DISCOVERY:
FLORIDA TECH
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Inhibiting Arterial Plaque Growth

In his laboratory, Kunal Mitra (C) poses with the new patent and graduate students Soumyadipta Basu (L) and Gopalendu Pal.

With a new patent in the portfolio, Florida Institute of Technology is in a good position to help solve a problem that plagues many heart surgery patients and their doctors. The patent, for an x-ray therapy to inhibit plaque growth in arteries, is held by Florida Tech along with Dr. Kunal Mitra, associate professor of mechanical engineering, and Dr. Charles Lambert, a cardiologist and former director of the Health First Heart Institute in Melbourne.

More than 40 percent of patients undergoing balloon angioplasty—a medical procedure to open a blocked artery—later experience a re-closing of the artery or restenosis, from plaque build-up. Among many other scientists, Mitra thinks this rate is unacceptable.

Already deeply interested in biomedical research, he perused the literature to see what solutions were in the works. Stent insertion, another invasive procedure, is the common first step after balloon angioplasty. To improve this remedy, researchers continue to experiment with different materials and types of stent coatings.

Mitra also began to look at how x-ray irradiation can inhibit plaque growth. In his reading, a journal article caught his eye about a procedure under development at Lawrence Livermore National Laboratory, which he later visited. The methodology relies on cardiac catheters to implant a miniaturized x-ray tube and high voltage cables within a blocked artery.

While the x-ray solution sparked his interest, he was concerned about its invasive nature. “When you put something inside the body you considerably reduce the margin of safety,” said Mitra “It is also harder to direct and control the dose.”

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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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"With our system, we can precisely deliver the energy, reducing potential damage to nearby normal tissue during exposure. Moreover, x-rays have higher penetrating power than optical waves, such as in laser therapy."

Dr. Kunal Mitra

"Inhibiting Arterial Plaque Growth" continued from page 1

Winning a grant from the National Science Foundation's Bioengineering and Environmental Systems Division in 2002, Mitra began developing a novel process in a U.S. Food and Drug Administration laboratory in Rockville, Md. During the development, he became associated with Dr. Charles R. Lambert, former director of the Health First Heart Institute.

Mitra developed a device to externally generate an ionizing dose of pulsed x-rays and irradiate the arterial walls by delivering the energy using hollow waveguides. "Use of the hollow waveguides give the procedure more control, making it much safer for the patient," he said.

"With our system, we can precisely deliver the energy, reducing potential damage to nearby normal tissue during exposure. Moreover, x-rays have higher penetrating power than optical waves, such as in laser therapy."

Similarly, Mitra's methodology can deliver precise radiation as a medical therapy to shrink tumors throughout the body.

The use of pulsed x-rays through hollow waveguides will allow radiation to be accurately placed near a tumor," he said. "This will protect the healthy tissue surrounding the tumor from being damaged by x-ray radiation."

Mitra, who has tested his applications on computer software that mimics biological tissues, has developed numerical models for analyzing the x-ray irradiation propagation. His students continue to support data collection for his arterial and tumor studies. "We have masses of data by now for phantom studies," he said.

Graduate student Gopalendu Pal (left) aligns a laser while Dr. Kunal Mitra measures optical signals from phantom tissue samples.

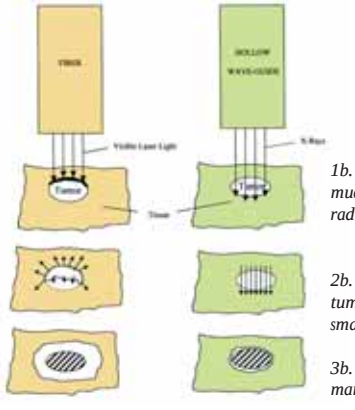
Animal testing will come next for the arterial studies; tumor studies will soon advance to human testing. "It's just a matter of getting the funding," said Mitra, who continues to explore sources to support his work. The work will complement his current research on tumor detection in animal models using short pulse lasers. The work, currently funded by various agencies, will soon advance to human testing.

Although Lambert has moved on to become a professor of medicine in Gainesville, Fla., the M.D. has made some initial contacts with biomedical companies to explore a relationship and to fund a prototype. Mitra stays involved with Health First and is a board member of the Joint Center for Advanced Therapy and Biomedical Research of Florida Tech and Health First. He hopes to expand his relationship there.

