Welcome to another edition of *Nuclear Engineering Impact*, our seventh issue if you’re keeping score. The promise of a sustainable future through nuclear energy versus the threat of a nuclear mishap has long been the uphill battle for our industry. And whether it’s a former Greenpeace leader, or even John Q. Public, starting to come around to those promises, we still have miles to go in preparing for what many believe is the dawn of a nuclear renaissance.

Last semester, two of our newer alumnae, Carolyne Joseph (BSNE ’07) and Felisa Limón (BSNE ’07), returned to campus to share their stories, pictures, and a video of a trip they made to Chernobyl. Both of these women—who could not have been much more than toddlers at the time of the Soviet Union disaster—wanted to see firsthand the effects of such a nuclear worst-case scenario as well as how the surrounding area has responded. Not only did they gain a greater sense of history, they also came away with a renewed appreciation for why our nuclear industry is so heavily regulated. You can read about their journey in our cover story.

In other stories, catch up with one of our professors (Shripad Revankar) whose interests in fuel cells and a hydrogen economy actually began because of a former student. Jerome Blautner (BSNE ’78) shares his take on the challenges of a nuclear renaissance in the “In My View” column. And our “Up Close: Students” feature focuses on both an undergrad and a PhD student who are taking their research interests global.

These are exciting times on campus. We will be interviewing three potential head candidates this spring and hope to have a permanent head in place by the summer or the fall. And as we coordinate our education and research efforts with industry, we are also proud to continue to work toward an energy future that is sustainable, green, and safe.

Vincent Bralts
Interim Head, School of Nuclear Engineering
UP FRONT
Vincent’s view

AROUND NE
Preparing for the nuclear renaissance • Award winners

UP CLOSE: FACULTY
Shripad Revankar on the frontlines of hydrogen

COVER STORY
Two young alumnae bring back stories from Chernobyl

IN MY VIEW
Insight from Sargent & Lundy’s Jerome Blattner

UP CLOSE: STUDENTS
An undergrad and a grad going global

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Building Toward a Nuclear Future

Faculty, students, and staff contribute to collective success

As the School of Nuclear Engineering continues to prepare students for the nuclear renaissance, great news abounds throughout our program. In addition to the new head search, we are looking for more new faculty. With grants and contracts nearly doubling in the past year, we are also actively recruiting talented graduate students.

An August 2008 article in U.S. News & World Report reported on the challenge of training nuclear engineers for one of the hottest jobs in the market. Desperately needed to replace a retiring workforce, young nukes are positioning themselves for not only choice careers but also for involvement in world-changing possibilities in the fields of energy, medicine, and elsewhere. And at Purdue, we are now producing about 10 percent of the graduating nuclear engineers in the nation.

If you’re interested in checking in with our progress, you might want to dial up our new Web site: www.engineering.purdue.edu/NE/. There, you can find our most up-to-the-date news as well as the occasional spotlight on faculty, students, and staff. One feature you’ll find is a story on the continued cross-disciplinary educational opportunities happening throughout the College of Engineering. Professors and researchers from our school, for example, are working with construction engineering and management students on the challenges involved with building next-generation nuclear reactors in this country.

Student involvement

Anyone deeply involved in this business of nuclear energy becomes an automatic spokesperson for an often misunderstood industry. Our students, both undergraduates and graduates, take eagerly to those debates. Purdue’s chapter of the American Nuclear Society (ANS) will spend another week at the end of this spring semester sharing facts and fictions about the nuclear industry with fellow Purdue students. Thanks to a donation from Exelon, ANS members and other students are now using a converted laboratory as an office, lounge, and computer center.

Award Winners

Our school is also proud to recognize two of our 2008 award winners. Jean Paul Allain (top right), an assistant professor of nuclear engineering, was voted best teacher last year. This award, determined by the students, is a testament to his dedicated mentoring in both classrooms and labs.

Last November, Kellie Reece (bottom right), a secretary in our main office, was awarded the clerical/customer service award. Selected from entries throughout the College of Engineering, Reece won based, in part, for her role in helping convert the old research lab into student offices (mentioned right). Shripad Revankar, an associate professor of nuclear engineering, nominated her for the award.

William Meiners
Learning Goes Both Ways

Close working relationship with an undergrad spurs a passion for fuel-cell research in professor

Walter had become fascinated with fuel cells during his summer at Los Alamos National Laboratories and told Revankar he wanted to focus on fuel-cell research in his graduate work. The problem for Revankar was that, as Walter’s graduate advisor, he only possessed a basic grasp of fuel cells—nowhere near the background needed to properly advise him through doctoral work. And so Revankar made his choice—he would delve deeply into fuel-cell research himself.

