Targeted Therapies

Zeroing in on cancer

PURDUE **NUCLEAR**

ENGINEERING**IMPACT**

WINTER 2006-07

On Oncology
A doctor's take
on cancer's fate

Golden Years
An alum's renewed
life as an artist

On my mind

Welcome back to *Nuclear Engineering Impact*. Here we showcase the efforts of people within the School of Nuclear Engineering who are making a positive impact on society. As educators, we want to have lasting effects on our students. As researchers, we want to bring technical expertise to some of the biggest problems facing humanity. And as a smaller school where students work for one of the most challenging degrees on campus, ours seems to be leaving quite a mark.

In issues one and two we featured students, faculty, and alumni making significant contributions in the areas of energy and the environment. To follow are a handful of stories about members of our nuclear family who are working to improve the general well-being of humanity. From better hearing aids, to targeted cancer treatment, to a pair of students looking at futures in oncology, these are a few places where Purdue nuclear engineers are impacting healthcare.

But it's not all healthcare here. You can read about a scholarship that honors a professor emeritus. And if you've ever tried to wrap your mind around the subatomic universe, you know it requires your imagination. So it's not surprising that a nuclear engineer could have an artistic eye. Just outside Chicago, we caught up with an alumnus who's spending part of his retirement painting the photographed scenes from his worldwide travels. The artist—Paul Wattelet—along with his wife Madeline, also recently answered the Goodwin Challenge, providing funds for a named professorship in nuclear engineering. Back on campus in the hallways of the Nuclear Engineering Building, students made their own artistic statements last fall.

As always, we welcome your input on our efforts. E-mail us at **peimpact@purdue.edu** with thoughts about what you've read and what you'd like to see in the future.

Vincent Bralts
Interim Head, School of Nuclear Engineering

From the editor

One of the first things you'll notice on this side of the magazine (if you read front to back) is the new face and message on this page. Lefteri Tsoukalas has stepped aside as head of nuclear engineering. Vince Bralts, associate dean of resource planning for the College of Engineering, is filling in while the search is on for his replacement. Shortly after Lefteri's resignation, Dean Leah Jamieson told faculty and staff that she appreciated "his almost five years of service to the school and the college. Under his leadership," she says, "the school has seen many positive changes."

As an administrator, Lefteri surely weathered a few nuclear storms, not the least of which was defending the school, college, and university against the sensationalistic ABC news broadcast about the dangers of a nuclear radiation lab on campus. Personally, I'll always remember Lefteri's passion for the possibilities of nuclear energy, his eloquence and knack for analogies, and the kindness he showed to those around him. Fortunately, he's returning to a faculty position, so he'll be able to put those passions into his teaching and research. Best of luck, Lefteri.

William Meiners
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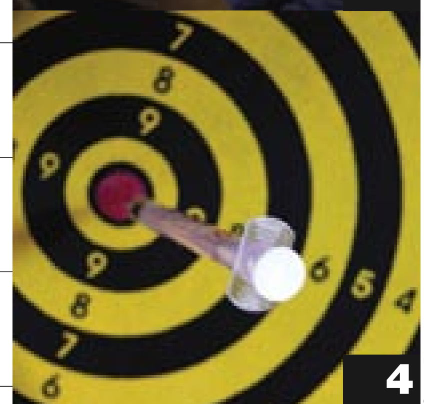

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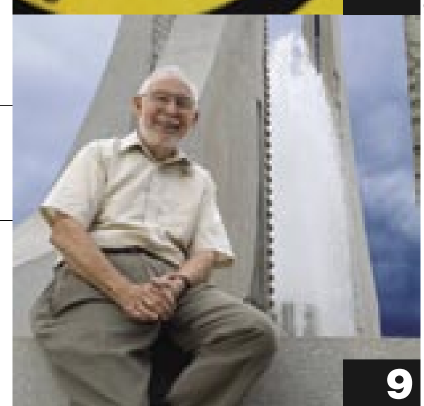
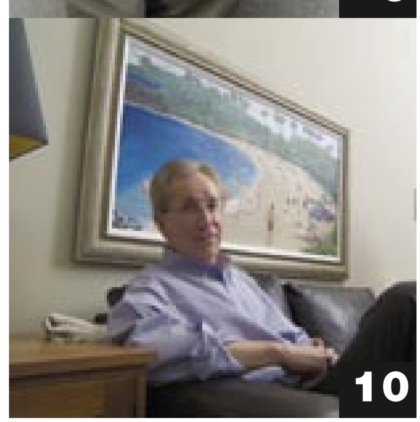





The Nuclear Family

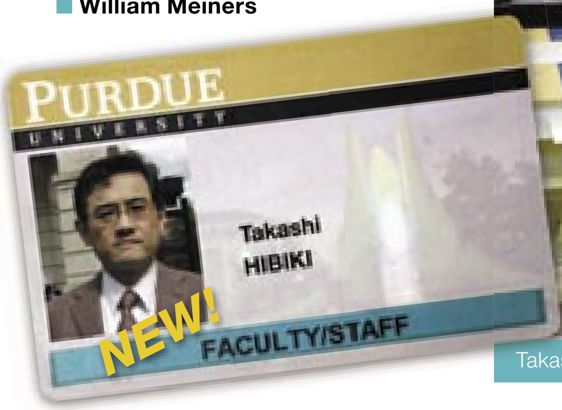
Global Possibilities

A renowned researcher joins Purdue.

The energy challenge certainly has global ramifications. And our success in solving this problem is dependent on a worldwide effort of scientists. At the beginning of the fall semester, our school was lucky to become the new home of Takashi Hibiki, a professor of nuclear engineering. Hibiki's world-renowned expertise in nuclear reactor thermal-hydraulics and neutron radiography will surely strengthen our already successful research group in that area. In fact, even before arriving on campus, Hibiki collaborated with Mamoru Ishii, our Zinn Distinguished Professor of Nuclear Engineering, on a book entitled *Thermo-fluid Dynamics of Two-Phase Flow*. Stay tuned for next semester's version of this magazine where we'll take a closer look at how globalization is driving research within the school.

