DISCOVERY:
FLORIDA TECH

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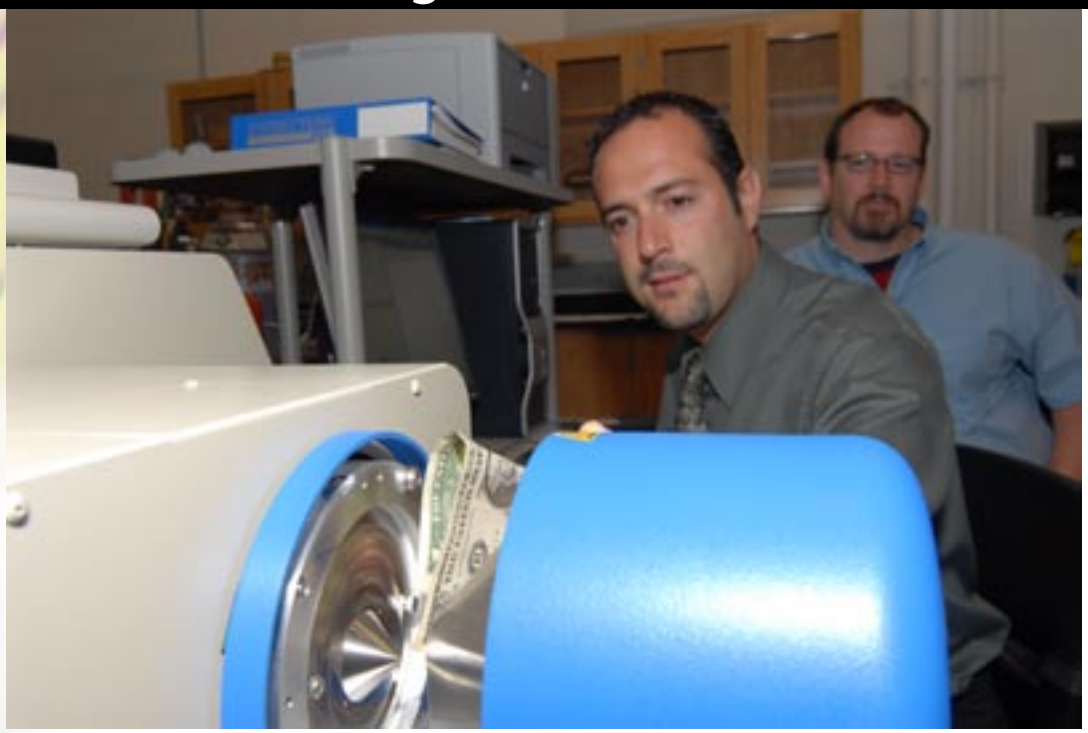
New DART is on Target



Nasri Nesnas puts a dollar bill through the DART analyzer. 90 percent of bills, he says, show traces of cocaine. This is because all bills mix together in government sorting machines, causing contamination. Joel Olson is at right.

It's not a toy. No one would think of $210,000 of award-winning mass spectrometry equipment that way—especially one touted as a candidate for a Nobel Prize. But **Nasri Nesnas**, assistant professor of chemistry, has been having a fun time experimenting with the new DART (Direct Analysis in Real Time) ionization method, since it was installed last spring.

Coupled with the AccuTOF mass spectrometer analyzer, the system is "by far, the most sensitive instrument that exists on this campus," said College of Science **Dean Gordon L. Nelson**. And, thanks to Nesnas promoting its purchase, Florida Tech was the first research university to own one.

Useful for analysis in research and forensics, the DART directly detects drugs, chemicals or explosives on surfaces, in liquids and in gases without the need for sample preparation. It slashes the hours of laboratory time required by other ion sources for mass spectrometers.

The highly sensitive DART is one component of a three-part system. The DART sensor and a vacuum chamber sit atop the mass spectrometer, housed in a cabinet the size of a small photocopier. A computer, beside the detection equipment, provides a read-out of the specimen's mass spectrum.

