

Educating Next Generation Engineers

ASEE-PSW 2009 Conference Proceedings (abstracts only)

ASEE-PSW 09 Conference

March 19-20, 2009



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Edited by

Mohammad Amin and Pradip Peter Dey

Preface

Welcome to the 2009 American Society for Engineering Education-Pacific Southwest (ASEE-PSW) regional conference. The theme of this conference is “*Educating Next Generation Engineers*”. We as university/college educators are responsible and continuously striving to prepare the next-generation engineers who will be ready to face the multi-faceted challenges required to move this nation forward. This conference is intended to bring together educators, researchers and practitioners from industry, academia and government to advance engineering and technology education and to encourage wider collaboration between academics and industry. The conference is held for the engineering community and hosted by National University. The large number of submitted papers is a clear indication of enthusiastic cooperation and response from the community. Out of the 70+ submissions, 46 full papers were accepted based on the reviewers’ comments and recommendations. Each submission was reviewed carefully twice (abstract first followed by full paper) by two to four reviewers. These reviewers not only reviewed papers, but also provided their help and support to many young faculty members in order to prepare the final manuscripts. The program committee made their best efforts to accommodate all submissions with academic merit and scholarship.

Many recognized speakers will present their research contributions in their respective fields. In addition, a number of distinguished keynote speakers known both nationally and internationally will deliver their lectures and a group of panelists will attend to discuss the following topic: “*Agile Problem Driven Teaching in Engineering, Science and Technology.*”

We gratefully acknowledge all the support and help that we have received from the members of the ASEE-PSW Board of Director especially the Chair, Dr. Debra Larson for allowing this conference to be hosted by National University. We also recognize and show our gratitude to ASEE administration for their cooperation and support. We would like to acknowledge the support and cooperation of all the authors and reviewers of the ASEE-PSW-2009 Conference.

We are grateful to Dr. Howard Evans, Dean, School of Engineering and Technology, National University, for his welcome address on March 19, 2009 and his help and guidance during the planning and preparation period of the conference. We are also grateful to the keynote speakers: Dr. Marvin White, Professor and Director at Lehigh University, Allentown, PA; Dr. Shu Chien, University Professor and Director at University of California, San Diego, CA; and Dr. Melissa Micou, a young talented faculty member in the Department of Bioengineering, University of California, San Diego, CA. We would like to express our sincere gratitude to Dr. Thomas MacCalla, VP, National University and Executive Director, NUCRI, for his support and a special presentation at the dinner. It is our privilege to welcome Dr. David Hayhurst, Dean, College of Engineering, San Diego State University, for his concluding speech.

Our special thanks to Dr. Jerry Lee, Chancellor of the National University System, Dr. Dana Gibson, President, National University, Dr. Tom Green, Provost, National University, Dr. Mel Green, Professor, University of California, San Diego, all SOET faculty and staff, and sponsors for their valuable suggestions and support. Thank you.

ASEE/PSW-2009 Conference Committee
San Diego, California
March 19, 2009

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Welcome by Conference Host



Howard Evans, Ph.D., PE

Dean, School of Engineering and Technology, National University
 Thursday, March 19, 2009, 8:45am-9:00 am

Dr. Howard Evans was appointed founding Dean of the School of Engineering and Technology, National University, in October, 2003. He received B.S. degrees in Physics and Chemical Engineering from Brigham Young University, and a Ph.D. in Chemical Engineering Science from the California Institute of Technology.

Dr. Evans has over 20 years of executive and senior technical management experience at 3M and IBM Corporations, primarily leading multidisciplinary, global technical organizations responsible for R&D; new business and market development; manufacturing engineering; quality; environmental, health and safety; and others.

The School of Engineering and Technology at National University currently has over 1000 students enrolled in 17 degree programs. Program areas include computer science, information technology, and information systems; construction engineering technology and construction management; engineering and technology management; systems engineering, environmental engineering, wireless communications, database administration and Homeland security and safety engineering.

Before joining National University Dr. Evans acquired 12+ years of voluntary involvement with higher education, including adjunct teaching and research in engineering at the University of Colorado and formal advisory involvement in both science and engineering at the University of Texas. Other past professional and academic activities include being a founding member and officer in the Central Texas Electronics Association; past chairman of IBM's Materials Shared University Research Committee; Ph.D. Recruiting Coordinator for IBM's Systems Technology Division; and executive sponsor for 3M division's student programs. He has published and presented widely in areas of surface science, electronic materials and processes, project management, and industry/university relations. He holds 4 patents and has received awards for excellence in technical innovation (IBM), technical authorship (IBM), teaching (University of Colorado), and scholarship (National Science Foundation).

Thank You Note from the Conference Chair



Mohammad Amin, Ph.D.

Professor, School of Engineering and Technology, National University

“One thing that never decreases by sharing is knowledge”. I would like to express my heartfelt gratitude and sincere appreciation to all the people who were directly and indirectly involved in making this conference successful. Without you, it would not be possible. It was a quite long journey to come to these final days of the conference. I have been looking forward to seeing you all on this special occasion where we will be discussing the future of our students: *the next generation of engineers*. Today I am truly honored and excited to see so many of my colleagues and fellow professors here who are dedicated to this noble mission: to promote and ensure the excellence in engineering education. As the conference chair, I had the privilege to learn a lot about you, your work and contributions in your fields and your organizations. I am very proud to know that we have so many talented and dedicated individuals from diverse backgrounds coming together to achieve the same goals. I am sure together, we can make a difference. *“One thing that has no ending is learning”*.

Biography of Mohammad Amin

Mohammad Amin received his Ph.D. and MS degrees in Electrical Engineering and MS degree in Solid State Physics from Marquette University, Milwaukee, Wisconsin, and M.Sc. and B.Sc. Honors degrees in Physics from the University of Dhaka, Bangladesh. He is currently working as a Professor at National University, San Diego, California. He has published and presented 60+ papers in the areas of electrical engineering applications, computer applications and biotechnology. He has 20+ years experience in teaching engineering, science, and math. He received an R&D award in 1996 from the *R&D Magazine 100 Awards Program* for the new development of *“IS4000 Solder Paste Statistical Process Control (SPC) System”*. He also received the GAANN Doctoral Fellowship for four years during his doctoral studies. He has three US patents on solder paste measurement techniques. He is the co-inventor of *“IS4000 Solder Paste and Residue Measurement System”*, manufactured by Alpha Metal Inc., a Cookson Company. He is a member of ASEE, and IEEE. His current research areas of interest are problem based learning (PBL), wireless communications, database, biotechnology, and electrical sensors.

Keynote Speaker

Recent Developments in Solid-State Nanostructures



Marvin H. White, Ph.D.

Lehigh University, Bethlehem, PA

Thursday, 9:00am – 9:50am, March 19, 2009

I will present an introduction to Lehigh University <http://www3.lehigh.edu/default.asp> followed by a description of several unique networks of universities in the United States, which offer researchers opportunities to create <http://www.nnin.org/> and model <http://www.nanohub.org/> experimental nanostructures – electronic devices and circuits with feature sizes less than 100nm. I will present an historical overview of the MOS integrated circuit leading to present-day CMOS nanostructures. I will describe our recent research into three different solid-state nanostructures. The first scaled device, a MOS transistor – used in advanced CMOS logic and microprocessors, uses a gate insulator comprised of two films (e.g. 0.5nm of SiO₂ and 1.6nm of HfO₂ – a so-called, high-K dielectric constant insulator), which are grown with atomic layer deposition (ALD). The second scaled device, a MANOS transistor, is a nonvolatile semiconductor memory (NVSM) used in cell phones, iPods, MP3 players, USB mini-drives and a solid-state replacement for hard drives. This device uses a gate insulator comprised of three films (8.0nm Al₂O₃, 8.0nm Si₃N₄, 2.2nm SiO₂). The oxide is a ‘tunneling’ barrier, the nitride the ‘storage’ region, and the aluminum oxide a ‘blocking’ barrier. I will discuss the write/erase, retention and endurance characteristics of these devices. I will discuss the modeling and challenges faced by these devices, which are being considered for the 32nm International Technology Roadmap for Semiconductors (ITRS) node <http://www.itrs.net/>. The third nanostructure, a BioMEMS planar implementation of a 3D ‘patch-clamp’ measurement system, characterizes ion transport in ion-channels on a biological cell with a high-gain, transimpedance amplifier to convert kHz, pA ion-channel currents to several volts. Ion-channel understanding is essential for the development of pharmaceutical drugs as ion-channels are linked to more than 40% of human diseases.

