the final report, organized the contents of the final report	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Created CAD models of components (Plate Heat Exchanger, Water Heater, Flow meter, Thermometer, Pressure gauge)	Updated the group on the work they had completed	
Bryana J	Created CAD models of components (Fixture/bed, Fittings, Shell & Tube Heat Exchanger, pump)	Updated the group on the work they had completed	
Olaniyi O	Conducted status report 8 edits,revisions, Sketches of top two concepts, and evaluation of best design	Updated the group on the work they had completed	

SENIOR DESIGN & PROFESSIONALISM II
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS
GROUP r

MINUTES OF GROUP MEETINGS

Meeting Date: 11-25-20 Meeting Time: 11:30AM-12:30PM Meeting Location: Zoom

Members Present: All Members

Agenda for Meeting (Items to be discussed or discussed at the meeting)

The group is meeting to discuss the work that we have done so far for the 10th report, and the revisions to previous reports/the final report.

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

11:30AM-12:00PM (All members) Went through the work that they had completed so far and shared with the group
12:00PM-12:30PM (All members) discussed the actions needed to be taken to complete the work, and any complications they had. Provided help and clarification to other members.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

No Issues

MEETING TASo ASSIGNMENT & DELIuERApLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

N9KV	T9Ba ABBmas Vk ig iV9K KVKnVdB9i it mBKWinse	DVmhVd9nbVBl gKvbWiVk & BcnKmiiVk fdgK i9BaB9BBmas Vk ms vdVhmgc BKWinse(B)	Al imgs Bi9aVs ny edgcv gs sgs-vVdfgdKmse KVKnVd
Gary T	Created CAD models of components (Pipes, Ball valves, Radiator, T joints, Elbow joints, Connectors, Filter)	Updated the group on the work they had completed	
Zach M	Conducted Chapter 2 edits and revisions	Updated the group on the work they had completed	
Iyanulolwa O	Created CAD models of components (Power source/surge protector, Insulation(fiberlass), Water supply tank/canister, Double Pipe Heat Exchanger)	Updated the group on the work they had completed	
Bryston R	Fabricated the table of contents for the final report, organized the contents of the final report	Updated the group on the work they had completed	
Don B	Ensure meeting minutes are up to date Created CAD models of components (Plate Heat Exchanger, Water Heater, Flow meter, Thermometer, Pressure gauge)	Updated the group on the work they had completed	
Bryana J	Created CAD models of components (Fixture/bed, Fittings, Shell & Tube Heat Exchanger, pump)	Updated the group on the work they had completed	
Olaniyi O	Conducted status report 8 edits, revisions, Sketches of top two concepts, and evaluation of best design	Updated the group on the work they had completed	

BELOW AVERAGE

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.20.2020 **Time:** 11am - 12pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Review the roles for each team member that were necessary to complete Status report 10 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 10

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 10 due this week. Each member was able to leverage other team members knowledge for their respective design analysis.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

In addition to our regularly scheduled meetings the group decided to meet saturday and monday to ensure progress is being made. Status report ten is very collaborative so it is imperative that we add those extra meeting hours.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue to Complete Status Report 10 CAD design on planning design analysis for data acquisition units	Continued to complete Status Report 10 CAD Design on planning design analysis for data acquisition units	
Joshua Cooper	Continue to Complete Status Report 10 CAD Design on planning design analysis for wall interior analysis	Continued to complete Status Report 10 CAD Design on planning design analysis for wall interior analysis	
Mustafa Jaffara	Continue to Complete Status Report 10 CAD design on planning design analysis for thermowell analysis	Continued to complete Status Report 10 CAD Design on planning design analysis for thermowell analysis	
Malik Williams	Continue to Complete Status Report 10 CAD Design on planning design analysis for wall surface temperature sensor analysis	Continued to complete Status Report 10 CAD Design on planning design analysis for wall surface temperature sensor analysis	
Darryl Geyen	Continue to Complete Status Report 10 CAD DEsign on planning design analysis for Fluid tank analysis	Continued to complete Status Report 10 CAD Design on planning design analysis for Fluid tank analysis	

Omar Attia	Continue to Complete Status Report 10 CAD Design on planning design analysis for Wood frame building analysis	Continued to complete Status Report 10 CAD Design on planning design analysis for Wood frame building analysis	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.23.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams, Omar Attia
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Discuss the roles for every member to complete Status report 10 for types of design analysis needed for our modular wall system
- Complete assigned work for status report 10