"If a dog can smell it, the DART can detect it, too," said Robert "Chip" Cody, co-inventor of the DART, which is a product of his company, JEOL USA.

Is there cocaine on that dollar bill? Mustard on your tie? A toxic chemical in that lagoon water? The system can tell just by placing the

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Discovery: Florida Tech
Focusing on the discoveries and innovations faculty and students are making at Florida Institute of Technology.

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object, liquid or gas in front of the sensor.

"There has been a deficiency at Florida Tech in mass spectroscopy," said Nesnas, who is responsible for the new system. "We had no equipment that offered high enough resolution, so we sent our samples to outside laboratories. Because we had such a great need, we were eager to own the system as soon as we learned it was available."

He thinks that bigger universities haven't bought it yet because they already have reasonably decent equipment.

"Our big need drove us. The instrument can go up to 10,000 mass units, or Daltons, which is way more than most systems."

The revolutionary DART was called a potential candidate for a Nobel Prize in a PittCon 2005 review article in the *Journal of the American Society for Mass Spectrometry.*

It is just the ticket for sample identification in a National Science Foundation-funded nanotechnology project under way by Nesnas and **Joel Olson**, Florida Tech assistant chemistry professor. Their project is to develop a photo sensor they think will help in fabricating miniscule cameras. The cameras would be the "eyes" of nanorobots used in medical, military and national security operations.

With **Virender Sharma**, Florida Tech associate professor of chemistry, Nesnas has already published one paper, in *Environmental Science and Technology*, about research that would have been impossible, said Nesnas, without the new system and the data that came from it.

Nesnas and Olson are most excited by their breakthrough discovery with the DART. They are in the process of publishing the news of a novel method for mass analysis of self-assembled monolayers (SAMs) on gold surfaces in the *Journal of the American Chemical Society.*

They found that the DART can ionize and analyze the SAMs, providing a mass spectrum of the adsorbed molecules. This is important because SAMs, which constitute an integral part of the emerging field of molecular electronics and nanotechnology, are difficult to analyze.

The only other means to perform direct mass analysis of these types of samples is Secondary Ion Mass Spectrometry (SIMS). Though SIMS is powerful, a SIMS instrument can cost up to $2 million and the results it provides can be abstract and difficult to understand, compared to the DART.

Is there cocaine on that dollar bill? Mustard on your tie? A toxic chemical in that lagoon water? The DART can detect it.

"The DART is sensitive enough to strip off and analyze a single layer of molecules on a sample—the molecules remain intact," says Olson.

"The ability to easily and relatively inexpensively analyze SAMs is a huge breakthrough for the analysis of these types of samples." The discovery, he says, will spawn at least two more projects.

The day-to-day use and exploration of DART capabilities at Florida Tech goes on. Nesnas is training faculty on DART usage and processing student research samples. Nelson finds the DART critical to measuring samples in his polymer research. Sharma and his graduate students welcome the fast results for their environmental studies on ground water contaminants.

Long-term plans, said Nesnas, include hiring a graduate student to process sample requests from local organizations. The outside income would pay the student and fund maintenance on the instrument.

"The DART has generated great interest in the industry," said Nesnas. "It has the potential to greatly impact all areas of chemistry that use mass spectrometry."

Karen Rhine

Tycho Spadaro, a junior and chemistry major, places a gold bead that has been treated with a self-assembled monolayer in the new Direct Analysis in Real Time (DART) mass spectrometer. The rest of the project team are Nasri Nesnas, seated; Kafui Kpegba, a department of chemistry postdoctoral fellow; and Joel Olson. Spadero has been conducting chemistry research since he was a freshman.

No Culture Clash in Longtime Collaboration

Florida Tech's two gurus of corporate culture and organizational change, **Roger Manley**, business professor, and **Wade Shaw**, engineering professor, are, themselves, lessons in workplace adaptation. Both know the yin of university life and the yang of corporate priorities. And their many industry clients seek their interdisciplinary wisdom.