Already possessing a background in nuclear engineering—where hydrogen, as in fuel cells, is a focal point—as well as in multiphase flow, it’s not as if Revankar had to start from scratch. But much of the chemistry Revankar had to learn was completely new to him. Despite the initial learning curve, however, Revankar counts himself fortunate to be given the opportunity to expand his area of practice.

“I’ve become very interested in the idea of a hydrogen economy,” says Revankar. “Basically that just means we would supply all of our own domestic energy needs through the use of hydrogen. It would mark a complete departure from a reliance on non-renewable carbon-based fuel sources. With a fuel cell, your only byproducts are water and heat. It’s completely clean.”

He points to Purdue’s on-campus coal plant, which operates at about a 30–35 percent efficiency rate. “If you were to employ fuel-cell technology, the efficiency goes above 50 percent, and that’s a marked improvement. Plus, you’re no longer burning any coal and getting all that pollution.”

Currently, however, such large-scale projects are still years away from even the planning stages. Most fuel cell applications right now tend to focus on portable devices like laptops and the power-smart backpacks used by soldiers. The simple reason: price.

“It’s not mainstream enough to become a consumer commodity,” Revankar says. “The supply is far too low. Right now, it costs $20–$30 to generate a kilowatt of power using a car. For a fuel cell that cost goes up to $2,000.”

But that doesn’t mean fuel cells haven’t been used for large-scale applications—just not within the consumer world. “Space shuttles use fuel cells, because in that context, price is not the most important driver. You also see some buses being converted to fuel cells, and some cities have employed fuel cells in waste-treatment facilities to convert methane gas into electricity.”

As for Revankar, he’s become fully immersed in the movement and the research. “Right now I’m teaching an undergraduate course called ‘Fuel-Cell Engineering’, and am in the process of writing a textbook on fuel cells,” he says. “I guess you can say I’m an official convert.”

And all thanks to an enterprising former student who didn’t want to change advisors. ■ Patrick Kelly
Lessons Learned

Purdue grads get firsthand knowledge of a nuclear worst-case scenario

By Gina Vozenilek
When disaster struck Chernobyl, then part of the Soviet Union, on April 26, 1986, information was slow to emerge. In fact, the world got its first hint of the crisis a day later, not from the Soviets but rather from workers at a nuclear power plant in Sweden who detected the radioactivity. Cold War secrecy impeded the dissemination of scientific data, which in turn contributed to the tragedy of Chernobyl. Not only was it a terrible and fatal accident, but Chernobyl also became the locus of international suspicion and distrust about nuclear energy’s safety. 

continued on next page....
In the summer of 2008, two young Purdue nuclear engineering alumnae set out to learn first-hand about the greatest nuclear accident in history. Carolyne Joseph (BSNE ’07) and Felisa Limón (BSNE ’07) journeyed to the rural spot in Ukraine to see for themselves what happened there and try to gain some perspective. They hoped to become well versed in the often-discussed disaster so that they could more convincingly debate the benefits of nuclear energy as a safe, green power alternative.

If the facts about Chernobyl remain hazy in the minds of the public, they are also less than crystalline in nuclear engineering classrooms. “In school we talked about it, but not in any great detail,” says Limón. “Satisfying the curiosity we had ourselves, we realized, would benefit a lot of people.” So they brought cameras and video recording equipment to capture their impressions and return with a clearer understanding of Chernobyl to share.

**Distrust’s long half-life**

Before they left the United States on their fact-finding trip, the women needed a doctor’s note clearing them for access to the site at Chernobyl. “I wasn’t sure what to expect when we arrived,” says Joseph, who notes that they felt more comfortable bringing their own dosimetry devices with them to tour the ruins. That token of distrust—packing their own radiation monitors for safety—is an artifact of the way information eeked out from Chernobyl to the world. Limón compares her anticipation of the Chernobyl experience with an earlier visit to Auschwitz. “I did not know how I would react, emotionally and professionally,” she admits. “I was nervous I would go there and be shaken.” Limón worried that the devastation at Chernobyl would cause her to second-guess her commitment to nuclear energy. She also thought she and Joseph might spend their visit combating secrecy and spin and closed doors on the past.

But that is not what they experienced. “The people in Ukraine were very willing to talk. They want to help clarify the Chernobyl accident to the world,” says Joseph. Limón found at Chernobyl “a sense of calm, a sense of release, because no one there denies that it happened. I felt a sense of loss, but it is, overall, a happy place. They are recovering.”