"Heart disease and cancer remain the two leading causes of mortality," said Mitra. "As the two most critical issues of biomedicine, they will continue to capture my interest and energy."

Karen Rhine

Comparison of thermal versus x-ray killing of a tumor



1a. Time exposure begins—depth stops at tumor margin, heat must propagate to kill entire tumor

1b. Depth controlled by energy, much less heat—cells killed by radiation and not by heat

2a. Heat goes in all directions eventually and kills the tumor

2b. X-rays penetrate the entire tumor, kill the tumor and a small margin beyond

3a. Dead tumor plus large margin beyond

3b. Dead tumor and a small margin beyond

Tsunami: George Maul's Vision of Hope

For more than a decade, Florida Tech's department head for Marine and Environmental Systems has steadfastly worked to establish tsunami early warning systems for high-risk regions around the globe.

This year, George Maul's lonely pursuit changed dramatically with the tragic tsunamis in the Indian Ocean.

Since then, Maul has been quoted in more than 200 media outlets throughout the world, spoken as part of a panel at the Smithsonian, and met with his peers at an international conference of the Intergovernmental Oceanographic Commission (IOC) in Paris.

Following is Maul's own account of how he became one of the world's leading experts on tsunamis.

It was a dozen years ago that I first began to learn what the entire world knows now—that tsunamis can strike quickly, anywhere in the world, with devastating effect.

The year was 1993, and I had not yet started my time at Florida Tech. I was a senior scientist at the National Oceanographic and Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratory.

That year, I was asked to convene a meeting on small island oceanography by the IOC of the United Nations. More than 50 people from all over the world attended this conference on the island of Martinique. For the conference, I researched and presented a paper with two colleagues that detailed the tsunami threat in the Caribbean. We were all surprised to learn of the very real danger these islands face.

"With my focus on the Atlantic Ocean, I wrote an editorial in 2003, published in *Sea Technology Magazine*, calling for an Atlantic-wide early warning system."

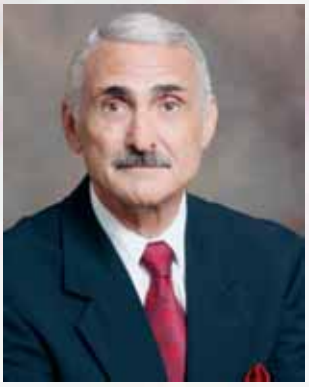
Dr. George Maul

This paper led me to edit a book published by the American Geophysical Union in 1996, titled, *Small Islands: Marine Science and Sustainable Development.* Our paper from the Martinique conference is the sixth chapter of this book.

This paper, conference and book began the call for a tsunami early warning system in the Caribbean. By the time I attended a 1994 meeting of Small Island Developing States in Barbados, I had just started at Florida Tech. At this meeting, we formed a group of experts on tsunamis. I was named chair of the IOCARIBE Tsunami Group of Experts dedicated to studying the need for an early warning system for the Subcommission for the Caribbean and Adjacent Regions of the IOC—IOCARIBE.

Through the mid-'90s, the Group of Experts worked diligently to create a proposal for the United Nations. There was a lot of science and politics to work through as we created a basis for an early warning system. By 2003, we fashioned a proposal that was approved by the Executive Council of the IOC. After this approval, we reached our most difficult obstacle—funding.

Toward that end, the IOCARIBE Tsunami Group of Experts worked with people on the Pacific Tsunami Warning System. While we received great help from very experienced scientists in the Pacific, to this day there is still no comprehensive early warning system in the Caribbean or the Gulf of Mexico.



Dr. George Maul, professor and department head of Marine and Environmental Systems in the College of Engineering.

It was during the late 1990s that I began my letter-writing campaign to the president and members of congress. Like a lone wolf howling in the wilderness, I was trying to get somebody's—anybody's—attention on the potential for disaster. I wrote my first letter to President Clinton in 1997 and received no response.

In 1998, a Papua-New Guinea earthquake struck that looked exactly like an 1867 earthquake that devastated the U.S. Virgin Islands. The islands were close enough to the undersea epicenter that the tsunami struck less than 10 minutes later. This 1998 event prompted a letter that year to President Clinton, and to my surprise, a response.

