

DISCOVERY: FLORIDA TECH

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Ships' Ballast Water Threatens Environment

Dr. Kevin B. Johnson, left, and Dr. Thomas D. Waite hold a plankton net that is used for capturing microscopic organisms in the water, such as potential exotic stowaways hiding in the ballast water of ships.



Can It Happen Here? Harmful invasions from non-native plants and animals have spread throughout the world, causing damage that is estimated to be in the billions of dollars per year. Shipping activity from ballasting operations has caused many of the most harmful invasions.

Ships spread aquatic organisms through the uptake and discharge of water utilized for stabilization. Between 3,000 and 5,000 species of animals and plants are transported daily around the globe in ships' ballast water.

According to the U.S. General Accounting Office, the national plan that addresses invasive species lacks a clear long-term outcome, and the implementation of preventive measures has been too slow. The National Oceanic and

Atmospheric Administration noted that no single agency of the federal government has the capacity to fully address invasive species, and little cooperation and coordination among stakeholders exists. This means individual states and their ports are left to develop and implement programs for preventing invasions.

Several states, including Washington and California, have strict ballast water treatment and discharge regulations already enacted

to reduce the risks of harmful invasions. Florida, which is the main hub of passenger cruise ships in the United States, does not have a coordinated plan.

The top three U.S. passenger ports are found in the state—Miami, Port Everglades and Port Canaveral. Together, they serve more than 50 percent of all U.S. passenger cruise traffic. Port Canaveral alone handles more than 15 percent of the country's

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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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Kevin B. Johnson, Melinda Millsap,
Karen Rhine, Thomas D. Waite,
Jay Wilson
Contributing Writers

Jeff Birmingham '04, Verna Layman,
Dave Potter, Paige Wachtler
Photographers

Judi Tintera
Art Director

Christena Callahan
Copy Editor

cruise line passenger traffic, with more than 1.22 million embarkations in 2004. Many ships calling at Port Canaveral routinely travel throughout the Caribbean and Mexico, while others stop over at the port in the middle of transoceanic voyages.

The local environment at risk from ballast introductions includes coastal zones, marshes and a system of connected lagoons. The Indian River Lagoon (IRL), the largest lagoon in the system, is 156 miles long and bridges temperate and subtropical latitudes. With more than 3,000 species, the IRL is believed to be the most diverse estuary in North America. This estuarine system is also home to dozens of endangered or threatened species, including the American alligator, the West Indian manatee and five of the world's seven species of sea turtles.

The IRL is a hotbed of biodiversity because of its remarkable length and habitats. Species adapted to cooler climates exist in the northern end, while species adapted to warmer subtropical climates exist in the central and southern portions of the estuary. Key habitats of the IRL, including seagrass beds, salt marshes and mangrove forests, are nurseries for small animals and provide protection and food for hundreds of species.

The same factors that enhance diversity in the Indian River Lagoon can also make it more vulnerable to invasion by exotic species. Because the IRL provides a variety of habitats over

a range of climates, exotic organisms from around the world have an increased chance of being dumped into an estuary where they can find a comfortable niche. They can eventually have a noticeable impact on their new habitat and the native species.

While exotic organisms have already been introduced to the IRL, two have the potential to exhibit significant ecological and economical impacts, i.e., a green Pacific macroalga (*Caulerpa brachypus*) and the Australian spotted jellyfish (*Phyllorhiza punctata*).

The alga belongs to a genus known to be extremely harmful as an invader in the Mediterranean. If it becomes well-established in the IRL, it might drive out native seagrasses. Because economically important fish and shellfish are dependent upon native seagrass beds, this introduced species could have far-reaching indirect effects on dozens of significant native species.

The Australian spotted jellyfish was introduced on the Gulf Coast, where it has become an established nuisance. In 2002, this jellyfish was found in the Indian River Lagoon in low numbers. It has since become scarce, but it is unknown whether it is in the early stages of invading the estuary. Like the macroalga that has invaded the Mediterranean, the spotted jellyfish not only impacts ecosystems, but the economy through depletion of various fisheries species. The

spotted jellyfish is a voracious predator on young fish and eggs.