■ **William Meiners**


Takashi Hibiki settles into his new office.



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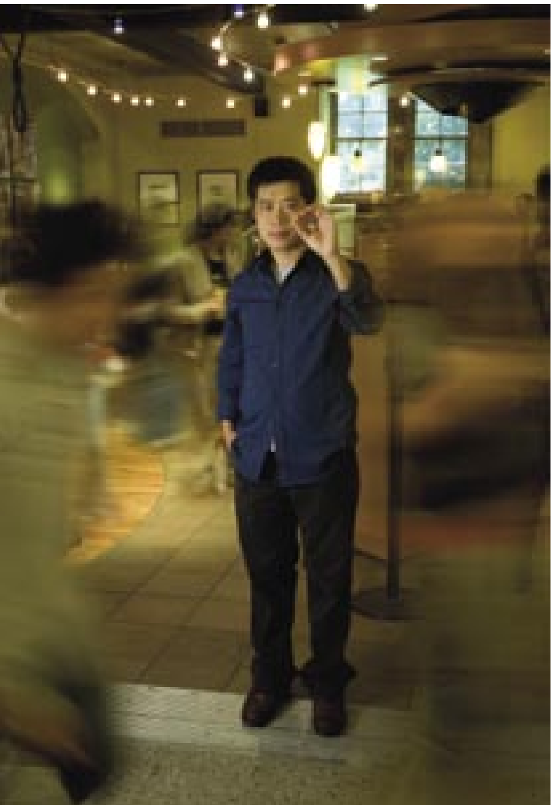


Rong Gao hopes to develop a hearing aid that adapts to environments, such as a noisy cafeteria.

Combating Hearing Loss

In collaboration with industry, a visiting professor is hoping to streamline technologies and costs for hearing aids.

The mission began 10 years ago with one question: How can we make a better hearing aid?

Today that question is being answered thanks to the research being conducted by Rong Gao, a visiting assistant professor in nuclear engineering, and others.

"We are working to simplify the fitting [of hearing aids] and reduce the costs," says Gao.

For many who suffer from a hearing impairment, finding the perfect hearing assistance device can be a maze of fittings, testings, and trial and error. Current devices amplify sounds found in the user's environment. And each user responds differently to each environment. Common complaints include discomfort and occlusion.

The software that Gao and his colleagues are developing would customize the performance of the hearing aid and could eliminate those complaints and simplify the fitting process.

Collaborator Stavros Basseas, the president of Zenith Sound, Inc., in Park Ridge, Illinois, and former corporate chief technologist with GN ReSound, explains the new fitting process based on systematic learning that combines the use of neural networks and fuzzy logic.

"As people describe the experience [of a fitting], there is a level of fuzziness in communication," says Basseas. "Rather than fight the fuzziness, we are trying to work with it to utilize it."

As a user is fitted for a hearing device, his perception of sounds will be different from others. Three sets of targets (soft, normal, and loud) are used, along with an evaluation that utilizes subjective indexes including loudness, tone, clarity, comfort, distortion, and noise. The user gives a quantitative measurement allowing the team to further segment based on categories such as age, lifestyle, preferences of the fitter, etc.

"We want this to be a learning prcess," says Basseas. "We have a way of capturing this knowledge in a systematic way, and then processing this knowledge in a central network."

With an infinite amount of data, the end-result will lead to a hearing aid that more easily adapts to a user's environment. "A good hearing aid is not just a good amplifier," says Gao. "It has to adjust to a cafeteria, a living room. It has to be very intelligent to detect the environment and adjust, taking into consideration the user as well as the fitter preferences."

Taking what they've learned, Gao is back in the lab developing the engine. They are investigating specialized components already on the shelf, such as those made by Texas Instruments, hoping to maximize their efforts. In the end, the work will create a device that will adjust and change to the user's environment, eliminating guesswork and frustration.

Not only do Gao and Basseas think their research will simplify and improve the fitting of hearing aids, they believe it also will reduce costs, thus making hearing aids more accessible to underserved populations in the United States and in third-world countries.

