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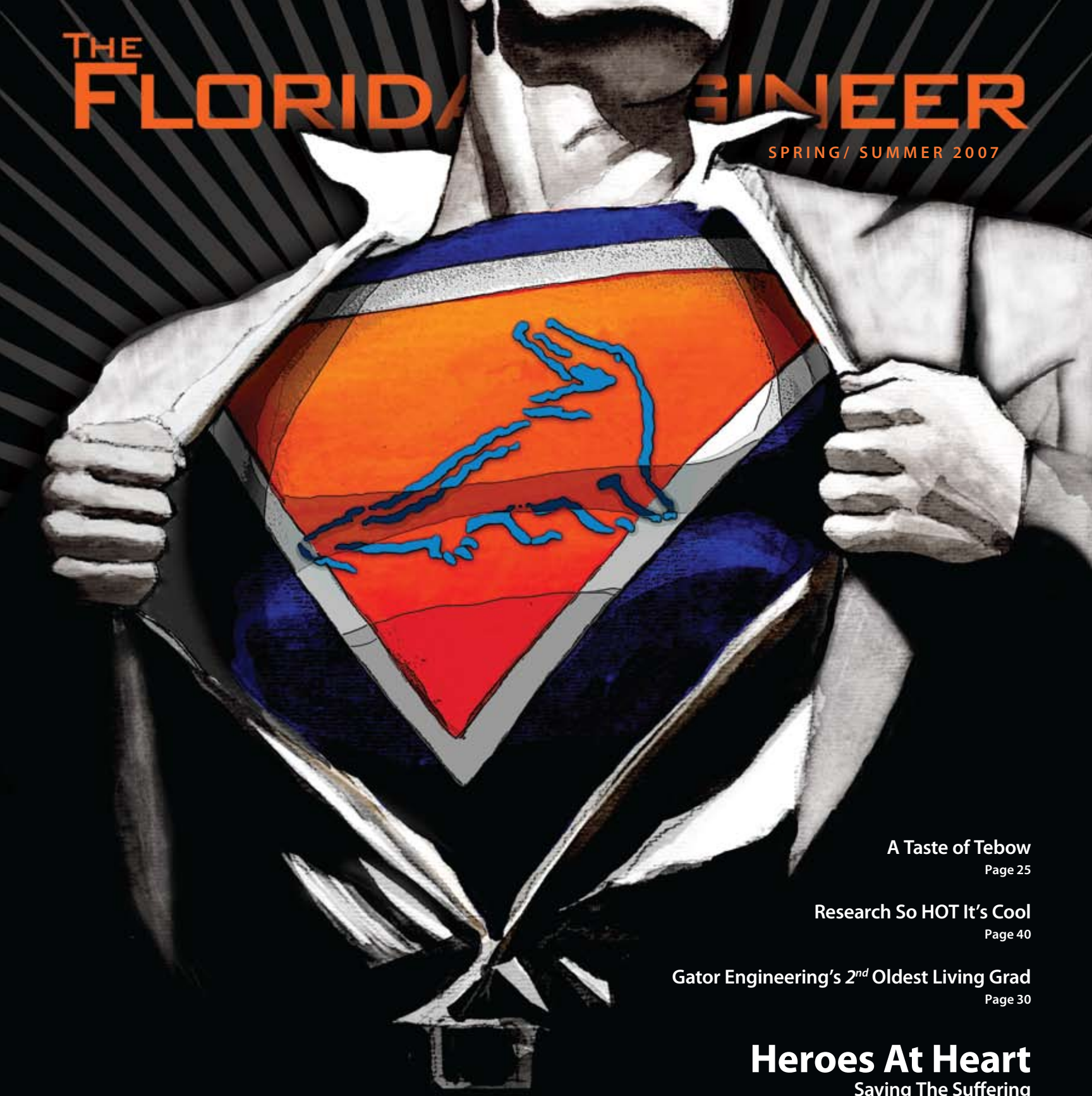


Heroes At Heart

Saving The Suffering
Fighting Fear
Protecting The People

UF | UNIVERSITY of FLORIDA

Not So Scary After All

By Aaron Hoover

Since the nuclear unrest of the 1950s and 1960s much has changed in the field of nuclear science — including medical, energy and homeland security applications.

