FEAR FACTOR

Why too many Americans associate nuclear power with nuclear destruction.

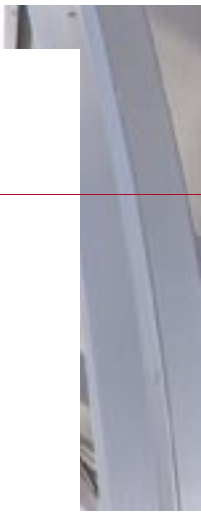
PURDUE **NUCLEAR** ENGINEERING

impact

FALL 2005

Einstein's Anniversary:
100 Years of E=mc²

Demystifying Nuclear Power:
Lefteri's Top Ten Myths



Vincent Walter

On My Mind

It is more than a happy coincidence that the first issue of *Impact* has an energy theme. Around the School of Nuclear Engineering (NE), energy is always on our minds. And I'm certain it's a concern of everyone who paid more than $3 for a gallon of gas this summer, anyone anticipating the high cost of keeping warm this winter, or anyone troubled by the depleting supply of fossil fuel. The good news is that there are enough of us troubled to work toward energy solutions.

How surprised I was this summer to pick up my copy of *The New Yorker* and find an inside-cover advertisement from a major oil company with the headline: "It took us 125 years to use the first trillion barrels of oil. We'll use the next trillion in 30." This is quite a confession. What scientists and many others have forecasted for a long time, the oil companies are finally admitting.

A nuclear energy solution, as advocated by myself and my NE colleagues, still has a public relations battle to win. When the press release for your industry is two dropped bombs in Japan, it's difficult to erase the image of the mushroom cloud. And we don't intend to minimize the power of that destruction. We do, however, want to point out the tremendous potential of this environmentally friendly alternative. To that end, we're looking to have *impact* as researchers, as educators, and even political proponents. Drop us a line; let us know how we're doing.

Lefteri Tsoukalas
Head, School of Nuclear Engineering

From the Editor

I'm very pleased to have a hand in shaping the initial *Impact* magazine for Purdue's School of Nuclear Engineering (NE). As a writer for the College of Engineering since 1999, I have had nothing but great experiences in working with the folks in NE. Like a lot of Americans, I know very little about the ins and outs of nuclear power. I know we're talking about a science that deals with the subatomic, but I'm a wordsmith, a Purdue propagandist if you will. Ever since meeting and working with Lefteri Tsoukalas a few years back, however, I've learned a great deal about the promise, along with the perceived problems, of nuclear energy. And even though we're writing with a Purdue "spin," we'll always focus on the facts. To follow are a handful of stories designed to introduce you to (or reacquaint you with) our nuclear program. But any good publication is a two-way conversation. Please participate in the dialogue by sending us your thoughts.

William Meiners
Editor
peimpact@purdue.edu

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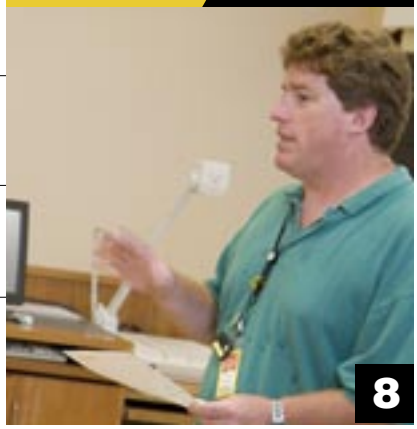

To celebrate the Centennial of Einstein's famous formula $E=mc^2$ in 2005, the School of Nuclear Engineering launched both a lecture and book series. October's guest lecturers included:

- Salomon Levy, President of S. Levy, Inc., spoke about "50 Years in Nuclear Power."
- Robert Urhig, Distinguished Professor of Nuclear Engineering at the University of Tennessee, explored transportation options in his presentation: "Why We Should Use Nuclear Energy for Transportation."
- Regis Matzie, Senior Vice President & Chief Technology Officer of Westinghouse Electric Company, addressed "Current and Future Trends in Commercial Nuclear Energy."