Biography of Marvin White

Marvin White received a B.S.E. in Engineering Physics and Mathematics, a M.S. degree in Physics from the University of Michigan and a Ph.D. from The Ohio State University. His area of research is the characterization and modeling of solid-state devices, sensors and custom integrated circuits. His recent work addresses charge transport and storage in MANOS multi-dielectric nonvolatile memories, MOS and CMOS nanoelectronic transistor modeling, BioMEMS, and SiC power devices. His teaching areas concern the Analysis and Design of Integrated Circuits for Systems Applications and Advanced Sensors and Semiconductor Devices. He has received several IEEE awards - ISDRS Aldert van der Ziel Award, Masaru Ibuka Consumer Electronics Award, J.J. Ebers Electron Devices Society Award and the IEEE Fellow Award. He is a member of the U.S. National Academy of Engineering. He has published nearly 300 papers with students and colleagues, contributed chapters to 5 books and holds 27 U.S. Patents. Prior to joining Lehigh, he worked at the Westinghouse Electric Corporation on advanced integrated circuits for systems applications. He has taken sabbaticals as a Visiting Fulbright Professor at Louvain la Neuve, Belgium, a Visiting Scientist at the U.S. Naval Research Laboratory and as a Program Director at the U.S. National Science Foundation. He has graduated 33 Ph.D.’s, and 61 M.S. students.

Keynote Speaker

How to Succeed as Next-Generation Engineers?



Shu Chien, M.D., Ph.D.

University Professor of Bioengineering and Medicine
 Director, Institute of Engineering in Medicine
 University of California, San Diego, La Jolla, CA
 Thursday, 10:00am – 10:50am, March 19, 2009

To become a successful engineer in this time of dynamic changes in the world, it is essential to have a solid core competence and the ability to learn new principles and technologies that continue to evolve. An engineer not only should have a strong foundation of natural sciences, i.e., physics, chemistry and mathematics, but also an excellent ability to communicate and to collaborate with others. Today, the key issues in engineering are closely linked with our society and human health. Therefore, engineering education should be integrative and continuous (life-long). In order to succeed in the engineering profession, it is essential to have the passion and dedication, the eagerness to learn, create, and execute, and the ability to work with others in a team environment.

Biography of Shu Chien

Shu Chien received his Ph.D. (1957) in Physiology from Columbia University, MD (1953) from National Taiwan University and Premed (1948) from National Peking University. Currently, he is a University Professor of Bioengineering and Medicine, the Director, Institute of Engineering in Medicine at University of California, San Diego. Prior to joining UC-San Diego, he worked for many well known organizations including Columbia University, National Taiwan University Hospital, Institute of Biomedical Science (Taiwan). He is the founding Chair of the Bioengineering Department at UC- San Diego. He has received more than 50 awards from US, China and other countries. He is associated with more than 20 national and international professional organizations. He has published nine books and 450 scientific journal articles. Please see the following websites for his bio and “Shu Chien Oral History” document (70 pages) published by IEEE:

- 1) http://www.ieee.org/portal/cms_docs_iportals/iportals/aboutus/history_center/oral_history/pdfs/Chien280.pdf
- 2) <http://www3.ntu.edu.sg/ICMMB15/download/keynote2B.pdf>

More interesting information can be found from the following book: Shu Chien: Tributes on His 70th Birthday” by: Lanping Amy Sung, Kung-Chung Hu Chien (ISBN: 9789812383839).

Dinner Speaker**Cultivating Collaboration and Interdisciplinary Practice****Thomas MacCalla, Ed. D.**

Vice-President National University and Executive Director, NUCRI, San Diego, California
 Thursday, 7:00am – 7:20am, March 19, 2009

We pay much attention to preparing future scientist, the next generation of engineers, and the teachers who carry the message, but we also need to focus on collaborative efforts to prepare and engage students K-20 and inform the public to maximize the effort. We know that data and information are gold and, when transformed into knowledge and shared, they become the mint. The task at hand, therefore, is to identify and analyze the resources for desired change and develop a manageable and measurable education, training, and community outreach strategy to bring it about and recognize the value of collaboration and engagement across disciplines and the professions.

Education

Bachelor of Social Science (BSS), Fairfield University, Fairfield Connecticut
 Master of Arts in Educational Administration *and* United States History, Fairfield University, Connecticut
 Doctor of Education in Curriculum, Instruction, and Supervision, Comparative Education, *and* American Literature, University of California, Los Angeles
 Post-Doctorate, Social and Regional Planning, University of California, Los Angeles

Professional Work Experience(this list contains only important positions)

2000 –Present: Executive Director, National University Community Research Institute (NUCRI)
Present National University Vice President, National University, San Diego California
1984-2000 Vice President, Multicultural Affairs, National University, San Diego, California
1978 -84 Exec. Director, International Institute for Urban and Human Development, San Diego, CA
1969-78 Vice President and Professor, US International University,

Professional Associations

Board of Trustees, Pacific Graduate School of Psychology, Palo Alto, California, APA and WASC approved Clinical Research Doctoral Program w/ Stanford University Medical School. Founding Steering Committee for the Adv. Tech. and Research Collaboratory for the Americas (ARTCA) in Costa Rica Member of the HASTAC Leadership Committee (2005-Present) Co-Chaired by Duke University and the University of California Humanities Research Institute at UC Irvine; Coordinator of National University’s HASTAC InCommunity for the HASTAC InFormation Year 2006-2007: “Creative Smart and Community Building” (November 9-11, 2007) Collaborator with the Institute for Computing in the Humanities Arts, and Social Science, (ICHASS) and the National Center for Supercomputing Applications (NCSA) at the University of Illinois, Urbana-Champaign. Member, Association for Integrative Studies (AIS), IEEE and the TeraGrid Campus Champion Program California Space Authority Education Workforce Development and North San Diego Economic Development Council

Keynote Speaker

Innovations in Undergraduate Bioengineering Education



Melissa Kurtis Micou, Ph.D.

Lecturer of Bioengineering, University of California- San Diego, California
 Friday, 10:40am – 11:05am, March 20, 2009

The Department of Bioengineering at the University of California, San Diego has grown dramatically since being established in 1994 as the first Department of Bioengineering in the University of California system. The educational mission of the Department has been to train future bioengineering leaders through inspiring education and dedicated mentorship. To accomplish this mission while training over 800 undergraduate students at any one time, the Department utilizes innovative teaching methods and curricula. This talk will summarize the Department's recent innovations in undergraduate education including the establishment of degree programs in biotechnology and bioinformatics, the incorporation of a capstone design experience with an emphasis on iterative design, and the introduction of cutting-edge technologies including microarray analysis and tissue engineering into core lab courses. Also presented will be an overview of educational initiatives outside the classroom including an NSF-sponsored Research Experience for Undergraduates (REU) program targeted to students from primarily undergraduate institutions, outreach activities with local high schools, and the Annual Bioengineering Day event featuring industry speakers and a Bioengineering Quiz Bowl competition. The strategies employed by UCSD Bioengineering to successfully train a large undergraduate population may be widely applicable as the number and size of Bioengineering/Biomedical Engineering departments across the country continues to grow.

Education

Ph.D. (2001) and MS (1998) in Bioengineering, UC- San Diego, La Jolla, CA
 B.S.E. (1996) in Biomedical Engineering, Magna Cum Laude, Tulane University, New Orleans, LA

Experience

Lecturer, 2007-present, University of California – San Diego, La Jolla, CA
 Assistant Professor, 2005-2007, The Cooper Union for the Advancement of Science and Art, New York
 Research Assistant Professor, 2003-2005, The Cooper Union for the Advancement of Science and Art, New York

Education Grants

National Science Foundation: REU Site: Regenerative Medicine, Multi-Scale Bioengineering, and Systems Biology, recommended for funding 2008
 National Science Foundation: Acquisition of Equipment for an Undergraduate Biomedical Engineering Laboratory at The Cooper Union (\$126,240), 2004-2006

Awards and Honors

National Institute of General Medical Sciences, NRSA Postdoctoral Fellowship
 American Association of University Women, Dissertation Fellowship
 Tulane University Dean's Honor Scholar, Full Tuition Scholarship

Concluding Speaker

When Did Engineering Become so Cool? Engaging a New Generation.



Dr. David T. Hayhurst

Dean, College of Engineering, San Diego State University, San Diego, CA

Friday, 11:10am – 11:35am, March 20, 2009

Dr. David T. Hayhurst began his tenure as the sixth Dean of the College of Engineering in August 2002. Prior to joining SDSU, he was Dean of the College of Engineering at the University of South Alabama in Mobile, and professor and chair of the Department of Chemical Engineering at Cleveland State University. A native of Massachusetts, he holds a Ph.D. and a bachelor's degree from Worcester Polytechnic Institute and a master's degree in from the Massachusetts Institute of Technology, all in Chemical Engineering.

While working as an academic administrator, Dr. Hayhurst continues to be active in research, specifically in the area of molecular sieve zeolites. He has numerous publications on molecular sieves and holds patents on their synthesis and applications. He has lectured extensively throughout the world on zeolites and was selected by the National Academy of Sciences as a participant for their Inter-Academy Exchange Program with the Academie der Wissenschaften der DDR.

San Diego State University's College of Engineering is home to eight degree programs (Aerospace Engineering, Bioengineering, Civil Engineering, Construction Engineering, Environmental Engineering, Electrical Engineering, Computer Engineering and Mechanical Engineering) and six research centers. It has more than 2,100 students and approximately 55 full-time faculty. In 2007-2008 the College received more than \$2.5 million in external grants and contracts for research and program administration and graduate student support.