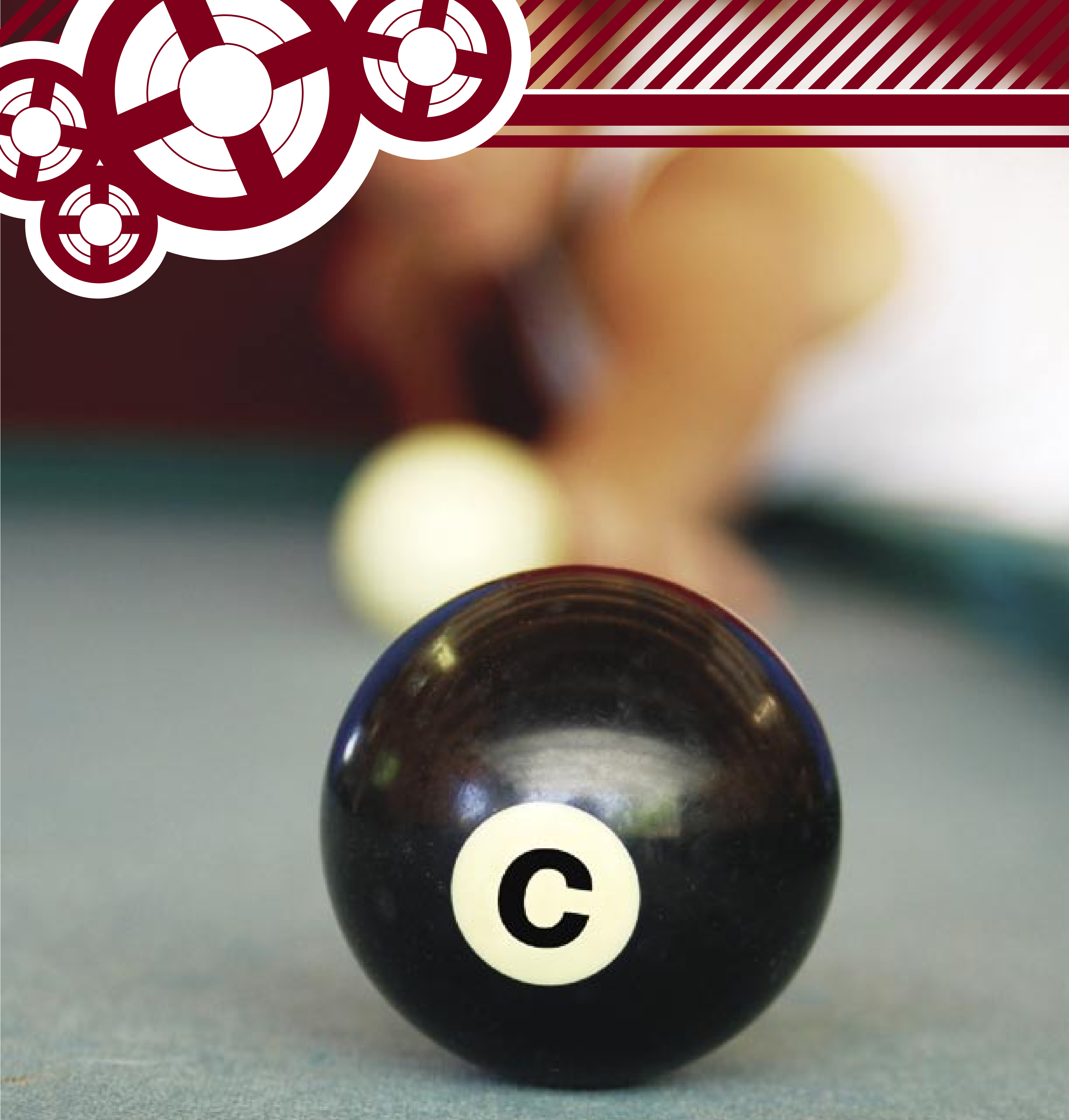
In the U.S. and Europe, Basseas feels the market needs to be segmented to address those with milder hearing losses. "In the U.S., 20 percent of the population has a hearing loss, but only 5 percent are fitted with aids," says Basseas. "We currently cater to the more severe loss. It's like glasses. When your vision becomes blurred, you try out reading glasses first. Those help, so eventually you move to prescription. It's the same concept. We need something for the less-severe loss."

However, the needs of the third-world countries are much different. "We need to address the severe cases first," says Basseas. "But the needs of the distribution channel are different there so it calls for a different strategy." Basseas and Gao feel their product eventually will make those distribution efforts more economical.

"We really want to make hearing aids accessible to those who can't afford them," says Basseas.

And while Gao has spent the past decade answering the initial question, it's clear that he enjoys his work. "It's interesting, and I'm helping people," adds Gao with a smile.

■ **Sharon L. Martin**



Through novel collaborations involving computational modeling and in laboratory experiments, one Purdue professor is hoping to develop cancer treatment therapies that zero in on sick cells and keep the healthy cells healthy.

TARGETED THERAPIES

By William Meiners

For the more than one in eight U.S. women (according to the United States National Cancer Institute) who develop breast cancer in their lives, the treatment can be as trying as the disease. Depending on the tumor stage of the breast cancer, the treatment options may consist of surgery, radiotherapy, chemotherapy, and hormonal therapy. For one Purdue woman—Tatjana Jevremovic, a professor of nuclear engineering—there's hope her research findings may lead to targeted therapies that could help ease that treatment pain for patients.

Jevremovic has two collaborations under way on both the theoretical and experimental fronts with bottom-line goals for improving radiation treatment. Along with a medical doctor, she's investigating the use of boron neutron capture therapy (BNCT) to kill cancerous cells, while sparing the surrounding healthy cells. And she's getting into the laboratory with researchers from the School of Health Sciences to test the use of microbeams in some very cell-specific research. Both projects are raising some eyebrows within academic circles and getting noticed elsewhere.

Shortly after arriving on campus in 2001, Jevremovic founded the Purdue Breast Cancer Research Group. "While current treatment protocols are effective for many, 30 percent of patients don't respond well," Jevremovic says. "Given their cancer is highly aggressive and grows exponentially, improving treatment is crucial."

Dedicated to the cancer cause, Jevremovic is working on a joint proposal with the Purdue Cancer Center and helping educate the next generation of doctors, oncologists, and nuclear scientists (see her students' story on page 7) who may be implementing new strategies through the course of their careers.

Redirecting Radiation

Jevremovic admits to being a bit of a conservative researcher. She would rather spend some time doing theoretical analysis and modeling before she starts experimenting. But her unique collaboration with Wael Harb (see "In My View" on page 8), a medical doctor from the Horizon Oncology Center in Lafayette, Indiana, is laying the groundwork for such validation attempts in the lab.

For Harb, a renewed international interest in using BNCT for cancer treatment piqued his own interest in the investigation. "This research is a merger between nuclear engineering and biology," Harb says. "Medicine in general is moving toward a more personalized approach. Medical oncology is especially focused on utilizing more targeted therapy that is able to recognize tumor cells and minimize side effects on healthy cells.

"The difficult part is to find a good target and be able to completely destroy the offending cells because even a few remaining cells can repopulate, causing the cancer to come back."

Tatjana Jevremovic outside the Nuclear Engineering Building.