On the book front:

- *Nuclear Principles in Engineering*, a book written by Tatjana Jeremovic, an assistant professor of nuclear engineering, kicked off a new series titled *Smart Energy Systems: Nanowatts to Terawatts*.
- *Thermo-fluid Dynamics of Two-Phase Flow*, co-written by Mamoru Ishii, the Zinn Distinguished Professor of Nuclear Engineering, and Takashi Hibiki, is the second book in the series.

Vincent Walter

PURDUE UNIVERSITY
COLLEGE OF ENGINEERING

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Graphic Designer.....**Robin Pickett**
Photographer.....**Vincent Walter**
Contibuting Writers.....**Mary Nauman**
.....**Blake Powers**

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Please send them to the following address:

Nuclear Engineering Impact
Purdue University
1435 Win Hentschel Blvd., Suite B120
West Lafayette, IN 47906-4153
E-mail: peimpact@purdue.edu

To make a gift to the School of Nuclear Engineering, please contact:

Michael Stitsworth
Director of Engineering Advancement
(765) 494-5345
mstitsworth@purdue.edu

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Hello, Dr. Choi

"He began to make little jokes, the sort that schoolboys like—mnemonics and puns that raised laughs and at the same time imprinted something in the mind."
—James Hilton, *Goodbye, Mr. Chips*

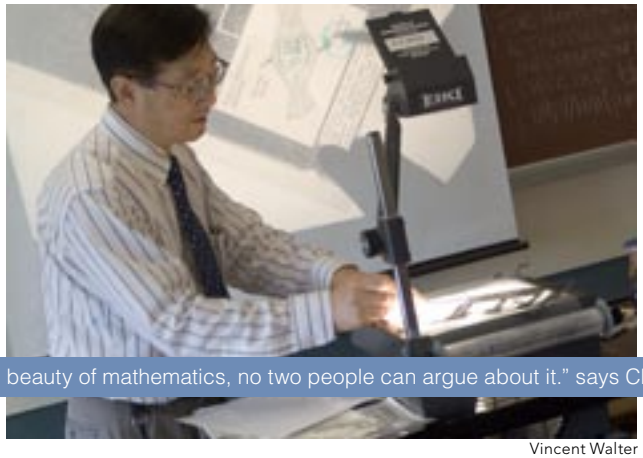
In 1933, when he was 33, James Hilton created an endearing figure of an English schoolmaster. His novel, *Goodbye, Mr. Chips*, spawned hundreds of letters, which Hilton claimed led "to the discovery of the original Mr. Chips in so many different parts of the world." Had Hilton been able to fast forward 72 years to Purdue University, he could have discovered another.

Like Chips, Chan Choi, a professor of nuclear engineering, has become something of a classroom favorite. He has won his school's teaching award five times in the last six years. But instead of early 20th century schoolboys ensconced in Latin recitations, Choi's audience, on a late summer day in 2005, is being led through a course of physics, mathematics, and the world of nuclear fusion. "That's the beauty of mathematics," Choi says as he works through a problem on the overhead. "No two people can argue about it."

But education is a two-way exchange, and that's what drives this professor. "I respect students tremendously because they too are professionals, just with less experience," Choi says. "I try to motivate them so that they give their best effort in order to reach their highest potential. If we do not engage in teaching students as a top priority, we shouldn't be here."

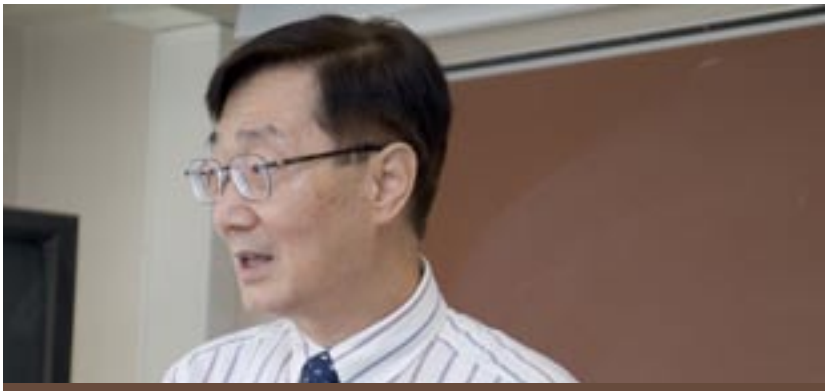
For undergraduates, Choi's motivation is their motivation. He tries to excite them about possibilities. "You don't know how much they know," he says. "You have to provide incentives to reward hard work and class attendance."