Each brings his knowledge and skills to the fore in a collaboration that began in 1989. Manley, then dean of the College of Business, hired Shaw as a faculty member that year.

Together they have published more than a dozen papers that scrutinize the values and attitudes of organizations, from the worst-case Dilbert-esque to the highly functional. Their initial joint research examined the challenges of technology transfer from knowledge-oriented universities to market-driven industry.

Their first collaborative papers, on analysis of responses to open-ended questions in employee attitude surveys, appeared in the early '90s. The professional relationship prevailed even after 1994 when Shaw, an award winner in the field of engineering management, moved over to the College of Engineering.

"I think we collaborate as much or more than anyone on campus," said Shaw. "I think it works so well for a number of reasons. We listen to each other and respect each other's point of view. We also share a willingness to take on difficult, ill-structured problems."

Each enriches the other's fields of inquiry.

"Wade is a visionary systems person," said Manley. "He sees the interconnectedness between the parts and the feedback loops. He can identify issues affecting risk management that alert a company to head off problems."

Among Manley's subject areas are organizational psychology and leadership skills. "If there was ever a teacher who practices what he preaches—who teaches what he has actually done—it is Roger," says Shaw.

Collaborators on papers that explore such topics as risk management, partnering and organizational learning, the duo's most recent effort is titled "Understanding Organizational Culture and its Role in Organizational Change and Partnering." Manley presented it at the 6th International Conference on Knowledge, Culture & Change in Organizations near Florence, Italy, last summer.

In the paper, they brought to bear much of their studies and consulting experience on the role of culture in planned organizational change. The paper's premise is that understanding an organization's culture is necessary to changing the organization.

"To introduce change, you must know what makes a company tick. Culture is a powerful, often-unseen force in organizations," says Manley.

"A framework for conceptualizing organizational culture can give management a perspective for assessing compatibility between strategic direction and the organization's culture.

"Characterizing an organization's culture and assessing its potential to help or harm corporate performance is the first step in changing organizational direction."

Wade Shaw and Roger Manley

The paper touched on partnering, a subject Manley and Shaw have focused on in joint consulting since 2000, when their services were engaged by a large construction firm. Partnering is a process which enables a group of service providers and clients, such as private sector companies and government agencies, to form an entity and formalize an agreement to work together. The result, frequently, is culture clash.

"The two parties must agree on shared goals, on how to communicate, handle differences and manage risks," says Manley. "A big part of the partnering process is to involve all the players and get their agreement, so that day-in, day-out decisions can be made by those closest to the action.

"If a company has a 'dog-eat-dog' kind of culture, the message is clear: 'don't partner.'"

The list of private and public sector organizations and community service groups for whom they have consulted is extensive and includes a Brevard County health care organization. They just wrapped up successful work there on leadership development and team building with non-physician managers.

The two colleagues have been on the Florida Tech faculty a collective 44 years. They serve on boards, committees and professional societies, are authors of more than 100 publications, including book chapters, journal articles and peer-reviewed papers, and continue to teach full course loads.

Their consulting brings credibility to their classes and lectures. "I would just like to be remembered for influencing the field that I'm in," says Shaw, "as well as being a positive influence on my students."

Karen Rhine

Recent Papers by Roger Manley and Wade Shaw

"Project Partnering: A Medium for Private and Public Sector Collaboration" (with R.C. Manley) Proceedings, 6th Annual International Academy of Business and Public Administration Disciplines Conference, Orlando, Fla., January 2006.

"Suppose the Construction Industry Took Partnering Seriously?" Proceedings, 10th Annual International Conference on Industry, Engineering and Management Systems, Cocoa Beach, Fla., March 2004.

"Incorporating Risk Management in Project Partnering" Proceedings, 25th National Conference of American Society for Engineering Management, Washington, D.C., October 2004.