A good target seems to be associated with HER-2 positive cancers. According to Jevremovic, the HER-2, or human epidermal growth factor receptor, is prevalent in 25 to 30 percent of all breast cancers, as well as many other cancers. Genetic alteration in the HER-2 gene produces a 10- to 100-fold increased amount of growth factor receptor on the surface of the cell, causing the cell to divide rapidly and uncontrollably. The result is that these tumors are statistically the most resilient to treatment.

"Our proposed radiation binary targeted concept is based on anti HER-2 monoclonal [MABs] that would be used as vehicles to transport the nontoxic agent to cancer cells," Jevremovic says. "A neutral nontoxic boron-10 would be used as an agent predicting that anti HER-2 MABs would assure its selective delivery to cancer cells.

"Once the tumor region is loaded with a satisfactory amount of the boron, it is irradiated with low-energy neutrons. This treatment [BNCT] has been used for head and neck cancers, melanoma, and glioblastoma for over 40 years in Japan and Europe and in the last decade in Argentina."

continued on next page

The theory, thus far successful on paper and through computational modeling, seems to satisfy the main criteria in cancer treatment. “It provides the ability to selectively attack the cancer cells while saving the normal tissue,” Jevremovic says. “It prevents the drug, which in this case is the neutral element of boron, from leaking away from the cancer region, and provides a highly efficient radiation dose with minimal overall side effects.”

So what’s next on the horizon? For the practitioner working at the Horizon Oncology Center, Harb believes the modeling and the published journal reports will lead to experimentation and ultimately implementation. “If we have a proof of concept that we are able to deliver the boron in very high concentration, then that will open the door for moving into more stages of research involving animals,” says Harb. “And down the road we may consider it for human trials.”

Understanding the Bystander Effect

Another aspect of radiation that’s motivating Jevremovic’s research is the use of microbeams to understand the biological mechanisms underlying the treatment of cancer. For the nuclear engineer and the researchers she’s collaborating with from health sciences, certain fundamental questions drive the work. Do only those cells damaged by radiation die? Do cells damaged by radiation on one treatment day respond the same way to radiation delivered on subsequent treatment days? Do cancer cells and normal cells respond the same way to radiation? Researchers are looking to the cellular level to answer those questions.

Rob Stewart discusses the use of microbeams for cancer treatment.

For Rob Stewart, an associate professor of health sciences, it involves a study of how cells communicate with each other. He says, “There are a lot of experiments which show if you irradiate some cells, they’ll send signals to other cells that can invoke cellular responses similar to the ones initiated directly by radiation, including cell death, mutations, and neoplastic transformation. It’s called the bystander effect.”

The whole classical paradigm for radiation effects, which dates back almost 100 years, Stewart says, is that radiation must to pass through a cell to kill it, or cause it to become transformed or cancerous. Within the last 10 years, researchers have used microbeams to target radiation at individual cells, or even at parts of individual cells, to examine how signals initiated in one cell are passed to other cells.

One experiment looks at a phenomenon known as cellular suicide. “The scientific name is apoptosis,” Stewart says. “The idea is that the cell recognizes somehow that it’s been damaged, or potentially damaged, and it invokes an enzymatic program that results in cell death.”

Colleagues Rob Stewart and Jian Jian Li in a health sciences lab.

This investigation of the intercellular pathways involved in cell death and other cellular responses may possibly lead to new strategies to biologically optimize radiation therapy for the treatment of cancer.

“The physics part of this project is not really that novel,” Stewart says, “but we’ve had some ideas for ways to use microbeams in slightly different ways.”

The idea, he explains, is that a researcher could irradiate some of the cells in a culture dish at 1 p.m., and those damaged cells would send out signals to the surrounding cells. If at a later time (say 2 p.m.), another dose of radiation were delivered to the cells, the signals released shortly after the first dose of radiation might enhance the survival of some cells to the second dose.

“There’s a whole time sequence to these phenomena,” Stewart says. By altering the time interval between doses and the fraction of the cells in the dish that are hit, the collective death response of cells in the dish can be modulated. “And that has implications for radiation therapy because those patients are usually treated once a day with a sequence of doses. By adjusting the timing and magnitude of the doses used in radiation therapy, we might be able to enhance cell killing in the tumor or, alternatively, reduce damage in normal tissues.”

“The overall goal of this project is to improve cancer treatment and to find new ways to focus on what we can understand and do at the cellular level,” Jevremovic says.

Close to Home

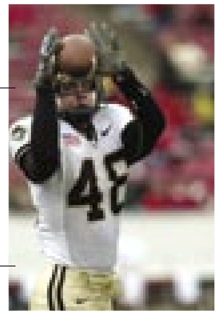
In addition to her research in nuclear medicine, Jevremovic has nuclear expertise ranging from nuclear reactor physics, neutron transport, and 3D technologies to nuclear radiation shielding designs for space applications to environmental studies, including smart systems, sensors, pollution prevention, green energy and green technologies. But to have within her grasp the opportunity to make a difference in how cancer patients are treated is very important to her.

“Cancer is everywhere and there is no life untouched by it,” Jevremovic says. “I have met many women who are breast cancer survivors, and each one of them has a unique story. I want to hear fewer stories. I also want to read one day that there are no battles lost to breast cancer. My motivation is strong in my determination to search for ways that will save every single life.” ■

Med School Bound

A summer internship and a research fellowship are helping two nuclear engineering undergraduates lay the groundwork for medical school.

Tom Cambell



From schedule-balancing acts that include everything from football practices through summer internships and assignments, Patrick Kohtz and Sheila Bolbolan are spending their days on campus preparing for a future in medicine.

For a pair of undergraduates who traveled from opposite ends on I-65 to arrive at Purdue's campus, a passion for nuclear science and some well-timed research projects are setting them both on the road to medical school. And it's all a part of their current five-year plans.