During class, Choi has made all of his lecture notes available, so students can read along, focusing on how the problems are solved. At the graduate class level, students, he says, are already motivated. Choi then shifts focus to stress expertise, professionalism, and attention to details.



"That's the beauty of mathematics, no two people can argue about it." says Choi.

Vincent Walter



Vincent Walter

Dr. Choi at home in front of the classroom.

And these aren't the easiest concepts in the world to master. For his nuclear fusion classes, Choi provides two graphic illustrations. "The sun is an ideal, natural fusion reactor," he says, "and of course the hydrogen bomb is an example of a manmade reactor which is characterized by its 'uncontrolled' release of tremendous energy fusion. What we need is a 'controlled' release of fusion energy for commercial applications. Because of energy demands, the power of fusion will have to be unleashed sooner than expected."

It's all very serious business to Choi because the payoff potential for future discoveries can be huge. "Engineers make daily life different and better," he says. "They have a direct impact on society, so society always expects more."

Because of these high expectations of his students, Choi makes high demands of himself. "I have three goals as an engineering educator," he says. First, he wants to educate students to engage in society, to get a job and put bread on their own table. He also wants to further their education because many will go on to obtain advanced degrees and enter into research. "But most importantly, and it's something I'm still working at, I want to prepare students to be lifelong learners."

This final goal, Choi admits, is the hardest to assess because "it's hard to tell how well they do until they get out into the field to even see progress," he says.

Recent students of Choi have gone on to work in the nuclear field at Los Alamos, and he's particularly proud to hear back from former students sharing news of their career success. And for a modern-day Mr. Chips who has no plans to hang up his mortar board anytime soon, each year new students arrive for Chan Choi, providing him with the opportunity to "help someone soar beyond me." **W.M.**

easing the FEAR FACTOR

Nuclear engineering educators are setting the story straight while educating John (and Suzy) Q. Public.

If you saw the "Radioactive Road Trip" episode of ABC's *Primetime Live* this fall where "undercover interns" traveled to campuses across the country, exposing the ever-present dangers of college nuclear reactors, you may have thought you were watching the show *Fear Factor*. The suspect investigative journalism tactics notwithstanding, the show does illustrate the perception problem in this country still associated with the use of nuclear energy. For many, it's forever linked with weaponry and mass destruction.

Lefteri Tsoukalas, Purdue's head of nuclear engineering, has spent an academic career battling misperceptions and educating both students and the public at large. "I understand and respect the enormous destructive power of this form of energy," he says. "I appreciate the fact that many people have a deep-seated fear of the dangers that nuclear power presents when it is used for hostile purposes or mishandled. However, I know that when properly managed, nuclear power is safe and efficient, and I believe the American public will benefit from acquiring a better understanding of the science to which I have devoted my life."

Particularly upsetting about ABC's story was the program's premise that the American public is threatened by the ease with which research reactors can be accessed. This is patently false, Tsoukalas says.

In Purdue's case, the reactor utilizes a tiny amount of fuel. At full power, it can produce roughly the energy needed to illuminate 10 100-watt light bulbs. While there is no such thing as complete safety in any endeavor, Purdue's reactor is as safe and secure as any laboratory can be. Located three stories underground, it is entered through an academic building, which is easily accessible to the public. However, the reactor itself is behind two locked doors and can be accessed only in the company of authorized staff fully trained in NRC security procedures.

"While nuclear fuels are by nature hazardous," Tsoukalas says, "the possibility of an accidental or deliberate threat to public safety from this facility is close to zero. In fact, a corner gas station or the fuel tank for a backyard barbecue grill presents a greater danger than this reactor."

