NC STATE UNIVERSITY

College of Engineering News

For Our Engineering Alumni and Friends Spring 2000

NC State engineers design pipe-crawling robot to help save lives

The pipe-crawling robot developed by students at NC State under the direction of Eddie Grant (pictured) and John Muth could help rescuers find survivors trapped in collapsed buildings.

When rescuers approach a collapsed building, they face the difficulty of trying to rescue the survivors they can find without accidentally injuring those that they haven't found. In the rubble of large buildings, it is difficult to know where people are trapped, and rescuers sometimes risk their lives climbing into the rubble to find survivors.

Eddie Grant, visiting professor of electrical and computer engineering and director of the Undergraduate Design Center at NC State, realized that if robots could get into the building, they would be able to find survivors without endangering the lives of rescuers. Because pipes are often left intact when buildings collapse, Grant conceived the idea of a pipe-crawling robot, and he challenged his senior design students in electrical and computer engineering to build a robot that could navigate pipes.

Under the direction of Grant and John Muth, visiting assistant professor of electrical and computer engineering, the senior design students created Moccasin I and Moccasin II, robots that can crawl through six-inch piping, using off-the-shelf components.

"The idea for these robots came when I was in Virginia at a meeting," said Grant. "One of the men I was meeting with was sent in to the Oklahoma City bombing with a marine special force. He told me that the rescuers would have given anything to have a robot that could go in and find the people. When I came back to NC State, I realized that this would make an excellent senior design project. And the students met the challenge very well."

The most recent design, Moccasin II, is able to navigate a complicated course of piping, complete with 90-degree turns and vertical climbs. The segmented robot has the look of a cyber-inchworm and uses pneumatics to force padded "feet" against the pipe walls as it extends and

(*See* **Robot,** *page 4)*

$24 million STC grant, largest in UNC system

NC State University, UNC-Chapel Hill, NC A&T SU and the University of Texas at Austin have received a prestigious, multimillion-dollar grant to advance groundbreaking research into environmentally friendly solvents.

The National Science Board gave its approval July 30 to the National Science Foundation (NSF) to establish the NSF Science and Technology Center (STC) for Environmentally Responsible Solvents and Processes. The director of the center is Joseph M. DeSimone, the William R. Kenan Jr. Distinguished Professor of Chemistry at UNC-Chapel Hill and Chemical Engineering at NC State. The center's co-director is Ruben G. Carbonell, KoSa Professor and director of the Kenan Institute for Engineering, Science and Technology at NC State. The center is one of five STC's authorized this year from a national pool of 300 pre-proposals.

The largest research grant ever received by any set of investigators in the UNC system, the $24 million center will be administered by the four institutions. The grant is an initial commitment of an estimated $18 million from NSF over five years, with matching funds bringing the total to $24 million. The center has a potential duration of ten years that could result in a total of $35M to $40M from NSF.

The STC will be the leading center in the world dedicated to discovering environmentally friendly processes using alternative solvents. Currently more than 30 billion pounds of organic and halogenated solvents are used worldwide each year in manufacturing, and considerably more water is used and contaminated by related processes.