**Coping with catastrophe**

Following the accident, a so-called Shelter Object was placed over the wrecked reactor to contain the radioactive emissions. Inside the Shelter Object, known to many as the Sarcophagus, the current dose rate is in excess of 40,000 rem/hr. Employees work in five-minute shifts once per day to minimize their exposure. Scientists at Chernobyl tell Joseph and Limón that it will be hundreds of years before Chernobyl is no longer a threat to its surroundings.

A five-step Shelter Implementation Plan was designed to minimize the environmental threat of Chernobyl.
long-term. The first three phases were completed in 2008, including a stabilization of the Shelter Object’s west wall and the installation of a dust suppression system to contain radioactive dust particles. Phase Four is the construction and installation of the New Safe Confinement, the largest moveable man-made object in the world. The massive semicircular dome of steel will be constructed first and then slid into place over the old Shelter Object by 2012. This will be the most critical piece for the shelter conversion into an environmentally safe system, and it will enable Phase 5: the deconstruction of Reactor 4 and burial of remaining radioactive materials, slated to be completed by 2063.

Through the years about 1,500 original residents of the rural village of Chernobyl have returned to their homes, which are marked with signs so that government patrols know residents are there. Radiation doses are safe at less than 200 mrem annually. But the nearby town of Pripyat stands empty. Dangerous levels of radiation are concentrated in the concrete of the high-rise structures that housed workers and their families. “It’s an abandoned ghost town, very eerie,” says Limón. She and Joseph toured a community center in Pripyat called, ironically, the Palace of Culture, its high ceilings open to the sky now, its colorful murals crumbling, empty chairs strewn about the space. “But Chernobyl is very beautiful as well,” Limón says. The environment, which had been so terribly damaged by the disaster, is making an astounding comeback. Where trees were once said to have glowed red from radiation, nature itself is recovering. Flora and fauna, some species of which were not in Chernobyl before the accident, are establishing themselves today. “Lack of human presence has allowed nature to flourish,” Limón explains.

Chernobyl’s Legacy
Joseph and Limón are eager to share their first-hand experience of Chernobyl. They are making a series of video presentations, tailored for different audiences, to help engineers and members of the public learn from the disaster.

To the young engineers, those born after Chernobyl, Joseph wants the movie to say, “Respect what you do.” She points to the “insane number of redundant safety systems” that are a part of their daily work and urges the up-and-coming generation of nuclear engineers to appreciate the importance of these seemingly excessive measures. “Even the smallest mistake can ruin the industry,” she says.

Limón concurs. “We have a procedure for everything,” she says, “and there’s a reason for that: Chernobyl.” The up-close footage the two filmed on their trip should help underscore the point.

And to the public, the pair hopes to be able to explain that a Chernobyl could not happen in this country. They want people to know that no reactor of the same design (the RBMK-1000) was ever built in the U.S. Limón points out that “there are risks involved with any industrial site, and in the nuclear industry that risk is technologically and physically designed for.” She also notes that it is harder to start up a nuclear reactor than it is to shut it down. Redundant safety measures, in place largely because of the Chernobyl accident, would shut a reactor down in the event of any mishap.

Nuclear’s Promise
Green and safe. These are two adjectives Joseph and Limón would like people to come to associate with nuclear power. “It’s clean energy,” Limón stresses. “Nuclear is a zero-emissions energy. It’s up there with
wind, solar, and hydro.”

Contrasting nuclear energy production with the coal industry, Joseph wants people to know that burning coal releases naturally radioactive particles into the atmosphere. “More radiation is emitted in a day with coal than in a lifetime of nuclear-energy production,” she says. And while clean coal is a promising technology, it isn’t here yet.

What to do with spent nuclear fuel remains one of the greatest challenges to the nuclear-energy industry. Other countries reprocess their fuel, but that solution is currently not permitted in the U.S. The uranium and plutonium that result from reprocessing have long been confused with concerns about nuclear-weapons proliferation, a fact that hampers the nuclear industry. “It’s an uphill battle because people have a hard time disconnecting nuclear weapons from nuclear power,” says Limón. “But it’s a worthwhile battle.” The alternative, burying nuclear waste in a deep repository (as proposed in the beleaguered Yucca Mountain plan), is also hotly contested.