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

During this meeting the team used this time to complete progression checks for status report 10. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Continue Completing Status Report 10 CAD Design on data acquisition units.	Completed Status Report 10 CAD Design on planning design analysis for data acquisition units	
Joshua Cooper	Continue Completing Status Report 10 CAD Design onon wall interior section.	Completed Status Report 10 CAD Design on planning design analysis for wall interior analysis	
Mustafa Jaffara	Continue Completing Status Report 10 CAD Design on Thermowells.	Completed Status Report 10 CAD Design on planning design analysis for thermowell analysis	
Malik Williams	Continue Completing Status Report 10 CAD Design on on wall surface temp sensors	Completed Status Report 10 CAD Design on planning design analysis for wall surface temperature sensor analysis	
Darryl Geyen	Continue Completing Status Report 10 CAD Design on Fluid Tank.	Completed Status Report 10 CAD Design on planning design analysis for Fluid tank analysis	

Omar Attia	Continue Completing Status Report 10 CAD Design on Wood Frame building.	Completed Status Report 10 CAD Design on planning design analysis for Wood frame building analysis.	

SENIOR DESIGN & PROFESSIONALISM I
FALL 2020 SEMESTER
REPORT ON GROUP DYNAMICS

MINUTES OF GROUP MEETINGS

Group #1

Date: 11.24.2020 **Time:** 12pm - 2:30pm **Location:** Zoom

Members Present: Donnie Edwards, Joshua Cooper, Mustafa Jaffara, Darryl Geyen, Omar Attia, Malik Williams
Members Absent:
Members Late:

Agenda for Meeting (Items to be discussed or discussed at the meeting)

- Meet with Dr. Shafiee
- Continued to discuss Status Report 10 CAD drawing model assignments for each team member

Detailed Minutes: (should include name of speaker and summary of what he/she suggested)

This meeting started off with the team having a detailed discussion regarding the analysis of our design. Each member was able to give a report to Dr. Shafiee regarding his completed work. After each members report Dr. Shaffie gave recommendations on how to improve upon the design for a more seamless and efficient experiment.

During this meeting the team used this time to complete progression checks for status report 10. Each member was able to leverage other team members knowledge for their respective design analysis. We were able to discuss in detail about each design analysis to get a better understanding of what the components consist of.

Brief statement on individual participation and or problems encountered with specific group members and how group resolved problem(s)

As a group we decided to have an extra meeting to discuss any final decisions or minor changes made to the Status Report 10 document.

MEETING TASK ASSIGNMENT & DELIVERABLES

Use this table to document task assigned and deliverables completed/submitted by each group member at this meeting

If deliverables were not completed, indicate the actions taken by the group on this individual.

Name	Task Assigned to team members at this meeting	Deliverables completed & submitted from tasks assigned in previous meeting(s)	Actions taken by group on non-performing member
Doonie Edwards	Complete final changes to Status Report 10 CAD Design on data acquisition units. Continue completing CAD simulations.	Continued Completing Status Report 10 on data acquisition units. Began CAD simulation on data acquisition units.	
Joshua Cooper	Complete final changes to Status Report 10 on wall interior. Continue completing CAD simulations.	Continued Completing Status Report 10 on wall interior. Began CAD simulation on wall interior section.	
Mustafa Jaffara	Complete final changes to Status Report 10 on Thermowells. Continue completing CAD simulations.	Continued Completing Status Report 10 on Thermowell analysis. Began CAD simulation on Thermowells.	
Malik Williams	Complete final changes to Status Report 10 on wall surface temperature sensors. Continue completing CAD simulations.	Continued Completing Status Report 10 on wall surface temperature sensors. Began CAD simulation on wall surface temp sensors	
Darryl Geyen	Complete final changes to Status Report 10 on Fluid Tank. Continue completing CAD simulations.	Continued Completing Status Report 10 on Fluid tank analysis. Began CAD simulation on Fluid Tank.	

Omar Attia	Complete final changes to Status Report 10 on Wood Frame building. Continue completing CAD simulations.	Continued Completing Status Report 10 on Wood Frame building. Began CAD simulation on Wood Frame building.	