

## TAMU System Engineering Network

*OUTREACH Strategy Team 2013*

### BACKGROUND

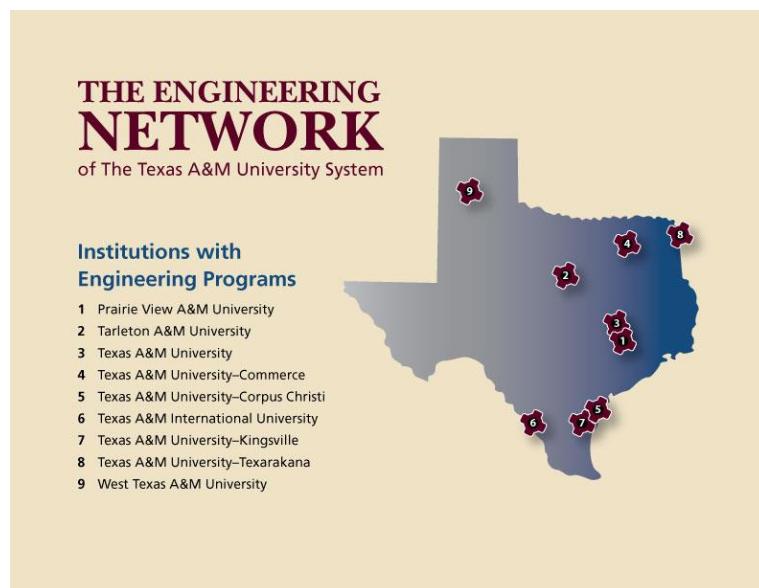
The Texas A&M University System (TAMUS) Engineering Network is comprised of nine institutions, including three Hispanic Serving Institutions (HSI), a Historically Black College and University (HBCU), and a number of newly created and growing engineering programs. Representatives from the TAMUS Engineering Network first met in 2008 under an NSF grant. At the end of the grant period, the team's membership of Deans and Department Heads/Chairs recommended that annual meetings continue to build upon the synergy developed among the institutions.

The TAMUS Engineering Network (Engineering Network) was convened in March 2012 by the Vice-Chancellor for Engineering, Dr. M. Katherine Banks. The primary purpose of the meeting was formation of three strategy teams: **Research, Education, and Outreach**. Subsets of administrators from the Engineering Network were assigned to the strategic committees. Dr. Banks designated \$50,000 per strategic area for the development and execution of pilot projects. Spring 2012 white papers were submitted from each strategic area, with approval and final details completed at the fall 2012 meeting to the System Network. Implementation began spring 2013 for each of the three groups.

### INTRODUCTION

The declining competitiveness of the United States and impending shortage of engineers has been the focus of numerous reports [1, 2]. The Texas Higher Education Coordinating Board attempted to respond to the looming crisis through the creation and implementation of the *Closing the Gaps: The Texas Higher Education Plan* [3]. Under the program's strategies, a goal to significantly increase the number of degrees awarded in critical Science, Technology, Engineering, and Mathematics (STEM) fields was established. To date, state-wide performance has fallen well below the designated target in this area [4].

Numerous studies have been undertaken to determine the primary factors that influence an individual's educational and career choices [5-8]. Results from a recent Intel funded study, which involved more than 1,000 teenagers, showed a lack of familiarity with the engineering field as one of the key barriers [9]. This was consistent with the findings in a 2005 study by Hirsch, Kimmel, Rockland, and Bloom [10]. The authors stated, "**One of the many reasons more students are not choosing to study engineering in college and pursue careers in engineering is that they simply do not know what engineering is or what engineers do**" [10, p.1]. Recognition of this has resulted in a growing movement to create awareness as a part of

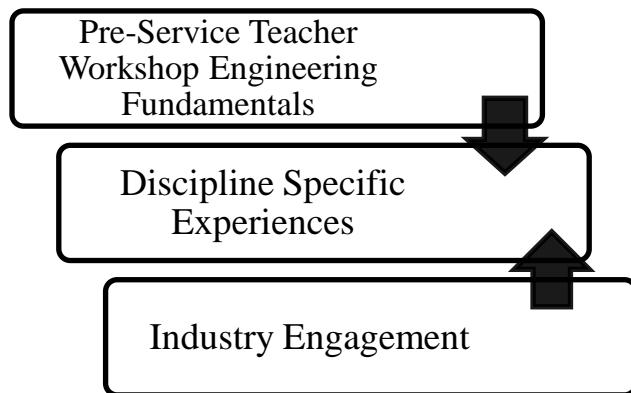


outreach efforts by engineering/STEM educational programs across the country. A majority of the universities in the Engineering Network conduct summer programs for middle and high school students; however, even though the institutions also have teacher education programs, little has been done for leveraging these two efforts. A majority of K-12 teachers have limited or no training in engineering and the implementation of specialized programs or efforts is often prohibitive due to limited resources. A study conducted by researchers at Valparaiso University [13] identified the need for a broad range of expertise to address the constantly change of emerging fields as major challenges faced by secondary teachers related to STEM subjects.