Photo by David Blankenship

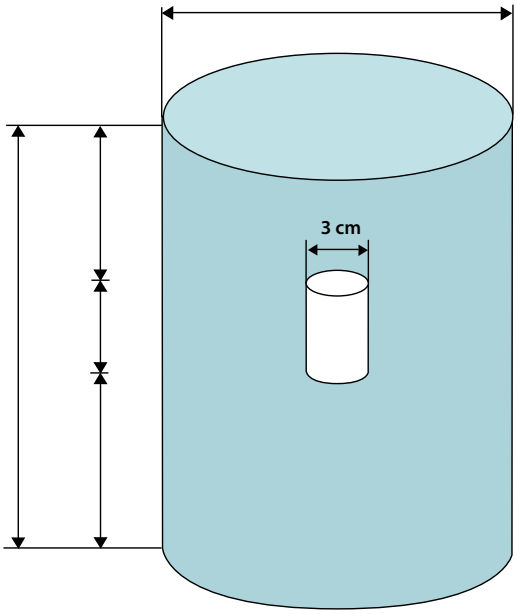
2007: A Nuclear Odyssey

Alireza Haghighat in the control room of the UF Training Reactor. Soon the system will be renovated to be completely digital.

When it comes to combating terrorism on American soil, nuclear security officials face a daunting challenge.

They must inspect thousands of semi-trailer-sized containers passing daily through the nation's ports. Yet just one container could conceal enough nuclear material to kill tens of thousands of people and devastate a city.

Part of the challenge is detecting bomb-making material in the first place, especially if it is cleverly shielded. But the tougher puzzle may be sorting out harmful from benign sources of radiation. Weapons-grade plutonium gives off a signal that lights up radiation detectors. But so do bananas. And kitty litter. And dozens of other legitimate items routinely shipped on the world market.



Warning — Very, Very Sensitive Material Enclosed

This shielded plutonium-beryllium neutron source makes high-energy neutrons from the 3-centimeter source look just like neutrons leaking from large masses of plutonium metal. This could replace Californium-252, an expensive and difficult-to-produce material now used to calibrate and test neutron-detection equipment.

Glenn Sjoden and his colleagues at the University of Florida Department of Nuclear & Radiological Engineering hope to help solve that problem — one made especially thorny by the need for the technology to work at the frenzied pace of modern commerce.

"What we're trying to do is develop new methods that will provide smoking-gun indicators of the bad material," said Sjoden, who joined UF as a professor four years ago after retiring as a nuclear research officer with the U.S. Air Force.

Nuclear energy may be the most obvious and best-known research focus in the Department, which was one of the first such departments in the Southeast and celebrates its 50th anniversary this year. With policy makers eyeing nuclear power as an ever-more-important electricity source due to declining fossil fuels and global warming, there's no question nuclear research is central. But it is far from the Department's only focus. The 12 full-time faculty and nearly 80 graduate students in the Department also have dozens of projects centered on nuclear security, nuclear medicine and space research — and they are making important contributions in each area.

A nuclear renaissance

Not long ago nuclear energy — even the very term *nuclear* — carried with it a black mark. It was the aftereffect of the 1979 and 1986 accidents at Three Mile Island and Chernobyl, respectively. While those memories linger, nuclear technology is getting a fresh look today. That's partly because nuclear energy plants appear to show promise of alleviating a looming energy shortage while offering an electricity source that does not produce the global-warming gas carbon dioxide — unlike competing coal and natural gas.

But there's also growing recognition that nuclear technology is critical for improving national security and fighting cancer — two top public priorities.

The changing climate has helped spur a renaissance for nuclear engineering at UF. In 2001, there were 39 undergraduate and 35 graduate students in nuclear engineering. In 2006, those numbers had grown to 115 and 79, respectively. In 2001, the Department netted about $2.5 million in research awards. Its faculty capture double that amount today. This spring, *U.S.News & World Report* ranked Gator Engineering among the Top-10 nuclear engineering departments in the nation.

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"Nuclear engineering appears to be critical to solving all the significant problems to mankind in the next 50 years," said Department Chairman Alireza Haghighat. "Our goal is to play a role in helping to make that happen."

The Department's energy research is wide-ranging. Strengths include nuclear plant simulation and nuclear fuels, with Haghighat, professor Jim Tulenko and others managing projects in these areas. With several utilities gearing up to build plants in the next two decades — including Progress Energy, which plans a new plant near Crystal River — the research is particularly timely.

"We cannot afford to build reactors every day, so when we do build them we want to already know exactly what we're going to get," Haghighat said. "We can do that through simulation. On the computation side, we are very strong."

Improving the nuclear shield

Another timely area of research in the Department is nuclear security, with Sjoden leading efforts as associate director of the Florida Institute of Nuclear Detection and Security. Created four years ago by the Florida Legislature, the institute's mission is to improve nuclear security in the fight against terrorism.