My letter trickled down to the Department of Commerce, and I was informed a warning system would be a priority for the first half of this decade. A NOAA funding plan would be put in place.

By 2000, my focus had drifted northward to a warning system for the entire Atlantic Ocean. I knew that, in 1755, an earthquake rocked Lisbon, Portugal, and set off a massive tsunami in the Atlantic. A similar event today would be murderous.

With my focus on the Atlantic Ocean, I wrote an editorial in 2003, published in Sea Technology Magazine, calling for an Atlantic-wide early warning system. I also wrote letters to the president, the secretary of commerce and every congressman and senator whose district or state touches the Atlantic—131 in all. I received two replies.

Our focus now is keeping all of the experts on the same page in terms of what must be done. In order to secure funding, we must avoid advocating competing plans, and come up with one comprehensive plan agreed on by all. It's not easy to do.

In the next several months, I expect to be busy, working with national and international agencies as we build, finally, a warning system for the Atlantic Ocean. Such a system will not prevent the loss of property from a Lisbon-sized tsunami, but will greatly reduce the cost in lives.

Saving these lives is a pursuit worth continuing, as my colleagues and I have done for the past dozen years.

Navigating the Winds of Change

The historic hurricane season of 2004 wasn't unprecedented in the state of Florida, but it missed being so by only a few miles.

Technically, Hurricane Ivan came ashore in Alabama, just missing being the fourth hurricane to make landfall in the sunshine state.

"Of course, that's little solace to the people of Pensacola and western Florida, who were hit by the most powerful part of the storm," said **John Williams**, Florida Institute of Technology's longtime hurricane researcher. "Since Ivan made landfall in Alabama, 2004 joins 1950 and 1964 as years in which the state had three hurricanes make landfall."

What was unprecedented was the manner in which hurricanes Frances and Jeanne made landfall. Both had a tremendous impact on Florida Tech, and the pair came ashore within five miles of each other, with Jeanne landing three weeks to the day after Frances.

John Williams

"That's never happened before. It was unprecedented," Williams said.

In addition to bringing destruction and misery to all corners of the Florida coast, the 2004 hurricane season provided a wealth of information to three Florida Tech engineers and scientists. Civil engineer **Jean-Paul Pinelli**, ocean engineer **Lee Harris** and meteorologist **Steven Lazarus** all say that there was much to be learned.

For Harris, the hurricanes validated much of his research on beach erosion.

"We had no surprises," he said. "Areas that had beach renourishment did pretty well. Those without did not. Those areas closest to the landfall site saw the worst erosion."

Beach erosion during a hurricane is caused primarily by the initial storm surge and the pounding of waves throughout the landfall. This erosion caused considerable loss of property in areas not reinforced by beach renourishment.

"Without beach nourishment, the damage along the Atlantic Coast would have been much worse," said Harris. "For example, in Melbourne Beach where we've had beach nourishment, damage to upland buildings was relatively minor. In Satellite Beach, where there has been no beach nourishment, the results for beachside homes, condos and property were devastating."

For Pinelli, the focus of interest wasn't the sea, it was the wind, and how the hurricanes would affect man-made structures.

"We learned new things, and had confirmation of what we expected," said Pinelli. "We saw first-hand that mitigation can be successful in preventing hurricane damage."

As evidence of the power of mitigation, Pinelli points to mobile homes.

Dr. Lee Harris visits Vero Beach in September 2004, inspecting an experimental sand-filled container revetment system that successfully provided coastal erosion protection during the hurricanes. He was the design engineer and oversaw the project construction during the summer of 1989, for the system noted by the Florida Department of Environmental Regulation (FDEP) for its successful performance.

Traditionally the most susceptible to hurricane wind damage, newer models fared much better in the face of Charley, Frances and Jeanne.

"What we saw with mobile homes is that the new standards did fairly well. That was striking. We'd tour a park and see older homes vaporized and newer ones fairly well intact," he said.

Dr. Jean-Paul Pinelli

Also striking were differences in actual wind speeds on the ground and what was reported as official by the National Weather Service. Pinelli is part of a group led by the Institute for Business and Home Safety that also includes engineers and scientists at the University of Florida, Clemson University and Florida International University. This group placed mobile towers with anemometers along the coast and wind pressure sensors on rooftops of homes in the paths of the Florida hurricanes.

