The College of Engineering at University of North Texas started a new program in Electrical Engineering with funding from the Department Level Reform of the Undergraduate Engineering Education. A new curriculum was designed to include the following major features:

- Partnership between industry and the university
- Focus on active learning and learning to learn
- Emphasis on teams and laboratory activities applied to real-world problems and introduction of business practices and concepts at the undergraduate level

During 2004, pilot courses in Learning to Learn and Radio Frequency Identification (RFID), a project course developed by an industry adjunct and team taught by a faculty member and the industry adjunct were conducted. The Learning to Learn course was inspired by and adapted from a similar course developed by Dr. Grey Guy at University of Toronto and includes topics such as consciousness, metacognition, language, reading, writing, problem solving, learning styles, creativity, memory and the biology of learning. The project-based RFID course covered the topics such as integrated design process, RFID applications, available RFID devices, standards, and testing of RFID devices. As part of the project course, the students were exposed to industrial practices of product development, economics and business aspects of product development, reliability, security and privacy and social implication issues. A best practices manual was also developed that will help future industrial adjuncts better understand how to teach this type of course.

Based on the positive experience from the pilot courses, these courses are offered to the new students enrolled in the Electrical Engineering department in the Spring 2005 semester. Ethics and professionalism are also introduced to the students early in the program so that they may acquire knowledge regarding best practices of professional responsibility and conduct. After completing the course, students will have a thorough understanding of the ethical dilemmas that arise in the work environment through problems presented in several case studies.

**Primary Goal Indicators:**
Global S&E workforce

**Secondary Goal Indicators:**

*This work is notable because*
The focus of this project is to develop a model curriculum representing a significant change in the manner Electrical Engineering (EE) students are educated.

*Other Indicators (Is this work transformative or multidisciplinary?):*
No other indicators apply.

**ENG/EEC 2005**

*Program Officer:* Patrick Carriere

**NSF Award Numbers:**

0431818

**Award Title:** A Project- and Design-Oriented Innovative Electrical Engineering Program

**PI Name:** Oscar Garcia

**Institution Name:** University of North Texas

**PE Code:** 1340

**NSF Contract Numbers:**

Submitted on 02/01/2005 by Patrick E. Carriere

EEC: Approved 02/03/2005 by Gary A. Gabriele

ENG: Approved 02/16/2005 by Joanne D. Culbertson
A Wireless Stent That Measures Arterial Blood Flow
Highlight ID: 10140

Present stroke-prevention procedures utilize carotid artery angioplasty followed by stenting to minimize effects from plaque build-up and to increase arterial flow. However, restenosis (narrowing of the artery) can occur, and diagnosis requires catheterization, an invasive surgical procedure.

To diagnose restenosis without stenting, researchers at the Wireless Integrated MicroSystems (WIMS) ERC at the University of Michigan have developed an active stent. This device has a wireless differential-pressure measurement system embedded in a microfabricated stent that can be used to diagnose reductions in intra-arterial blood flow caused by the onset of restenosis. The stent is formed using microelectrodischarge machining and is as strong as commercial devices. The sensors are mounted on a monolithic substrate and can be implanted during stenting or vein grafting procedures. The sensor receives transcutaneous power from an external system and uses an on-chip antenna that conforms to the arterial wall. The device is only 200µm thick, with a volume of 2mm³. It can detect a 13 percent reduction of blood flow in the carotid artery.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Collaborations

Cross-disciplinary

This work is notable because
The development of this new wireless stent with sensors for detecting blood flow in situ, based on the ERCs advances in wireless technology applications, will reduce the need for painful and expensive catheterizations.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves high risk research.
The use of microminiaturized wireless transmitting sensors in an in situ biological application posed severe challenges that were successfully overcome to produce this advanced biomedical device.

This work involves multidisciplinary research.
This advance in medical device technology would not have been possible without the collaboration of electrical engineers, chemical engineers, biomedical engineers, and physicians.

ENG/EEC 2005
Program Officer: Bruce Kramer

NSF Award Numbers:

9986866
Award Title: An Engineering Research Center In Wireless Integrated Microsystems

PI Name: Kensall Wise
Institution Name: University of Michigan Ann Arbor
PE Code: 1480

NSF Contract Numbers:

Submitted on 01/13/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/04/2005 by Joanne D. Culbertson
ERC Yields a Strong Return on Investment

Do the taxpayers of Georgia benefit from the states investment in the Microsystems Packaging Research Center (PRC) at the Georgia Institute of Technology? According to a study prepared by SRI International for the Georgia Research Alliance, the answer is a resounding, Yes!.

Between 1994 and 2004, the state of Georgia invested $32.5 million in the PRC. The SRI study shows that the direct benefit of these investments to the Georgia economy was nearly $192 million. Direct benefits include jobs created by PRC and spin-off companies, license fees and royalty income from PRC inventions, sponsored research, consulting income to PRC staff and faculty, and the value of PRC workshops and short courses to Georgia firms.

In addition, the $192 million in direct benefits produced ripple effects on the Georgia economy in the form of indirect and induced benefits. These include purchases of goods and services by businesses that directly benefit from the PRC and by employees whose earnings come from PRC-related activities. The indirect benefits total an additional $159 million over ten years.

Thus, SRI estimates that the total quantifiable contribution of the PRC to the Georgia economy over 10 years is $351 million, more than a 10-to-1 return on the States investment.

During the same period, the NSF invested virtually the same amount in the PRC, $32.7 million, as Georgia did. Thus, NSFs return on investment within Georgia alone also was more than 10-to-1. Economic benefits of the PRC outside the State have not been quantified; but they certainly include benefits to the Centers industrial members, who collectively contributed a total of $60.7 million. All of these firms are national and many of which are multinational in their scope of operations. In addition, several spinoff companies have been formed which are headquartered outside the State. When these factors are considered, the leverage provided by NSFs investment is very substantial.