(See **STC**, *back page)*

Notes

- Winser **Alexander**, electrical and computer engineering, received the National Society of Black Engineers "2000 Dr. Janice A. Lumpkin Educator of the Year Award" at the Golden Torch Awards ceremony, March 2000 in Charlotte.
- October 1, the University lit up the Memorial Belltower in red lights in honor of Jayant "Jay" **Baliga**, electrical and computer engineering, for attaining his 100th patent.
- Hans **Conrad**, materials science and engineering, received the TMS 2000 Distinguished Materials Scientist Award.
- Robert F. **Davis**, materials science and engineering, received the 15th R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension in October 1999.
- Donald **Dudziak** and Charles W. **Mayo**, nuclear engineering, received the ANS Training Excellence Award.
- Richard **Felder**, chemical engineering, and Carl **Zorowski**, mechanical and aerospace engineering, received the Alexander Quarles Holladay Medal for Excellence, 1999.
- Paul **Franzon**, electrical and computer engineering, and students John **Damiano**, Bruce **Duewer**, Alan **Glaser**, Toby **Schaffer** and John **Wilson** were chosen as one of five winning teams in Phase One of the SRC Copper Design Challenge.
- H. Christopher **Frey**, civil engineering, served on the Inter-Governmental Panel on Climate Change meeting on Good Practice in Inventory Preparation, England, October 1999. Frey participated in the NAE 5th annual Symposium on Frontiers of Engineering in fall 1999. Also he received the 1999 Chauncey Starr Award from the Society for Risk Analysis.
- Richard **Gould**, mechanical and aerospace engineering, has been appointed director of Applied Energy Research Lab (AERL), succeeding James Mulligan.
- Associate Dean John **Gilligan** was elected to serve on the board of directors of the Engineering Research Council of the American Society of Engineering Education for a three-year term.
- Robert M. **Kelly**, chemical engineering, was named director, NCSU Biotechnology Program.
- Robert M. **Kolbas**, head of electrical and computer engineering, was elected Fellow, IEEE, January 2000.
- Teresa A. **Helmlinger** (BS Engr. Oper. '78 NC State; MBA Duke '85) was named executive director of the Industrial Extension Service, effective July 26, 1999, replacing Tom Stephenson, who retired.
- The College began offering a new **Master of Computer Science** degree in fall 1999 through its distance education program.
- Jagdish (Jay) **Narayan**, materials science and engineering, received the 1999 Gold Medal from ASM-International.
- Mohammad **Noori**, the John Woodman Higgins professor of mechanical engineering and head of the Department of Mechanical Engineering at Worcester Polytechnic Institute, was named head of mechanical and aerospace engineering at NC State, effective November 1, 1999. He succeeds Fred DeJarnette, head since 1994 and interim head one year prior. DeJarnette returned to teaching and research.
- Douglas E. **Peplow** (NE PhD '99), postdoctoral fellow, was awarded the Mark Mills Award by the American Nuclear Society.
- On May 16, 1999, NC State University renamed its flight test facility near Butner "Perkins Field" in honor of **John N. Perkins**, retired aerospace engineering professor, and his late uncle, Captain Albert N. Perkins, a US Naval commander and aviator.

Energy-efficient rebuilding follows Hurricane Floyd

IES projects spur rebuilding, growth

The devastation created in eastern North Carolina by the floodwaters of Hurricane Floyd brought new opportunity to rebuild North Carolina in a more energy-efficient way. Working in partnership with the Energy Division in the NC Department of Commerce, the NC Solar Center of the Industrial Extension Service (IES) constructed an energy-efficient home in Kinston to be used by a family displaced by flooding.

"With so many families in need of housing, and many of those having lost everything they own in this flood, there is a desperate need for housing that is truly affordable," said Larry Shirley, executive director of the Solar Center, a program administered by IES. "For the thousands of new homes to be constructed, we feel we should build a model of energy efficiency that can be replicated throughout eastern North Carolina. If we build these homes in an energy-efficient manner and use solar energy wherever we can, the homes will have much lower energy bills and be quite affordable."

The model energy home, a one-story home of less than 1,100 sq. ft., has upgraded insulation, comprehensive air sealing which prevents infiltration, advanced HVAC duct design and sealing, and a number of other measures. This approach, according to Shirley, provides not only an inexpensive house to heat and cool but also one that is comfortable, healthy and durable.

"The homes are being constructed in the style of Habitat for Humanity," said Shirley. "Cities and towns throughout the region will see that this approach should be carefully considered because it yields a quality home that is both affordable and environmentally sound. That is a winning combination for rebuilding this ravaged area of our state."

IES offers a variety of engineering and technical assistance programs across the state. For more information, call (919) 515-2358, or visit the website at www.ies.ncsu.edu.