Lefteri's Top 10: Myths Surrounding Nuclear Power

1. **Nuclear power is dangerous to the environment.**
   LT: When managed well, it's one of the cleanest ways we have to produce massive industrial grade electricity. In fact, by not producing hydrocarbons, nuclear power is clean and green.
2. **Nuclear energy is so energy intensive to construct that it's an overall energy sink.**
   LT: If you do the life-cycle analysis (energy return on the energy invested) it is upwards of 20 to 40 times over the lifetime of the plant.
3. **The waste from nuclear power has to be stored for hundreds of thousands of years.**
   LT: Advancements in modern technologies to burn waste while it is still in the reactor, and by separating bad isotopes, we can reduce the number to around 200 years, a proven, manageable timeframe.
4. **Nuclear power has a weapons-like global impact on the world.**
   LT: Because the press release for nuclear power was the atomic bombs in Japan, the perception is that nuclear power accidents have catastrophic global impact. It turns out that even the worst nuclear accident (Chernobyl) was a local catastrophe, but did not have much global impact. The continued burning of fossil fuels, however, does have significant global impact.
5. **The use of nuclear power leaves mountains of nuclear waste behind.**
   LT: The actual amount of waste is very small. A typical-sized reactor may produce 20 tons every year, which is a small, manageable amount. And the nuclear industry takes total responsibility for the waste it produces.
6. **With nuclear power waste, there's always something you have to get rid of.**
   LT: Waste is a misnomer. For the most part, the waste is fuel. We should keep, monitor, and reprocess it. In fact, the Yucca Mountain repository for nuclear waste should probably be called the Strategic Fuel Reserve of the United States.

So it would seem that even terrorists would have bigger fish to fry than what havoc they could wreak from exploding a dirty bomb at a college campus reactor. However, this fear inspired by a lack of education can be dangerous. At one point in the ABC program, host Diane Sawyer offered, "By now we expect you're wondering why so many colleges even have nuclear reactors."

Sawyer needs to wake up and smell the hydrocarbons. In addition to scientific forecasts that strongly suggest a soon-to-be-depleted supply of oil [see cover story on the college side], there is also the environmental impact of two centuries' worth of burning hydrocarbons.

In July of this year, *The Economist* reported the "unlikely alliance between the nuclear industry and many environmentalists, as a growing number of greens have come to believe that nuclear energy is the best way to reduce carbon emissions."

But even with green support, the industry is entering a crisis point. The U.S. nuclear workforce, or lack of it, is part of the infrastructure dilemma. "The people who built the existing power plants in the 1950s, '60s, and '70s are retiring and dying," Tsoukalas says. "The skill set is found through education. We currently have about 1,500 students studying engineering at universities. That's too few. We need to quadruple that number."

Nuclear reactors on college campuses provide part of the training which will eventually help improve lives: through the generation of electrical power, through creation of new and better procedures to diagnose and treat disease, through development of enhanced scientific processes, through industrial applications.

Moving Mountains, Recycling Waste

For his part, Sean McDeavitt, a Purdue alum with three nuclear degrees (BSNE '87, MSNE '90, PhD '92), is back on campus to help educate that next generation of nuclear engineers and make some headway in recycling research. Now an associate professor with a courtesy appointment in materials engineering, Mcdeavitt is using 11 years of industry experience at the Argonne National Laboratory to spread the word in lectures. He is also faculty director of the radiation lab and he has the "freedom to pursue angles."

Sean McDeavitt calls for a show of hands.

A particular angle has to do with the Advanced Fuel Cycle Initiative (AFCI), which is developing next-generation recycling technology over the next 30 years. One of the goals of AFCI, McDeavitt says, is to change the design criteria of Yucca Mountain, slated to store nuclear waste for 10,000 years. "Hundreds of millions of dollars have been spent on a hole in the ground that's already going to be too full," McDeavitt says. "We want to scale up the process to handle things that last for a long time—uranium, plutonium, et cetera.

"People say this stuff is going to be around for eternity. But if you can pull it out, you can also put it back in. You can re-burn it for energy content. The things that are left have half-lives of 500 years. Man has never built anything that's lasted for 10,000 years. So the engineering problem becomes much more tractable."

With funding from the Department of Energy and the Idaho National Lab, McDeavitt is part of an AFCI program that's utilizing the research of hundreds of people, several national labs, and multiple universities. "My particular project is to take the output of the chemical separation process and develop the methods and materials to convert them and store them safely," he says.