Therefore, the Outreach Strategy Team seeks to **address the gap in secondary teacher knowledge on engineering degrees** by engaging 12 students seeking secondary STEM teaching degrees at each of the nine System Network campuses. The objective will be to join with industry to make these pre-service STEM teachers aware of career opportunities in engineering, and to distinguish the currently taught Scientific Inquiry Method from the engineering design concept taught in college engineering courses and later applied on the job. This will allow for those going into STEM secondary teaching to be able to address student questions associated with what does an engineer do and be able to guide their students into these fields with greater confidence.

## PROPOSED PILOT PROGRAM

The Outreach Strategy Team proposes supporting the advancement of STEM education in Texas by creating a professional development engineering workshop for secondary pre-service STEM teachers. The pilot program (Figure 1) seeks vertical alignment of workforce and academic skills and practices of engineers that could be part of the secondary curriculum, with a common message and foundation established that maintains and honors the unique needs of industries in regions throughout Texas serviced by TAMUS engineering programs.



**Figure 1 TAMUS Engineering Network STEM Secondary Pre-Service Teachers Development Pilot Program**

### Teacher Workshop Pilot Engineering Curriculum

The National Academy of Engineering's *Engineering in K-12 Education: Understanding the Status and Improving the Prospects* identified a model for K-12 engineering education [14]. The Outreach Strategy Team will adapt and implement this recommended model's four "threads": Mathematics, Science, Technology, and Engineering Design. These threads are commonly found in the first year engineering student experience, and though math and science are high school topics, the majority of grade 7-12 teachers have had limited or no exposure to

engineering. This inhibits their ability to recommend engineering as a career other than the traditional “you are good at math and science so major in engineering” advice. The NAE also established a set of attributes deemed necessary for success in the engineering profession [15]. Both the attributes and engineering design process are discipline and region independent, and with involvement of industry stakeholders the Outreach Strategy Team desired to develop a pilot of regionally specific experiences for use in the 7-12 classroom.

The Outreach Strategy Team proposes the TAMUS Engineering Network develop and deliver a conceptual understanding of skills sets needed in an engineering curriculum as background for secondary STEM pre-service teachers. This pilot program would introduce concepts on 1) the field of engineering, with an overview of its various disciplines, 2) the engineering design process and differences between it and scientific inquiry method, and 3) the NAE’s attributes of engineers in 2020. Participation would be funded for a minimum of 12 pre-service teachers majoring in STEM at each of the 9 TAMUS Engineering Network campuses.

### **Discipline Specific Experiences**

The universities of the TAMUS Engineering Network represent different geographic regions of Texas, each with its own identity and unique area industries. The Outreach Strategy Team recognizes this fact and believes the pilot program must take into account this diversity to be effective with individuals in that region.

Bandura defined *self-efficacy* as the perception of or belief in one’s own ability to be successful in a given situation [16]. Self-efficacy influences how a person thinks, feels, and behaves and research has shown a relationship between it and career choices [17-18]. The researchers indicated one of the key elements to developing a positive self-efficacy is mastery experiences. Participating institutions shall develop hands-on experiences that are embedded in components of the foundation curriculum and reflect the disciplines and expertise of the local industry in each of the regions serviced by the institution. Regional industries will relate to those in the Texas Industry Concentrations report from the Governor’s Office ([www.governor.state.tx.us/files/ecodev/concentrations.pdf](http://www.governor.state.tx.us/files/ecodev/concentrations.pdf)).

### **Industry Engagement**

Under the typical industry-educational model, companies see their role as one of employer after a student completes an engineering degree. This places the burden of recruitment and instruction solely upon the educational institutions, leaving industry with the end process to employ those qualified. This model often results in a disconnect, both in the number of qualified graduates and the skill set of the graduates. The Outreach Strategy Team recognizes the need to jointly engage industry throughout the education process.

Social modeling or observation of role models is cited as another key element in developing a positive self-efficacy [16]. The final stage of the pilot program shall involve direct engagement of the participants and industry through job shadowing or similar activity. The job shadow not only enhances the career awareness of the field but provides participants with a direct application of the principles gained through the first two stages of the program.

## **PROGRAM IMPLEMENTATION**

A one week pilot program is recommended to include information on engineering fundamentals and disciplines, along with industry involvement. Examples of potential formats are shown below.

