

# **TECHNOLOGY EMPOWERED ENVIRONMENTS FOR MATHEMATICS AND SCIENCE EDUCATORS**

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**TEACHING & LEARNING WITH TECHNOLOGY IN  
MATHEMATICS & SCIENCE CLASSROOMS  
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The Texas A&M University System  
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# SCOPE OF THIS PRESENTATION

Share with you my perceptions of technology in education.

Ask, “What are the uses and misuses of technology?”

Ask, “Is there a unique incorporation of technology or does one need to adopt an “evolvable, scalable” approach?”

Invite you to write a joint paper for publication - “Learning Environments of the Future”.

# HOW DOES A STUDENT SPEND TIME?

*“Much of a student’s learning takes place at times and places outside of the school. Today's students spend 14% of their time in school and 53% at home or in the community where a third of the time, not counting sleep, is spent watching television. Increasing amounts of time also are devoted to surfing the Web and chatting with friends online.”*

Bransford, Donovan, Pellegrino (1999)

# **TECHNOLOGY - PERCEPTIONS AND VIEWS**

# TECHNOLOGY ENVIRONMENT TODAY'S KIDS ARE USED TO AND TAKE FOR GRANTED

<http://focus.ti.com/docs>

**Residential Gateway**

- Multiplayer gaming
- Video on demand
- Home security
- Digital audio

**Wired PC**

- Streaming video
- Print/file sharing

**Wireless Laptop**

- Distance learning
- Video calls
- MP3 downloads

**IP Phone**

- Internet access
- Multiple voice lines
- Wireless printing
- Wireless IP phone

**Printer**

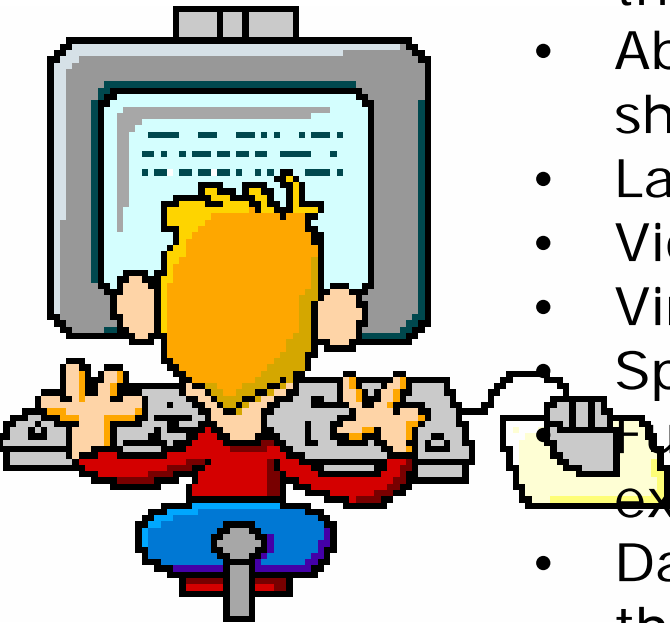
**Broadband Access**

**Home Networking**

At the heart of the digital home sits the residential gateway distributing a host of enhanced content and services without the need for wires.

The infographic depicts a modern home network. A central residential gateway is connected to a broadband access point. A wired PC is shown with a list of capabilities. A wireless laptop is used for distance learning, video calls, and MP3 downloads. An IP phone is used for internet access, multiple voice lines, wireless printing, and wireless IP phone. A printer is also shown. A person is playing a game on a console, and another person is using a PDA. A large screen displays a game score of 5,530 pts. and a car. The word 'GRANTED' is written in large letters at the top right.

# CLASSROOM OF THE FUTURE?



- Tablet or Laptop for each of the children permanently housed in the classroom of the future
- Wireless networking (with cabling provided in the event the wireless network is down)
- Ability to extend network into homes for file sharing (or use WWW for that purpose)
- Large interactive whiteboard
- Video conferencing
- Virtual reality learning tours
- Speech recognition software
- Full integration of the CotF's network into the existing school building's network.
- Data logging sensor equipment throughout the classroom
- Integration of the computer-controlled telescope into the network

# BUT TECHNOLOGY INTEGRATION IS MORE THAN THAT!

- Technology should be an empowering tool, not an end in itself.
- You, as teachers, must determine how technology will enhance the environment and empower the user.
- This empowerment comes in different ways at different schools for different students.
- Technology allows you to “customize” the different learning styles of the students.
- If we do not incorporate and integrate technology we lose ground.