"Action Research, Appreciative Inquiry and Organizational Learning" Proceedings, 2002 IEEE International Engineering Management Conference, St. John's College, Cambridge, UK, August 2002.

"Incorporating Appreciative Inquiry into the Action Research Process" Proceedings, 2002 American Psychological Society Annual Conference, New Orleans, La., June 2002.

"Making the Psychological Contract More Explicit for Engineers and Other Technical Professionals" Proceedings, 2000 American Psychological Association Conference, Miami, Fla., June 2000.

Military Pilot Research Could Save Lives

Pulling G's Degrades Flying Performance Longer than Expected

Military pilots are "away from the switch" or can be incapacitated for at least 60 seconds when they pull high G's, according to recent research conducted by **John Deaton**, chair of the Aviation Human Factors Program at Florida Institute of Technology.

"The decrement in performance is a lot longer than researchers originally thought," said Deaton, a former Navy aviation psychologist.

Their brains are robbed of normal blood flow before they lose consciousness. They are awake, but are not at 100 percent for 12–30 seconds. "They are in a twilight zone prior to losing consciousness," Deaton said. This almost loss of consciousness is called ALOC.

Then, they can lose consciousness for another 12–30 seconds, called gravity loss of consciousness or GLOC.

In addition to performing studies on military pilots in a human centrifuge, Deaton also searched through military safety data and interviewed military pilots about their experiences—at least the experiences they could remember.

> "Anytime we can save one person's life and a multimillion dollar airplane, it is worth it."
>
> *Winston Scott*

A curious phenomenon is that some pilots have GLOC amnesia. They don't remember ever losing consciousness. Deaton said this was proven to one pilot who volunteered to be subjected to a ride in the centrifuge, while his buddies watched. "He swore to all of them that he never lost consciousness, until we showed him the videotape. He was stunned by what he saw," Deaton said.

Deaton suspects there are many more incidents of GLOC or ALOC that go unreported. The GLOC event is underreported because they don't remember it. And, even if they did remember, Deaton questioned, "Would they want to report it and risk not being allowed to fly for a couple of days?"

GLOC is a major issue for military flight training. "Military pilots are taught to push the envelope; and their ability to push the envelope and tolerate G's helps them overcome their enemies who may be flying less maneuverable aircraft," Deaton explained.

While "pushing the envelope," pilots get close to losing consciousness, then back off. "The military didn't really think it was a problem." The research video shows centrifuge volunteers pulling 5-1/2 G's for 3 to 4

Military pilots were subjected to 3 1/2 G's in a centrifuge during studies conducted by John Deaton. During the studies, they were told to avoid any straining maneuvers that would prevent gravity loss of consciousness (GLOC). These pilots pull 5 1/2 to 6 Gs flying high-performance aircraft, such as the Navy's FA-18 and the Air Force's F-16.

John Deaton

Winston Scott

seconds. Although it wasn't enough to lose consciousness, they were not functioning at 100 percent. During ALOC, a period before losing consciousness, the pilots in Deaton's study couldn't talk or do simple math problems for about 10–15 seconds.

Incidents of GLOC reflected in military data from training squadrons were quite high, although the number of fatalities was low. This is partially due to the fact that the instructor can take over if the training pilot loses consciousness. The most alarming statistic was the incidents of GLOC in operational, single-seat aircraft. There is a 33 percent chance of fatality. To put it more directly, Deaton said, "The probability is one out of three you're going to die if you experience GLOC."

"It's very important research," said Capt. Winston Scott, former part-time professor of aeronautics at Florida Institute of Technology. "Anytime we can save one person's life and a multimillion dollar airplane, it is worth it." When Scott was a fighter pilot, he worked with Deaton at the Naval Air Warfare Center in (Warminster) Pennsylvania.

Scott, a former NASA astronaut, has accumulated more than 5,000 hours of flight time in 20 different military and civilian aircraft, and more than 200 shipboard landings. He remains an active pilot flying various aircraft.