In addition to his duties at San Diego State University, Dr. Hayhurst serves on the Workforce/Education Committee of the San Diego Economic Development Corporation, and is a member of the Board of Directors of CONNECT and of the Engineering and General Contractor Foundation. He has been active in K-12 outreach and facilitated the designation of San Diego State University as the California State Affiliate University for Project Lead the Way, a nationally-recognized program for preparing middle and high school students for careers in engineering.

Dr. Hayhurst and his wife, Mari, raise, show and judge AKC champion Great Danes, Whippets and Boxers.

Abstracts

Classifying Student Engineering Design Project Types

Micah Lande and Larry Leifer
Center for Design Research, Stanford University

Mechanical Engineering 310 is a graduate-level project-leaning-based mechanical engineering design course at Stanford University that takes its project prompts from sponsoring companies in industry. In the past 30 years, over 325 projects have been presented and worked on by students teams. The nature of these projects has shifted over time from Manufacturing-focused and Test/Tool-focused projects to standalone Product-focused and Human-centered Design products and systems. This paper classifies project types and characterizes maps this change over time.

Learning Communities Improve Retention in Engineering and Computer Science

Raman Menon Unnikrishnan and Ricardo V. Lopez
College of Engineering and Computer Science
California State University, Fullerton

As a comprehensive university, California State University, Fullerton (CSUF) serves approximately 37,000 students from a variety of cultures and backgrounds, with the recent increases tied to the immigrant population from Mexico as well as Central and South American countries. The majority of this surge has been from first-generation college students. The college, in an attempt to reverse its historical legacy for high student attrition, provides support and services that will help its diverse student population succeed academically and socially. The overall retention effort centers on a number of initiatives but this paper focuses on one such program, *The Engineering and Computer Science (ECS) Scholars Program* that is intended to create learning communities during the freshmen years. The *ECS Scholars* program is a learning community established in collaboration with Title V Retention Programs, the University Learning Center (ULC), the Center for Academic Support in Engineering and Computer Science (CASECS) and Freshmen Programs. The *ECS Scholars* program launched in the fall 2006 semester focuses on the academic success of *first-time freshman* (FTF) in engineering and computer science. While the ECS Scholars program is an at large initiative not aimed at any single community, its impact on underrepresented groups is found to be significant.

Using Tablet PCs to Enhance Student Performance in an Introductory Circuits Course

Amelito G. Enriquez
Cañada College
Redwood City, CA

Tablet PCs have the potential to change the dynamics of classroom interaction through wireless communication coupled with pen-based computing technology that is suited for analyzing and solving engineering problems. This study focuses on how Tablet PCs and wireless technology can be used during classroom instruction to create an Interactive Learning Network (ILN) that is designed to enhance the

instructor's ability to solicit active participation from all students during lectures, to conduct immediate and meaningful assessment of student learning, and to provide needed real-time feedback and assistance to maximize student learning. This interactive classroom environment is created using wireless Tablet PCs and a software application, NetSupport School. Results from two separate controlled studies of the implementation of this model of teaching and learning in sophomore-level Introductory Circuit Analysis course show a statistically significant positive impact on student performance. Additionally, results of student surveys show overwhelmingly positive student perception of the effects of this classroom environment on their learning experience. These results indicate that the interactive classroom environment developed using wireless Tablet PCs has the potential to be a more effective teaching pedagogy in problem-solving intensive courses compared to traditional instructor-centered teaching environments.

Using an On-line Survey Tool to Streamline Outcomes Assessment

Phillip R. Rosenkrantz, Ed.D., P.E.
Industrial & Manufacturing Engineering Department
California State University, Pomona

Outcomes assessment required to meet ABET accreditation criteria can be very time consuming. Deciding what and how to measure can take many hours of faculty time on both a department-wide and individual basis. Data gathering and analysis is another time consuming activity. Finally, preparing self-studies and other reports can consume many hours as well. It was College of Engineering's Assessment Committee conclusion after two rounds of ABET Assessment under the ABET 2000 criteria that a more strategic and systematic approach was needed for gathering and organizing data. In an effort to simplify assessment processes, the IME Department at Cal Poly Pomona has been increasingly using SurveyMonkey on-line surveys to gather data from students, alumni, faculty, and industry. One of the reasons for widely adopting SurveyMonkey is the ability to create a data base that makes it easier to collect and analyze data, share results, and prepare descriptive statistics of results over time. The purpose of this paper is to show how SurveyMonkey can be used for various assessment situations and demonstrate how easy it is to create a data base in the process

Photonics Research and Education at California Polytechnic State University

Xiaomin Jin, Dennis Derickson, Simeon Trieu, and Samuel O. Agbo
California Polytechnic State University, San Luis Obispo, CA

California Polytechnic State University is a major undergraduate teaching institute. We have a very active photonic teaching and research program in the Electrical Engineering (EE) department. In the recent years, the photonics group went through a big transition of the program with one professor retirement (founder of the program) and two new faculty members arriving. Our recent activities comprise following three major parts: 1) Expanded teaching laboratory, 2) Strong faculty/students research projects, and 3) Active SPIE student club. We are presenting the above three efforts in this paper.

Longitudinal Contact with Individual Students as a Route of Encouraging Self-Determination in Chemical Engineers

Paul Blowers
Department of Chemical and Environmental Engineering
The University of Arizona

It is difficult to have contact with individual students over a sustained period of time due to constrained schedules and competing time demands. However, frequent contact with individuals over time allows advisors to build student strengths in self-determination while tailoring advice directly to changing interests.

The talk will highlight advising opportunities from outreach, through retention, continuing to graduation, and post graduate interactions that fit within student progress towards their individual careers. Appropriate advising content for a technically rigorous chemical engineering program will be used as examples of how to motivate students towards exploring options and making decisions that open new doors to professional development. The issue explored is that self-determination comes from inside the student and that confidence in personal evaluation is fostered through directed activities throughout students' time with us.

Objectives that readers should be able to meet will be:

- to have the ability to identify points of contact where longitudinal contact can be encouraged
- to have the knowledge of how to remove impediments to longitudinal advising through reconstruction of advising duties in larger programs with many staff members, or through directed contact with students in smaller departments
- to have the ability to link student possibilities to exploratory activities that lead to self-determination

Students in chemical engineering are generally very strong in academic abilities, but often have not been exposed to a breadth of activities and possibilities that enable them to construct their own paths. Sustained advising contact has led to strong statistically-based success of students who have progressed through our program with approximately 30% of our graduates entering top ten chemical engineering graduate programs, 100% student placement of graduates almost every year, and a host of university-based, state, and national awards going to our students.

Distance Learning and Cognitive Load Theory to Enhance Computer Programming for Mechanical Engineers: Qualitative Assessment

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A computer programming class for students of mechanical engineering was re-designed with regard to both content and delivery. The goal was to improve student learning attitudes. Cognitive Load Theory (CLT) was used to re-design the content; on-line technologies were used to re-design the delivery. Since the targeted students were not computer scientists, the course was re-designed to focus on computer programming examples used in mechanical engineering. Scaffolding was used to integrate syntax elements with each other, algorithms with each other, and, the algorithm to the syntax. The effort was assessed using student attitudinal data. The effort confirmed the utility of CLT in course design, and it demonstrated that

hybrid/distance learning is not merely a tool of convenience, but one, which, used purposefully, inspires students to learn.

**A Junior Level FPGA Course in Digital Design
Using Verilog HDL and Altera DE-2 Board for Engineering Technology Students**

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This FPGA course is designed for junior level students who are pursuing a baccalaureate degree in electronics and computer engineering technology. Exercises were adapted for use of the Altera DE-2 development board, which were donated by Altera cooperation. Software used was Quartus II, which is freely available from Altera website. The board was found to be useful and student-friendly for majority of the laboratory exercises and for simple design projects.

**Design, Fabrication, and Analysis of Photodynamic
Therapy Oxygen Monitoring System for
Use in Esophageal Carcinoma**

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Photodynamic therapy (PDT) is an effective and minimally invasive treatment modality with relatively fewer side effects than chemotherapy and radiation, which has been approved by the FDA for treatment of esophageal cancer. Maximum therapeutic outcome of the PDT protocol for each individual patient requires optimization of the components of PDT operating at their highest efficacy. Tumor necrosis, the method of malignant tissue destruction by PDT, is carried out by the toxic singlet oxygen molecules that are being formed from the molecular oxygen in the tumor. The availability of molecular oxygen, being the rate limiting step for PDT, plays a key role in the treatment protocol. Currently, the PDT of esophageal carcinoma is a relatively blind process since there is no method to monitor the tumor oxygen level during the treatment. In this paper, we present an optical technique to monitor molecular oxygen level in the PDT milieu. The method described herein is a reflection oximetry technique designed with small semiconductor lasers and a silicon photodiode. The light used for monitoring system comes from two semiconductor diode lasers of 650 nm and 940 nm wavelengths. The two lasers and the photodiode are integrated into a small package which is then mounted onto a balloon catheter containing the PDT light delivery system. The lasers and photodiode are powered and controlled by a control box that is connected via a cable. The light sources and the photodiode output are controlled by LabVIEW virtual instrumentation. The sequential on and off light sources and the respective reflective signals are processed with MATLAB. The latter code integrates with LabVIEW to make an automatic calculation of the corresponding light absorption by each chromophore to determine the change in oxygen level as well as the amount of blood and oxygen present in the treatment area. The designed system is capable of monitoring the change in oxygen level and the blood flow in any part of the human body where it is possible to place the package.