Uncontrolled ballast discharge provides opportunities for invasive species to gain a foothold in coastal waters, harming local fisheries and impacting the fishing economy. Should an introduced species drive out native seagrasses, fish of economic concern could be harmed, including spotted seatrout,

snook, drum, sheepshead and snapper. In addition to potential fisheries impacts, the Australian spotted jellyfish could displace native jellyfish. Approximately half of the sea turtle species of the IRL feed on jellyfish and it is unknown what effects an invasion might have on turtles and other endangered and threatened species.

There should also be concern about exporting Florida species into foreign bays and estuaries, not out of altruism, but for the financial good of our ports. Destination ports are extremely sensitive to possible invasions from imported ballast. It is important they perceive ships utilizing Port Canaveral, for example, as safe with regard to ballast water quality. If shipping companies and cruise lines consider Port Canaveral to be a low-risk port, due to its ballast policies and controls, then the industry will be encouraged to continue and expand shipping out of the port. Conversely, shipping and cruise interests may consider relocating their facilities from ports perceived as high or of questionable risk with

regard to the presence of possible invaders.

The risk is real. In the 1980s a jellyfish, native to the central Florida coast, was introduced via ballast water to the Black Sea. Since that time, this exported predator has become established as an invader and decimated the fishing economies of the region. An important fishery in the Black Sea has suffered virtual collapse due to these jellyfish feeding on young fish and eggs, with nearly a 97 percent reduction in the annual catch.

We are at risk for harmful aquatic invasions if trends in other parts of the world are any indication. Although the global shipping industry is being pressured to treat ballast water (by the United Nations International Maritime Organization protocols), it will be years before it is required of all ships. In the meantime, Florida and regional authorities would be well-advised to initiate ballast water management programs to protect our ports from bio-invasions for the good of our natural resources, as well as port commerce.

*Thomas D. Waite and
Kevin B. Johnson
College of Engineering*

With more than 3,000 species, the Indian River Lagoon is believed to be the most diverse estuary in North America.

▶▶ Florida Tech Chemist Explores Iron's Potential

"Ferrate is my love because it can do so many things ... it can solve so many problems in the water."

Perhaps one day **Dr. Virender Sharma**, professor of chemistry, will be known as the Iron Man, but not for the reasons you might assume.

He isn't a triathlete or bodybuilder, or a fan of the Iron Man in *Marvel Comics*.

Although not one of these larger than life characters, the Florida Tech chemist could someday grab the limelight as a hero for his research involving iron. He's turning his love and fascination for ferrate, otherwise known as iron, into solving medical and environmental problems. "We can apply chemistry to solve these problems," Sharma explained.

His ferrate research has the potential to reduce arsenic in groundwater and contribute to understanding crippling diseases. His current research with iron and copper is in its early stages of development, but he is making progress during his sabbatical at Stanford University where he is a visiting professor. Collaborating with Dr. Edward Solomon, Sharma is learning new spectroscopic techniques and hopes to continue the relationship after returning to Florida Tech in July.

Working in a state-of-the-art laboratory in spectroscopy, Sharma plans to use the Stanford Synchrotron Radiation Laboratory X-ray source to probe nanoscale and atomic-scale structures. If he keeps his nose to the grindstone, he thinks his research will reveal the structure of ferrate in liquid. He said this will help him "understand how ferrate can easily remove (groundwater) contaminants, such as arsenic, the silent killer." With this information, he can improve the process of removing arsenic from groundwater.

Arsenic occurs naturally in the environment, and also comes from pesticides and wood preservatives. "It is a big problem in the Southwest (United States) and Bangladesh," Sharma said. This is causing great concern because arsenic is known to cause skin lesions and cancer.

Sharma admits he loves studying ferrate. "Ferrate is my love because it can do so many things," he said. For example, "it can solve so many problems in the water."

It can decompose pollutants, remove them from the water and ensure all bacteria and viruses are removed.