- The College held a memorial service for Richard (Ric) **Porter**, assistant dean for academic affairs, who passed away suddenly in July 1999. The service drew colleagues, friends, family and hundreds of devoted student advisees.
- Injong **Rhee**, computer science, received a Faculty Early Career Development (Career) Award from NSF, who will provide $269,000 over the next four years to support his research in wireless network environments for digital communication.
- Jonathan G. **Rossie** Jr., computer science, received a Faculty Early Career Development (Career) Award from NSF. The funding, $207,000, provided over four years, will support his research project, "Safe Observable Components: Programming-Language Support for Object Interaction Protocols."
- Lawrence (Larry) **Silverberg**, mechanical and aerospace engineering, was appointed director, Mars Mission Research Center, July 1, 1999, replacing Gerald Walberg.
- William (Billy) **Stewart**, computer science, stepped down as director of the Operations Research program January 1, 2000. Shu-Cherng **Fang**, industrial engineering, is serving as interim director.
- Katharine **Stinson** (AE '41), the first woman to receive an engineering degree from NC State, received the Women in Aerospace (WIA) 1999 Lifetime Achievement Award, presented October 1999 in Washington, DC.
- Paul **Turinsky**, professor of nuclear engineering, is serving for the second time as head of nuclear engineering, effective November 1, 1999. He succeeds Donald Dudziak, department head since May 1990, who returned to teaching and research.
- Luke **Zettlemoyer**, computer science, received the Computing Research Association Outstanding Undergraduate Award 2000.
- Paul **Zia**, Distinguished University Professor Emeritus of civil engineering, was honored September 1999 by the US Department of the Interior with the Citizens Awards for Exceptional Service for his contributions to the Cape Hatteras Lighthouse move. Zia is a member of the National Academy of Engineering.
- The College of Engineering and the College of Management joined forces to develop a unique educational program that addresses the needs of the State's rapidly growing computer networking industry. The new program, **Master of Science in Computer Networking**, was approved by the UNC Board of Governors in May 1999.

Wolfpack Legends Team Puts Pedal to the Metal

And you can keep track of their latest race results and upcoming competitions at their *very* cool website: http://www.mae.ncsu.edu/legends/ . The Wolfpack team finished the 1999 ICAR fall season as the first-place champions!

Students Build Robots in Mechatronics Summer Workshop

Again this summer, high school students will design, build and test robots at NC State as part of the Mechatronics Systems Workshop for Young Scholars. This program introduces students to mechatronics – a combination of information technology and mechanical, electrical and computer engineering. In the week-long program, rising high school juniors and seniors attend classes and labs, getting hands-on experience with solving typical challenges faced by engineering students. The students are allowed to take home the robots they create.

For more information, visit this website: http://www.engr.ncsu.edu/academic/SITE/prog.html .

Alumni, send address corrections for this newsletter to: Supervisor, Biographical Processing, Advancement Services, Campus Box 7501, NC State University, Raleigh, NC 27695, or call (800) NCS-ALUM.

Engineers' Fair 1931: First Prize, Electrical Engineering's entry, marking the 100th Anniversary of the Dynamo – Modern Dynamo 1931 versus Faraday's Dynamo 1831. Photos, from the collection of C.A. Holbrook (Civil-Construction '31), donated by C.A. ("Gus") Holbrook, Jr. (Engr. Operations '69) of Albemarle, NC.

Robot - continued from front page

John Muth prepares to load Moccasin II into a pipe for a test-crawl.

contracts its body along the pipe course.

"The use of pneumatics for movement is an important factor because sometimes there are explosive gases present in buildings that have collapsed," said Grant. "Electricity would have the potential for igniting these gases so we designed the robot to use compressed air instead. This gives it added portability, as well. The robot can run off air tanks when there is no electricity to run an air compressor, and it is designed so that it breaks down into components that can easily be carried in backpacks to remote disaster sites."

Moccasin II is outfitted with a tiny video camera and lights that feed video through a cable to a monitor so its location in the pipe can be seen. The robot can also carry sensors that could "hear" or sense vibrations from someone tapping on the pipes.

The on-board video and ability to carry sensors into the pipes makes Moccasin II a versatile robot that could be used not only for search and rescue but also for repairs on piping in areas where humans would be in danger, such as in nuclear power plant pipes or in gas lines. With other modifications, it could be used to detect cracks in sewer or water lines.

"The robot is very versatile," said Grant. "We are currently working on modifying a different robot based on what we have learned from the Moccasin design. Using compressed air is the key to making a robot that is safer in areas where combustibles are present."