**Primary Goal Indicators:**
Connections

**Secondary Goal Indicators:**
Data collection/analysis

*This work is notable because*
Investments in the ERC by both NSF and the State of Georgia yielded more than a 10-to-1 return within Georgia alone, in terms of companies and jobs created, intellectual property licenses and royalties, and income generated. Thus, the impact of funding for ERC activities is highly leveraged.

*Other Indicators (Is this work transformative or multidisciplinary?):*
This work involves multidisciplinary research.
All research in the PRC is cross-disciplinary, being focused on the "system-on-a-package" approach to microelectronic device packaging.

ENG/EEC 2005

*Program Officer:* Lynn Preston

*NSF Award Numbers:*
9402723

*Award Title:* Engineering Research Center for Low Cost Electronic Packaging

*PI Name:* Rao Tummala

*Institution Name:* GA Tech Research Corporation - GA Institute of Technology

*PE Code:* 1480

*NSF Contract Numbers:*
Submitted on 01/13/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/04/2005 by Joanne D. Culbertson
GPS Array Monitors Deformation of the Earth's Crust
Highlight ID: 10154

The earth's crust bends or deforms before it breaks, just as a stick bends before it breaks across your knee. When the earth's crust breaks, it is called an earthquake. Except for a few cases, the deformation of the earth between earthquakes, during which time the forces driving the earthquake build up, has been invisible to scientists.

The Global Positioning System (GPS), which is well known for its revolution of navigation, has also revolutionized the study of the earth's shape and changes in that shape. Relative movements of less than 3mm between two points separated by hundreds of kilometers can now be measured by GPS. Networks of GPS stations currently monitor the relatively rapid movement of the earth's plates and the slower deformations due to the interaction of two plates at their boundaries, such as in California. Using GPS, researchers are approaching the ability to test the fundamental premise of plate tectonics that the plates are rigid.

The ability of GPS to measure both small and slow deformations naturally leads to its use in studying the problems of earthquakes and attendant seismic hazard. The GPS Array for Mid-America (GAMA) is a Mid-America Earthquake Center project to determine if deformation is occurring in the New Madrid seismic zone by using a network of continuous GPS stations. Preliminary results suggest that deformations may be occurring inside the seismic zone, and these deformations are consistent with the types expected based on the earthquake activity, models for stress in the North American crust, and geologic studies of old earthquakes (paleoseismology). While these results are preliminary, they are a factor of ten better than those of previous attempts. Improvements in the measurement of this deformation over the next few years will help in developing better explanations for the causes of New Madrid earthquakes and will contribute to improvements in seismic hazard estimation.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Cross-disciplinary

Next generation facilities and platforms

Instrument technology

This work is notable because
The development of the GPS Array, the continuous monitoring it allows, and the results obtained so far provide an order-of-magnitude improvement in our ability to understand the causes of earthquakes in the New Madrid seismic zone and to gauge the hazard they present. This effort serves as a demonstration project for similar GPS arrays that could be installed in other seismic zones.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
The GPA Array for Mid-America relies on the collaborative work of seismologists, geologists, civil engineers, and electrical engineers for its development, emplacement, and exploitation.

ENG/EEC 2005

Program Officer: Rick Fragaszy

NSF Award Numbers:

9908548
Award Title: Research Experience for Undergraduate in Earthquake Engineering

PI Name: Daniel Abrams
Institution Name: University of Illinois at Urbana-Champaign
PE Code: 1480

NSF Contract Numbers:
High School Researcher Wins Top Honors for Visionary Work

Highlight ID: 10146

Most precollege programs offered by universities aim to give young students a glimpse into the fascinating world of science and engineering, in order to spark their interest in these subjects for further study. The ERC for Biomimetic MicroElectronic Systems (BMES), at the University of Southern California (USC), found one precocious student in whom that spark caught fire. Noelle Stiles, then an 11th-grader at Villa Park High School, began working with BMES Prof. Armand R. Tanguay, Jr., in Fall 2003 after she was introduced to him at a science fair. Initially, Tanguay mentored her science fair project, and then accepted her as a full member of his Optical Materials and Devices Laboratory at USC when it became apparent that she was deeply committed to her research. She is the only high school student ever to become a full member of the lab.

At the outset, all of Noelle’s research work was on a volunteer basis, under the auspices of various science fairs. When she became a member of Tanguay’s research group, she also became affiliated with the BMES ERC and began participating in weekly meetings of the Retinal Prosthesis Research Group at the USC Keck School of Medicine. She has been present at an FDA surgical trial of a retinal prosthetic microelectrode array (implanted by BMES Director Dr. Mark Humayun), and participated intensively in the successful surgical implantation of the first intraocular camera in a dog’s eye in July 2004.

As for Noelle’s performance in science fairs and competitions, her accomplishments are notable. In the 2004 Orange County Science & Engineering Fair, her project, Intraocular Camera for Retinal Prostheses: Restoring Vision to the Blind, took the Grand Sweepstakes Award, Senior Division (9-12) (the top prize of the entire Fair); First Place, Physiology, Senior Division (9-12); and First Place, Center for Inquiry West (an organization founded by Carl Sagan and Murray Gell Mann), for the best project demonstrating critical thinking.

Continuing with the same project, in October 2004 Noelle was named a semifinalist in the 2004-5 Siemens Westinghouse Competition in Math, Science, and Technology at the national level. As such, she is recognized as one of an elite 300 math, science, and engineering students in the entire country.