**Simzlab - Interactive Simulations of Physical Systems for
Active Individual and Team Learning**

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Teaching by lecture and textbook alone does not satisfy students' needs. Many physical systems are too complex to be conveyed fully by the static plots and drawings in books. Essential to learning is active practice and application of new knowledge. Real experiments are wonderful - but cost and space constraints limit the number which can be implemented - usually from zero to a few in most courses. Interactive software simulations can engage students actively in the learning process and help them to understand and work with complex systems. Interactive simulations engage the student^{2,3}. They are interesting and fun to use^{4,6}, and help students take responsibility for their education⁷.

This paper describes a software application – SimzLab⁸ - and what we have learned from developing and using it. Our main objective has been to provide students with virtual lab modules to supplement lecture courses on chemical processes.

**A Conceptual Approach to Developing a
Universal Remote Laboratory for
Education and Research in Electrical Power Engineering**

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One crucial element of education in electrical power engineering is the laboratory component. The laboratory instruction may be delivered in physical laboratories using real equipment or through simulation software tools, and in many cases utilizing both simulation and real equipment. Remote laboratories, where experiments are performed on real equipment remotely via simulation interfaces, have recently gained keen attraction. In this paper, a novel approach to delivering remote laboratory education is presented. The major components forming the new laboratory system include a real power system, an online monitoring and control station and a web client-server system. Sample activities that may be performed remotely through this laboratory are described. These activities range from a simple experiment for evaluation of transformer performance to more involved studies such as voltage stability and generator startup. Renewable energy activities may also be added. In addition to laboratory instruction and applied research, this remote laboratory is expected to be an ideal setting for distance learning.

Use of Concept Maps to Build Student Understanding and Connections Among Course Topics

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Students often have a difficult time becoming strong engineering students because they are used to some of the prerequisite courses in science and mathematics being somewhat formulaic and "plug-and-chug" in their approaches. When students have been challenged by prior courses that are not formulaic, they often rate them as being harder or complicated. The transition of becoming more broad-thinking in problem approaches is a difficult one, even for very hard working and bright students. Concept maps enable instructors and students to more concretely describe connections among different course topics and to place new knowledge into a comprehensive problem solving framework.

Examples of concepts maps from a series of chemical engineering courses are used to discuss how the idea of concept maps can be used in different ways. Concept maps built over the semester for a sophomore material and energy balances course are used to highlight how layering of new concepts and an inherent increase in complexity leads to a comprehensive overview of material. Use of the concept map in lecture example problems demonstrates how one can utilize the given problem statement to see how solutions to conceptually challenging problems are built. A concept map from an equilibrium thermodynamics course at the junior level is used to show how disparate yet interrelated ideas can be bridged together through a hierarchical definitional approach. Finally, a concept map illustrating sustainability in the context of technical, social, economic, and environmental issues for a senior design series is examined for pedagogical relationships on why certain topics were selected for the courses.

Student feedback has consistently shown that the idea of concept maps enables students to solve more complex problems with greater confidence. Students have also indicated that they have developed concept maps for subsequent courses on their own, even though it was not required and instructors did not encourage these efforts. Students seem to benefit from these activities.

A Framework for Developing Courses on Engineering and Technology for Non-Engineers

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Kate Disney, Mission College, Engineering Faculty
Elsa Garmire, Dartmouth College, Professor of Engineering
Tim Simpson, University of Pennsylvania, Professor of Engineering

Americans need a better understanding of the wide variety of technology used everyday. The need for technological literacy is great for both individuals and the nation in general. Creating a population with a more empowered relationship with technology will require a significant and extensive initiative in undergraduate education. Curricula and course materials that are easily adoptable in diverse and varied institutional environments are vital in this effort. The National Academy of Engineering in two reports: *Technically Speaking: Why All Americans Need to Know More about Technology* (2002), and *Tech Tally: Approaches to Assessing Technological Literacy* (2006), outline the characteristics of a technologically literate citizen. The International Technology Education Association (ITEA) and the American Association for the Advancement of Science (AAAS) have also developed standards for technological literacy. The NSF supported a working group lead by the American Society for Engineering Education (ASEE) Technological Literacy Constituent Committee to develop standardized and readily adoptable

undergraduate courses on this topic. This group met on March 26-27, 2007 and developed four models to serve as standardized courses on technology. A framework was established for specific course outlines consistent with the content areas established in *Tech Tally* of: technology and society, design, products and systems, and technology core concepts and the ITEA technology topic areas. To make it possible to accommodate the diverse requirements of curriculum committees on varied campuses, the framework offers flexibility to faculty in planning courses within each proposed model while still accomplishing the goals of the standards. This framework will form the organizational infrastructure for creating a repository of course materials as well as an online community for course developers and instructors.

Computer Applications in Mechanical Engineering

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Juniors in mechanical engineering at California State University, Sacramento (Sacramento State) are required to take a 3-unit course titled “Computer Applications in Mechanical Engineering (ME 175)”. Prior to the fall 2000 semester, FORTRAN and MATLAB were the primary software packages used. The prerequisites are (i) any high-level programming language including C and C++, (ii) engineering materials, (iii) circuits and (iv) engineering mechanics –statics. The mode of course delivery is two 50-minute lectures and a 3-hour laboratory per week. Emphasis was on the introduction to numerical computation and assigned problems were solved on a PC/Workstation. Tests and final exams that rely heavily on computation were used to evaluate student performance; laboratory reports were used to assess writing skills. It was observed that a typical class was made up of two types of students; those who enjoyed programming, and students who considered programming as drudgery and were not motivated to do more than the minimum amount of work required to get a passing grade. The latter group also had difficulty relating the computer exercises in the textbook to real-world applications. After teaching this course a few times, the author decided to explore methods that might make the course more exciting to a greater number of students while remaining challenging. After some research it was decided that computer control of objects using microprocessors might be a good addition that will allow the students to test their programming skills, complement the techniques encountered in the numerical exercises, and at the same time lead to fun and challenging designs.

Teaming Multi-level Classes on Industry Projects

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For the past few years we experimented with teaming students from a sophomore-level class and a senior-level class to work on industry projects. The classes are “work design” and “facilities design.” Projects are selected to require the application of knowledge from both disciplines. In addition, the projects are selected from small local companies. The intent of this paper is to describe the benefits and difficulties associated with this methodology. While specific classes in this experience are typical of an industrial engineering curriculum, the lessons learned and benefits could translate to other disciplines.

Redevelopment of a Systems Engineering Course into Blended (Hybrid) Mode

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Research in the area of teaching methods supports the use of an appropriately designed blended mode to supplement a traditional lecture format. A blended or hybrid course, by definition, reduces face-to-face (f2f) "seat time" so that students may pursue additional teaching and learning activities outside of class, typically online. This paper describes the process and experiences of the redesign of a systems engineering course into a blended course. To be successful, the redesign requires careful application of pedagogical concepts and continuous improvement using an understanding of how students learn. This paper is a status report of an ongoing effort.

Laboratory Projects Appropriate for Non-Engineers and Freshman Engineering Students

Kate Disney, Mission College, Engineering Faculty
John Krupczak, Hope College, Professor of Engineering

The engineering departments at Hope College and Mission College both offer technological literacy courses targeted to non-science majoring students. These lab-based general education courses are designed with mechanical dissection and "make-and-take" lab projects that represent core technology.

These technological literacy courses are often referred to as "*How Stuff Works*" classes, because the focus is how and why core technology works as it does. Students are exposed to the scientific principles underlying the technology, and with this the students build or modify devices to work in a manner that satisfies a human desire, which is the engineering component.

Lab projects are constructed primarily with common, ordinary parts typically found in local retail stores. The use of simple parts helps to reduce abstraction and clarifies the underlying science of the technology. Engineering is explained primarily with natural language, demonstrations, teacher modeling, and hands-on lab projects. The lab projects either require students to take apart a device and analyze the functional parts (mechanical dissection) or build from scratch a new device (i.e. "make-and-take" projects).

Core Technology is defined as technology that is familiar to students as users. Core Technology is also technology that appears repeatedly in many engineered systems. Examples of Core Technologies are 1) a speaker, 2) a radio, 3) the LED, 4) the transistor, 4) the lever, 5) the internal combustion engine, 6) a DC motor, etc. These technologies are so familiar in everyday systems that students have a starting point from which to build their knowledge.