# A NEW LEARNING PARADIGM

- Distributed resources
- New media
- New modes of knowledge
- Blurring of educational boundaries
  - between sectors, disciplines, roles
- Continuous and discontinuous change
- Lifelong learning
- New forms of participation

# KEY QUESTION

What would it mean to you for your students to be 'empowered' e-learners?

*(i.e. what would they be able to do, or do better/differently, as a result of incorporating technology?)*

# EMPOWERED LEARNERS?

*“[With e-learning environments] there will be no need for teachers as they are today...instead the focus will be on the employment of the best teachers to assist in the development of computer-based learning using the best curriculum and instructional strategies.”*

Contributor to IFETS discussion list, July 1999

# HOW DO WE ACHIEVE THAT?

First we need to change our mindsets.

What is the purpose of education?

How do we change our instructional styles and practices so as to make them more interesting and relevant to our students?

How do we assess each student's learning and progress so as to truly attain the true usefulness of technology - leveling the playing field?

How do we change our paradigms so as to expand our own horizons?

# WHAT IS THE MISSION OF HIGHER EDUCATION?

Education is a process of discovery, a process of exploration.

Hence, its mission should be to provide the widest repertoire of possibilities with which a student is faced when entering a learning situation.

“Teaching is recreating the subject in the student’s mind.”  
Northrop Frye

Educare (Latin) = To draw out.

# TECHNOLOGY - FACTS

- Every two or three years, the knowledge base doubles.
- Every day, 7,000 scientific and technical articles are published.
- Satellites orbiting the globe send enough data to fill 19 million volumes in the Library of Congress – every two weeks.
- High school graduates have been exposed to more information than grandparents were in a lifetime.
- Only 15 percent of jobs will require college education, but nearly all jobs will require the equivalent knowledge of a college education.
- There will be as much change in the next three decades as there was in the last three centuries.

# PAVING THE COWPATH!

Attempts to use technology in higher education have been very haphazard  
- paving the cowpath!

- Systems have been designed only to automate existing processes.
- Computers have been thought of as strictly computational devices.
- Desktop workstations have not accomplished much more than to replace the typewriter and the adding machine.

Technology should be used to enhance the learning experience by creating a new educational platform and reconfiguring the way a student learns.

Network learning - accessing libraries, scholars, networks, and information worldwide

# WHAT HAPPENS IF WE CHOOSE NOT TO INTEGRATE TECHNOLOGY?

Technology is a multi-edged tool.

Education has become a commodity.

Imagine true outsourcing of education.

MIT has begun making all its courses available on the web.

Just as we have telecommuters, we will have teleeducators and telelearners.

Systemic thinking is what is needed.

# SYSTEMIC CHANGE

Systemic change is thinking about *systems* – policy systems, education systems, social service systems, information systems, technology systems.

It is to enact change while moving beyond thinking about individuals and individual organizations, single problems and single solutions.

Systemic change is a cyclical process in which the impact of change on all parts of the whole and their relationships to one another are taken into consideration.

In the contexts of schools, it is a philosophy advocating reflecting, rethinking, and restructuring.

# SYSTEMIC CHANGE - LOGISTICS

- Create a vision of what you want the system to look like and accomplish.
- Take stock of the current situation.
- Identify strengths and weaknesses of the current system in light of the vision.
- Target several priority items for improvement.
- Establish a plan for addressing these priority items and for measuring success.
- Assess progress regularly and revise actions as needed.
- Take stock again and use feedback to revisit vision and begin cycle again when the action cycle is completed.

# BETTER EDUCATION THROUGH TECHNOLOGY

- Through the use of advanced computing and telecommunications technology, students have access to new and different types of information, can manipulate it on the computer through graphic displays or controlled experiments in ways never before possible, and can communicate their results and conclusions in a variety of media to their teacher, students in the next classroom, or students around the world.

# BETTER EDUCATION THROUGH TECHNOLOGY

- For example, using technology, students can collect and graph real-time weather, environmental, and populations data from their community, use that data to create color maps and graphs, and then compare these maps to others created by students in other communities.

# BETTER EDUCATION THROUGH TECHNOLOGY

- Similarly, instead of reading about the human circulatory system and seeing textbook pictures depicting bloodflow, students can use technology to see blood moving through veins and arteries, watch the process of oxygen entering the bloodstream, and experiment to understand the effects of increased pulse or cholesterol-filled arteries on blood flow.