Safety, along with high efficiency, is a constant goal in the production of nuclear energy. And just as we see an increasing number of students enroll in the School of Nuclear Engineering at Purdue, researchers and educators like McDeavitt and Tsoukalas hope to also spread some knowledge to the American populous. ■ **W.M.**

7. Nuclear energy is dangerous because it deals with an extraterrestrial form of energy—activity that takes place in the sun, or out in the cosmos.
LT: The fact is we're surrounded by radiation. It's very natural, ordinary, and common.

8. Nuclear power is something you have to take care of forever.
LT: From what we know, nothing stays radioactive forever. It decays. And it's easy to detect. Unlike chemical substances and biological viruses, radioactivity screams out to us.

9. Of all technology, nuclear power is too complex for man to handle.
LT: The early phase of nuclear technology did have some problems, but as we build on experience and move towards more sophisticated technology, it becomes safer. In the United States, with less than 10 percent of the installed capacity, nuclear power produces more than 20 percent of the electricity.

10. Nuclear power will very quickly eliminate a limited supply of uranium.
LT: We have not fully explored all potential reserves of uranium. There's uranium everywhere. We have been living off inventories, but new technologies will allow us to find more and extract more from the waste, oceans, and unexplored areas of the world. With proper diligence and due process, nuclear can be a renewable form of energy.

Better Than Imagined

A young alumna's first job at GE lets her explore the possibilities of nuclear medicine.

Nuclear physicists will tell you they work in the world of imagination—envisioning the happenings of a subatomic universe. The latest marketing slogan for General Electric is "imagination at work." Can you think of a better place for a Purdue nuclear grad to land a first job?

Kristen Wangerin can't. She's taken her 2005 BS degree to the General Electric (GE) Global Research Center in upstate New York, where she's beginning a research career as a nuclear scientist. While it may be her first rung on the corporate ladder, it's a culmination of a number of years of hard work.

A northwest Indiana native (Dyer, specifically), Wangerin says her nuclear engineering pursuit evolved from original interests in meteorology and astronomy. She attended a Seminar for Top Engineering Prospects (STEP) camp at Purdue following her junior year in high school, and after attending labs for aerospace and nuclear engineering she traded in her love of stars for a study where professors talked about harnessing the power of stars.

Still, Wangerin wasn't too thrilled with the idea of power plants or big machinery. Her options opened her freshman year when she met Tatjana Jevremovic, an assistant professor of nuclear engineering [see research profile on page 7]. "I started doing research with her right away," Wangerin says. "I started looking into Pebble Bed Modular Reactors but soon switched to neutron capture therapy for detecting and treating tumors. The idea of applying nuclear science for medical applications was new to me and very exciting."

Vincent Walter

Wangerin then, on campus in fall of 2004...

Encouraged by a classmate now attending medical school—David Barbara (BSNE '03)—Wangerin pursued technical studies with a healthcare bent. "I wanted to work on this stuff and help people, but I didn't want to work in a clinical setting," she says. "Nuclear technology and concepts present a variety of opportunities in medicine, and I learned they could be advanced on the research and design side of things."

For Jevremovic, Wangerin's success is quite nearly an opportunity lost. "I knew Kristen would do very well," she says, "but I was hoping she'd stick around Purdue for graduate studies."

"Nuclear technology and concepts present a variety of opportunities in medicine, and I learned they could be advanced on the research and design side of things."

—Kristen Wagerin (BSNE '05)

But the research center had that covered, too. Wangerin received a national scholarship from the Society of Women Engineers sponsored by GE. At the beginning of her senior year, a phone call came offering both a job and a chance to obtain a master's degree in a three-year program. She'll work and take classes at the center in her rookie year, where each module focuses on a different GE business. Then she'll enroll in the nuclear medicine division of Rensselaer Polytechnic Institute (RPI), the nation's oldest technological university.

Photo from GE Global

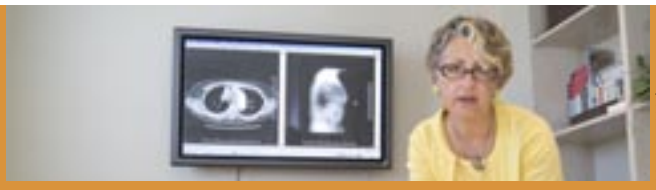
and now at GE Global.