The world of the subatomic universe is not for the meek of mind, yet the School of Nuclear Engineering continues to attract students who may not fit the engineering stereotype. Patrick Kohtz, for example, is a fifth-year senior who's also completing his final year of eligibility on the football team this fall. A Frankfort, Indiana, native and a former freshman walk-on now in possession of a full athletic scholarship, Kohtz is one of the few engineering students on campus who balances schoolwork with practices, games, and a steady dose of bumps and bruises.

Several players Kohtz has known have had to choose between engineering and football. "I'm not saying I've chosen engineering over football," he says, "but I would say I really have to put in a lot of time for it."

Likewise, Sheila Bolbolan, a junior from the Chicago area, knew she wanted to spend her time at Purdue turning whatever engineering studies she encountered into a medical application. That process began in her freshman year when she began working with Tatjana Jevremovic (see story on page 4), a professor of nuclear engineering, in the "Nuclear 120" class. This past summer, as a participant in the Summer Undergraduate Research Fellowship (SURF) program, Bolbolan continued that work.

"With SURF this summer, I worked in collaboration with the health sciences department to research the bystander effect, using X-ray microbeams," Bolbolan says. "I created a computational model of a cell culture dish to be used in the microbeam, and I simulated a source to examine the dose distribution in the cell culture."

For Kohtz, his association with Jevremovic led to last summer's internship at Goshen Health Systems in northern Indiana. "I had spent the last four summers here [on campus] working out for football," Kohtz says, "and I thought the real-world experience would be nice."

Within that real-world setting Kohtz was able to observe life in the radiation oncology department of the hospital, making him an eyewitness to treatments, treatment planning, the calibration of equipment, and much more. Along with a few hands-on projects, that wide range of exposure has helped to solidify his plans for a future in oncology, for which he is now preparing with prerequisite classes.

"The problem with nuclear engineering and football," Kohtz says, "is that if you take too many hours, you'll pay for it with your grades." Thus, Kohtz describes his five-year-plus plan as a "super super senior" route.

Bolbolan, who serves as treasurer for Purdue's American Nuclear Society, also anticipates a fifth year and a graduation celebration in 2009. "I'm definitely thinking about medical school," she says. "I plan on continuing my research in nuclear medicine throughout my educational career."

For now both students seem to be benefiting from the school's close-knit community, getting to know their classmates, professors, and even some of the alumni who have steered similar paths before them. And in another 10 to 15 years each may likely answer affirmatively to the query: "Yo, is there a doctor in the house?" ■ **William Meiners**

Cracking the Cancer Cell

While the disease continues to be a global killer, the dawn of a new age in cellular and molecular biology could help stem the cancer tide.

Dr. Wael Harb, M.D., Horizon Oncology Center

"According to the American Cancer Society, one of two males and one of three females living in the Unites States are likely to develop cancer in their lifetime."
–Dr. Wael Harb

As a medical oncologist, I am frequently asked if we have found an answer for the cancer problem. Although we often think about this problem as a concern for someone else, from an individual perspective it is a real risk for all of us.

According to the American Cancer Society, one of two males and one of three females living in the Unites States are likely to develop cancer in their lifetime. As a result, 1.4 million new cancer cases are expected this year with over 564,000 deaths from cancer. This makes cancer the number two killer after heart disease, accounting for one out of four deaths. Unfortunately, according to the World Health Organization, this problem will likely escalate as the global cancer burden is set to double over the next 20 years as a result of aging population. On the plus side, however, over 65 percent of people diagnosed with cancer today are likely to live more than five years. This is considered an improvement over the 50 percent five-year survival rates seen 30 years ago.

The good news is that we are entering a truly revolutionary era that will drastically change our ability to combat cancer. The root of this revolution dates back to 1952 when Francis Crick, an ex-physicist, and James Watson, a former ornithology student, cracked the secret of life when they discovered the double helix structure of deoxyribonucleic acid, DNA. Half a century later in 2003 the first phase of Human Genome Project determined the complete sequence of the 3 billion DNA subunits (bases), identified all human genes, and made them accessible for further biological study. This progress has opened exciting new areas of cellular and molecular biology. The result is an incredible knowledge of cancer. We know what makes a cancer cell a cancer cell, what cancer cells need to develop, and how cancer cells behave, interact, overgrow, and die.