As an Air Force officer, Sjoden specialized in monitoring the nuclear activities of countries participating in nuclear test ban treaties. He could have landed a higher paying job in industry after retirement, but he came to UF because he said he felt educating the next generation of nuclear engineers is important. He also wanted to work with Haghighat — a friend for decades, and his dissertation adviser at Pennsylvania State University.

With the institute established shortly after he arrived, Sjoden quickly drew on his background to step up UF's nuclear security research. Today

Photo by David Blankenship

he and colleagues such as assistant professor Jim Baciak have about 10 projects funded by agencies including the National Nuclear Security Administration and the Department of Homeland Security.

Several efforts focus on the problem of detecting hidden nuclear materials in shipping containers by drawing on the Department's strengths in computer simulation.

It is possible to design and build new radiation detector technology using real radioactive material to produce telltale signals. But Sjoden said researchers can save enormous amounts of time and money by simulating those signals. A graduate student recently succeeded in one such effort, centered around a 1-inch capsule of plutonium-beryllium the Department has owned since the 1970s.

Using computer modeling, the student found a way to transform the signal from the capsule — which cannot be used to make a nuclear weapon — into a signal matching that of plutonium, which *can* be used for a weapon.

"He designed a shield that transforms that signature into something that looks like a weapons signature," Sjoden said.

UF and other researchers can use the signal to research better detection technology without any dangerous and highly controlled weapons material.

In a separate project, another student under Sjoden's supervision crafted a computer algorithm, or specific set of computer instructions, to make handheld radiation detectors more effective. Sjoden said the problem with the current detectors is sometimes they don't separate multiple sources of radiation. The algorithm shows early promise of making the handheld detectors more sensitive to multiple radiation sources in a single container.

"It only takes one to get through to cause very large problems and a significant impact on our country," Sjoden said. "So anything we can do to make the detection process more effective is welcome, especially if we can do something that is widely used out there."

The future of medicine

Department researchers are working toward a similar public impact in another area — nuclear medicine.

One long-standing project is to determine the most effective doses of radiation during therapy — doses that differ based on the size, weight and age of different patients. Children are much more sensitive to radiation exposure than adults, so those doses have to be scrutinized and carefully

The Fantastic Four

From left — Glenn Sjoden, Gabriel Ghita, Scottie Walker and Jim Baciak stand with a neutron- detection apparatus, part of sponsored research for the Department of Energy's National Nuclear Security Administration.

Photo by David Blankenship

The Phantom Baby

It's not spooky — it's useful. David Hintenlang uses this patient, a pediatric "phantom," to teach graduate students about medical imaging. The phantom contains simulated organs that can be detected by X-ray or other imaging methods.

kept in check. This research is being done by nuclear engineering professor Wes Bolch and associate professor David Hintenlang.

But education is also key to the Department's nuclear medicine initiatives. A prominent example is the Department's graduate program in medical physics. The program — the only such accredited program within an engineering department in the nation — trains graduate students to operate the machines used in radiation oncology in hospitals. Demand for graduates is extremely high, with the nearly 40 master's-level students in the program commanding six-figure salaries upon joining the workforce as *physicists*, the hospital term for the position.

Haghighat created a doctoral track — computational medical physics — aimed at producing innovators in the field.

"We are basically training people who can design new devices and program new algorithms," he said. "And that's really where I see our major contribution in this discipline."

A more advanced reactor

In space research, meanwhile, professor Samim Anghaie is working on long-term efforts to tap nuclear power for new space propulsion systems. The technology has potential for use in the first manned mission to Mars.

Whether researchers are focusing on security, space, energy or health, they have a unique resource at their disposal — a tiny nuclear reactor. The only such training reactor south of North Carolina, Gator Engineering's reactor was the first in Florida, built in 1959. Last year, it became the second research reactor in the U.S. to convert from using highly enriched uranium to low-enriched uranium fuel under the Global Threat Reduction Initiative, a program aimed at reducing the presence of harmful nuclear material.

Haghighat said that although the reactor was heavily used in its early decades, it has not reached its full potential in recent years. One of his main goals is to completely revamp the reactor, making it a University-wide research facility.

Progress Energy donated $425,000 — money that was matched by the state — to renovate the reactor's control system. Haghighat's goal is to make the control system the first in the country to be completely digital, which he said would make it a good testing facility for new nuclear power plants. He also wants to broaden the reactor's capabilities to make it useful for a wider range of researchers.

"We want to build different types of experimental applications at each port. So we can actually bring in users, both within the University and outside," Haghighat said. "So basically, we will have a really advanced, modern facility."