"I lucked out there," Wangerin says. "In RPI's nuclear engineering school they have a focus on radiation detection, dosimetry, and transport for medical applications. They also have a 3D virtual patient model for more accurate simulation."

It all leads to a future she must still be imagining. In her daily routine for now, Wangerin's working with PET-Positron Emission Tomography. PET technology detects positrons that are emitted from a radioactive isotope. This isotope is coupled to a targeting molecule, which is taken up in areas of higher metabolism in the body.

Wangerin likens PET to X-ray or CT in that one can see what's going on inside the body. And she credits a Purdue "Radiation Detection and Measurement" class with giving her the background skills for the data acquisition system she's developing. "Once you detect the positrons, you can figure out where they came from and make an image," she says. "This image can be used to locate a tumor, for example, and help with treatment planning."

In the world of GE Global Research, Kristen Wangerin (BSNE '05) seems to have placed a foot squarely, and smartly, on an upward path. ■ **W.M.**



Vincent Walter

Radiation and Globalization

In the world of research for more effective uses of radiation, one Purdue professor is keeping her eyes wide open.

By Blake Powers

The word "global" has a world of meaning for Tatjana Jevremovic. An assistant professor of nuclear engineering, Jeveremovic says she has "to think globally." From her cooperative research efforts ranging throughout Indiana institutions and the rest of the world to her desire to advance targeted radiation therapy across a range of cancers, she cannot afford a narrow focus.

Breast cancer—a focus in particular—led her to found the Purdue Breast Cancer Research Group in 2002, shortly after her arrival in West Lafayette. "While current treatment protocols are effective for many, 30 percent of patients don't respond well," Jevremovic says. "Given their cancer is highly aggressive that grows exponentially, improving treatment is crucial."

Jevremovic is working with a medical doctor—Wael Harb of the Horizon Oncology Center—to create a new protocol that augments, rather than replaces, current treatments. Along with a team of students, they are developing a novel binary targeted treatment modality. The goal is to make treatments more effective, while expanding the success rate to those for whom current treatments fail.

She's also hoping to advance the use of microbeams to treat cancers in infants and children, as well as deep-seated brain tumors in adults. Conventional radiation treatments can hit both cancers and surrounding tissues. In adults, while not optimal, this can be dealt with. In infants and children, however, a much greater area can be affected because of their smaller sizes. With deep-seated brain tumors, it's not always possible to treat the cancer without damaging brain tissue. Microbeams allow for an extremely narrow focus, minimizing damage to the surrounding tissues. This technology, less than 10 years old, is promising to pediatric oncology. With a courtesy appointment in the School of Health Sciences, Jevremovic is also collaborating on microbeam studies and has recently been awarded a Purdue Cancer Center grant.

Advancing all areas of radiation therapy is the goal of a third research emphasis by Jevremovic. With the aid of colleagues and students, she's developing an upgraded and modern radiation treatment planning tool to be used in radiation oncology at Unity Medical Center in Lafayette by next summer. In addition, her international effort seeks to develop new and improved computational models for use in research and treatment planning. Such models allow new techniques to be tested and verified in ways not previously possible, while developing individualized treatments for patients.

A Nuke's Road Less Traveled

Jere Jenkins' nontraditional path to academic success began 21 years ago.

Vincent Walter

Nuclear science is not an easy undertaking. Consider the path of Jere Jenkins, a master's student in nuclear engineering and the director of Purdue's radiation lab.

Joseph Petrelli

Jenkins with the lightweight varsity women's eight team at the Dad Vail Championships in 2004.

Jenkins first came to Purdue in 1984. Remember 1984? It had been George Orwell's fictional forecast for Big Brother long before bad reality television. Macintosh offered the world its first Apple. Reagan was in the White House. Gene Keady was still relatively new to Purdue. And not a single cell phone disrupted a lecture hall.

The Alliance, Ohio, native was a tad too small for big-time college football (even though Rose-Hulman made a modest scholarship plea), so Jenkins would opt for Purdue Crew and the hard-core science studies he always loved. As a freshman, he was torn between chemical and nuclear engineering. He became a nuke.