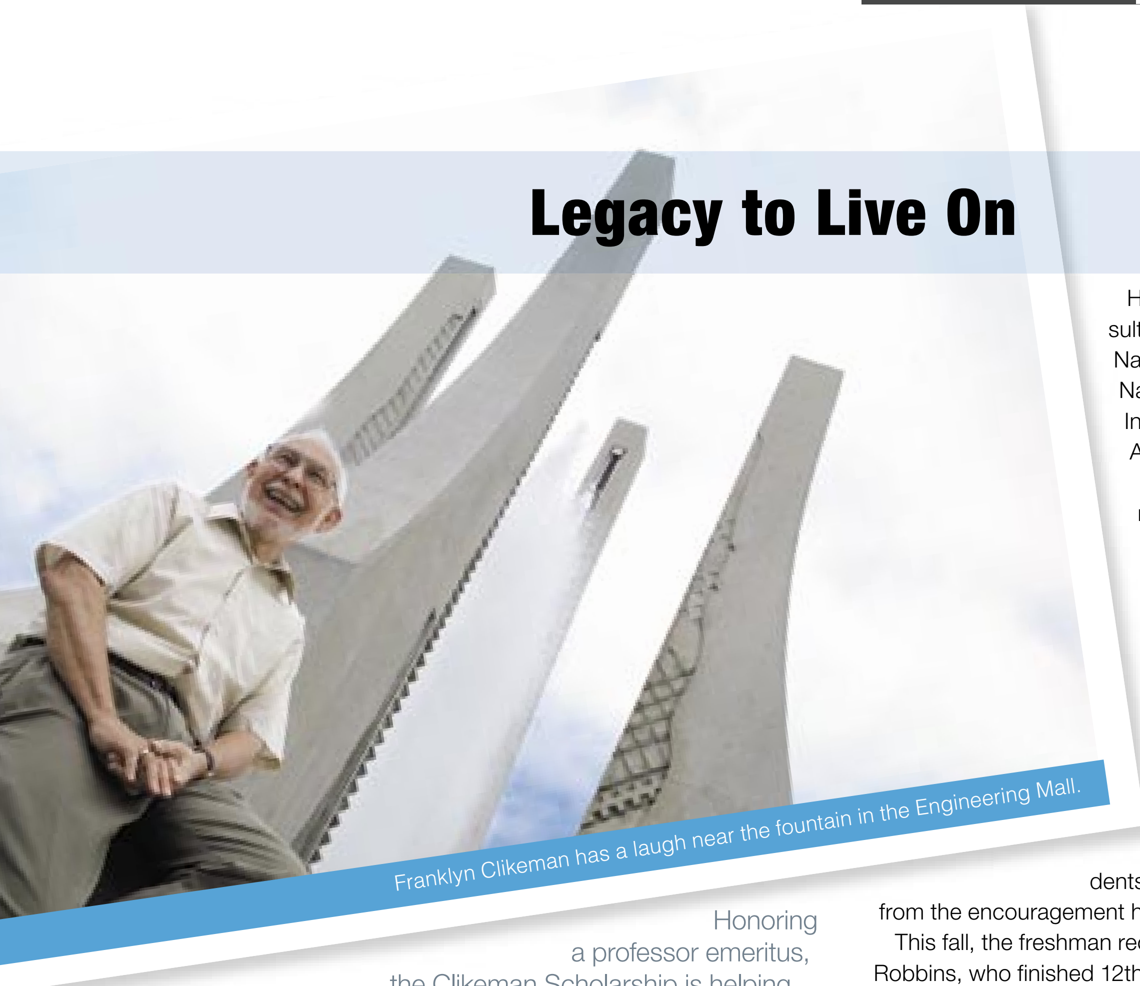
A rapidly advancing knowledge of cancer genomics, proteomics, metabolomics, pharmacogenomics, and nanotechnology will enable us to crack the cancer cell. We will identify individuals at high risk of developing cancer and develop tailored preventive strategies. We will diagnose cancer at very early stages by utilizing highly sensitive and specific screening molecular and imaging techniques. We will design and deliver highly targeted therapeutics to the cancer cells. We will minimize side effects by sparing the healthy cells. In essence we will achieve our major goals in improving the cure rates, survival, and quality of life for the majority of cancer patients.

For its continuing advancement, cancer research is dependent upon close relationships among many disciplines. This can only be achieved by an intimate alignment of oncologists with a large array of scientists that include biochemists, geneticists, immunologists, pathologists, pharmacologists, physicists, and engineers. In light of the great success registered at the basic science level but relative paucity of effective therapies, it would be wise to establish human and economical resources addressed to a multidisciplinary collaborative effort in cancer research.

In my view, the nearby horizon is very bright in the fight against cancer.

Wael Harb, M.D., Horizon Oncology Center

Legacy to Live On



Franklyn Clikeman has a laugh near the fountain in the Engineering Mall.

Honoring a professor emeritus, the Clikeman Scholarship is helping undergraduates achieve a nuclear enginering education.

A lifetime passion for "working with young kids and trying to get them to do their best" earned Franklyn Clikeman many kudos—Outstanding Undergraduate Teacher in 1994, a spot in the Purdue *Book of Great Teachers*, a fellow in the Purdue Teaching Academy, and a scholarship named in his honor.

"Teaching was the last thing I was ever going to do in my life, I thought when I got my PhD. But, yes, I liked teaching. I liked seeing the students develop," says the nuclear engineering professor emeritus who's equally renowned for his research in detecting and measuring nuclear radiation and reactor physics parameters.

Over the years, the Montana native developed unique radiation detector systems, and, together with colleague Karl Ott, the Fast Breeder Blanket Facility at Purdue to study neutron reaction rates. "That was a milestone. Interest in fast reactors died, but now it's in vogue again," he says of the 1976 project.

Clikeman came to Purdue in 1970 after earning his doctorate at Iowa State University in 1962 and serving post-doctoral, assistant, and associate professor posts at the Massachusetts Institute of Technology. During his tenure, he directed Purdue's Nuclear Engineering Radiation Laboratories, supervised the PUR-1 Reactor, and served as assistant, acting head, and head of nuclear engineering.

He's been in demand for consulting, too, serving Sandia National Laboratory, Argonne National Laboratory, and the International Atomic Energy Agency, among others.

Of all his career achievements, Clikeman says he feels best about "being a good teacher."

Thanks to contributions from colleagues and friends to the Clikeman Scholarships Fund, established at his 1999 retirement to reward students for academic achievement and leadership potential, nuclear engineering students will benefit for years to come from the encouragement he modeled.

This fall, the freshman recipient of $1,000 is William Robbins, who finished 12th out of some 300 at Louisville High School in Ohio, where he was president of the concert choir and student council treasurer. His interest in nuclear engineering, sparked in chemistry class, complements his other goal. "I'm in the ROTC program, going into the Navy. It's something I've wanted to do ever since I was a kid," Robbins says.

An earlier recipient, Bruce Haan from West Lafayette, Indiana, received the scholarship three times. "It was great for helping me get started in my schooling," he says. Haan is now following Clikeman's first calling, to teach. "I would like to teach high school math when I graduate. Ultimately, I want to become a high school principal."