While Sharma concentrates on solving environmental problems with iron, he leaves no stone unturned. He also wants to know how iron acts in mammals. "We still don't know how

iron is used in our bodies," Sharma said. He hopes to understand how ferrate can inactivate pathogens, contaminants and viruses.

"Copper, along with iron, plays an important role in the biological and chemical processes," Sharma said. He is researching copper proteins and iron during his stay at



Dr. Virender Sharma

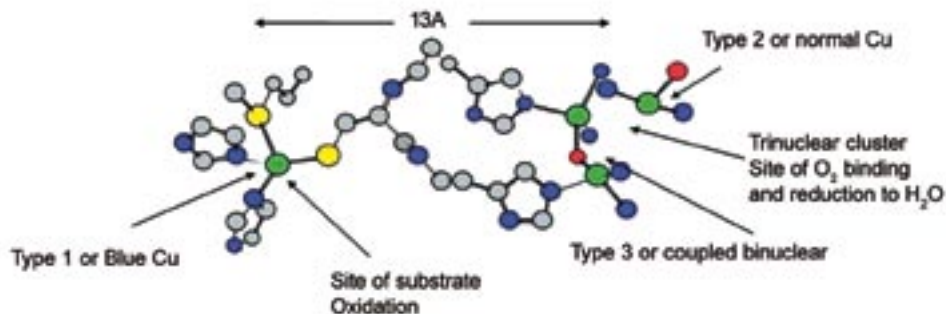
Stanford. "Copper proteins are essential for iron transport in mammals and yeast." They are necessary for the body to build bone, nerves and other tissue. Understanding these processes in living organisms could lead to better approaches to treat diseases, such as Menkes syndrome or Wilson disease.

Menkes syndrome is a genetic disorder that causes copper to build up in the kidney, while remaining deficient in the liver and brain. Wilson's is a hereditary disease that

causes the body to retain copper. The copper buildup leads to damage in the kidneys, brain and eyes.

Sharma believes chemistry research will reveal solutions to these and many other problems. This belief was the reason behind his exuberance when he said, "Chemistry is so exciting!" Sharma is a convincing disciple of chemistry's possibilities.

Melinda Millsap



Dr. Virender Sharma is researching copper proteins and iron during his sabbatical at Stanford University. Understanding these processes in living organisms could lead to better approaches to treat diseases. This figure displays the crystal structure of copper protein. Copper (Cu) sites are shown in green spheres and the separation of Type 1 (T1) copper sites from other copper clusters (T2 and T3 copper sites) is 13 Å (Å = hundred-millionth of a centimeter). In between the copper sites are amino acids (cysteine and histidine, which are essential for human development).

Engineering Students Dive into Water Projects: Attracted by Hands-on, Real-world Experiences

On a sunny March day, sitting outside the Link Building, home of the Department of Marine and Environmental Systems, Hunter Brown's eyes light up when he talks about the project that will earn him his ocean engineering master's degree. The underwater inspection and surveillance vehicle, he says, has anti-terrorism potential.

Brown is like most men and women attracted to Florida Tech for ocean engineering—they have a passion for going to the beach, for surfing, scuba or both. They think it's fun to tinker with things mechanical and challenging to conceptualize and design.

An integrated ocean engineering curriculum and hands-on, real-world opportunities draw the undergraduates. Master's and doctoral students enroll because the university offers one of the country's few graduate programs in the discipline. And because, like Brown, they can dive into vehicle projects that combine their most intense interests.

Brown, a scuba diver with a technical rating, has finished the software, tether and interface, as well as the design of the three-foot-long, unmanned project. Now he's tackling the vision component.



above: Hunter Brown reviews plans for the underwater inspection and surveillance vehicle.



left: MARC-1 conceptual design rendering.

"It will have two cameras, one on the front and one on the side," he says. "It will 'fly' underwater, inspecting a pipeline, for example, with the side camera, and 'look' forward for obstructions." Potentially applicable for homeland security, the vehicle could locate packages of drugs or mines attached to the undersides of vessels.