"We learned that wind speeds on the ground were less than what were reported by the National Weather Service. The University of Florida measurements downgraded hurricanes Frances and Jeanne from a category two and three respectively to category one. Both hurricanes had winds of 80-85 miles per hour with gusts of 105 miles per hour—much less than what we thought at the time."

The storms let Pinelli and his research colleague,

"We learned new things, and had confirmation of what we expected. We saw first-hand that mitigation can be successful in preventing hurricane damage."

Dr. Jean-Paul Pinelli

Chelakara Subramanian, demonstrate that a novel wireless sensor system they developed could be easily deployed on rooftops and provide valuable data throughout a hurricane event. The collected data will lead to improved building code provisions in the future.

Dr. Chelakara Subramanian

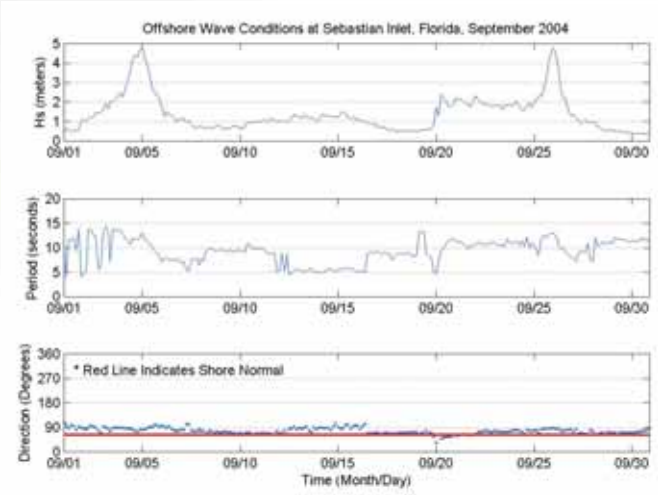
For Pinelli, the good news is that building code changes are making the difference. The bad news?

"We're still building right on the beach. And the hurricanes that hit us last year weren't nearly as strong as we thought, or as strong as what might come next."

What might come next is what keeps Lazarus up at night. Since last fall, he's tried to understand the "why" of the hurricane season. Why was it such a violent year for Florida? Why did two hurricanes make landfall within five miles of each other? Unfortunately, as is always the case with these powerful storms, he's found no easy answers.

Dr. Steven Lazarus

"The problem with trying to understand why a hurricane followed the path it did is that hurricanes are not like blocks of wood in a stream or a balloon in the air," Lazarus said. "The path of a hurricane is the result of a dynamic interaction in both directions. The truth is, storm motion is still not clearly understood."



September 2004 wave data recorded by Florida Tech's coastal station at Sebastian Inlet Florida, research by Dr. Lee E. Harris.

Lazarus said one of the culprits in last year's Florida hurricane season was a Bermuda High that dominated the Atlantic during the month of September. The previous eight Septembers saw the formation of a trough. While a trough most likely steered the hurricanes away from Florida, the high did much the opposite.

The fact remains that hurricanes are, in many ways, unpredictable.

"A lot of factors had to go right, or wrong, depending upon your point of view, to create the hurricane season of 2004," said Lazarus. "But, that doesn't mean it can't happen again."

Jay Wilson

The Vero Beach Marine Lab facility suffered extensive damage from wind and water.

The Highwaymen of Civil Engineering

Professors' research strives to improve the usability of asphalt millings.

Dr. Paul Cosentino and Dr. Edward Kalajian rethink RAP.

A quarter of a million dollars says that Florida Tech civil engineering professors **Paul Cosentino** and **Edward Kalajian** are onto something big in their quest to improve our roads and highways through recycled asphalt pavement (RAP) research. In fact, that's how much they were granted ($261,000 to be exact) in their latest Florida Department of Transportation (FDOT) award. David J. Horhota, PhD. P.E. is overseeing this project for the FDOT.

This newest phase of research will continue the momentum of their 15-year-old quest to determine the properties of various waste materials. For the past five years, Cosentino and Kalajian have received FDOT funding to investigate RAP's qualities and viability for road building and other applications.