As a professor, Clikeman mentored graduate students from all over the world—the U.S., Brazil, Pakistan, and Taiwan, in all a supervisor or co-chair for 15 master's and seven doctoral students. "I had good students," he says. "I'm very pleased with them."

While Clikeman has left the lab and classroom, he still gives to others, currently as a volunteer in the Tippecanoe County prosecutor's office. He's also "catching up on genealogy," and he enjoys welcoming and encouraging students who receive the scholarship named in his honor. ■ **Kathy Mayer**

Portrait of the Executive in Retirement

After a career spent in the nuclear industry, Paul Wattelet has reunited with his first love—art.


Paul Wattelet and his wife Madeline at home, just outside Chicago.

Paul Wattelet (PhD '67) has happily exchanged his executive accoutrements for an artist's palette. The recently retired chairman, president, and CEO of Sargent & Lundy LLC in Chicago now uses acrylic on canvas to capture scenes he loves and has photographed from around the world: harbor and beachscapes full of people in Hawaii, architecturally stunning historic buildings in China. And he paints special works for loved ones around the Midwest: he and his wife, Madeline, have six grandchildren—each with Grandpa's creations in their rooms.

"Art was really my first love," Wattelet says. "All through junior high and high school, I took art classes. It was only when my teachers explained that I couldn't make a living in art that I decided to become an engineer."

With a physics degree from Illinois Institute of Technology, Wattelet came to Purdue in the early 1960s to study physics, but was drawn to the exciting horizon of nuclear engineering. "Within one semester, I had changed my major and was working with professors studying reactor physics. I was hooked," he says. "Commercial reactors were just starting to be built in the United States; it was exciting to be involved right at the beginning of nuclear power.

"Nuclear engineering was always in the back of my mind," Wattelet continues. The seeds had been planted by his father, who worked for a company that made control rod drive mechanisms for Navy nuclear submarines.

Doctorate in hand, Wattelet became a senior engineer with Westinghouse Electric Corporation in 1966, working on nuclear reactor design. "My Purdue education afforded me an opportunity to get in the nuclear business at a very high level. It prepared me well," he says.

Wattelet also had a front-row seat to the political halt to the nuclear power industry over plutonium fears. "It was devastating," he says. "Back then, plutonium had so much promise it was widely believed we'd be in a plutonium market by the 1990s or the 2000s.

"I think the world is fortunate to have developed nuclear power at the time it did," he says. "At that time I thought, from a strict logic standpoint, that nuclear power was the only way for the future energy needs of the world. I still believe that."

Wattelet sees the day when oil and coal and gas will run out, somewhere in the next 25-50 years, and people will start taking nuclear power seriously again. Many parts of the world with limited natural resources, such as South Korea and France, are already in that mindset, he says. "The U.S. seems to react to crisis. The good part about nuclear power is that it's proven, safe, and we know how to do it," he says.

When that time comes, Wattelet says, the problem may be more human than technical. "We're very concerned about being able to get enough qualified people in the engineering area to keep the reactors going. Purdue seems to be one of the exceptions to the lack of national growth in nuclear engineering," Wattelet says.

As he paints, Wattelet reflects on his nearly four decades in the nuclear industry, including 33 years with the same firm. He joined Sargent & Lundy (S&L) in 1972 and advanced through several management positions, culminating with eight-and-a-half years at the helm. S&L is a comprehensive firm that designs nuclear, coal and gas power plants, and the additional facilities and systems to support the plants.

A few years before retirement, Wattelet wrote a book about business sustainability,

Managing to Get It Done: A Manifesto on Business Sustainability from the CEO of a Company That Has Been Managing to Get It Done for Over 100 Years. The business values have application in the overall nuclear industry as well. "Most reactors were designed for a 40-year life span, so a lot of the focus is on keeping them sustainable, which takes a tremendous amount of engineering, maintenance, and upgrading."

For today's graduate students, Wattelet has this wisdom: "Focus on what you have to do to get done, then, in the real world, broadening yourself is extremely important," he says. "If you think as an engineer you won't have to deal with people, you can't get through life that way. Become people oriented in business. It's an absolute necessity."

Education, hard work, and the timeless values of leadership and vision. For Wattelet, they combine to paint a balanced scene of a career well-spent. ■ **Amy Page Christiansen**

Wattelet in his studio, where he paints photographed scenes (opposite page) from his worldwide travels.

check it out

Starry, Starry Hallway

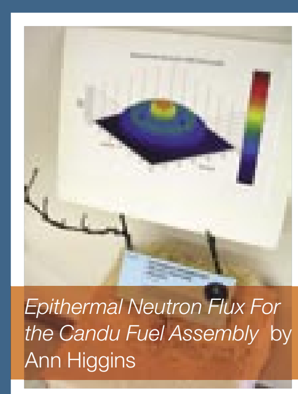
Students make artistic sense of nuclear concepts.

Can't tell fission from fusion? Sure, *you* probably can, but most folks outside a certain pedigree or degree probably cannot. For today's nuclear engineering student, part of the maturation process is learning how to explain concepts to your average Joe and Josephine on the street.

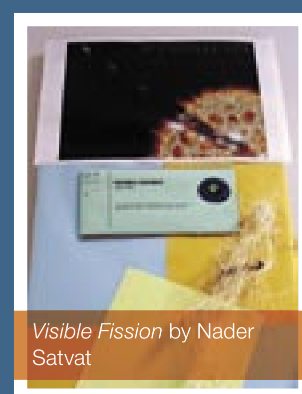
That translation is what Tatjana Jevremovic (see story on page 4), a professor of nuclear engineering, had in mind when she made a summer assignment. "I wanted students to turn a nuclear concept into a piece of art," she says. "I wanted them to see beyond mathematical results."