Today, as a high school senior, Noelle continues her research within Dr. Tanguay’s research group and the BMES ERC on the visual psychophysics and optical systems design criteria applicable to both intraocular and extraocular camera designs for retinal prosthetic devices. This remarkable young student accomplished all of this in a single year!

Primary Goal Indicators:
Greater diversity

Secondary Goal Indicators:
Global S&E workforce

Public understanding of science

Connections

Underrepresented individuals and institutions (AC/GPA selected)

Identifying new opportunities

This work is notable because
This young woman is an excellent example of the tremendous pool of potential talent available among women and minorities, from which the STEM fields can benefit if they receive timely encouragement. The BMES ERC’s education and outreach programs include intensive mentoring of students at all levels, including precollege in some cases, and are flexible enough to allow a high school student to join a Center research team.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This students research at BMES relies on the cross-disciplinary mix of expertise resident within the Center in optoelectronics, electrical engineering, biology, neuroscience, and medicine.
Program Officer: Sohi Rastegar

NSF Award Numbers:

0310723
Award Title: An Engineering Research Center for Biomimetic Microelectronic Systems
PI Name: Mark Humayun
Institution Name: University of Southern California
PE Code: 1480

NSF Contract Numbers:
Submitted on 01/14/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/03/2005 by Joanne D. Culbertson
High School Student Research Leads to Innovative Tool
Highlight ID: 10138

All the ERCs pursue programs designed to interest precollege students in science and engineering education and research. Occasionally these programs involve the participation of students in center research. But seldom do the activities lead to innovative new technology!

During 2001 and 2002, Al Brzeczko was a senior at the Baltimore Polytechnic Institute high school. Under the Ingenuity Project at Poly, a citywide public school program for academically gifted high school students, he found a mentor in Randy Golberg, a graduate student at the National Science Foundation-funded Engineering Research Center for Computer-Integrated Surgical Systems and Technology (ERC CISST), at Johns Hopkins University and began pursuing research in surgical robotics. Al’s research progressed to the point that he began working with CISST Center Director Russell Taylor and Dr. Peter Evans, a CISST-affiliated surgeon, on development of an original device to assist in knee surgery.

The result was the Smart Alignment Tool for Knee Mosaicplasty. This device is a computer-assisted accessory to an existing surgical tool, a chisel used for punching out cartilage. The purpose of the Smart Alignment Tool is to keep the chisel aimed perpendicularly to the surgical site. It was a unique tool, the first of its kind. Al built a prototype and presented his results at the prestigious Medical Image Analysis and Computer Assisted Interventions (MICCAI) Conference in 2001.

In 2005, Al Brzeczko is completing his B.S. in computer engineering at Johns Hopkins, with an interest in robotics that was stimulated by his early research experience at CISST.

Primary Goal Indicators: Global S&E workforce
Secondary Goal Indicators: Connections

Cross-disciplinary

Instrument technology

This work is notable because
This talented high school student, with the assistance of a graduate student mentor and working with the ERCs Director and a surgeon, combined computer science, robotics, and biomechanics to develop a unique biomedical device to assist in knee surgery.

Other Indicators (Is this work transformative or multidisciplinary?):
This work involves multidisciplinary research.
This successful research and development effort by a high school student involved collaboration with physicians as well as electrical and mechanical engineers.

ENG/EEC 2005
Program Officer: Rajinder Khosla
NSF Award Numbers:
9731748 Award Title: ERC: Engineering Research Center for Computer-Integrated Surgical Systems and Technology
PI Name: Russell Taylor
Institution Name: Johns Hopkins University
PE Code: 1480

NSF Contract Numbers:
Submitted on 01/13/2005 by Lynn Preston
EEC: Approved 02/08/2005 by Gary A. Gabriele
ENG: Approved 02/16/2005 by Joanne D. Culbertson
Innovative Education Programs in Microsystems Packaging

The Microsystems Packaging (MSP) industry, which spans from integrated circuits (ICs) to end-product systems such as cell phones, is as big as the IC industry itself, with a global market in excess of $150B. Despite its market size, MSP has not become an academic subject. The reasons include the highly multidisciplinary nature of the subject and the lack of faculty prepared to teach such breadth. Most universities teach one or two MSP courses. As a result, the industry's human resource needs remain unfulfilled and companies typically recruit single-discipline engineers or scientists and train them on the job. That is, until Georgia Tech's Packaging Research Center (PRC) changed things. Over the past 10 years the PRC has developed new and unparalleled curricula at the B.S., M.S., and Ph.D. levels. There are more than 20 new courses, involving more than 700 students annually, and a new technical track called Microsystems: Devices, Integration and Packaging. Furthermore, these programs have led to the first fundamental undergraduate textbook and the first entrepreneurial Practice Oriented Masters (POM) program with an emphasis on technology, business and leadership skills, to prepare future leaders for managing emerging technology companies. The PRC is now the largest producer of the most sought-after Microsystems packaging engineers, producing more than half of all new MSP specialist engineers in the U.S. The Center has graduated over 500 students who now work in R&D, manufacturing, or marketing. Industry has given outstanding feedback regarding the quality of students and how quickly they hit the ground running. The impact of PRC educational programs extends beyond Georgia Tech. The Center extended MSP education to minority and female undergraduates from other universities through an 8-week summer research experience. The Center also established extensive partnerships with the two large professional societies, IEEE and IMAPS, to develop 15 new web-based courses in different strategic technologies for use by the world community. It created International Academic and Technical Conferences and Workshops to extend and disseminate its research and educational programs. One example of the impact of these workshops has been the use of PRCs undergraduate textbook at 47 universities around the world.