“I think the more people hear about how safe, reliable, clean, and affordable nuclear energy is, the more people will support it,” says Limón. “And it’s a technology that is here now.” The nation currently has 104 nuclear reactors in operation, providing 20 percent of the nation’s electricity. With government support, Joseph predicts that up to 10 new plants could be running or under construction within the next two decades. “Nuclear could be a limitless source of energy,” she says.
Securing a Sustainable Energy Future

Nuclear engineering alumnus addresses challenges of a nuclear renaissance

Sustainability with our energy use, hand-in-hand with security, is critical to a worldwide future. As we embark on a nuclear renaissance, it is truly an exciting time to be a nuclear engineer—both with the widespread activity supporting new plants and on-going license renewals, power up-rates, and other extensive enhancements at existing plants. Nuclear power plants are again being recognized as a very valuable asset, and the industry offers many career opportunities for nuclear and other engineers. A large challenge for the U.S. nuclear renaissance is the impending retirement of many experienced engineers. The nuclear industry’s average age is close to 50 years with a large age/experience gap between this group and new talent. Time is critical to effectively transfer decades of knowledge and know-how to a new, large workforce. This incoming group will need to support the ongoing safe, reliable operation of the current 104 U.S. nuclear plants as well as the design and construction of the next generation of nuclear plants.

At Sargent & Lundy, we specialize in the design of power plants and have been deeply involved in nuclear power since 1954. For us, nuclear power never went away. Over the past three years, we have sensed the need for more nuclear engineering support and have increased our new engineer hiring. Our baseload work has enabled us to maintain an excellent core staff of nuclear-power experts and bring on new people but not at the level that will be needed for the new plant surge. Depending on our responsibility for the new plant design, we will utilize a staff of 250 to 400 engineers and designers (nuclear, mechanical, electrical, and structural). So, even at companies like ours, the challenge will be to effectively transfer the knowledge of experienced staff to a much larger group.

The foremost requirement is always plant safety. The design and construction of the new plants will be robust and more standardized. A revamped licensing process will provide a more stable, predictable regulatory environment and an “in-advance reactor design certification.” Some of the Generation III+ new plant design approaches are more of a passive-design philosophy with gravity-fed cooling water from elevated holding pools and natural convection for heat transfer. Other new plant designs have increased safety margins through the use of new design advances. The Nuclear Regulatory Commission (NRC) has been reviewing and certifying these designs from the major reactor vendors, and this process will last through 2012. Additionally, 17 combined construction and operating license (COL) applications were developed and submitted to the NRC for a total of 26 reactors.

The critical path for the new plants is the continued smooth implementation of this new licensing process. The first actual plant construction will begin after completion of the NRC COL licensing review, probably in 2011. Engineers and skilled craftspeople are and will be a crucial part of this process. It has been estimated that as many as 350,000 new jobs will be created over the next 20 years in support of the potential new reactor growth.

Finally, we need to dispel concerns about nuclear energy and promote it. In many ways, the safety record and benefits of nuclear power speak for themselves, although, as we saw in the U.S. for a long period, the message was overshadowed. These nuclear plants are massive, reinforced structures designed to withstand earthquakes, hurricanes, 100-year floods, and terrorist activities with layers of backup safety systems and the most sophisticated security and emergency preparedness plans in the U.S. industrial sector. The public has regained its confidence in nuclear power, and concern for global warming has helped highlight its emission-free benefits. Many environmentally concerned people now support nuclear power. Nuclear power as a safe, economically stable, clean source of electricity is a message that needs to continue to be reinforced. ■ Jerome Blattner (BSNE ’78, PE) is a senior vice president at Sargent & Lundy.
Getting in GEARE

The Global Engineering Alliance for Research and Education (GEARE) is a unique program designed to supplement the education of engineers so they are prepared to function immediately in the global workplace. The program was created by the College of Engineering at Purdue in partnership with the Universität Karlsruhe (Karlsruhe, Germany); Shanghai Jiao Tong University (Shanghai, China); and Indian Institute of Technology Bombay (Mumbai, India).

Students Without Borders

Nuclear engineering students take a global perspective

Manuel Sztejnberg came out of high school in Argentina interested in physics and engineering, and he also knew that he wanted a career that would apply these sciences to health. While studying “Engineering in Medical Physics,” he did research for his thesis at the Comisión Nacional de Energía Atomica (CNEA) in Buenos Aires. Sztejnberg went on to do a fellowship there, too, because by then, he had “fallen in love” with boron neutron capture therapy, or BNCT (see page 11).

“It’s an incredible area because it contains so many disciplines,” says Sztejnberg, a PhD student in nuclear engineering.

The scale and scope of the work being done at CNEA impressed Sztejnberg. “When I went to work there, it was like a whole new world,” he says. “It was a very big step in my career, because BNCT combines nuclear physics, nuclear engineering, a lot of medical physics, and many other biomedical sciences. In the day-to-day, you begin to learn about a lot of other disciplines.”