**WHAT WILL BE THE WORLD  
INTO WHICH WE PREPARING  
OUR STUDENTS?**

# **GRIPPING STUFF: GECKOS TOES ARE COVERED IN TINY HAIRS**

*Andre Geim, the University of Manchester*

Geckos are famed for their wall-climbing antics and their ability to hang from the ceiling by a single toe. They can do this because their digits are covered in millions of tiny hairs that bond with any surface.

The prototype adhesive could have limitless applications — tires with more grip, surgical tape and sticky gloves for rock climbers.

The tape is covered in millions of protruding plastic polymer 'hairs'. Each one is just two thousandths of a millimetre high, allowing them to get extremely close to the molecules that make up a surface. On dry surfaces the hairs are subject to weak attractions called van der Waals forces that occur between molecules. On wet ones, suction-like capillary action grips the hairs.

**Gripping stuff: geckos  
toes are covered in  
tiny hairs.**

Nature, June 6, 2003

# *WHAT MAKES IT SO DIFFICULT TO RUN ON A BEACH*

*JUN UEHARA, THE UNIVERSITY OF CALIFORNIA, LOS ANGELES*

Strange, counterintuitive behavior of granular materials.

Pressure at the bottom of a tall column of sand is the same irrespective of how high the column is.

Pressure underneath a sand pile is lowest where the pile is highest.

Sand pouring through a funnel can become stuck even when the funnel is several times wider than the largest grains. All of these properties result from the way in which stresses are passed from one grain to another as they are pressed together.

Understanding this mechanism would help to explain the 'impact-damping' properties of sand — this effect is what

# HARRY POTTER NEWSPAPER?

*Yu Chen, E Ink Corporation, Cambridge, Massachusetts*

Ultra-thin display brings e-newspaper - newspaper that updates itself with the latest headlines every day.

The screen is less than 0.3 mm thick, flexible enough to be rolled into a tube just 4 mm across and can be viewed from almost any angle.

Similar technology could even make clothes that double as video screens. This would need a display that refreshed itself every 15 milliseconds. The new screen currently takes around a quarter of a second.

The main challenge is to increase the speed and reduce the thickness.

# *EMPHASIZE RELEVANCE*

Prepare the students for the world they will be graduating in, not the world we are in now. We need to work “backwards” - where we need to be in five years and what we need to do now to get there - rather than imposing our current mindsets on our students.

**MAKE THE COURSEWORK AND  
THE  
CURRICULUM MORE  
RELEVANT!!!**

# WHAT IS EXPECTED OF OUR GRADUATES?

***“The new Ph.D. degree would cultivate a broader range of academic and career skills, offer more program options, provide students with more knowledge about a variety of careers, and foster a greater sense of entrepreneurship than is customary.”*** Report of the National Academies (1995)

***“Student interests should be paramount in designing a graduate curriculum that prepares students for a broad array of careers.”*** Association of American Universities, (1998)