The program combines many of his interests. He's capitalizing on a bachelor's degree in applied mathematics,

an interest in the underwater world and a summer undergraduate experience where he developed a machine vision project.

Although the vehicle may not be a finished product when Brown graduates this summer—lacking its structural

housing—he will be able to demonstrate its capabilities in a Florida Tech pool. Then, another student can complete the project for graduate credit, maybe adding a robotic arm or some sensors, too.

"Many of the projects become refined and completed over the years by a series of students," says **Dr. Stephen Wood**, assistant professor of ocean engineering and Brown's faculty adviser. Wood, who is also coordinator of the Florida Tech Underwater Technologies Laboratory, sits today in this Frueauff Building lab, surrounded by projects in various states of completion.

The MARC-1 (Modular Amphibious Research Crawler) is an example of a project shaped by many hands, as students have

tinkered with it for their design project over several years. All undergraduate engineering students must complete a design project in order to graduate.

"The remotely operated MARC-1 began in spring 1999. The first year they built the basics, the second year the instrumentation, motor housings and extension pole



Dr. Stephen Wood

The MARC-1 is deployed on an ocean test ... after several maneuvers it returns to shore.





MARC-1 before assembly

went on," says Wood. "When the third year students grappled with it, they threw out much of what was already done and the team started over.

"It was a lot of trial and error. Sometimes failure is better than immediate success," says Wood.

Wood published an article on the three-wheeled vehicle in the February 2006 issue of the journal, *Sea Technology*, and has fielded a few inquiries about its commercial use, including one from a clammer.

Designed to operate underwater in the surf zone, the vehicle can reduce or eliminate the need for divers. Today the remote-controlled MARC-1 is 95 percent

finished. Wood expects to see it used in physical oceanography classes for coastal processes, beach profile surveying and for scientific data collection.

This year 15 ocean engineering undergraduate students displayed their projects in an April design

showcase. One team presented an autonomous mobile buoy to monitor coastal and lagoon areas and collect data on ecosystems; another exhibited a glider AUV, which will

extract biological samples from the water column and take photos; another group showed off a powered hydrofoil boat; and a team adapted a previous design team boat project into a displacement hull ship.

Potentially applicable for homeland security, the vehicle could locate packages of drugs or mines attached to the undersides of vessels.



Assembly complete. Ready to deploy.

A displacement hull carries a heavier load and travels further on less fuel.

"Every senior design project is practical. They can be used later by students and faculty in research," says Wood.

Guiding students on these and similar projects keeps Wood plenty busy.

"It's so gratifying to see a student go from start to finish on a project," says Wood. "This university allows the students to tackle

a variety of underwater projects. Our ocean engineering program offers underwater technologies, naval architecture, instrumentation, coastal processes, bio-fouling and corrosion. We have it all."

Karen Rhine



▶▶ Pocket-Sized Solution Brings Big Caregiver Support

High tech with a human touch is the order of the day in the laboratory of **Dr. Annie Becker**, Florida Tech professor of business.

Her student researchers are pooling their programming skills to build humanity into a Pocket PC via the PocketBuddy. As part of a virtual network of support built by the team or researchers, PocketBuddy will become a vital tool and social link for often overwhelmed caretakers of Alzheimer's disease patients.

Becker collaborates on the project with **Dr. Frank Webbe**, Florida Tech professor of psychology. Called Buddy Computer Coordinated Healthcare System (or, Buddy for short), the project is already in the queue for a patent. The project is funded by a \$400,000 contract from the Agency for Healthcare Research and Quality of the U.S. Department of Health and Human Services and \$200,000 from the

Alzheimer's Association (in partnership with Intel Corporation and Agilent Technologies).

"Caregivers of Alzheimer's disease patients have a huge burden and they are often elderly themselves," says Becker. "Our goal is to develop information and communication technology (ICT) that promotes quality of life for these providers. This, in turn, should affect the quality of life for the patients." The technology, she says, will be accessible even to those with minimal computer skills.