But there were still boundaries. From boxes to branches, discarded office supplies to donated crackers from Japan, the artwork had to be comprised entirely of things recyclable. Swapping thinking caps for berets, students who normally work with charts and graphs started tuning into to the right sides of their brains. Their creations, by late August and the start of school, spilled into the hallways of the Nuclear Engineering Building.

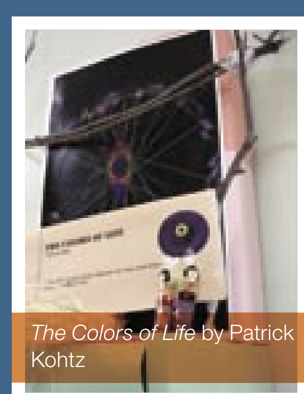
In the end, Nader Satvat, a master's student, took the most votes for first prize with his work entitled "Visible Fission." Maybe not much of a resume builder, but something to write home to Iran about. And while this handful of nukes has about as much chance ending up in the Louvre as Van Gogh does resurfacing at Oak Ridge National Labs, perhaps they learned a little something about the creative process. ■ **William Meiners**



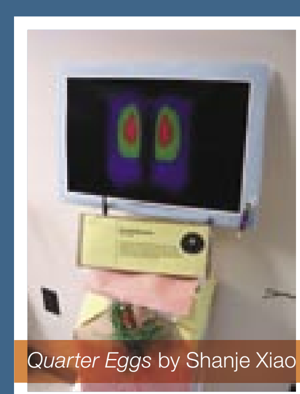
Epithermal Neutron Flux For the Candu Fuel Assembly by Ann Higgins



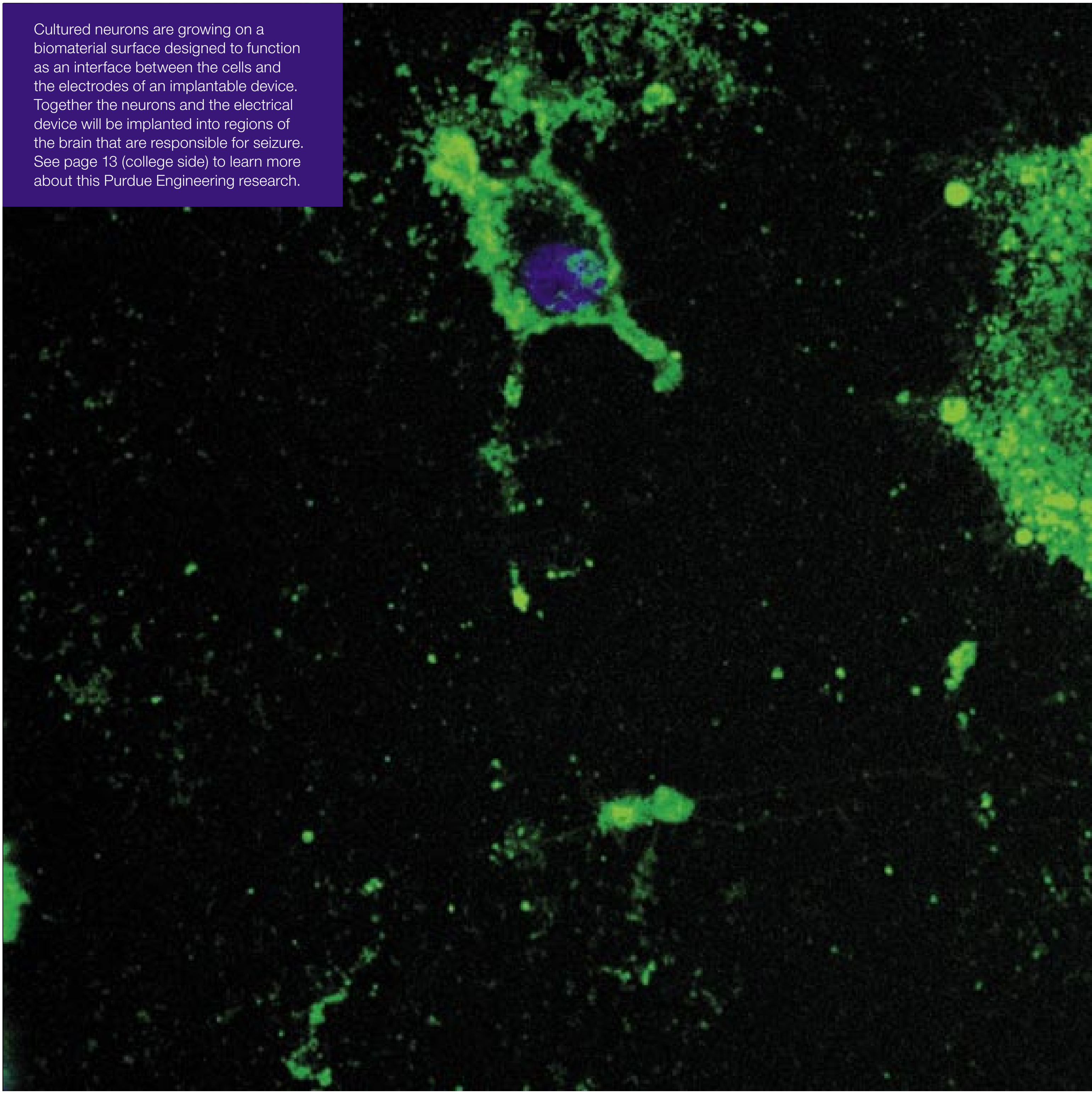
Visible Fission by Nader Satvat



The Colors of Life by Patrick Kohtz



Quarter Eggs by Shanje Xiao



Cultured neurons are growing on a biomaterial surface designed to function as an interface between the cells and the electrodes of an implantable device. Together the neurons and the electrical device will be implanted into regions of the brain that are responsible for seizure. See page 13 (college side) to learn more about this Purdue Engineering research.