All people can and should understand the workings of common core technologies and have a basic understanding of the underlying science. With a "How Stuff Works" class, students are given a foundation that can be applied later to learning about other technologies not covered in the course. The benefits to having a technological foundation are clear – many important issues of our time have a technological component. With a proficient understanding of current technological issues, citizens could be more participatory and effective members of society.

Much work has been done through NSF funding to bring engineering, science, and technology to the public, but teacher materials for the college level are primarily available in electronic form. Support for faculty

needs to extend beyond electronic file sharing to include supplying ‘starter’ kits that contain all the parts needed for students to build a project.

The Hope College – Mission College collaboration, with support from the National Science Foundation, is providing kits to faculty at other institutions and assessing if putting equipment and materials into hands of teachers is an effective means of getting more lab projects adopted into technological literacy and freshman engineering courses.

Multipoint Remote Temperature Monitoring and Data Acquisition System Using RF Technology

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Embedded system and wireless technology has entered in all aspects of life with variety of useful functions. Wireless communication has changed the way data can be transferred and viewed across locations. Industrial wireless modems use electromagnetic waves to transmit modulated data typically using RS-232 standards. The focus of this work is the development of a “Multipoint Remote Temperature Monitoring and Radio Data Acquisition Embedded System” that is taking advantages from embedded microcontroller, such that interaction and processing with the wireless transceivers and the temperature sensors. The multipoint remote temperature monitoring radio data acquisition embedded system project is implemented using DS-18B20 digital thermometers that gives 12-bit resolution, long range 433Mhz HAC-UM96 with serial interface RF modems and the Freescale HCS12 microcontrollers. This hands-on project aims to use the mentioned hardware for remote data acquisition to monitor and collect temperature and report back wirelessly to be further processed by the embedded microcontroller. One RF modems is used to communicate with the rest of the RF modems and receives the temperature from the remote locations. Project is implemented by using the HCS12 Dragon 12 plus Development Board as embedded microcontroller and “Code Warrior”, an Integrated Development Environment (IDE) for embedded applications. The software is written in ‘C’ programming language using the Code Warrior IDE. The Code Warrior IDE has been developed by Freescale Semiconductor Company^[1].

Agile Problem Driven Teaching in Engineering, Science and Technology

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In problem driven teaching, all major teaching activities are driven by a problem or a set of problems. Some typical problem solutions are demonstrated by the instructor. Problems could be based on real world or realistic or abstract situations. Recent research suggests that abstract problems may have some advantages over others. This paper demonstrates how course learning outcomes are adequately handled in agile problem driven teaching in Engineering, Science and Technology courses for effective interactions.

Problem driven teaching is not the same as Problem Based Learning (PBL). Students as well as educators enjoy PBL. With PBL, learners are usually organized into groups, and one or more problems are given to each group for solving the problems under the supervision of the instructors. Although PBL is highly successful in certain environments, it is not necessarily appropriate for all learners and for all topics, since

the teaching methods may not be dynamically adjusted modified. on the basis of different challenges faced by different learners for different topics. Adjusting teaching methods based on learner feedbacks may be appropriate in multi-model, multi-strategy learning environments. Agility in teaching/learning and grading helps to overcome the different challenges faced by different learners for different topics. Our discussion of agile problem driven agile teaching considers all instructional strategies including lectures, transformations, experimentations, problem solving, analogical, case-based and mathematical reasoning for affective learning utilizing tools and technologies in an innovative way. Teaching is unlike any other job; An effective teacher must take complete responsibility for student's learning and reasonable grades specification. Agile problem driven teaching may be the right approach for solving some of the most crucial problems in engineering education.

Prerequisite Skills Testing as an Indicator of Student Retention

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The results from a prerequisite skills exam, administered in a Solid Mechanics course in the sophomore year of the Aerospace and Mechanical Engineering degree curriculums, are evaluated as a possible identifier of at-risk students in an effort to increase student retention. The prerequisite skills exam was first implemented over two years ago in select engineering and math courses as a type of mastery exam, allowing students multiple attempts to pass the exam for credit towards their grade. This exam was largely created in an effort to boost student achievement in core engineering courses, but is also expected to be a useful self-assessment tool in anticipation of the next ABET visit. There are currently pressures to identify at-risk students and subsequently increase student retention through a variety of interventions, especially at a small, private university that is funded primarily through tuition dollars. Select results from the Solid Mechanics prerequisite skills exam are compared against a variety of factors, including drop-out rates, change of majors, and performance in both the Solid Mechanics and overall degree program performance. The study concludes that failure to pass the prerequisite skills exam can be a useful indicator for at-risk students.

The Capstone Design Experience in the Mechanical Engineering Department at California State University, Fullerton

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The terminal learning experience in the mechanical engineering program at California State University, Fullerton is the series of two design classes: ME 414 and ME 419 taught respectively in the Fall and Spring semesters. These two courses have the goal of immersing the students in the real-life engineering problems where they are engaged in systematic application of the principles of design and solving open-ended problems for specific situations and/or needs and in utilizing knowledge acquired during their studies at the University. Design is about testing ideas, failures and successes and solving problems as these appear during the semester. Decisions have to be made at each step of the process, compromises must be reached among the team members, optimization of components is done and ultimately the project must be fabricated, tested and it must perform as stipulated, that is the requirement that the department has imposed on each and every design project. The principal objective of this sequence of courses is for the students to develop an understanding of the design process as it applies to a serious mechanical engineering project. Students must be able to select standard off-the-shelf components as well as design non-standard mechanical sub-systems. One of the key features of these two courses is the creative utilization of

contemporary software packages i.e. Pro-E, Fluent, Ansys, Solid Works as well as MathCad, MatLab, AutoCad and Project Management software. Simulation is readily utilized and the students readily appreciate ability to virtually analyze a real system rather than engage in costly sequence of physical prototypes designed iteratively by intuition and/or trial-and-error prior to building a physical prototype. Strict requirements are maintained in developing the RFP and subsequently the proposal for the projects, maintaining the documentation of the progress, adherence to the Gantt chart and communications with the vendors and/or fabricators. Cost issues are carefully evaluated and teams are mandated to stay within the allocations given either by the instructors or industrial sponsors. Project teams are strongly encouraged to seek additional funding from sources within and without the University, i.e. from chapters of professional organizations (ASME, SAE, SAMPE), Orange County Engineering Council - the umbrella organization of all engineering societies within Orange county and from major industrial corporations such as Boeing, Fluor, Parsons, General Dynamics, Lockheed-Martin, Hughes etc. The projects given to the teams vary so as to meet their individual interests ranging from biomedical projects, automotive (Mini Baja, Drift Car, Formula One), avionics, renewable energy, equipment for the handicapped... Teams are carefully created with the intentions of balancing students' talents and skills as well as their desires to work with their friends. The penultimate results are a working prototype and a portfolio detailing all elements of each of the design projects. The Power Point or similar presentations which take place at the end of the semester in front of Design Juries is the climactic event of the courses where the defenses of the projects are conducted and which is a significant component of the grades given to each design team member for their performance and contributions to the project.

Application and Practice of Sustainable Development in Engineering

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In recent years there has been an ever increasing need for sustainable design. However sustainable design sometimes may be in conflict with existing design standards. The topic that this study addresses is the ethical dilemma between design standards and Sustainable design. This is a newly arising conflict resulting from the recent "green" Movement. This is a new challenge facing the modern engineer. This is a problem that the new generation will have to learn to understand and deal with.

Is There a Correlation Between Conceptual Understanding and Procedural Knowledge in Introductory Dynamics?

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Engineering professors are usually quite successful at teaching their students to choose an appropriate equation and then substitute appropriate numbers into that equation. This procedural knowledge is practiced on homework problems, quizzes, and tests. By the end of their collegiate careers most students become reasonably skillful at these types of tasks. What is more uncertain is if these students actually graduate with a deep conceptual understanding of their course material.

Students tend to struggle with the course content in Introductory Dynamics. This is often the first rigorous course in engineering that a student takes, and much of the content seems counter-intuitive. Many students continue to talk about the force that "throws you outward" when you are travelling in a curve, and struggle to understand that a rotating mass has more kinetic energy than one that is translating. We have assessed student conceptual understanding by administering the Dynamics Concept Inventory (DCI) before and after

the course. The scores on the DCI will be correlated to scores on a midterm test and a final exam to see if there is a correlation between student conceptual knowledge and procedural knowledge.

Teaching Classical Control to Mechanical Engineers via Take-Home Experimental Setup Based on Microcontrollers

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Supplementing a control systems class with a hands-on experience for students by working on a real dynamical system helps in better understanding the classical control theory and emphasizes the importance of its applications. For a small size class this could be achieved by developing laboratory setups with various experiments that students can perform in groups taking turns. Many universities have already added a laboratory to their programs and have reported the beneficial effect of that for the students [3, 4]. In most cases they rely on commercially available laboratory setups [5]. Even then, finding suitable times that can accommodate all students might be difficult and it brings the necessity of a room and an instructor for the sessions. Solutions for those problems have been proposed by utilizing remote access laboratories via the Internet [6]. However, this would require additional equipment for remote access and still keeps the need for a specific room.