Primary Goal Indicators:
Global S&E workforce

Secondary Goal Indicators:
Greater diversity

Collaborations

Underrepresented individuals and institutions
Identifying new opportunities

Cross-disciplinary

Expand access (AC/GPA selected)

This work is notable because
Over the past decade this center has developed new curricula at all levels in an important emerging field, Microsystems packaging, where little in the way of organized curricula existed before at any university. It has developed more than 20 new courses, a new technical track, the first-ever undergraduate textbook in the field, and the first practice-oriented masters aimed at creating industrial leaders in the field. Thus, the center has become a magnet for students worldwide, and is now the largest producer of the most sought-after microsystems packaging engineers in this globally important field, while extending its educational reach worldwide via the web, the new textbook, and international conferences it organizes.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2005

Program Officer: Lynn Preston

NSF Award Numbers:

9402723

Award Title: Engineering Research Center for Low Cost Electronic Packaging

PI Name: Rao Tummala

Institution Name: GA Tech Research Corporation - GA Institute of Technology

PE Code: 1480

NSF Contract Numbers:

Submitted on 01/31/2005 by Mary F. Poats
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/03/2005 by Joanne D. Culbertson
Integrating Nanoscale Science and Engineering into the Undergraduate Engineering Curriculum

The University of WisconsinMadison (UWM) is integrating nanotechnology-based educational modules into selected engineering courses. In addition to one new course that has been created under this effort, existing courses have been modified, removing outdated examples and replacing them with cutting-edge content based on current research and emerging applications in nanotechnology. Nanotechnology curriculum modules have been tailored to fit the needs of the course and the level of audience to ensure that the nanotechnology-based concepts and examples are permanently incorporated for long-term impact. To enhance dissemination beyond the UW campus, several of the new experiments and demonstrations developed have been contributed to the teaching resources of the UWM Materials Research Science and Engineering Center in the web-based Laboratory Manual for Nanoscale Science and Technology, available at http://www.mrsec.wisc.edu/edetc/nanolab/index.html, and the Nanoworld Cineplex available on the Internet at http://www.mrsec.wisc.edu/edetc/cineplex/index.html. This Nanotechnology Undergraduate Education (NUE) project has impacted UWM courses such as Introduction to Engineering, Introduction to Modern Materials, Materials Laboratory II & III, Micro- and Nanoscale Mechanics, and Advanced Mechanical Testing of Materials. In particular, the Introduction to Modern Materials and Introduction to Engineering courses are taken by freshman and impact a large number of students, attracting them to fields where nanoscale science and engineering is of developing importance. In the first year of implementation alone, 337 UW-Madison students have learned about nanotechnology-related concepts through this effort, and 232 of them have done so through a hands-on experience.

Primary Goal Indicators:
STEM education

Secondary Goal Indicators:
Global S&E workforce

Collaborations
Cross-disciplinary

This work is notable because
This project achieved a large-scale overhaul of several areas of the engineering curriculum at the UWM to incorporate cutting-edge content based on current research and emerging applications in nanotechnology. Because many of the new or updated courses are introductory courses that impact a large number of freshman students, there is a greater potential to
interest them in fields where nanoscale science and engineering is of increasing importance worldwide.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

ENG/EEC 2005

Program Officer: Mary Poats

NSF Award Numbers:

0304479

Award Title: NUE: Integrating Nanoscale Science and Engineering into the Undergraduate Engineering Curriculum

PI Name: Wendy Crone

Institution Name: University of Wisconsin-Madison

PE Code: 1340

NSF Contract Numbers:

Submitted on 01/31/2005 by Mary F. Poats
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/03/2005 by Joanne D. Culbertson
Microsoft Products Include Digital Personal Technology
Highlight ID: 10124

With real and fast-growing concerns about identity theft, security of intellectual property, and even cyber-terrorism, computer security is a major focus of governments, businesses, and individuals alike. Microsoft Corporation is now shipping new products that contain security technology developed by DigitalPersona, a Caltech Center for Neuromorphic Systems Engineering (CNSE) start-up company. DigitalPersona, founded by former CNSE students Vance Bjorn and Serge Belongie in 1996, developed U.
are U. fingerprint identification technology, winning the coveted Best of Comdex award for computer peripherals in 1997. The new Microsoft products incorporating this technology are: Optical Desktop with Fingerprint Reader, Wireless IntelliMouse® Explorer with Fingerprint Reader, and Microsoft® Fingerprint Reader.

Password management is a growing problem for many computer users, at home and at work. People often have to keep track of many different passwords and user names in order to get secure access to check e-mail, shop at favorite web sites, and use bank accounts or company databases. The new Microsoft products introduce biometric password management using the DigitalPersona Password Manager Software, which includes the novel DigitalPersona IDentity Engine that makes fingerprint recognition fast and reliable.

The new products aim to reduce password fatigue by making it more convenient to open password-protected pages while continuing to insure privacy and security. The fingerprint reader is specifically designed to be intuitive and reliable. The fingerprint recognition technology allows people to log on to the PC, switch between users, and access favorite online sites at the touch of a finger. It is expected that this technology will soon become ubiquitous wherever people use computers.

Primary Goal Indicators:
Connections

Secondary Goal Indicators:
Collaborations

Cross-disciplinary

This work is notable because
The company, DigitalPersona, is a spinoff of the Caltech ERC, founded by ERC alumni and faculty. Their award-winning products are seeing rapid adoption in the computer interface peripherals market by industry leaders such as Microsoft Corporation.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Development of these new computer-interface devices required the collaboration of an interdisciplinary team of researchers in electrical engineering, robotics, image processing, computer science, biology, and product design.