## **Pilot Program Option 1**

- Day 1: Engineering Fundamentals
- Day 2: Discipline Specific Experiences
- Day 3: Discipline Specific Experiences
- Day 4: Industry Engagement – i.e. talks, job-shadowing,
- Day 5: Mentoring Engagement, breakfast/luncheon with industry & in-service teachers

## **Pilot Program Option 2**

- Day 1: Engineering Foundation Principles
- Day 2: Discipline Specific Experiences
- Day 3: Discipline Specific Experiences
- Day 4: Discipline Specific Experiences
- Day 5: Mentoring Engagement, breakfast/luncheon with industry & in-service teachers

Often the majority of teachers in a region have their teaching degree from the university serving that region. Therefore, by targeting pre-service teachers at each of the nine Engineering Network campuses, not only will the knowledge on engineering be increased for teachers in the university's recruitment area, but the pre-service teachers who participate will be linked directly to personnel in the Engineering Network campuses' engineering programs. Twelve pre-service teachers majoring in secondary STEM degrees (i.e. math, chemistry, physics, etc.) will be selected via individual processes developed by each of the nine campuses. A minimum stipend of \$250 will be awarded to each pre-service teacher. An allowance will be allocated for each of the 9 campuses to purchase materials for used in this pilot project, which may be given to participants for use in their future classrooms. Data on the number participating and participant demographics will be submitted to the Engineering Network, along with summary of surveys if used.

## **TIMELINE**

**October 2012-March 2013:** Finalize program and designate campus contact

**April 2013:** System schools finalize week-long program and activities; select and notify at least 12 pre-service teacher participants (suggested by April 30<sup>th</sup>)

**April-May 2013:** Purchase materials for workshop

**Summer 2013:** TAMUS engineering pre-service teacher workshop pilot.

**Fall 2013:** Optional campus follow-up with participants still enrolled

Lessons learned reported at TAMUS Engineering Network Fall meeting

## **RECRUITMENT STRATEGY**

Pre-service teachers in 8-12 certification programs will be solicited to programs on the nine Engineering Network campuses. Selection criteria should include: full-time student enrolled in STEM teaching major; Jr/Sr status, graduating within 3 semesters; short explanation (optional) on what participant hopes to accomplish by attending the week-long program; along with

demographic information for cumulative reporting at this project's end. Each campus to select at least 12 participants. If 12 qualified juniors and seniors are not available, campuses may consider students classified as sophomores.

## SUMMARY

Despite an emerging movement in engineering education, participation and accessibility to these programs remains limited due to a variety of reasons, including a lack of formal training for a majority of future teachers in the state of Texas. Specialized engineering programs have been developed and are offered across the state of Texas. However, a majority of these programs are focused on career awareness for students. While these programs have been shown to be successful, they affect a relatively small number of students. The number of students impacted would grow exponentially if qualified teachers integrated engineering design principles into the classroom.

The development and implementation of a one-week professional development engineering workshop is proposed for 7-12 pre-service teachers enrolled at the System Network campuses in STEM teaching majors. The program will be offered across the state of Texas by the TAMUS Engineering Network institutions. The program will seek to narrow the knowledge gap related to the field of engineering and principles of engineering design that exists with future teachers due to limited or no formal training in engineering education. The program will seek to engage all stakeholders with a common message.

## Working Budget

Outreach Strategy Team will fund the following budgets on each of the nine Engineering Networks campuses:

Materials per campus for take-away kits for each pre-service teachers use in classroom \$18,000  
Stipends to pre-service STEM teachers to participate in pilot program

\$250 per pre-service teacher x 12 students x 9 TAMUS campuses	\$27,000
Mentoring engagement activity at end of program 9 campuses @ \$555 each	<u>\$ 5,000</u>
Total Allocation from Vice Chancellor to Outreach	<b>\$50,000</b>

## MEMBERS OF OUTREACH TEAM

**Chair:** **Brent Donham**, Engineering & Technology, Department Head, Texas A&M University-Commerce

**James Pierce**, Dean of Science & Technology, Tarleton State University

**Thomas Mitchell**, Dean, College of Arts & Science, Texas A&M International University

**Don Topliff**, Dean of Agriculture, Science & engineering, West Texas A&M University

**Pete Linkins**, Dean, College of Science, Technology, Engineering, and Mathematics,  
Texas A&M University- Texarkana

**Cindy Wall**, Executive Director, Texas Center for Applied Technology, TEES

**Magda Lagoudas**, Director, Engineering Student Scholarship & Academic Programs, Texas A&M University

**Jorja Kimball**, Director, Strategic Research Development, TEES

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