At the Aerospace and Mechanical Engineering Department of The University of Arizona, it is not unusual for the Control System Design course to have enrollment of about 100 students. This makes offering a lab section with the course nearly impossible. As a way to avoid canceling the practical experience of the course, we developed an inexpensive and portable setup, which can be taken home by the students, and they can work on it as their term project. Besides addressing our organizational problems, this solution brought an opportunity to demonstrate to students a modern approach towards control systems using computers and implementing the controller in software.

Using Model Eliciting Activities in a Dynamics Course

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Typical assignments in a traditional dynamics course often do little to motivate students or to give them an indication of how they would use the material in a future job situation. Many instructors are now attempting to provide motivational projects, hands-on demonstrations, and even laboratory assignments to increase understanding and motivation. To help provide motivation and real-world context in our dynamics courses at California Polytechnic State University San Luis Obispo, we have implemented three model-eliciting activities (MEA). Model-eliciting activities (MEAs) originated in the math education community. They focus on the process of problem solving and model development, rather than just a final answer.

The first MEA requires students to create an Accident Reconstruction Procedure for police officers in Sri Lanka. The student teams were given four accident reports, some pulled from actual police reports, to analyze and use in determining their procedures. They had to utilize work-energy and momentum principles as guidelines, in addition to accounting for uncertainty and other noise in the data. Their Model Documentation was in the form of a memo to the Sri Lankan Police Chief, along with their analysis of the four accidents.

The customer for the second MEA is a publishing company of dynamics textbooks. The student teams had to develop guidelines to send to potential developers of online multimedia example problems. Their “Engineering Consulting Firms” then had to develop one of these multimedia examples according to their guidelines. The final MEA involves a physical experiment in which students have the opportunity test the validity of their work. The student teams are asked to analyze a catapult to help with an historical battle re-enactment in England.

**Development of a Student-Centered Hands-on Laboratory
Experiment of Chemical Detection using Micro-cantilever Sensor and Optical Lever
Amplification Technique ***

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The development of an undergraduate experiment in micro- and nanotechnology based on the detection of chemicals via microcantilever sensors is described. The modified process allows the use of a simple wet-etching station to produce the cantilevers using commercially available substrates, which allows schools without access to clean room facilities to implement the experiment. Simple data analyses demonstrating first-order adsorption kinetics and Langmuir isotherm have also been included to assist in the interpretation of the data. Assessment of the educational impact of the experiment has shown a significant increase in domain knowledge and total engineering design experience of the students. Comparison between groups that have participated in design-only version vs. full-scale hands-on experimentation show increased appreciation of the field of nanotechnology, as well as in the students’ perceptions of their marketability.

**(An expanded version of this manuscript has been submitted for publication in International Journal of Engineering Education).*

Modeling the Dynamics of a Small Catapult to Enhance Undergraduate Studies

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It is estimated that the average engineering student will work 3000 "back of the book" style homework problems by the time that they graduate. While these problems can certainly help with the learning process, many do not mimic any type of real world systems that an engineer will encounter in their careers. Furthermore, most do not require the student to develop a physical model of the actual system that they attempt to analyze - this is already done for them in the problem. An example of this can be found in any dynamics book; the work-energy chapter invariably contains problems with springs attached to different slender rods in a variety of different contrived orientations.

We have attempted to improve student analytical skills and to provide real world context to the study of rigid body dynamics by creating a catapult project. Students are given rubber bands, catapults, rulers, weights, and a scale. They must determine how to model the arm, the energy stored in the rubber bands (e.g., linear or non-linear springs), and the ensuing projectile motion. Their computations are then tested on launch day - when raw eggs are hurled 20 to 45 feet at a small picture of their instructor.

There are a number of different dynamics aspects that can be incorporated into the catapult project. The fixed pin that holds the arm at the bottom can be analyzed using Newton's second law, and a stopper pin

that the arm hits can be examined using impulse momentum principles. Students have even analyzed the internal axial stress at a point in the arm as a function of the arm angle as the arm rotates.

The catapult project is easy to implement and provides a real world artifact that students must analyze. They make decisions about how to model a true physical system, what effects are negligible (e.g. drag and friction), and what measurements must be taken. We have found this to be a motivational and fun way to help students learn about rigid body dynamics.

Finite Element Analysis Tutorials for an Undergraduate Heat Transfer Course

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Commercial finite element packages are widely used in industry thereby making exposure to this analysis and optimization tool an important component of undergraduate engineering education. Finite element analysis (FEA) tutorials have been developed for various undergraduate engineering courses, including mechanics of materials, vibrations, heat transfer, fluid mechanics, and machine design and analysis; these tutorials serve as an effective teaching and learning resource that reinforces the fundamental concepts and applications of each course. This paper discusses the implementation, results, impact, and assessment of incorporating steady-state and transient heat conduction tutorials into an undergraduate heat transfer course using SolidWorks and COSMOSWorks commercial software. The primary goals of these tutorials are to provide the students with (a) a different insight into the heat transfer concepts that are covered in a traditional undergraduate course, (b) a basic knowledge of finite element theory, and (c) the ability to apply commercial finite element software to engineering problems involving thermal systems. Assessment has been done through the use of pre- and post-tutorial quizzes, student opinion surveys, and demographic surveys of student learning styles. Furthermore, the implementation of a design project that involves an application of the knowledge gained from the tutorials is also discussed.

The Role of Computing in Education: The Next Revolution

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As computing technologies continue to rapidly advance, the knowledge economy also continues to be a more important part of the world economy. Ubiquitous computing is here to stay and it has become one of the main fibers of social, cultural, and economical life. It is an enabling technology that can increase the productivity in a wide range of applications and economical activities. Besides economic growth potential, computing also provides an opportunity for educational growth; this paper represents a summary of the discussions of researchers from industry, government and academia who were assembled to address how this evolution of computing can impact education in the next revolution.

Potential Value of Toys in Engineering Education

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Classroom demonstrations add to students' interest and their understanding of the subject matter. Many references are available that deal with demonstrations, for example in physics courses¹⁻⁴ and engineering⁵⁻⁶. A wide variety of apparatuses and processes have been developed or adapted for demonstrations; these range from simple to complex, inexpensive and homemade devices to elaborate, expensive and commercially available units. Children's toys and the so called "executive toys" or novelties have also been employed as demonstration tools⁷⁻¹⁰. Properly selected toys offer at least three advantages: (1) they are relatively inexpensive and readily available for immediate use; (2) there is a good chance that students are familiar with them from their own experiences; and (3) they exhibit a wide variety of scientific concepts. In addition to their utility for classroom demonstrations, toys can be used for other educational purposes such as informal science education and inspiring ideas for student projects.

The literature on toys in education is indeed rich, especially in publications such as *American Journal of Physics*, *The Physics Teacher*, and the European journal *Physics Education*. Since engineering fundamentals are extensions of those of physics, the paper on toys written by colleagues in physics could well be relevant and applicable to our profession. Most of the toys discussed in the literature are related to aspects of solid mechanics, popular and well know toys like the top, yo-yo, gyroscope, slinky, balancing toy, buzzing magnets, rattle disk, Euler's disk, etc. An online search for physics of toys will reveal adequate number of links to get an interested reader on a journey to learn more, however, two excellent papers are included here for completeness¹¹⁻¹².

Some of the toys discussed in the literature are related to fluid mechanics. Probably the oldest one and the most frequently written about "fluids toy" is the Cartesian diver, a floating object in a bottle of water that can be moved up or down based on the force exerted on the bottle, that demonstrates hydrostatic pressure and buoyancy. Its use has been documented as early as the 17th century¹³, but interestingly it has continued to the present day in several forms and modifications¹⁴⁻¹⁷. Another popular toy is the drinking bird, an oscillating bird that seems to take small sips of water by tilting down to make a contact between its felt-covered beak and water in a glass and up, and repeating this cycle for quite a long time, demonstrating evaporation and center of gravity¹⁸⁻¹⁹. A wonderful old toy is the putt-putt boat which demonstrates the third law of Newton among other phenomena it exhibits²⁰⁻²². Slime and silly putty are also child's toys that have remained popular for several decades as goeey and deformable substances with strange rheological behavior²³. One can think of the lava lamp as an example of a novelty item that shows strange fluid properties in an artful and pleasing way. Other fluids related toys are soap bubble generators, smoke ring and air vortex generators (known as blasters), balsa wood or paper model airplanes, rockets, and balloon helicopters among others. It is interesting to note that Ludwig Prandtl, a giant figure in Fluid Mechanics, was fascinated by toys as observed by Theodore von Karman, one of his most famous students²⁴. The late Professor Julius Sumner Miller found toys "enchanting." He hosted many TV shows on physics demonstrations with simple devices and toys in the 1960s and 70s. Video clips of several of his shows are available on YouTube²⁵.