# AREAS OF TECHNOLOGICAL COMPETENCY

Operating Environments

Telecommunications

Spreadsheets

Databases

Applied Technology

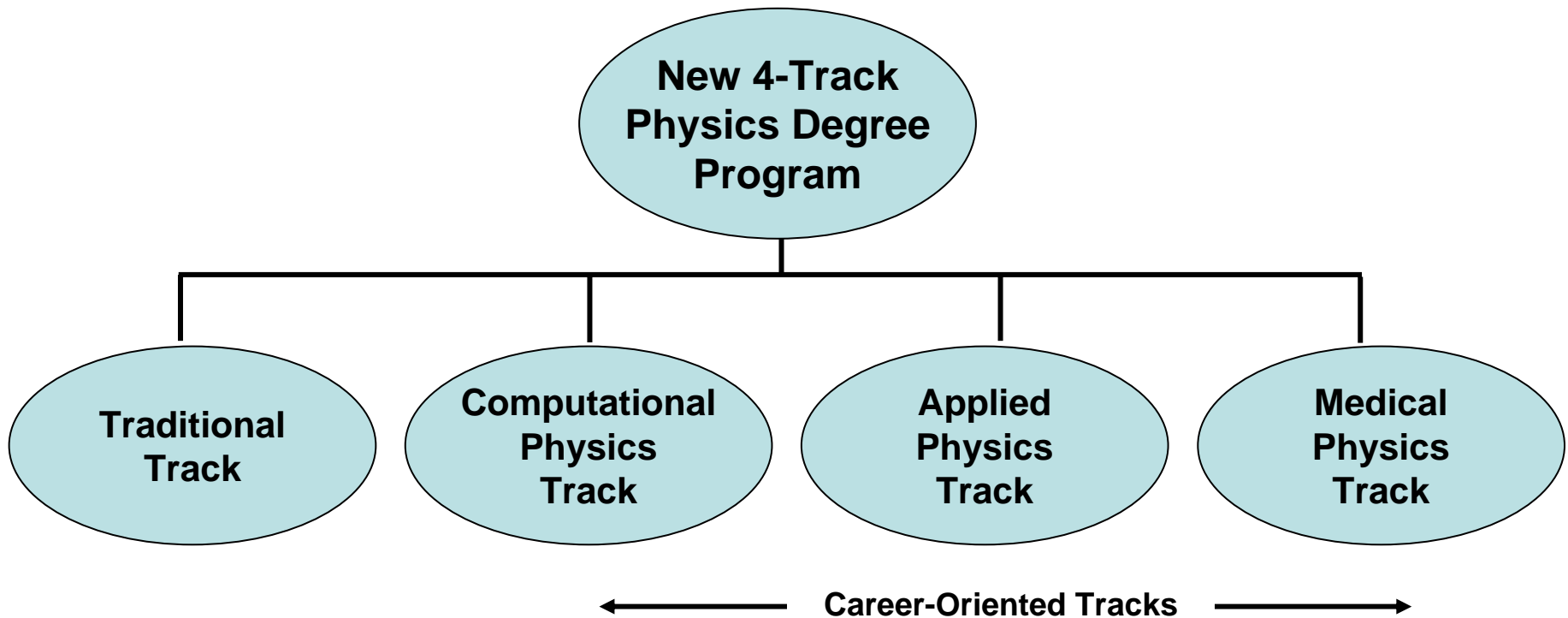
Word Processing and Desktop Publishing

Graphics and Multimedia

**WHAT ARE WE DOING AT  
PRAIRIE VIEW A&M UNIVERSITY?**

# ***NEW 4-TRACK PHYSICS DEGREE PROGRAM***

- ❑ **The new four-track degree program is an innovative approach with a potential to attract more students to physics.**



# *CHANGES IN THE PHYSICS CURRICULUM*

- ❑ **Introduced a new course - PHSC 2103: Quantitative Physical and Biological Sciences - to provide a more extensive and in-depth content for science teachers teaching Integrated Physics and Chemistry (IPC) courses.**
- ❑ **Introduced a new Online Weather Course that may be used as an excellent forum for bringing together elements of fundamental science in an applied setting.**
- ❑ **Introduced a capstone course - PHYS 4473: Senior Research Project - that should provide potential science teachers with teamwork and classroom management skills.**
- ❑ **A new Physics Education Track is being discussed with the College of Education for possible implementation towards producing physics teachers.**
- ❑ **In process of joining the Texas Electronic Coalition in Physics (Texas A&M University-Kingsville)**

# *A FEW OF OUR ACTIVITIES*

- ❑ **A Science Education Laboratory (SEL), to be in place by summer 2003. The SEL will be an innovative learning environment for school teachers and students.**
  
- ❑ **A Physics Learning Center, completed June 2003.**
  
- ❑ **Visited Eisenhower, Elkins, Elsik, Royal high schools to discuss collaborations.**
  
- ❑ **Aligned curricula for for transfer students from San Jacinto College District.**
  
- ❑ **Have a collaborative research proposal approved.**

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

# ***SCIENCE EDUCATION LABORATORY (SEL)***

## **An innovative learning environment**

- ❑ An innovative learning environment for high school teachers and students.
- ❑ The main thrust is to make science interesting and fun for the learner as well as encourage scientific and critical thinking practices.
- ❑ SEL will provide multi-media equipment, hands-on gadgets of learning to stimulate interest in the physics and physical sciences via a number of digital experiments, novel demonstrations and computer simulations.
- ❑ One example of a “digital experiment” is the Virtual Environmental Science Lab, in which the student plays environmental scientist and explores some of the problems facing the environment in a specific eco-system.