The pipe-crawler has been a big hit with the media – and arguably the biggest story ever to come out of NC State University in the way of media attention – with calls and email messages pouring into the College of Engineering news office from around the world. Some big names in media have picked up the story: BBC Radio 5 Live from London interview with Eddie Grant; BBC Horizon; BBC Tomorrow's World; CNN; Japanese television news show; Science & Technology News Network; Motion International, Canada; Fox National News; *ParisMatch* magazine; *Engineering Magazine* of London; *KIJK* magazine of Germany ("Onderzoek – Ideeën en experimenten, RoboRups"); *Ça M'intéresse* magazine of France ("Robotique – Une chenille pour fouiller les décombres"); *Wired* magazine; *Popular Science* magazine; *Sensors* magazine ("Research & Developments – Mobile Robot Is Designed for Rescue Operations"); *New Scientist* magazine; *National Geographic* website; *Science Daily*'s website; and countless other inquiries, with calls continuing to come in.

Computer Engineering seniors Steve Cottle (left), Brian Dessent (right), and Jason Cox (not pictured), along with professors Eddie Grant and John Muth, comprise the team that developed the pipe-crawling robot.

Computer Science project keeps "Girls on Track"

Mladen Vouk, professor of computer science, and NC State computer science doctoral student Tiffany Barnes are working with education researchers to develop education and tracking tools for a project aimed at improving the math and science education of adolescent girls.

The "Girls on Track" project, funded by NSF, will track the progress of girls at four middle schools in Wake County. Vouk is working with Sarah Berenson, professor of mathematics education and director of the Center for Research in Math and Science Education at NC State, to design computers as tools for the project.

"Computers need to be viewed more as tools or appliances for learning rather than as ominous equipment. How computers are perceived in a classroom can be a wall or impediment to education" said Vouk. "What we would like to do is make the computer more of a basic tool, to take away the intimidation factor."

Berenson will select girls, teachers and guidance counselors to participate in the program. The participants will be tracked to determine what factors are involved in the students' loss of interest and to test various computer tools and other strategies for improving their performance in science and math.

Vouk and Barnes are developing the computer tracking software as well as software to aid the teachers and guidance counselors. Last summer the first training sessions in a pilot test of the program were held.

"It is very important that we provide training for the teachers for this project," said Berenson. "We cannot expect teachers to incorporate the computers and the software in their classroom if we don't teach them how to use the technology."

"Studies have shown that girls have a tendency to lose interest in math and science during their middle school years," said Vouk. "We don't believe there is really one particular factor that causes these girls to lose interest in math and science. Instead, we believe it is a variety of factors – cultural, environmental, social. "By tracking the progress of the participants, we hope to find out how to prevent the loss of interest."

Automobile emissions research to reduce pollution

Air pollution caused by vehicle emissions has long been a concern in our society. Each year, the number of ozone alerts increases, indicating that the quality of our air continues to decline, due in part to the emissions of automobiles.

At NC State University, researchers are working to find ways to reduce automobile emissions. Using a newly developed machine, engineers are analyzing emissions produced by a variety of gasoline-powered automobiles. Christopher Frey, associate professor of civil engineering, and Nagui M. Rouphail, professor of civil engineering, and their team of researchers will use the information collected by the instrument to create computer models that show the effects of driving patterns and traffic signals on automobile emissions.

"We are the first to use this particular instrument for research. As a matter of fact, this is the first instrument of its kind," said Frey. "It offers an easily portable, on-board analysis of what air pollutants a vehicle is actually producing during operation."

The instrument, developed by CleanAir Technologies International Inc., offers low-cost, portable emissions analysis. NC State received the first machine produced, and the research team has worked with the company to refine and modify the instrument.

The unique ability to measure the actual emissions produced by a particular vehicle during start-up and driving allows Frey and Rouphail to use real-world data instead of the generalizations based on laboratory-produced data currently used to predict emissions.

"What makes this instrument perfect for this research is that it can be set up easily in any vehicle," said Frey. "In the past, these analysis instruments for on-board testing were expensive and bulky."