Deaton's research exemplified the need to teach military pilots more effective anti-G maneuvers. The maneuvers primarily involve straining abdominal and leg muscles to keep blood in the upper part of the body. He said future training programs should emphasize teaching these maneuvers in a centrifuge. Pilots can also be taught how to recognize the symptoms that occur before loss of consciousness.

1. Visual loss: develop tunnel vision, lose ability to see colors, field of vision becomes more narrow until blackout
2. Before blackout, the pilot can hear, but can't see
3. There is only a matter of seconds before hitting the ground—to reduce the G's and come back
4. Seizure activity occurs when the pilot recovers from GLOC

This research may seem irrelevant to the average person who doesn't fly flight fighter jets and experience 5 ½ to 6 G's, but maybe not. Pilots in training are subjected to an average of 3 ½ G's, about the same as people on amusement rides. Mission: Space at Disney World in Orlando, Fla., is reported to pull 3 to 4 G's. It's conceivable the amusement park rider could feel some aftereffects similar to a fighter pilot's ALOC, especially given the fact that the typical park rider may not be in as good physical shape as a pilot, nor be experienced in recognizing and combating acceleration forces when they occur.

"We're not clear whether there are some long-term effects that could affect normal activities, such as their ability to drive home," Deaton said. "The ride may not end when they get off the ride."

Melinda Millsap

"Military pilots are taught to push the envelope; and their ability to push the envelope and tolerate G's helps them overcome their enemies who may be flying less maneuverable aircraft."

John Deaton

An F-16 fighter during a maneuver

Developing the Next Generation of Robotics

New Part-Orienting Devices May Put Traditional Robots Out of Work

The irony found in his research is not lost on Florida Institute of Technology mechanical engineer **Pierre Larochelle**. The associate professor is, after all, in charge of the university's robotics lab.

"I think a lot of people are surprised when they hear what we're working on now," said Larochelle.

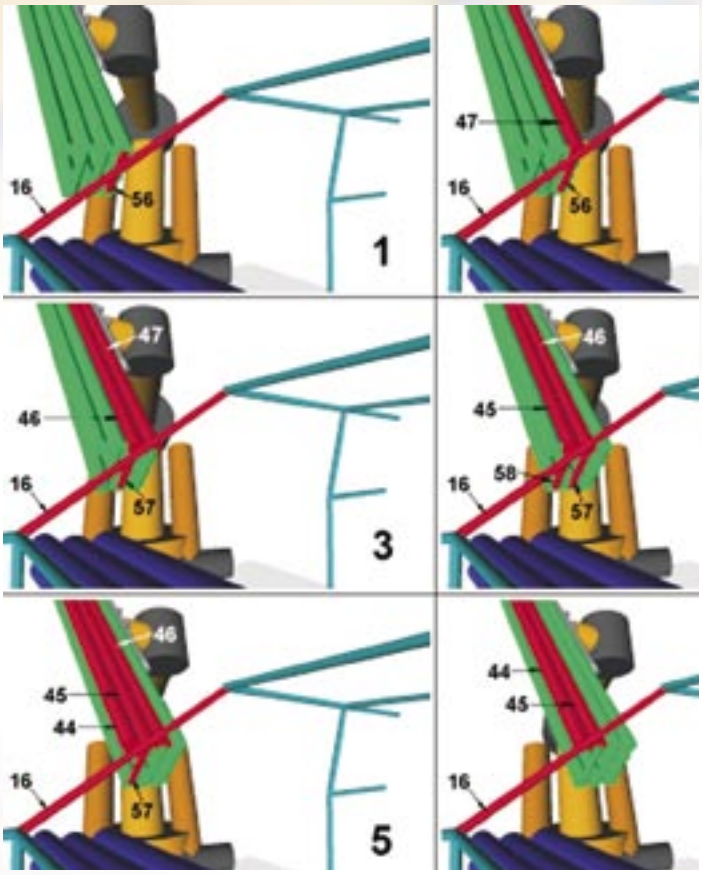
What they, Larochelle and a host of undergraduate and graduate students, are working on now is a way to replace traditional robots in the 21st century assembly line. Their research is part of a collaboration with University of Dayton researchers Drew Murray and Michael Turner.