ENG/EEC 2005
Program Officer: Lynn Preston

NSF Award Numbers:
9402726
Award Title: Engineering Research Center for Neuromorphic Systems Engineering
PI Name: Pietro Perona
Institution Name: California Institute of Technology
PE Code: 1480

NSF Contract Numbers:
Submitted on 01/13/2005 by Lynn Preston
EEC: Approved 03/01/2005 by Gary A. Gabriele
ENG: Approved 03/01/2005 by Joanne D. Culbertson

Microsoft's new Fingerprint Reader, based on technology developed by a CNSE spinoff, makes it possible to replace passwords and switch users with the touch of a finger.

Permission Not Granted
New Device Improves Image-Guided Needle Placements
Highlight ID: 10134

The value of image-guided needle-based therapy and biopsy for use in dealing with a wide variety of medical problems has been proven. However, both the accuracy and the procedure time vary widely among practitioners of most systems currently in use. Typically, a physician views the images on the scanners console and then must mentally relate those images to the anatomy of the actual patient. A variety of virtual reality methods, such as head-mounted displays, video projections, and volumetric image overlay have been investigated, but all these require elaborate calibration, registration, and spatial tracking of all actors and components. This creates a rather complex and expensive surgical tool.

Researchers at the ERC for Computer-Integrated Surgical Systems and Technology (CISST), in collaboration with Dr. Ken Masamune of Tokyo Denki University in Japan and the Siemens Corporation, have developed an inexpensive 2D image overlay system to simplify, and increase the precision of, image-guided needle placements using conventional CT scanners. The device developed at the CISST ERC consists of a flat LCD display and a half mirror, mounted on the gantry (see figure). When the practitioner looks at the patient through the mirror, the CT image appears to be floating inside the patient with correct size and position, thereby providing the physician with two-dimensional X-ray vision to guide needle placement procedures. Researchers have conducted cadaver studies for several applications with a clinically applicable device. Dr. Laura Fayad at the Johns Hopkins Medical Institutions has also performed joint arthrography of the shoulder and hip joints, achieving millimeter-level accuracy in needle placement. An Institutional Review Board application for the CT-guided system and an MRI-compatible prototype is under development.

Primary Goal Indicators:
Cross-disciplinary

Secondary Goal Indicators:
Collaborations

Connections

Instrument technology

This work is notable because
Researchers at this ERC brought to bear expertise from engineering, medicine, and computer science to develop an important new tool for surgeons. This relatively simple and inexpensive device will improve the accuracy of biopsies and treatment procedures requiring precision needle placement.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
This novel development involved extensive collaboration of physicians with electrical and computer engineers, including practitioners from industry as well as university researchers.

ENG/EEC 2005

Program Officer: Rajinder Khosla

NSF Award Numbers:

9731748
Award Title: ERC: Engineering Research Center for Computer-Integrated Surgical Systems and Technology
PI Name: Russell Taylor
Institution Name: Johns Hopkins University
PE Code: 1480

NSF Contract Numbers:

Submitted on 01/13/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/04/2005 by Joanne D. Culbertson
Researchers Discover Coral Reefs Healthier Than Previously Thought

Scuba divers and other nature lovers will attest to the beauty and wonder of the colorful reefs that line many resort shores. Scientists, and coral lovers, have been very concerned that environmental hazards and too many human visits have damaged this important part of the oceans ecosystem in much of the world's reefs.

Researchers at the Center for Subsurface Sensing and Imaging Systems (CenSSIS) at the University of Puerto Rico-Mayaguez (UPRM) and the Woods Hole Oceanographic Institution (WHOI) conducted a campaign in the US Virgin Islands to assess the health of deepwater coral reefs. Using CenSSIS image processing and mosaicing techniques, researchers determined to their surprise that deepwater reefs are not being significantly eroded.

CenSSIS researchers at UPRM and WHOI gathered evidence by using the SeaBED autonomous underwater vehicle (AUV), a CenSSIS research facility based at UPRM, to conduct hyperspectral imaging, radar, and acoustic sensing studies. They discovered that deepwater coral reefs in the U.S. Virgin Islands may occupy a much larger area and be in better health than previously thought.

Four digital photo transects were conducted at the Hind Bank Marine Conservation District at depths ranging from 32 to 90 meters. At a depth of 40 meters, they found well-developed coral reefs with up to 70 percent living coral cover. The SeaBED vehicle provided unprecedented information on a little-known coral reef habitat that is common along the upper insular slopes of many Caribbean Islands.

**Primary Goal Indicators:**
Contributions

**Secondary Goal Indicators:**
Greater diversity

Connections

Next generation facilities and platforms

*This work is notable because*
The unique research facility represented by this underwater vehicle presents a suite of instrumentation that allows a wide range of measurements to be made simultaneously, providing knowledge that could not be gained before about the marine environment, and answering important questions.

*Other Indicators (Is this work transformative or multidisciplinary?):*

*This work involves multidisciplinary research.*
This research facility embodies expertise and involvement of researchers from electrical and mechanical engineering, bioengineering and biology, and marine science a very disparate range of collaboration that an ERC makes possible.

ENG/EEC 2005

Program Officer: Sohi Rastegar

NSF Award Numbers:

9986821
Award Title: An Engineering Research Center for Subsurface Sensing and Imaging Systems - CenSSIS
PI Name: Michael Silevitch
Institution Name: Northeastern University
PE Code: 1480

NSF Contract Numbers:

Submitted on 01/14/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/16/2005 by Joanne D. Culbertson
Researchers Fabricate Nano Test Tubes
Highlight ID: 10157

Researchers from the University of Florida have discovered how to use carbon and silica nanotubes to make minuscule test tubes. Carbon nanotubes, which occur naturally in soot, are rolled-up sheets of atoms that can measure less than 1 nanometer (the span of 10 hydrogen atoms) in diameter.