The more he worked with BNCT in Argentina, the more he realized he needed to learn more about nuclear engineering—radiation detection, the inner workings of a reactor, and dosimetry, for example. A propitious visit to the labs of CNEA by Purdue researcher Tatjana Jevremovic, an associate professor of nuclear engineering, put Sztejnberg in contact with his future. Jevremovic recruited him to Indiana to research BNCT as a treatment for stubborn forms of breast cancer. “It’s a very interesting approach,” says Sztejnberg, who is now in his third year of doctoral work. “It’s a huge challenge, but with a very promising future.”

Sztejnberg traveled with Jevremovic back to CNEA in Buenos Aires in December to observe new techniques for detecting and treating cancerous tissues. Small animals were irradiated in a special reactor facility to study a novel therapeutic option. The facility was built expressly with such applications in mind and is one of the first of its kind.
Sztejnberg is excited by the collaborative spirit that exists between CNEA and Purdue. When he completes his PhD, he would like to continue his connection with both places. He believes the dynamic interplay of disciplines at CNEA could be well complemented by the strong nuclear engineering expertise at Purdue. “I have to stay open to both,” says Sztejnberg, “It’s my ideal.”

German engineering
Another internationally minded student, sophomore Marc Paff, is the first representative from the School of Nuclear Engineering to be selected by Purdue’s Global Engineering Alliance for Research and Education (GEARE) program to study overseas.

It won’t be Paff’s first time in Germany; his father is a German-born businessman, and Paff’s family has moved back and forth between Germany and the U.S. several times. Paff appreciates the example of his father’s international perspective in business: “The same thing should apply to engineering,” he says. “We work in a global economy and always have to look at the world market. Besides, some of the challenges facing engineers are global crises. It makes sense that everyone should try to work together to solve them.”

This summer, Paff will work in a domestic internship in nuclear engineering. During the spring semester of his junior year, he will be interning in Germany and studying at the Universität Karlsruhe. GEARE started in the School of Mechanical Engineering, so Paff will be a pioneer of sorts, working closely with his advisors to design a course of study that optimizes his opportunity to attend classes at one of Europe’s premier technical universities.

But Paff is most looking forward to his German internship. “I don’t assume that lab work in nuclear engineering is the same as work in the field,” he says. He has his eye on a spot with a German firm where scientists have recently discovered six new chemical elements. The global research institute is called Gesellschaft für Schwerionenforschung, which translates to the Center for Heavy Ion Research.

“The internship will give me a glimpse of life after college,” says Paff, who thinks he would like to continue with graduate studies in nuclear engineering when he completes his undergraduate degree. His experience abroad will no doubt help him in that pursuit. ■ Gina Vozenilek

The ABCs of BNCT
In clinical trials of BNCT, cancer patients are injected with boron-containing compounds that are absorbed preferentially by cancer cells. Then patients are irradiated with a neutron beam that loses energy as it moves through the tissues to arrive at the tumor region as “thermal neutrons.” The planted boron nuclei absorb the neutrons, causing a focused nuclear reaction. The products of the reaction, the alpha particle and lithium-7, deposit energy within a precise area about the diameter of a cell, thus killing cancer cells and sparing surrounding healthy tissue.

The science underpinning BNCT has been around for many years. The first clinical applications were attempted in the 1950s but were discontinued because of poor results. Too much healthy tissue was being damaged by radiation, mainly because the boron-containing compounds were being absorbed too globally.

Promising biochemical advances have given researchers new compounds with which to deliver boron to cancer cells: boron phenylalanine (BPA) and boron captate sodium (BSH). These compounds are much more effective at targeting the cancerous tissues. And physicists and nuclear engineers are improving their ability to generate neutron beams that travel at the proper speed and to the precise depth where they are needed. BNCT is again being considered in experimental research to treat thyroid cancer and other cancers of the head and neck. Scientists around the world are also sharing research on BNCT to treat liver, lung, and skin cancers.
Seemingly the stuff of futuristic gaming, this illustration uses rocket experimentation data from Purdue researchers. The two figures shown in repetition are Delayed Detached Eddy Simulations of combustion instability in an experimental rocket combustor. Guoping Xia, a senior research scientist, and Randy Smith, a graduate student, created the simulations working with Charles Merkle, the Reilly Professor of Engineering with appointments in aeronautics and astronautics and mechanical engineering. The experiments are conducted by a research group led by William Anderson, an associate professor of aeronautics and astronautics.