Chris Frey uses a first-of-its-kind instrument to measure automobile emissions in real-traffic conditions. The data he gathers will help determine how traffic patterns influence pollution.

"A common belief based on laboratory emissions data is that idling produces high emissions," said Frey. "However, based on what we have collected so far, idle emissions are much lower than expected. Acceleration is the dominant producer of high emissions, indicating that changing traffic patterns to allow fewer stops with longer delays may reduce emissions."

Although it is commonly believed that high speed driving can produce very high emissions, results from the research team's measurements so far indicate that high speed emissions can be relatively low as long as driving is at a constant speed and on a level road. On the other hand, emissions can increase substantially when changing speeds to make lane changes or when accelerating rapidly to high speed.

The team is working with officials from the NC Department of Transportation to better understand the relationship between traffic signal timing and emissions. The results of this project will provide a basis for predicting the effect of new traffic signal timing on vehicle emissions during real-world driving. The researchers hope that improving the timing of traffic signals can have a significant effect on pollution in high-traffic areas.

Foundation News

Phoenix Family gives $100K

J. Stuart Phoenix (BS ESM '76), director of FMI Corporation, and his brother, Frank J. Phoenix (BS ESM '76), of Pacific Environmental Services, Inc., have given $100,000 from the Phoenix Family Foundation to be used for Engineering scholarships.

Foundation Notes

- **George Rouskas**, associate professor in computer science, has been awarded a $159,190 Hewlett-Packard equipment grant. The proposal involves the departments of electrical and computer engineering and computer science and will be used to support the networking activities of the two departments and the Master of Science in Computer Networking.
- **Clancy and Theys Construction Company** of Raleigh has donated $75,000 to the College to endow the I.E. Clancy Scholarship. The gift, initiated by president Tim Clancy, will support merit scholarships valued at $3,750 each.
- **Gloria K.** and **J. Phillip Kennett** (IE '62) of Colfax have endowed $50,000 to the College of Engineering to fund merit scholarships.
- **Charles D. Lamb** (CE '76) and **Patricia D. Lamb** (ME '77) of Richmond, Virginia, have endowed $25,000 to the College. The Lambs' endowment will fund Engineering scholarships.
- **Mimi** and **Tom Cunningham** (BS '71, MS '74, MAT) of Wilmington have endowed $25,000 in unrestricted support to the College.
- **Dwight Edwin "Ed" Rose** (CE '82) of Charlotte, president and general contractor of Shelco Inc., has pledged $25,000 to endow the Rose/Shelco scholarship in Civil Engineering as part of a $100,000 endowment with **Barry Gardner** (CE-Construction '75) of Shelco, Inc. and the Shelton Foundation.
- **Fujitsu Network Communications Inc.** has pledged $20,000 to continue its support of merit scholarships in the College of Engineering.
- **Andersen Consulting** has supported the College by giving a gift of $10,000. The money will be used to sponsor this year's College of Engineering Endowed Scholarship Dinner on April 14.

GTE presents $255K grant

(Left to right) Alan Tharp (head of Computer Science), Associate Dean John Gilligan, Steve Toler of GTE and Robert Kolbas (head of Electrical and Computer Engineering). The GTE Foundation has awarded a $255,000 three-year grant to support Engineering scholarships, fellowships and classroom equipment in the departments of Computer Science and Electrical and Computer Engineering.

Hewlett-Packard grants $2 million

Thomas Conte, associate professor of electrical and computer engineering, is one of four researchers nationwide selected to receive support from a $2 million grant from Hewlett-Packard Company. The grant, consisting of cash and equipment, will support teaching initiatives in the area of Explicitly Parallel Instruction-set Computing (EPIC) at NC State and three other universities, California State University, Los Angeles; the Georgia Institute of Technology; and the University of Illinois at Urbana-Champaign. EPIC, a new way to express programs to a computer that simplifies their circuitry and increases computer performance, is the foundation of next-generation computer architecture developed jointly by Hewlett-Packard and Intel.