But even the best-laid plans get sidetracked. "I did the undergrad thing off and on," Jenkins says. Over the course of a decade Jenkins would wrestle with the nuclear curriculum. He bartended at Harry's Chocolate Shop. He even got into hazardous waste for a few years—working as a hazardous waste engineer in Chicago. Jenkins married in 1992. He followed his wife back to Purdue in 1995 as she pursued a PhD in biology.

He then volunteered to help coach his old rowing team, and they hired him full time as an assistant coach in 1996.

"I coached the freshman men for six years," Jenkins says, "and then coached varsity women for two years."

He finally picked up classes again in 2001, earning his bachelor's degree a year later. "I had been doing an engineer's job in Chicago, but wasn't making engineering money because I lacked the degree," Jenkins says. "The motivation to take care of my family [now with children] got me back into school."

How did he do this time? "I got all A's and one B," he says. "I'm married and have two kids, but I got a B in 'human sexuality.'"

His senior design group also won the national design competition for the American Nuclear Society. Jenkins thinks this may have brought him some attention because his age (or nontraditional student status) along with his ability to speak in front of people made him a spokesman for the group.

From there he jumped right into the nuclear graduate program, but the demands of coaching—"easily 60-to 70- hour work weeks"—were starting to compete with the increased challenge of grad-level courses. "I was in the right place at the right time when they offered me the job of directing the radiation lab," Jenkins says.

"The more I discovered, the more I wanted to learn. I'll never learn everything, but I can never stop learning."

—Jere Jenkins

Today Jenkins balances his time between the daily routines of the radiation lab, studies, family, and now teaching. He teaches one class in the fall and two in the spring about radiation detection and measurement.

Jenkins equates coaching with teaching. "Being with the crew team was great," he says. "I learned a lot. To me coaching is not necessarily different from teaching. The motivations between students and athletes are different, but it's been an easy transition."

With graduate coursework behind him, Jenkins will next transition into his master's thesis. He's working with three professors and two people from national labs "on making use of spent nuclear fuel waste to engineer electricity." For his part, Jenkins is working on reactor design with Tom Downar, a professor of nuclear engineering.

The reactor physics drew Jenkins to nuclear in the first place. "We have the biggest, coolest machines out there," he says. "There's nothing like a nuclear power plant.

"Nuclear is such a well-rounded discipline because we have so much exposure to everything else. You have the training to go into medicine or computer engineering. The more I discovered, the more I wanted to learn. I'll never learn everything, but I can never stop learning."

And for someone who's spent 21 years in, out, and around academia, that's a pretty good philosophy. **W.M.**

Ensuring Lifelong Learning

By Mary Nauman

Imagine a Purdue nuclear engineering graduate, five years into a career in reactor physics but preparing for a new professional opportunity in reactor safety. Although she's got a strong grasp of the field, a quick refresher into her old class notes would help her get off to a good start. Most engineers in this position would have to dig up those notes or find an old textbook, but this Purdue alumna has a private account accessing a massive database of nuclear engineering information. She can review Purdue's cutting-edge research, current and past course notes—even videotaped lectures.

The scenario is a glimpse into the future, but the database concept—"Nuclear Engineering Lifelong Learning," or NEL3—is a brainchild now of Lefteri Tsoukalas, head of the School of Nuclear Engineering. It's also an example of an exciting initiative that can take flight with the aid of unrestricted funds.

Unrestricted funds allow the college and school's administrators to seize opportunities as they arise, responding to new ideas swiftly and effectively. Areas that benefit from gifts of unrestricted funds include:

- Professional-development opportunities for students
- Guest lecture series and other school-wide events
- Faculty recruitment efforts
- Laboratory experience and research

Tsoukalas sees NEL3 as a perfect example of the promising but nascent programs that can evolve through unrestricted funds. New equipment must be purchased and classrooms must be updated in order to make NEL3 a reality. Once this support is provided, however, NEL3 will create a paradigm shift in engineering education, says Tsoukalas: "Graduates will be organically connected to the school for 40 years, not four years. The time our students spend earning their degree at Purdue will only be one part of their lifelong learning process. Through NEL3, they will have continual access to the most up-to-date information regarding the subatomic universe."