The three earned a $411,000 grant from the National Science Foundation (NSF) in 2004. Halfway through the life of the grant, Larochelle, Murray and Turner have made tremendous progress.

The goal for their research is to create a lower-cost assembly machine for manufacturers in a variety of high-tech industries.

"To reduce costs, assembly line designers try to keep robotic manipulations on the assembly line as simple as possible," said Larochelle. "Typically, the robots have six or more motors that allow them to perform an infinitely wide variety of motions; these motors make robots expensive and challenging to program."

With the NSF grant, Larochelle and his collaborators have developed a solution, the Part Orienting Device (POD).



Virtual testing of the POD allowed the researchers to make changes to both design and setup as they prepare to begin real-world testing.

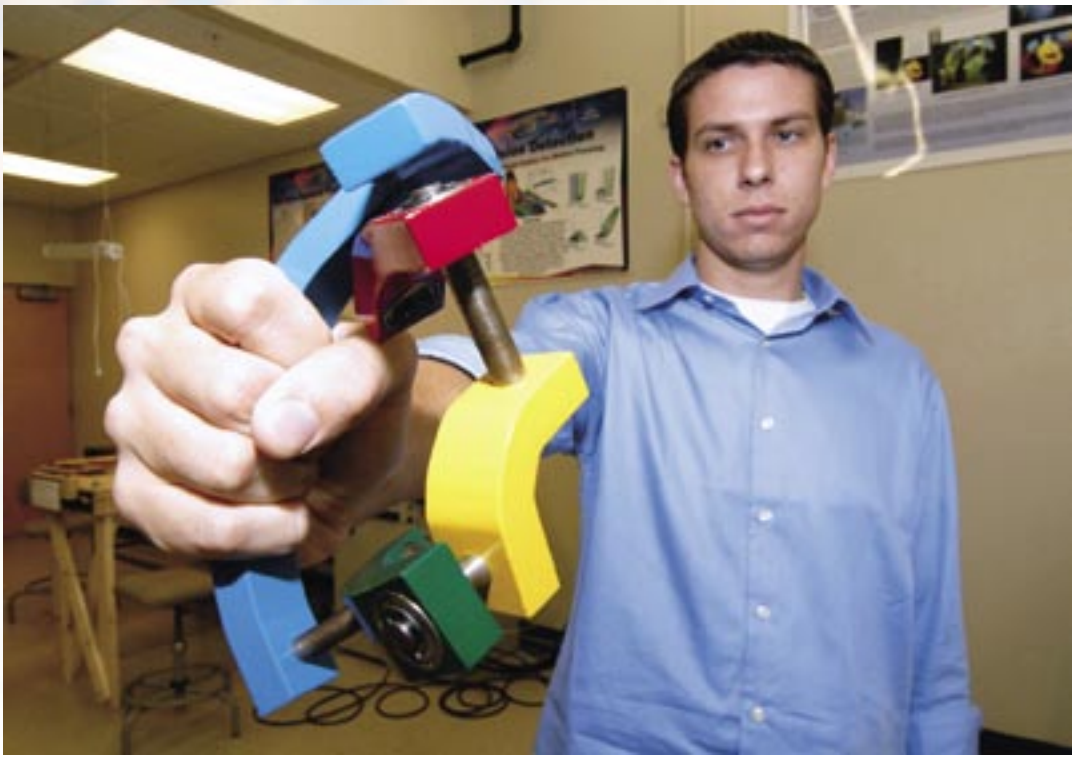
From left: Jason Schuler, Pierre Larochelle, John Ketchel

"PODs are at the core of our spherical mechanisms research. These prototypes will accomplish the same assembly line tasks as robots, but with only one or two motors, lowering costs and maintenance," said Larochelle.