The purpose of this paper is to introduce three fluids toys that, although available for quite sometimes, have not been documented in the literature. Indeed the author was surprised that his search did not result in any relevant references, as he had assumed for sure someone had seen the educational value of these toys and

had written about them. Thus, he decided to write this paper to share his findings about these toys and their potential in education.

Comparison of BOKI and BOK2 to NAU's Undergraduate Civil Engineering Program

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The American Society of Civil Engineering is promoting change to the path for entering the professional practice of civil engineering. This change is articulated in Policy 465¹, which supports the attainment of a Body of Knowledge (BOK) by way of a fulfillment pathway: bachelor's degree plus a master's degree or thirty semester credits plus experience. This paper presents a review of the two versions of the BOK, BOK1 and BOK2, and a comparison of these versions to the undergraduate civil engineering curriculum at Northern Arizona University (NAU), which is benchmarked to the 2007-2008 ABET Criteria for Accrediting Engineering Programs².

Understanding Histograms, Probability and Probability Density Using MATLAB

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This paper presents an attractive way to introduce the fundamental terms used to describe a random variable using a MATLAB environment. The Uniform and the Gaussian random variables are considered. The demo programs include histograms, probability, probability density and distribution functions. The results of the evaluation of the program are also presented.

From Sequential to Parallel

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There is an urgent need for traditional programmers who write programs meant for a single processor to be able to modify or write new codes for multiple processor machines. Unfortunately, writing parallel programs has been esoteric, considered too complex and had been confined to a few developers. This paper presents Microsoft .NET framework versions and enhancements that provide modern approaches that are relatively easy for traditional programmers to learn rapidly and use. These new technologies provide support for both shared memory as well as distributed memory parallel programming models such as a decentralized software service model. However, the presentation of these technologies needs to build on the general background of the stored programmed memory model used by the traditional programmer. It needs to add structures that enable them to incrementally move from sequential model to the parallel model of computation. The goal of the paper is to present a comprehensive structure that integrates the parallel programming model with the sequential model and introduces the technologies in this context. The paper argues that a second level programming course should be based on such an approach. Such a course will be useful for students as well as professional programmers who need this new skill in the light of more and more multi-core, many-core and cluster based commodity multi-computing.

MATLAB-Based Demo Program for Discrete-Time Convolution

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Though the field of engineering has changed dramatically in the last 20 years, the teaching engineering has changed relatively little¹. Many of the engineering lecture courses are taught using a traditional method i.e. only with the support of a blackboard or transparencies. The major disadvantages of traditional teaching methods are that students usually have to choose between taking notes and listening to the lecturer. As a result, most of the learning in traditional teaching is individual, since the students in the classrooms are taking notes or listening instead of participating². Consequently, many students in conventional classrooms develop little confidence in their own ability to learn³.

Demonstrations that illustrate concepts with visual aids are one of the important tools in the field of engineering education. They help students connect theory with practice; they realize how theory and systems are connected⁴. Students learn better, remember longer and are better able to identify the appropriate concepts to solve new problems when they learn by addressing concrete problems and actively participate in exploration and pursuit of knowledge³.

The availability of personal computers (PCs), their increasing calculation power, and their enhanced graphical possibilities enable teachers to take the advantage of the pedagogical possibilities afforded by new technologies⁵. Computer-aided learning has become extremely popular and its use in classroom can be very helpful by adding more analytical capabilities in all engineering areas⁶. It can be applied in the aspects of teaching, learning, validation, and research in engineering education⁴. Besides, it is beneficial especially in terms of saving time and efforts for both teaching and learning in the educational process⁴.

Our experience at the National Institute INAOE⁷⁻⁹, shows that the development and usage of software tools represent an effective teaching approach and increase students' learning. Such software tools must be reliable, student-friendly and with no requirements for the corresponding programming knowledge. In pursuance of this goal we developed the educational demo program to support the theory provided in basic courses in which the fundamentals of Digital Signal Processing are taught. The next section provides a brief description of the program. Section 3 shows the demo program in details. Last section is dedicated to the demo program evaluation issue.

Expanding Engineering Education through Undergraduate Research Experience in Micro-Robotic Drug Delivery

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This paper examines the use of MEMS research in bio-medical micro-robotic drug delivery as an education vehicle for expanding the effectiveness of undergraduate engineering education in order to meet advancing

challenges of the future. Micro-robotic drug delivery is a diverse area of research with emerging applications in intraocular surgery and cancer treatments. This research requires integration of engineering sciences such as bio-systems, fluid mechanics, thermodynamics, chemistry, material sciences, and more. This allows various engineering disciplines to utilize their classroom knowledge in direct research with real, innovative applications in technology. This method of complimenting engineering education with curricula-related research has shown improvement in engineering accomplishment and learning that is advantageous to the future success of undergraduate engineering education

Towards a Joint Degree Program in Ambient Computing

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Funded by the US-EU Atlantis Program, International Cooperation in Ambient Computing Education (ICACE) Project is establishing an international knowledge-building community for developing a broader computer science curriculum aimed at preparing students for real-world problems in a multidisciplinary, global world. ICACE is collaboration among three US and three EU universities joined forces to create a core curriculum in Ambient Computing. The curriculum will include aspects of social science, cognitive science, human-computer interaction, organizational studies, global studies, and particular application areas as well as core computer science subjects. Programs offered at partner institutions will form trajectories through the curriculum. A degree will be defined in terms of combinations of trajectories which will satisfy degree requirements set by accreditation organizations. The curriculum is evolving with student and faculty exchanges on both sides of the Atlantic and expected to lead to joint- or dual-degree programs among the partner institutions in the future.

Engineering 101: Peer Teaching with LEGO NXT Robotics

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The vast amount of knowledge and the multitude of disciplines encompassed by engineering can often be intimidating and difficult, creating an educational barrier for beginning students. The goal of an introductory engineering class is to present engineering as an exciting and welcoming field of professionals who work together to solve problems. An introductory engineering class that lacks creativity, teamwork and encouragement often fails to inspire students and may turn some away from engineering. This paper describes a modern approach to team-based learning and peer teaching in the context of an introductory course for freshmen engineering students. More specifically, the use of LEGO NXT® construction kits was tested as tool to enhance the experience of group projects. LEGOs are approachable, intuitive and have application in numerous construction projects. The low cost, reusability, and availability of a variety of sensors for LEGO kits make them ideal teaching materials compared to other expensive, specialized products. Our project involved presenting students with a task of designing a ribbon-climbing robot which must detect a randomly placed marker and report its height through a wireless communication link. The

students were provided with basic mechanism design formulas and calculations allowing them to optimize their design. The project culminated in a final competition between the teams in the class. The project emphasized self- and team learning. The teamwork and the final competition encouraged flexibility, interaction and support between the students, behavior necessary of successful engineers.

Teaching Online in Electrical Engineering; Best Practices Experiences and Myths

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Online teaching is here to stay. We cannot longer deny or refuse to teach on line, therefore we must reinvent ourselves and develop skills that we did not have or did have and did not know it. This paper attempts to describe the practices we have had in the teaching of electrical engineering courses online. We will show how effective, ELLUMINATE™ has become versus the classic face-to-face classroom teaching. To do so we split one class in two sections; the first one is the online section and the second one is the classroom face-to-face section. To reduce duplication, while the on line section is taking the class; the classroom face-to-face section takes the class via an LCD projector.

The time has arrived where all students have a laptop or have a PC at home. 90% of the students taking these classes own a laptop with wireless communication. It is very encouraging to see that the students in the classroom face-to-face class have their own laptops connected to the online class so that they can minimize note taking and pay more attention to the lecture. The question is; how do I make sure that students outside of the classroom are connected to the online class? The answer is in the software that we use. Basically, we have a list of students logged on to the left side of the screen. Furthermore, there is an interactive aspect of our system via sound and video. I do prefer sound only so that those students that do not have access to a large broadband ISP, at least they can listen and talk without many interruptions or slowing down their system.

Curricula for Using Waste Tires in Civil Engineering Applications

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The United States generates about 300 million waste tires each year. Approximately 40 million of these are generated in California alone. Waste tires stored in stockpiles can pose significant public health and environmental issues. Stockpiled waste tires provide an ideal breeding ground for mosquitoes and rodents, which can transmit diseases. Tires placed in stockpiles can ignite resulting in tire fires that are difficult to extinguish. Although the Environmental Protection Agency does not consider scrap tires as hazardous waste, tire fires release hazardous compounds which pollute the air, soil and water. Nationwide, millions of dollars has been spent to clean up tire fires.

Laboratory Projects Introduced in Teaching Manufacturing Processes Course

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Mechanical engineering students should graduate with strong practical and interpersonal skills^(1,2). Manufacturing Processes is a fundamental mechanical engineering course offered to junior students in engineering schools⁽³⁾. The primary objective of this course is to give students exposure to understanding of a range of modern manufacturing processes and practices. Students are expected to be able to select appropriate manufacturing processes and fabricate parts after completing the course. Normally, this course includes laboratory activities and fabrication projects. Students use different manufacturing equipment and make parts to get a “real” feeling of the manufacturing process. In the past two years, the author has introduced several innovative projects while teaching this course in University of the Pacific's School of Engineering and Computer Science. The goal of the projects is to inspire students' interest in the manufacturing engineering field. Students are expected to use the knowledge learned in this and other engineering courses such as Engineering Graphics and Materials Science to solve synthesis engineering problems. These projects are also aimed at helping students to better understand the fundamentals discussed in the classroom, making learning more enjoyable and improving student satisfaction. This paper will discuss these projects.