The device is a standard Pocket PC, weighing five ounces, or so, and about as big as a wallet. A touch screen, with little or no typing required, and a keypad with big buttons make it easy to handle. Additionally,

sophomore **Brandon Schmitt**, of Melbourne, is building a voice recognition and voice synthesis system to assist the visually impaired.

Like Schmitt, each of Becker's other student team members, who sit elbow-to-elbow in the lab, is developing a particular PocketBuddy attribute. Each has become a pioneer in making PocketBuddy usable for aging caregivers. The students design Pocket PC interfaces taking into account the normal aging of vision, motor skills, hearing, speech perception and cognition.

Nicolas Suc, a computer science graduate student from France, works on the journal. This logs various events of a day, e.g., social activity, exercise and support group, as well as feelings. "He thinks there should

be a French version," laughs Becker, "but I said, 'first things first.'"

Mashhour Solh, a graduate student in electrical engineering from Lebanon, is developing a text-messaging and e-mail system. "The key," says Mashhour, "is to keep these tools simple."

Sophomore **Jonathan McKenzie**, who lives with his family, including a grandmother afflicted with Alzheimer's disease, works on the medical management and medication reminder components.

Computer science graduate student **John Clarke** is creating an online checklist for personal events, like appointments and birthdays. He's also developing games for leisure time, which can be played with support group members through a Web interface. "Checkers and maybe a puzzle game, like Sudoku," he says.

Becker, who has a background in information systems and database management, oversees the technical content. From 2002-2004, while on the faculty at an Arizona university, her work brought her in touch with the lack of technology for monitoring diabetes patients, many of



The information management team looks at Nicolas Suc's latest efforts on the system's journal. From left: Dr. Annie Becker, Luke Nowak, Mashhour Solh, Jonathan McKenzie, John Clarke and Brandon Schmitt.

them homebound. Knowing that Alzheimer's patients and their caregivers suffer from similar isolation, when she returned to Florida Tech, she started a dialogue with

Webbe, who helped found the East Central Florida Memory Clinic in 1991, has a long-standing interest in geriatric issues. Contributing knowledge of the disease, and of caregiver and patient issues, he leads a team of psychology student researchers, who will help validate use and acceptance of the technology.

His team comprises students working on master's degrees in applied behavior analysis—including **Melissa**

"Caregivers of Alzheimer's disease patients have a huge burden and they are often elderly themselves. Our goal is to develop information and communication technology (ICT) that promotes quality of life for these providers."

Dr. Annie Becker

Knoll, Sophie Laurent and **Tristan Webbe**—and on clinical Psy.D. degrees, such as **Alyson Sincavage** and **Edan Critchfield**.

Undergraduate students, to participate in in-home data collection, will join the team later.

"I wanted students who had experience with the elderly population, with behavioral intervention and clinical design," said Webbe. "This team's knowledge set and

experiences are very good and they are also savvy technologically."

The graduate students will visit up to 10 homes. Each researcher will observe two to three times a week and note commonly occurring situations and behaviors. When the prototype is ready, they will take it into homes to see how it might be refined and observe if the tool eases the caregiver's burden.

"We don't want to continue development in a vacuum," says Webbe.



Jonathan McKenzie shows Dr. Annie Becker his work on the reminder components.

"We also want to offer caregivers something to ease their burden, not just give them something else to do. Our bright idea is no good unless it helps."

The Pocket PC and its Web-based counterpart will have a two-fold function to support quality of life and independent living—social and informational. The technology links caregivers to a virtual network of family, friends and healthcare personnel. Besides e-mail and text messaging, a "buddy blog" will connect network members regardless of geographic boundaries or time constraints. Healthcare professionals, through blog data mining capabilities, can monitor patient and caregiver health trends.

"We believe this is a significant step forward in using information and communication technologies to promote aging with dignity through 'stay at home' initiatives," says Becker.

"The thinking is that older adults can't use this technology. We're going to prove them wrong."

Karen Rhine



Dr. Frank Webbe and Dr. Annie Becker

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instructional program to improve student competency in practicing and applying statistics.