Nanotubes are grown in a membrane-like alumina template. The diameter of the tubes depends on the diameter of pores in the template, and the length of the tubes is determined by the thickness of the template. Researchers modified their templates to make nanotubes that were closed on one end by adjusting the template so that the pores were closed on one end, thus producing nano "test tubes."

The nano test tubes could eventually be used as tiny bottles. With nano caps added, these bottles could contain a few molecules of DNA, drugs, or proteins to be released in specific places in the body in response to a chemical signal, irradiation, or other stimulus. Nanotubes will eventually be made from other materials with different biochemical properties. In this way, the outer surfaces of the test tubes can be modified to encourage their uptake by particular types of cells. Such "smart" nanotubes will have designed-in biochemical properties such as biocompatibility or biodegradability and will carry out specific biomedical or biochemical functions.

Smart nano test tubes and bottles could be in practical use within 10 to 20 years. This work appeared in the March 10, 2004 issue of Nano Letters.

Primary Goal Indicators:
Identifying new opportunities

Secondary Goal Indicators:
Contributions

Collaborations

Connections

Cross-disciplinary

This work is notable because
By conducting the first-ever broad-based and systematic research effort on the development of nanotube technology for biomedical applications, these researchers have pioneered a new area of exploration in the field of bio/nanotechnology. The potential payoffs of research in this area in terms of fundamental knowledge and new biomedical technologies for treating disease are enormous.

Other Indicators (Is this work transformative or multidisciplinary?):
This work involves high risk research.
While there is enormous interest in using nanoparticles to encapsulate enzymes, deliver drugs, etc., the nanoparticles used have almost always been spherical, since spherical particles are easier to make. These researchers focused on the development of technologies for preparing tubular nanoparticles of any size and composed of nearly any material. They have demonstrated the concept of "smart nanotubes" that are bioengineered and tailor-designed to accomplish specific desired functions.

This work involves multidisciplinary research.
Research in bio/nanotechnology requires collaboration among chemists, chemical engineers, materials scientists, and biochemists.

ENG/EEC 2005
Program Officer: Tapan Mukherjee
NSF Award Numbers:
0210580
Award Title: NIRT: For Biomedical Nanotube Technology
PI Name: Charles Martin
Institution Name: University of Florida
PE Code: 1480
Safe Racer Competition Wins Young Minds for STEM
Highlight ID: 10136

It is vital to the Nation's future that we find ways to get young students interested in science, technology, engineering, and mathematics during the elementary school years. With support from the Engineering Research Center for Computer-Integrated Surgical Systems and Technology (ERC CISSST) at Johns Hopkins University, MBNA Motorsports, and NASCAR, Dr. Leigh Abts spearheaded the Safe Racer Competition for Baltimore County elementary schools. Focusing on the Maryland Voluntary State Curriculum, the competition's Challenge Problem is to design and develop a fast, open-topped sports car and suitable safety equipment to enable the racing driver Egbert (an uncooked egg) to (1) survive an accident in practice when his racing car crashes into a barrier, and (2) go on to win the Cup.

The activity consists of four main components: a written report, an oral report, a car entry, and a car performance demonstration. Each elementary school has trials to select the competing team from that school. Teams consist of 3-4 students. In the Safe Racer competition, students demonstrate the thinking and acting inherent in the practice of science and engineering. They use scientific skills to explain the interactions of matter and energy and the energy transformations that occur; and they use engineering to design the car and safety equipment, based on those physical parameters, that can survive and win the race.

Safe Racer is now formally part of the required Baltimore County Curriculum for elementary schools to connect Science and Math through engineering design concepts. Over 130 schools and over 9,000 students from diverse backgrounds took this course in 2004—a big step in getting elementary children to discover the wonders of math and science through playing and tinkering with engineering design concepts.

Primary Goal Indicators:
Public understanding of science

Secondary Goal Indicators:
Greater diversity

This work is notable because
This program reached over 9,000 Maryland elementary school students with exciting and challenging activities aimed at increasing their understanding of and interest in science, technology, engineering, and mathematics concepts through hands-on play.

Other Indicators (Is this work transformative or multidisciplinary?):
No other indicators apply.

ENG/EEC 2005
Program Officer: Rajinder Khosla

NSF Award Numbers:
9731748
Award Title: ERC: Engineering Research Center for Computer-Integrated Surgical Systems and Technology
PI Name: Russell Taylor
Institution Name: Johns Hopkins University
PE Code: 1480
Smart Nanotubes for Selective Biomolecule Delivery to Living Cells
Highlight ID: 10139

Most drugs used to treat life-threatening human maladies such as cancer, heart disease, and AIDS cause serious side effects. This problem results from the fact that in most cases the drugs are administered to the whole body, even though they need to act on only a small part of it. Researchers at the University of Florida’s Particle Engineering Research Center (PERC) developed a major new alternative drug transport technology consisting of an assembly of monodispersed tubular nanoparticles with and without "chemical sensing" nanocaps at the ends of the tubes. Specific targeting technology (e.g., surface antibodies directed against desired tissue/cell types) is incorporated into the structural platform. Simply stated, smart nanotubes would be able to deliver drugs to only the target cells (diseased cells), thereby greatly reducing the dose a patient would need to take and providing targeted and more effective treatment.

One major challenge was to produce undamaged silica nanotubes in very large quantities. PERC researchers have solved this problem. They developed a procedure to produce very high quality silica nano test tubes in very large numbers (> 10^10 nano test tubes/per cm² of alumina template). The figure shows the fluorescence micrograph of covalently attached rhodamine on the inner surface of silica nano test tubes.

By allowing the delivery of several classes of important therapeutic agents to only those cells or tissues that require the medication, the smart nanostructures developed in this R&D program will markedly improve drug safety and efficacy.