Hewlett-Packard has established the HP EPIC Architectures Initiative in Computer Science, sponsored by the company's University Grants Program, to support education and training in EPIC-related concepts. Conte will use his portion of the grant, totaling more than $300,000 over the next two years, to support development of course modules and textbook writing.

Conte has been involved with the development of EPIC technology since 1994. More information about the research is available at http://www.tinker.ncsu.edu.

$1 million endowed chair in Computer Science established

A $1 million endowed chair in computer science has been established through the generosity of SAS Institute Inc. of Cary. SAS gave $666,000 to the Department of Computer Science to endow a distinguished professorship in data warehousing, an important software methodology for delivering and managing information for decision-making by users. The gift was eligible for a matching grant of $334,000 from the Distinguished Professors Endowment Trust Fund maintained by UNC General Administration.

The chair is named the SAS Institute Professor of Computer Science. It will enable the department to recruit a world renowned computer scientist who will contribute to the development of data warehousing processes through student academics and research.

Dean Nino Masnari said, "SAS Institute has long been a strong supporter of the College of Engineering and our computer science department. We deeply appreciate the Institute's continuing commitment to the success of our programs as evidenced by this most recent gift."

In recent years, computer science at NC State has emerged as one of the most rapidly growing disciplines on campus.

"We are very excited about the growth and leading-edge research and teaching activities that have been going on in our department," said Alan L. Tharp, head of the Department of Computer Science. "The SAS Institute professorship will help continue this momentum, and most exciting is what this scholar will be able to contribute to the educational experience of our students."

A concentration in data warehousing is in keeping with the department's goal to move into new areas, Tharp said. He expressed appreciation to SAS "for allowing us to move forward in program goals to provide highly qualified people for the areas that can definitely help the economy of North Carolina."

"By establishing this professorship, SAS Institute can help ensure that NC State remains a leading university in engineering and computer science," said Dr. Jim Goodnight, president and CEO of SAS Institute. "We also hope this will help increase the number of computer science graduates who can provide the talent to lead companies like SAS Institute into the next millennium."

In addition to this most recent donation to NC State, SAS Institute also provides four endowed scholarships in the departments of Computer Science and Statistics.

Meet the NC State Engineering Foundation staff

Foundation staff members are (left to right - front row) Leslie K. S. Gartenberg, Assistant Director of Departmental Development, Electrical and Computer Engineering; Suzanne Wells, Program Assistant; Carla Abramczyk, Assistant Director of Departmental Development, Chemical Engineering; and Ben Hughes, Executive Director of Development and College Relations and Executive Director, NC State Engineering Foundation, Inc. (Back row) Nahid Bozorgi, Assistant Director for Corporate and Foundation Relations; Gwen Bell, Assistant to the Director; and Ed Hand, Associate Director of Development.

BASF presents gift

Gary Gibson (left), manager of mechanical design at BASF, presents Dean Nino Masnari with a check for $10,000 to support Mechanical and Aerospace Engineering and Chemical Engineering.

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STC - continued from front page

Carbon dioxide was long thought by scientists to be extremely limited as a solvent until DeSimone and his students designed polymerization processes to make commodity plastics in it like Teflon™, Plexiglass™ and polystyrene. An outgrowth of this research included the design of surfactants (detergents) for carbon dioxide by center faculty that enabled it to be a powerful solvent for many solvent- and water-intensive industries. Carbon dioxide has great advantages over other solvents: it is inexpensive, it is non-toxic and non-flammable and it is accessible in many forms, gas and liquid.

Joseph DeSimone (left) and Ruben Carbonell are co-directors of the new $24 million Science and Technology Center.

Carbonell said that he expects that "carbon dioxide will become the solvent of the future," the main enabling ingredient in most high tech industries such as plastics, pharmaceuticals, electronics and biotechnology.

The research into carbon dioxide by DeSimone and his students has already led to the commercialization of a novel process that utilizes carbon dioxide instead of organic solvents for dry cleaning. The resulting company, Micell Technologies, has generated a dry-cleaning franchise business called Hangers, with franchises in operation since 1998.

Read more news about the College of Engineering on the World Wide Web **http://www.engr.ncsu.edu/news.releases/coe.news.html.** Questions? Call (919) 515-2311.
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