To make a gift to the School of Nuclear Engineering at Purdue, contact: Michael H. Stitsworth
Director of Engineering Advancement
mstitsworth@purdue.edu
(765) 494-5345
College of Engineering
Purdue University
Engineering Administration Building, Room 101 400 Centennial Mall Drive
West Lafayette, IN 47906-2016

Nuclear Reactions

Growing support for nuclear energy and the building of new nuclear plants is promising early in the 21st century.

Robert Long (MSNE '59, PhD '62) is owner and sole member of Nuclear Stewardship, LLC, which provides consulting services in nuclear and industrial health and safety, quality assurance, management, and leadership. His nuclear engineering career spans 45 years.

Most readers will be surprised to learn that more than 50 U.S. national and regional newspapers and news magazines (within their editorial and commentary pages) have expressed their support for nuclear energy and new nuclear plants on their editorial and commentary pages. The excitement becomes even more contagious when reading stories in the nuclear industry journals and magazines. There are now 35 reactors with 20-year extensions to their licenses. Another 14 have filed for license renewal, and 25 more have indicated plans to file for renewals over the next six years.

There are 103 U.S. nuclear units operating at about 90 percent average capacity factor, supplying about 20 percent of emission-free electricity in the United States. Worldwide, the thriving nuclear industry operates a total of 442 nuclear power plants in 31 countries, supplying 16 percent of the world's electricity.

But most exciting of all, especially for those of us who have spent our careers in the industry, are the announced plans by several utility consortia to seek early site permits for construction of new U.S. nuclear power plants. And the Department of Energy (DOE) has already partnered with NuStart Energy Development LLC and a Dominion Power lead consortium to test the NRC combined construction and operating license (COL) process. A third partnership is under consideration. The national energy bill passed in August 2005 provides investment stimulus to the consortia and investment protection against the risk of licensing delays.

The growing concerns about global climate change have led even leading environmental activists to suggest that nuclear power has to be considered across the globe. The U.S. Energy Information Administration anticipates as many as 50 to 60 new plants worldwide by 2025. China leads with a 1082 percent change between 2002 and 2025; India projects 428 percent growth; and South Korea, 86 percent. Ongoing surveys confirm strong public support for nuclear energy, with 70 percent agreeing that nuclear energy benefits, even with some risks, warrant continued use of nuclear power.

The support for nuclear energy is even higher in the plant communities surrounding nuclear power plant sites. As a member in 2004 of a review team for the Purdue School of Nuclear Engineering, I was excited to learn that Purdue is seriously considering the design and construction of a new university research reactor. This would support the once-again growing enrollments in nuclear engineering undergraduate and graduate degree programs. This growth is occurring nationwide, and there have been new NE degree programs started at such institutions as the U.S. Military Academy and South Carolina State University.

Through the DOE Innovations in Nuclear Infrastructure and Education program, there are new levels of cooperation among our nation's colleges and universities in attracting and delivering wonderful educational opportunities to a new generation of students.

Nuclear energy is second only to coal in the U.S. generation of electricity and the future is bright for the start of new plants and an even cleaner environment for our nation. Purdue University research and development, along with graduating students, will be major players in the future of nuclear power.

— **Robert Long**

Within the back page of Nuclear Engineering's *Impact*, we hope to connect with you, the reader. In future issues, we might run your letters, show retrospective photographs, and offer up brain teasers. For our first final page, we're offering two of the three. The historic photo here shows Purdue President Frederick Hovde inserting a tube containing natural uranium into a graphite pile to start up a subcritical nuclear assembly. Purdue's reactor first fired up in 1962.

You don't have to be a nuclear physicist to participate in the brain teasers, but it may help. For our first quiz we're asking you to wrap your mind around the phenomenal smallness of the atom. You can send your best guesses and letters to peimpact@purdue.edu

Kneeling left to right are V. E. Bergdolt, associate director of the "new" Nuclear Engineering Laboratories; George Hawkins, dean of engineering; and President Frederick Hovde. In the background is B. G. Dunavant, radiological control officer of the university.

If a nucleus was the size of a golf ball, how large (approximately) would an average-sized man be?