RAP is the material milled prior to the resurfacing of old or distressed asphalt pavements. Typically, a scraping device breaks up the worn pavement and 2–4 inches is taken off the top layer and then resurfaced with new hot mix asphalt. RAP seemed like the perfect recycling solution. When it was time to rejuvenate a highway, contractors could remove the damaged layer of pavement, then use 50 percent of the millings mixed into the new asphalt mix with considerable cost savings.

The RAP crusher goes to work during post milling processing to resize the RAP for use in recycling.

The Superpave Challenge

In the late 80s, a new system for grading liquid asphalt cements and a new design process were developed, which led to stringent new standards for state agencies. These new specifications are known as Superpave (SUPerior PERforming Asphalt PAVEment) and were adopted by FDOT in 1995. Although Superpave ensures longer-lasting highways with less ruts and cracks, it severely restricts the use of RAP in new construction. FDOT now specifies no more than a 15 percent admixture of RAP, resulting in huge stockpiles of RAP throughout the state.

The professors' last study, completed in 2001, introduced a new application for RAP material and developed a new specification, allowing RAP to be used as a stabilizing material for the subbase below rigid pavements. They concluded that RAP is a suitable material for use as a structural fill and for

"The next phase will not require a test site to be built, but instead will involve full-scale testing at the FDOT State Materials Lab in Gainesville, Florida to determine field performance."

Dr. Edward Kalajian

roadway base and subbase applications. The study also found that RAP had excellent drainage characteristics.

According to Dr. Cosentino, "Though it's not stable enough for use as substrate, RAP can be used in many other applications."

They recommend the use of RAP for backfill in roadways or as construction material for embankments around pipes and culverts, with potential use in roadway subbase and base applications if it meets appropriate highway construction specifications, such as the Limerock Bearing Ratio (LBR), the single most indicative test of a base course's stability.

Large RAP piles, like the one above, result from millings that cannot be used by contractors in new hot mix asphalt—an increasing problem throughout the state.

Entering the Next Phase

The new research, "Investigating the State-wide Variability and Long-Term Strength Deformation Characteristics of RAP and RAP-Soil Mixtures," will build upon previous findings, with two main objectives:

— To assess the statewide variability of RAP to determine if the conclusions and specifications recommended are applicable for RAP throughout Florida; and

— To evaluate and develop specifications on the long-term behavior of RAP and RAP-soil mixtures.

These objectives will address a major concern of Florida contractors. They worry that the engineering properties of millings around the state could vary to such a degree that their sites may not receive FDOT approval. By testing for creep (the settling of the road surface as load is applied over a period of time), the research will determine properties and predict the long-range performance of the different mixtures.

Graduate students who will be working on the research include: **Desi Dikova**, **Carl Sandin** and **Karima Degin**. In the course of the two-year project, at least six undergraduate students will have the opportunity for hands-on participation.

The Melbourne office of APAC, one of the largest transportation construction contractors in the U.S., will provide technical assistance and supply some of the materials used for laboratory testing and evaluation.

"We value our working partnership with Florida Tech. There has been a lot of productive information sharing in order to provide an industry perspective as to the possible benefits related to the research," said Chris Brunais, vice president of APAC's Central Florida Division and a member of Florida Tech's Construction Industry Advisory Board (CIAB).

Over the past several years APAC has been a valuable resource, providing materials and allowing test sections to be built on site and monitored over long time periods.

"The next phase will not require a test site to be built, but instead will involve full-scale testing at the FDOT State Materials Lab in Gainesville, Florida to determine field performance," Kalajian explains.

The two-year project will not only ascertain the properties of various RAP mixtures, but also conclude where and how it should and shouldn't be used. Their findings and recommendations will be incorporated into FDOT manual specifications.

Kathie L. Grant

"Grant and Contract Growth" continued from page 8

Dr. Niescja Turner—$400,000 from the National Science Foundation for her project, titled, "Dynamics and Evolution of Magnetic Storms in Varying Solar Wind Conditions."

Dr. Robert van Woesik—$260,000 from the Global Environmental Fund/World Bank to establish coral reef study sites in Mexico, Zanzibar and the Great Barrier Reef.

COLLEGE OF ENGINEERING

Dr. Thomas Belanger—$50,500 from the Southwest Florida Water Management District for a follow-up sediment study of Florida's Crystal River at King's Bay.