Primary Goal Indicators:
Cross-disciplinary (AC/GPA selected)

Secondary Goal Indicators:
Contributions
Collaborations
Connections

This work is notable because
Accelerate progress in selected S&E areas of high priority by creating new integrative and cross-disciplinary knowledge and tools, and by providing people with new skills and perspectives.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves high risk research.
This is a highly significant new application of nanotechnology to an important medical need. Major challenges that were overcome included the biochemical fine-tuning of the targeting technology and the procedures for large-scale production of high-quality antibodies.

This work involves multidisciplinary research.
Development of the new drug delivery paradigm was possible only through the collaborative efforts of an interdisciplinary team including chemical engineers, materials scientists, and pharmaceutical researchers.

ENG/EEC 2005

Program Officer: Tapan Mukherjee

NSF Award Numbers:

9402989
Award Title: Engineering Research Center for Particle Science & Technology at the University of Florida
PI Name: Brij Moudgil
Institution Name: University of Florida
Supercritical Solvent Reduces Environmental Impact of Semiconductor Manufacturing

Highlight ID: 10120

Solvents are used in many industries to clean and transport corrosive chemicals during production, including the manufacture of computer chips, but are not part of the finished product. An industry goal is to lessen the expense and environmental damage caused by handling and disposing of these chemicals. Supercritical fluids are used commercially to replace conventional solvents to decaffeinate coffee, synthesize polymers and pharmaceuticals, create microelectromechanical structures, and dry-clean clothing, among other uses. Supercritical fluids have some special properties: They are easily separated from other chemicals and penetrate structures of any size or shape.

Anthony Muscat, a University of Arizona professor with the ERC for Environmentally Benign Semiconductor Manufacturing (EBSM), developed a new process using supercritical carbon dioxide (scCO2) in the manufacturing of microelectronic devices. This novel approach replaces standard halogenated solvents which have many drawbacks with a chemical that is safe, low-cost, and recyclable and that doesn’t cause waste disposal problems. This pressurized form of carbon dioxide can be easily prepared and is already present in large quantities in the emissions from microchip fabrication plants. The scCO2 fluid also has the desirable properties of both liquids and gases and is much less costly than the conventional chemicals. Also, its properties allow new ways of depositing and patterning organic films as well as cleaning microstructures. Combining the scCO2 with novel deposition and lithographic technologies is an effective way to create structures with very fine features. The Center used scCO2 to restore a new dielectric film after patterning, showing that this film could be used in computer chips.

Several chip manufacturers are testing and validating the industrial use of scCO2, and the December 2003 edition of Scientific American recognized Professor Muscat as one of the 50 people in the nation who contributed the most that year to the advancement of technology in science, engineering, commerce, and public policy. The EBSM ERCs ongoing work on scCO2 use will continue to advance the technology of computer chip manufacturing in ways that are environmentally sound.

Primary Goal Indicators:
Contributions

Secondary Goal Indicators:
Connections

Cross-disciplinary

This work is notable because
The cross-disciplinary, systems-oriented environment of the ERC enabled this significant advance toward cleaner manufacturing of semiconductors, recognized as one of the years major contributions in technology development.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Development of this new approach to environmentally friendly semiconductor manufacturing was possible only by bringing to bear the ERCs collaborative expertise in chemical engineering, materials science, chemistry, electronics, and manufacturing.

ENG/EEC 2005

Program Officer: John Hurt

NSF Award Numbers:
9528813

Award Title: Environmentally Benign Semiconductor Manufacturing

PI Name: Farhang Shadman

Institution Name: University of Arizona
Taking EUV Interferometry from the Lab to the Tabletop

Highlight ID: 10127

Interferometry using the ways that electromagnetic waves interfere or interact with each other to make precise measurements of objects and physical phenomena is one of the most powerful metrology (or measurement) tools available. It is routinely combined with visible lasers to yield practical solutions to a very diverse set of metrology problems, including precise alignment of instruments and mapping the density of plasmas. (A plasma is a special, highly ionized form of gas that behaves differently from normal gases and has many uses in scientific research.)

Using shorter wavelength light in the extreme ultraviolet (EUV) and soft x-ray regions of the electromagnetic spectrum greatly enhances the resolution of interferometry and allows materials that cannot be penetrated with visible light to be measured.

Until recently, most EUV and soft x-ray interferometry required large light sources only available at a few National facilities, such as synchrotrons or laboratory size x-ray lasers. CSU faculty and students from the ERC for Extreme Ultraviolet Science and Technology developed a new tabletop setup for interferometry at EUV wavelengths. The instrument, now in use at CSU, combines an extremely compact EUV laser excited by a fast electrical discharge, and a novel interferometer configuration based on diffraction gratings. Experiments supported by the US Department of Energy demonstrated that the setup could be used to map the evolution of dense plasmas that cannot be probed using visible lasers because of their large density gradients.

CSU researchers also collaborated with scientists at the Lawrence Livermore National Laboratory (LLNL) to demonstrate for the first time soft x-ray interferometry with ultra-fast temporal resolution in the picosecond time scale. This instrument is being used at LLNL for diagnostics of dense plasmas. Further work may allow the detailed mapping of the electron density distribution in plasmas, with applications for inertial confinement nuclear fusion. Finally, UC-Berkeley, the University of Colorado, and CSU are developing a tabletop interferometer for use in metrology of the optics and the lithography of future generations of integrated circuits.

Primary Goal Indicators:
Expand access

Secondary Goal Indicators:
Collaborations

Cross-disciplinary

Instrument technology

This work is notable because
This work has moved extreme ultraviolet and soft x-ray interferometry out of large synchrotrons and laboratories and onto a tabletop scale that is much more readily accessible to researchers and students.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves multidisciplinary research.
Development of the new, scaled-down facility for interferometry was possible only through the collaborative efforts of an interdisciplinary team of electrical engineers and physicists.