COLLEGE OF AERONAUTICS

A \$1.5 million gift from the Emil Buehler Trust of Paramus, N.J. The gift will fund the new Emil Buehler Center for Aviation Education and Research at Florida Tech. The center will consist of a main building and hangar, located on eight acres at Melbourne International Airport. Site preparation will begin in fall 2006, and completion is estimated by spring 2008. In addition to flight training, the building will house research centers in human factors and simulation research. The building will also house a fixed base operation, providing students with valuable hands-on opportunities in the growing aeronautics field.

▶▶ Message from the Dean

"Technology with a human touch" is an excellent description of the Florida Institute of Technology. The "human touch" is clearly the focus of research within the College of Psychology and Liberal Arts. Our faculty and students investigate humans, their behavior and their contributions through the ages and throughout their lifespan.

Sometimes the focus is on humans' use of technology, whether it be historically, such as investigating how technology helped Floridians fight the "mosquito wars" or futuristically, such as the use of Palm Pilot technology to assist caregivers of patients with Alzheimer's Disease, or the use of computer technology to assist in the teaching of science and mathematics.

Faculty members are also researching how to modify human behavior.

They are examining ways to enhance positive behaviors (e.g., effective team performance, service learning, coping with chronic illnesses) to correct problem behaviors (e.g., self-injury and food refusal among children with autism) and to identify and prevent misbehaviors (e.g., faking on job applications, discrimination in the workplace, domestic violence). This applied research has great utility for dealing with the perplexing problems and issues of our society.

Historical human conflicts, such as the American Civil War and Christian-Muslim disputes, are being examined to better understand present circumstances and future possibilities. A comprehensive understanding of the past informs and directs future actions. To correct the fallacy that all people think alike, our faculty is studying the thinking and behavior of populations beyond the United States, specifically in Asia and Europe.

The meanings and messages communicated by prose, poetry, art and other media are unearthed and better understood through research. Our faculty is tackling such interesting topics as how the media represents the wetlands, the politics of change in adolescent literature and the history of textile art.

Research in the College of Psychology and Liberal Arts is rich and varied. The work of our 47 faculty members is complemented by that of our 190 graduate students and 175 undergraduates. In addition to directing their research to national and international audiences through publications and presentations, faculty members are active in presenting the results of their research to local audiences. This enhances the cultural milieu of the region and addresses community issues. By doing so, the College hopes that all will recognize and appreciate the "human touch" within Florida Tech.



Dr. Mary Beth Kenkel

Best Wishes,

Mary Beth Kenkel, Ph.D.
Dean and Professor
College of Psychology and
Liberal Arts

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 to fund the Buddy Computer Coordinated Healthcare System. The system, Buddy for short, supports quality of life and aging-in-place initiatives. She and **Dr. Frank Webbe**, School of Psychology, previously received \$200,000 from the Alzheimer's Association (in partnership with Intel Corporation and Agilent Technologies) to study the use of PocketPC and Web technologies. They will combine expertise in psychology and information systems to ease the burden of these caregivers.

COLLEGE OF ENGINEERING

Dr. Thomas Belanger—\$80,000 from the South Florida Water Management District to study impacts on the St. Lucie River Estuary and Indian River Lagoon in Martin and St. Lucie counties. He will apply the funding to add three sites to three sites already under investigation, to find out if septic tank effluent is contributing significant nutrients and bacteria to the river and lagoon.

COLLEGE OF SCIENCE

Dr. Marc Baarmand—\$360,000 from the U.S. Department of Energy (DOE) for research aimed at discovering the origin of mass. His work is on the Compact Muon Solenoid (CMS) project, which is located at the European Center for Particle Physics, CERN, in Geneva, Switzerland. Baarmand will join other scientists in collecting data from proton-proton collisions.

Dr. Richard Tankersley—\$119,000 from the National Science Foundation to develop an interactive statistics tutorial. The tutorial will support inquiry-based instruction in biology and ecology. He will develop a Web-based, interactive tutoring system and

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