Dr. Charles Bostater—$85,000 from the U.S. Department of Education's Fund for the Improvement of Postsecondary Education to support efforts to improve remote sensing systems.

Dr. Fredric Ham—$175,000 from the Army Research Laboratory for the first phase of work to classify infrasonic signals of interest using a neural network classifier.

Dr. Lee Harris—$88,000 from the Sebastian Inlet Tax District to continue his work in operating a wave and weather data collection system at Sebastian Inlet.

Dr. Eric Thosteson—$59,000 from the Harbor Branch Oceanographic Institution to analyze the light, or bioluminescence, exhibited by ocean organisms.

COLLEGE OF BUSINESS

Dr. Shirley Ann Becker—$1.5 million from the U.S. Department of Labor to establish a National Center for Small Business Information.

Dr. Andrew Cudmore—$50,000 from Ron Jon Surf Shop to perform extensive consumer research at all five Ron Jon locations during 2005. His research will focus on how customers identify with each Ron Jon site.

Dr. Judith Barlow and **Dr. Deborah Carstens**—$198,000 from the Department of Health and Human Services (part of the National Institutes of Health) for a community-wide initiative. The grant was awarded to Health First, Brevard 211 and Florida Tech to improve quality of care and patient safety.

Message from the Dean of the College of Science

In many respects 2005 is the "year of science" at Florida Tech. In January the new College of Science (CoS) was formed, home to the departments of Biological Sciences, Chemistry, Mathematical Sciences, Physics and Space Sciences, and Science and Mathematics Education.

Dr. Gordon L. Nelson

In January, we dedicated the new F.W. Olin Physical Sciences Center. This $14 million, 70,000-square-foot teaching and research building is home to the departments of Chemistry, and Physics and Space Sciences. Because science is not something you study but something you do, the building has 52 laboratories and only three classrooms.

The building includes: a new 400mHz nuclear magnetic resonance spectrometer; a high bay Physics Experimental Hall, with space for fabrication of instrumentation and experimentation in specialized areas such as advanced lightning research and high energy physics; and a 32-inch fully automated telescope, the largest in Florida.

The CoS faculty research has reached an all-time high, nearly $12 million in current contracts, led by the Department of Physics and Space Sciences with $5.6 million, and the Department of Biological Sciences with $4.4 million—an impressive average of $200,000 per faculty member.

The Department of Mathematical Sciences continues to produce the largest number of publications at the university and has the third highest number of Ph.D. graduates. Biological sciences has the largest number of graduate students in CoS, 65.

Physics and space sciences is distinct in having one of the largest number of undergraduate majors nationally in astronomy and one of the largest undergraduate physics programs in the Southeast. Science and mathematics education continues to offer unique content-rich degree programs in the context of a College of Science. Chemistry, while the smallest of some 200 graduate-level chemistry departments nationally, ranks well within the top 100 in research. The College of Science is clearly a set of departments, faculty, and students of which one can be very proud!

The new F.W. Olin Physical Sciences Center is home to the departments of Chemistry, and Physics and Space Sciences.

Grant and Contract Growth

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

COLLEGE OF SCIENCE

Dr. David Carroll—$187,000 from the National Institutes of Health to research fertilization and early development.

Dr. Semen Köksal, Dr. Robert van Woesik, and **Dr. Philip Bernhard**—$50,000 from the United States Geological Survey (USGS) to establish a Coral Database (CoralData) node for the southeast region of the U.S.

Dr. Ramon Lopez—$254,500 from Boston University to support a National Science Foundation science and technology organization that studies space weather.

Dr. James Mantovani—$75,000 from NASA to work on an electrodynamic system for self-cleaning solar panels and other surfaces that could be used on future space exploration missions to Mars and the moon. He joins in this research with the University of Arkansas, Appalachian State University, Oklahoma Baptist University, MIT, NASA Kennedy Space Center and NASA Glenn Research Center in Cleveland, Ohio.

Dr. Terry Oswalt—$150,000 from an anonymous donor to enhance a previous donation to build an astronomical research telescope. This grant will enable Florida Tech to build the state's largest telescope.

Dr. Richard Tankersley—$1.7 million over three years from the National Science Foundation for an interdisciplinary project to work with Brevard County high school teachers to develop new learning modules.

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