ENG/EEC 2005

Program Officer: Filbert Bartoli
NSF Award Numbers:

0310717
Award Title: Engineering Research Center for Extreme Ultraviolet Science and Technology
PI Name: Jorge Rocca
Teaching Teachers the Importance of Experiential Learning

Through a Research Experiences for Teachers (RET) project during the summer of 2004, Drexel faculty taught 18 K-12 RET Fellows from inner-city and suburban Philadelphia schools the importance of experiential or hands-on learning in science and engineering.

The Drexel participants provided resources, tools, and ideas that will allow the Fellows to serve as credible mentors to students to pursue studies in the STEM disciplines. They held workshops on effective strategies to bridge technology and curriculum at the K-12 levels. They provided guidance and resources for RET Fellows to prepare and submit proposals for curriculum development and equipment acquisition for science and math education. They enabled access for all of the RET Fellows to the Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope, Environmental Scanning Electron Microscope, the Drexel Data Acquisition and Analysis Laboratory, and e-resources through the Drexel Library. And they provided computers (equipped with data analysis and simulation tools) for the personal use of Fellows for research, journal retrieval and curriculum development.

Based on the success of this RET program, Drexel University partnered with the School District of Philadelphia and the Franklin Institute (Philadelphia Museum of Science) to submit a proposal to the Commonwealth of Pennsylvania to expand experiential learning programs to 200 K-8 teachers each year for three years. In other leveraged spin-offs of this project, three Drexel faculty members are working with three RET Fellows from three different schools on developing a high-school FIRST (For Inspiration and Recognition of Science and Technology) Robotics program, on a NASA GLOBE (Global Learning and Observations to Benefit the Environment) project to measure atmospheric radiation, and on a NSF-sponsored project on wireless communication.

Primary Goal Indicators:
Continuous learning (AC/GPA selected)
Secondary Goal Indicators:
Greater diversity

STEM education

Underrepresented individuals and institutions

This work is notable because
Providing K-12 teachers with hands-on research and education experiences demonstrated the power of experiential learning in science and engineering. The project also helped participants bridge the gap between technology and curriculum by providing workshops and resources to support curriculum development. Finally, the project has led to a number of other related projects throughout Philadelphia schools.

Other Indicators (Is this work transformative or multidisciplinary?):
No other indicators apply.

ENG/EEC 2005

Program Officer: Mary Poats

NSF Award Numbers:

0227700

Award Title: RET Site: Research Experience for Teachers in Areas of Innovative and Novel Technologies in Philadelphia [RETAI...Philadelphia]

PI Name: Mun Young Choi

Institution Name: Drexel University

PE Code: 1360

NSF Contract Numbers:

Submitted on 02/01/2005 by Mary F. Poats
EEC: Approved 02/08/2005 by Gary A. Gabriele
ENG: Approved 02/16/2005 by Joanne D. Culbertson
Ordinary media streaming on the Internet is limited to grainy video and low-quality sound. Traditional Internet technology cannot produce anything close to the quality that we expect from a modern movie theater. An interdisciplinary team at the University of Southern Californias (USCs) Integrated Media Systems Center has demonstrated how the Internet can support very high-quality media transmissions that enable real-time, multi-site, interactive, and collaborative environments. The result has been two successive steps towards the realization of broader immersive technology, i.e., the creation of the complete aural and visual ambience that places a person or a group of people in a virtual space where they can experience events occurring at a remote site or communicate naturally regardless of their location.

The first realization of this vision has been the Remote Media Immersion (RMI) system. RMI encompasses all end-to-end aspects from media acquisition, storage, and transmission up to their final rendering. Specific technological advances in this work include the synchronized delivery of multiple high bandwidth streams; transmission error and flow control protocols that ensure data integrity; and high-definition video combined with immersive audio to provide the highest quality rendering.

The second realization is the Distributed Immersive Performance (DIP) system, which adds interactive multi-user capabilities to RMI while retaining its high-fidelity qualities. The DIP system blends multiple cutting-edge media technologies to create the ultimate immersive digital media platform. In the photos, two musicians, Dennis Thurmond (accordion) from USCs Thornton School of Music and Elaine Chew (piano) from USCs Epstein Department of Industrial and Systems Engineering, are performing Piazzolla’s Le Grand Tango together but at different campus locations by using the DIP system.

The results of this interdisciplinary research, when fully realized, will allow people at different locations to interact and collaborate over the Internet on any kind of endeavor almost as realistically as if they were in the same room.

**Primary Goal Indicators:**
Cross-disciplinary

**Secondary Goal Indicators:**
Contributions
Collaborations
Connections

*This work is notable because*
This research required the expertise of collaborating researchers in the areas of signal processing, networking, data management, human-machine interfaces, and the performing arts. The results, when fully realized, will allow people at different locations to interact and collaborate over the Internet on any kind of endeavor almost as realistically as if they were in the same room.

**Other Indicators (Is this work transformative or multidisciplinary?)**:
This work involves multidisciplinary research.
This research required the expertise of collaborating researchers in the areas of signal processing, networking, data management, human-machine interfaces, and the performing arts.

ENG/EEC 2005

*Program Officer:* Bruce Kramer

*NSF Award Numbers:*

**9529152**

*Award Title:* Engineering Research Center for Integrated Media Systems Center

*PI Name:* Adam Powell

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Permission Granted
Credit: University of Southern California
Institution Name: University of Southern California
PE Code: 1480

NSF Contract Numbers:
Submitted on 01/14/2005 by Lynn Preston
EEC: Approved 02/03/2005 by Gary A. Gabriele
ENG: Approved 02/03/2005 by Joanne D. Culbertson