# TECHNOLOGY INTEGRATION

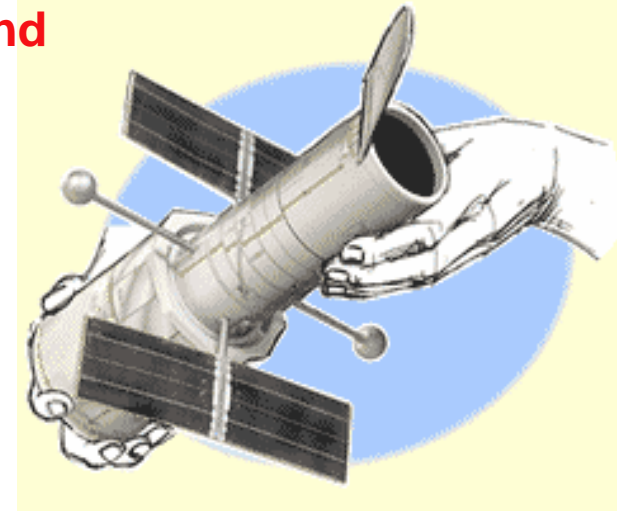
- ❑ Physical Science course sequence - PHSC 123 and PHSC 2103 - will be using Hewitt's Conceptual Physical Science which also has a fully integrated web-based course management.
- ❑ Engineering Physics course sequence - PHYS 2513 and PHYS 2523 - will be using Serway and Jewett which also has a fully integrated web-based course management.
- ❑ Two laboratory rooms to be equipped with Smart Boards.
- ❑ Physics Learning Center is fully networked to Internet II. The computing environment coupled with the audio-video equipment should provide an enhanced high technology-aided learning environment.
- ❑ Physics Department's website is being upgraded to include a virtual reality tour of the department laboratories.
- ❑ "Electronic communities of Practice And Learning (E-PALs)" among Academy Members, partnering high school students and other schools is being planned.

# ***COLLABORATIVE FUNDING EFFORTS***

- ❑ “Physics in STEP” - Proposal to NSF - PVAMU + Hempstead HS and Royal HS (5/03)**
- ❑ “Project Operation Accelerate (XLR8)” - Proposal to Thurgood Marshall Foundation - PVAMU + Royal HS (6/03)**
- ❑ “Project LEAP - Learning Enhancement and Advancement with Physics” - Proposal to NSF - PVAMU + Tarleton State University (6/03)**
- ❑ Possible proposal to NSF’s Advanced Technological Education Initiative - with San Jacinto College (10/03)**

# *FLEXIBLE AND MULTI-PATH ROADMAP TO INCLUDE ROADS NEW AND LESS TRAVELLED*

- We are creating “learning and practicing environments” for school students and teachers.
- **These environments will be in multiple forms:**
  - A “Scenario Laboratory” - simulations of potential careers and tutorials on “roadmaps” to professional careers
  - **Courses in history of science and technology with “what if” scenarios - recreate the subject in student’s mind**
  - Art/drama interpretations of history of science/ technology
  - **Multi-disciplinary projects at schools**
  - Interactive e-mentoring
  - **Summer internships in industry**
  - Writing projects



# *WHEN IS A STUDENT CONSIDERED EDUCATED? PASSING A TEST VS. COMPETENCE*

We don't consider a patient cured when his sprain has healed or he's been restored to a minimal level of functioning. The patient is cured when he can again do the things he loves to do. - Society of Orthopaedics

We don't consider a student educated when she passes an examination or a test! That just means she is prepared for a minimal level of functioning. The student is educated when she can do the things she loves to do while at the same time be a valued member and value-added contributor to the society.



## The Adventure

# WHAT NEXT?

- **We invite you to collaborate closely to examine the curricula and incorporate changes to “fill the gaps” and align the curricula.**
- **Science departments and the College of Education at PVAMU design a new specific science education curriculum with project-based instruction.**
- **A mechanism and a schedule for periodic school and university faculty collaboration be set in place (Project ACE).**
- **Organize a regional/national workshop/conference - *Systemic Approaches to Science Teacher Development* - for comparing science teacher preparation efforts.**
- **Enhance the partnerships to collaborative research initiatives on new dimensions and practices of teaching.**

# *PARTING THOUGHTS*

***“Navigate your ship by the light of the stars, not by the light of every passing ship.”***

**- General Omar Bradley**

# PARTING THOUGHTS

*"Simulation and visualization tools can help students recognize patterns, reason qualitatively about physical processes, translate among frames of reference and envision dynamic models. These curricular approaches improve success for all types of learners and may differentially enhance the performance of at-risk students."*

Chris Dede (1999).



<http://www.i2i.pvamu.edu/physics/index.htm>