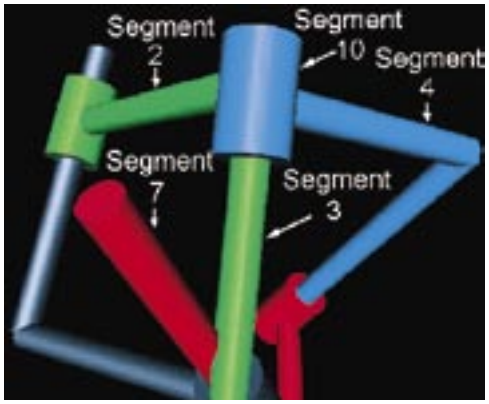
Spherical mechanisms are used on assembly lines to correctly orient a product for the next step in the line. An iPod, for example, might need to be oriented one way to install the computer screen and another way to install an earplug receiver jack.

So far, the engineering for the POD has proven successful in the computer and the laboratory. Research team members are now ready to take the next step with the POD.

"We're going to design a prototype POD for a real manufacturing task," said Larochelle. "In this way, we'll take the concept out of a lab and onto the assembly line."



Schuler shows off a model of the POD.



The researchers used computer programming to design the POD and to test it in a variety of virtual environments.

Their efforts thus far have not gone unnoticed. In the past two years, Larochelle and his collaborators both at Florida Tech and at Dayton have published or presented in a dozen different venues. The latest paper was published as part of the proceedings of the 2006 American Society of Mechanical Engineers International Design Engineering Technical Conferences held in Philadelphia in September. One of Larochelle's co-presenters there was a Florida Tech undergraduate student, **Jason Schuler**.

Currently heading to press is another article, written by Larochelle and freshly-minted Florida Tech Ph.D. **John Ketchel**. The article, "Computer-Aided Manufacturing of Spherical Mechanisms," will be published in *Mechanism and Machine Theory* in 2007.

While much has been achieved so far, the research has proven to be quite challenging.

"We've learned that the problem is even harder than we thought it would be two years ago," said Larochelle. "But we've also seen that we can create something that industry has a real interest in. What we're working on has a lot of promise to yield a useful design tool."

As for the irony inherent in his research, Larochelle sees the ongoing work as part of a natural progression.

"I've always loved working with robots," he said. "Now, I'm really enjoying researching these mechanisms that will replace them. The research is really exciting because we're focusing on ideas not being pursued by many people. In this way, our work has a real chance to change how things are built for generations to come."

Jay Wilson

Grant and Contract Growth continued from page 8

Dr. Jean-Paul Pinelli—$300,000 from the National Science Foundation for work on a wireless sensor network. The network would monitor pressures on roofs of buildings and would be valuable for measuring and characterizing hurricane wind loads on structures. **Dr. Chelakara Subramanian** and **Dr. Ivica Kostanic** are co-principal investigators.

Dr. John Trefry—$182,000 from the U.S. Department of Interior, Minerals Management Service, through a contract with Battelle Science and Technology International. The funding, for a seventh year of research, supports field research by Trefry and his team on the potential, long-term impacts of offshore oil exploration and production in the Alaskan Arctic. "We want to know about possible problems before any significant impacts occur," said Trefry.

Dr. John Trefry and **Dr. John Windsor**—$198,537 from the St. Johns River Water Management District for an 18-month study of potentially toxic substances in the Indian River Lagoon. They will examine the results of efforts to reduce the input of these toxins to the coastal environment over the last 15 years and study new sites.

COLLEGE OF SCIENCE

Dr. Mark Bush—$177,000 from the Gordon and Betty Moore Foundation (founder of Intel) to work on an investigation of past tree line and carbon balance in the Andes. This is part of an $860,000 grant shared with Wake Forest University, University of Oxford, University of Edinburgh and University of California at Los Angeles.