CIBRED via CIERRA for Educating the Next Generation of Engineers

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The National Science Foundation CI-TEAM (*Cyber-Infrastructure Training, Education, Advancement, and Mentoring for Our 21st Century Workforce*) awarded the Virginia Bioinformatics Institute at Virginia Tech University a two-year Implementation grant for a CIBRED* (*Cyber-Infrastructure for Biological Researchers, Educators and Development*) project. The collaborative undertaking involves partnerships with scientists, researchers, secondary school teachers, and college faculty from several institutions nationwide. It is designed to build an enriching and engaging curriculum development and deployment program that would prepare undergraduate, middle and high school students for research environments where cyberinfrastructure systems, tools and services are used effectively to fuel a knowledge-based economy.

The deployment phase is a CIERRA for STEM field careers and 21st century education and workforce component. This two-pronged approach could be considered as K-12 educational, outreach, and training (EOT) stimulus and renewal strategy. CIERRA stands for Cyber-Infrastructure Education Recruitment, Retention, Advancement), while STEM stands for Science, Technology, Engineering, Mathematics. EOT is the roadmap for preparing the next generation of engineers and future scientists in the global knowledge economy. This paper highlights the E in STEM referencing a Team Science approach to preparing the next generation of engineers, technicians, researchers, and future scientists. CIBRED and CIERRA are used here as a way to show how this collaborative, project-centric bioinformatics initiative can contribute to the development of an educational pipeline to prepare in/out-of-school youth with 21st century workforce skills and foster innovation and interdisciplinary practice. The product and the processes are applicable to K-12 engineering education.

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Bio-molecular Engineering Verified by High Sensitivity Detection

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An interdisciplinary, industry-academic collaboration was conducted to aid students at the Pitzer College Vaccine Development Institute and the Claremont Colleges to study the progression of Tobacco Mosaic Virus (TMV) on plants. Symptoms of the virus, including discoloration and mottling, usually takes weeks to develop. The students genetically inserted the gene for green fluorescent protein (GFP) into the virus genome. The genetic modification allows the viral infection to be detected within a few days via fluorescent imaging. The detection of the fluorescence was aided by UVP, LLC. Fluorescent images of a tobacco relative (*Nicotiana benthamiana*) agroinfected with GFP-TMV was captured daily using a macro imaging system to document the intensity and area of the viral expression. The quantitative data is used to observe the movement and expression of the virus under various conditions and when changes are made to the viral gene sequences. Students were exposed to the technical aspects of fluorescence imaging besides being able to rapidly verify their biological work.

CIBRED: Engineering Education on Cyberinfrastructure with a Multidisciplinary Approach for Non-Engineering Students

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Although the role of cyberinfrastructure in engineering education and research is advancing, the use of the concept and infrastructure are quite limited in the courses for the allied health professionals. CIBRED* (CI-TEAM Implementation for Biological Researchers, Educators, and Developers), an NSF funded project, provides a unique opportunity for these authors to introduce the concept of cyberinfrastructure to non-engineering educators and students by designing, developing, and deploying course materials with a interdisciplinary approach. At present, two courses are being developed for deployment and assessment during Fall of 2009. These interdisciplinary courses are being developed in a modular format integrating scientific and technology information from a variety of disciplines. These modules can be incorporated into existing or newly developed courses. One module is for allied health professionals to learn about cyberinfrastructure for healthcare management. The other module focuses on human migration, which introduces engineering education to the undergraduate students from humanities and social sciences. Project-based learning concepts have been implemented in developing these courses to teach various relevant disciplines. The focus is to teach students from diverse disciplines some essential concepts on computer technology in the context of applying cyberinfrastructure. These courses developed for K13 & K14 levels will be offered in an innovative classroom setting for hands-on experimental learning with a focus on solving

scientific problems as a team. These courses will also be deployed for online learning in a virtual classroom. The effectiveness of such an approach, introducing concepts from engineering education to the non-engineering students, will be assessed through formative and summative methods for further development and dissemination.

**CIBRED is funded by NSF award OCI-0753375 to O. Crasta*

Is “Dewey’s Experience” Synonymous with the Current Usage of the Term?

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One of the most amazing aspects of higher education, in nearly all cultures, is that while it is generally viewed as valid or important in at least some context, it generally derives its credibility from the external milieu. Thus if intellect is popular, so is higher education – and visa versa. Importantly, this extends well beyond popularity. It includes aspects of acquiring and valuing knowledge that sometimes have the curious effect of putting higher education in the strange position of placating ideas and beliefs that are known (via research and scholarship) to be wrong. While in some ways this is just a political problem that any organization might encounter – it becomes a problem if the results are curricula that lack integrity and ultimately utility. For many fields the key to this problem is the idea of experience. Additionally, there are two aspects to the issue of experience for many curricula. First is the idea that experience is important and necessary as identified externally (beyond higher education) and the second is the idea that some knowledge may not be gained without experience. The following discusses John Dewey and his work, creates a broad description of the concept of experience in higher education for the purpose of further illuminating the aforementioned problem, and provides an initial attempt at a framework for considering the use of experience in curriculum.

Integrating Design Application and Communication Skills into Senior Design Courses

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This paper recounts the evolution of a capstone senior design course taught at Embry-Riddle Aeronautical University in Prescott, Arizona. It will discuss the development of the application based learning objectives and the integration of a technical communication component into the course in question, and the challenges and negotiations involved in successfully implementing these changes in course content.

The content of this aircraft design course was conceived after a review of previous senior design briefings and of recent alumni surveys. The design briefings were shown to be lacking in any true understanding of physical application of analytical tools, while the alumni survey indicated that the students were given insufficient communication training during their tenure at the university. As a result, the course content was radically altered to address these perceived weaknesses.

To address the lack of application of analytical tools, both wind tunnel and structural testing of scaled aircraft models were introduced into the course. The wind tunnel models were used to verify the aerodynamic loading and stability predictions made during the preliminary design phase completed in

a prerequisite design course. Structural testing was then completed to verify the design team's ability to predict structural response to load completed via finite element model simulation. Further design verification has recently been added in the form of flight testing of scaled flight test articles designed to fly with RC components.

The lack of communication training was addressed by introducing team-teaching with a communications instructor. This instructor provides lectures and additional guidance in the areas of technical writing, group presentations, and teamwork. The instructor is responsible for 30% of the grade for all written and oral communication submittals.

The integration of design application and communication skills has been very successful in preparing Embry-Riddle students for real world employment as evidenced by alumni comments. Senior students also enjoy being placed in a hands-on environment which allows verification of the theoretical learning they have been exposed to during their previous courses.

The Integration of Ruby on Rails As An Agile Teaching Tool in IT Curricula

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Ruby on Rails (RoR) is an extensive framework of Model-View-Controller (MVC) architecture comparable to Java's use of Tapestry and Struts and Microsoft's .NET frameworks. The ease of its use and productivity make it an obvious choice for agile web development that is being confirmed in the web marketplace. Its ease of use made it a prime candidate for trial training of Information Technology (IT) students for multiple technology purposes beyond just web development. RoR has proved to be a multi-faceted agile teaching tool in IT courses from an elementary to very advanced level. It is database agnostic and allows students to easily switch databases from MySQL to MS-SQL and Oracle and experience an immediate comparison virtually impossible with other frameworks. It functions ideally under virtualization and in this context is the perfect tool for working under both Windows and Open Source environments and in being the vehicle for implementing problem-focused learning scenarios. Of equal importance, RoR teaches proper application development formality using the RESTful approach that increases performance and resilience and reduces latency. RoR ease of use by students to learn quite different IT skills is demonstrated in introductory IT, database, security and Web system architecture courses.

Problem-based Learning: Implementation of Efficient Two Factor Authentication for University Computer Systems

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The implementation of an efficient two-factor authentication process for users to gain access to university computer systems was developed by students in an undergraduate Information Technology (IT) security course. Many universities use the less-reliable, single factor authentication of a process ambiguously referred to as NetID for faculty, staff, students and alumni. Although referred to as NetID, the process and technology may vary widely across universities. Witnessing the inadequacy of NetID to provide a secure university infrastructure, students were challenged to develop an improved, more secure authentication protocol. They based their solution upon an SSL secure web-site that also required a client browser certificate. This process combined a less-known feature of

SSL, a client browser certificate unique for each user (one factor), with the standard ID-Password of the web site (second factor). To make it not only secure but efficient the students cleverly stored the second factor component in a secure, portable container on a USB flash drive that makes it usable on computers in class and out of class.