Dr. Ramon Lopez—$124,000 from the National Science Foundation for a unique line of research in the area of cognitive science. This is the scientific study of the mind or of intelligence. He will apply the approach to selected topics in earth and space science education.

Drs. Matt A. Wood and **Terry Oswalt**—$478,180 for four years in support of the Southeastern Association for Research in Astronomy (SARA) Research Experiences for Undergraduates (REU) Summer Intern Program. The grant comes through a partnership between the National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program and a Department of Defense program. SARA brings in 11 to 12 talented undergraduates from around the country to work one-on-one with faculty mentors from several of the eight SARA Consortium university members.

Message from the Dean

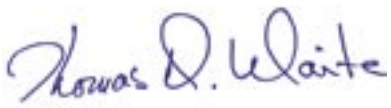
Thomas D. Waite, Ph.D.

As we begin the 2007 academic year, the College of Engineering (CoE) is poised to expand its educational presence at Florida Institute of Technology. The CoE is the largest academic unit within the university, with seven departments and nearly 1,700 students. We offer a unique educational experience for our students, by providing hands-on experience to all of our undergraduates through our capstone design courses.

Last year's student projects exhibition attracted nearly 1,000 visitors to our campus. Innovative student projects included a working electromagnetic gun and portable stoplights for utilization in communities damaged by tornadoes or hurricanes. No other CoE provides the same level of support to its students for these capstone design projects as Florida Tech. In fact, Florida Tech has been asked by the prestigious King Faud University of Petroleum and Minerals (KFUPM) to help it develop a capstone project process similar to ours. This summer, Dr. Talal Al-Kharobi, a KFUPM professor of computer engineering, and a student spent a month at Florida Tech working with faculty and students in the CoE to learn how to design capstone projects.

Faculty research in the CoE continues to grow, with nearly 60 proposals totaling more than $15 million submitted last year to federal and state agencies. This activity represents an increase of more than 12 percent over the previous year. The research ongoing in the CoE covers a broad span of disciplines, ranging from computer security to construction materials for highways. In addition to the normal research undertaken by the faculty in the CoE, there is a substantial amount of research which has significant military or security ramifications.

At all levels, the CoE is moving forward. We anticipate that our current growth in both educational excellence and research productivity will continue making the engineering educational experience at Florida Tech one of the best in the world.



Grant and Contract Growth

The university continues to increase research funding to support a variety of continuing and new projects.

COLLEGE OF BUSINESS

Dr. Annie Becker—$400,000 from the Agency for Healthcare Research and Quality of the U.S. Department of Health and Human Services. This combines with $200,000 from the Alzheimer's Association (in partnership with Intel Corporation and Agilent Technologies) awarded to collaborator **Dr. Frank Webbe**, professor of psychology, to develop information and communication technology. The project, called Buddy Computer Coordinated Healthcare System (or, Buddy for short), supports quality of life and aging-in-place initiatives. Buddy takes advantage of information and communication technology in linking caregivers to a virtual support network of family and friends of Alzheimer's disease patients.

COLLEGE OF ENGINEERING

Dr. Elizabeth Irlandi-Hyatt—$233,998 from the Florida Fish and Wildlife Conservation Commission, plus matching funds of $77,999 from the Wildlife Research Institute. Dr. William Arnold of the institute is the co-investigator for the three-year research project involving beach renourishment based on biological consideration for worm rock, sea turtles and other common animals, such as ghost and mole crabs, and coquina clams.

Dr. Steven Lazarus—$108,431 from NASA to participate in a collaborative effort of data thinning, similar to digital imaging. He is working with the University of Alabama in Huntsville (UAH) Information Technology and Systems Center Research Laboratories and NASA personnel to create a data-reduction tool. The tool would be useful for real-time applications in NASA data streams, which apply in NASA operations and research as well as in private industry communities.

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