MARQUETTE UNIVERSITY

RESEARCH

2007

TODAY'S PROBLEMS. TOMORROW'S SOLUTIONS.

MARQUETTE UNIVERSITY

Be The Difference.

A MESSAGE FROM THE PROVOST

A university by its very nature is engaged in the generation of new knowledge. Marquette's mission clearly articulates this vision:

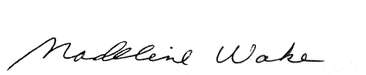
Our mission, therefore, is the search for truth, the discovery and sharing of knowledge, the fostering of personal and professional excellence, the promotion of a life of faith, and the development of leadership expressed in service to others.

We believe that scholarly endeavors fuel the passion for intellectual growth in faculty and students. Research, scholarship, and creative activities inform and enrich the education of our students, provide an essential creative outlet for faculty, and contribute to the betterment of society. As we commit to building an even stronger research focus within the university, we keep in mind our mission of service to others. Thus, much of the research at Marquette is focused on improving the human condition and validating the worth and dignity of others.

In this publication, we feature current efforts in areas of children, ethics, biotechnology, crime, and aging. We have included well-developed programs of research and those in early stages of development.

Marquette supports the research initiatives of faculty and students in a variety of ways. Through the generosity of Helen Way Klingler, the university provides generous internal research support. Annually, faculty compete for $150,000 and $90,000 three-year Way Klingler fellowships to advance their research. The internal fund also supports fourth-year sabbaticals for junior faculty. In order to ignite the passion for science early, several departments offer intensive summer research experiences for undergraduate students. You will note their accomplishments on pages 22 and 23.

These pages offer just a glimpse of the scope of research at Marquette. You can learn more at www.marquette.edu/research — or visit us in person. We welcome the opportunity to tell you more!



Madeline M. Wake, Ph.D.
Provost

On the cover: Daniel Sem, Ph.D., holds a model of a protein. Sem is an assistant professor of chemistry and director of the Chemical Proteomics Facility at Marquette. Read more about his work on page 10.

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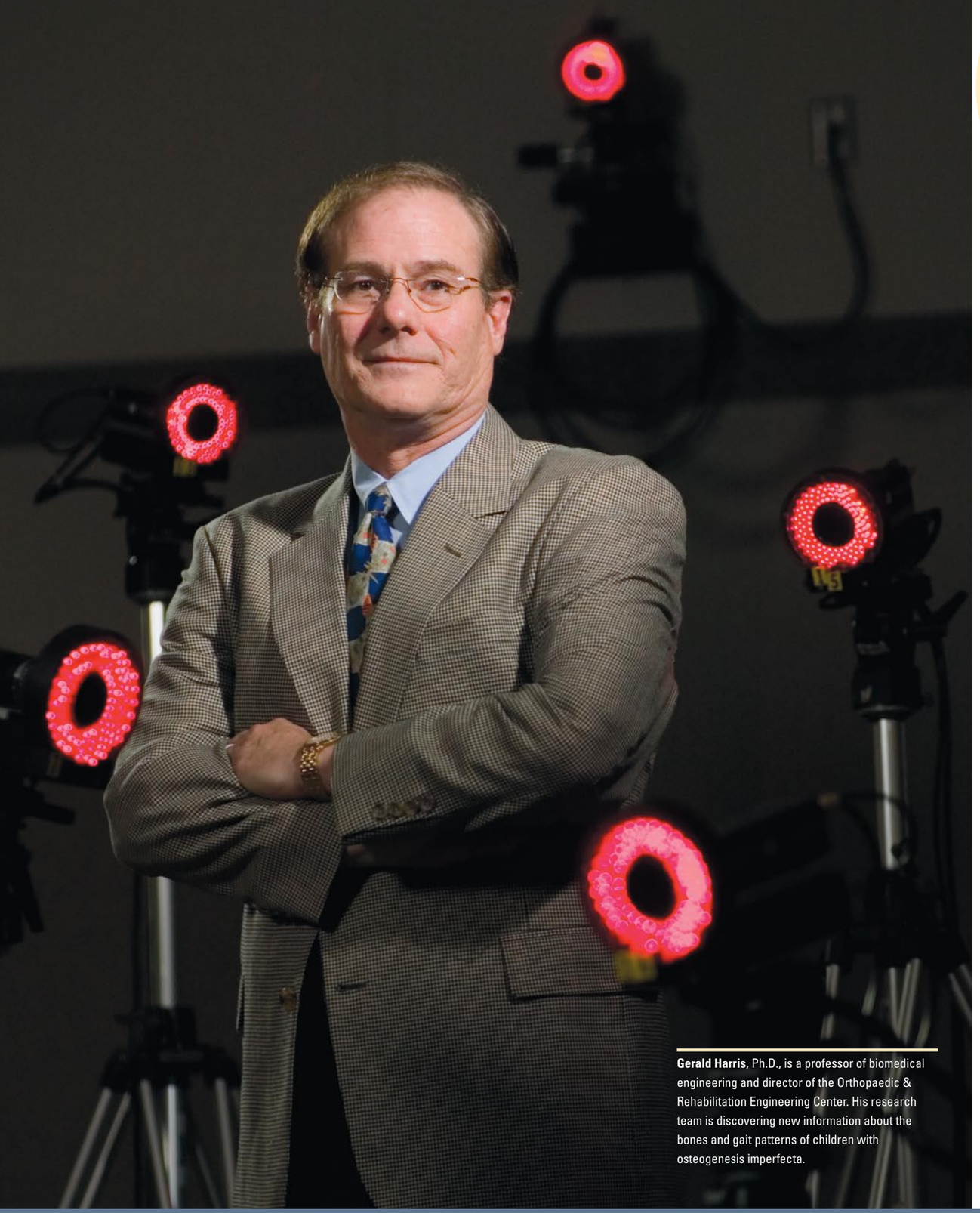


Gerald Harris, Ph.D., is a professor of biomedical engineering and director of the Orthopaedic & Rehabilitation Engineering Center. His research team is discovering new information about the bones and gait patterns of children with osteogenesis imperfecta.

CHILDREN

PROTECTING BRITTLE BONES

Imagine bones so fragile they can snap under the slightest pressure — even from simply walking. That's the reality for children with osteogenesis imperfecta, or "brittle bone disease."

There's a lot that we don't know about this debilitating disease. But **Gerald Harris**, Ph.D., and other experts are working to fill in the blanks.

Harris is a biomedical engineering professor and director of the Orthopaedic & Rehabilitation Engineering Center, a joint effort of Marquette University and the Medical College of Wisconsin's Department of Orthopaedic Surgery. The OREC team is using nanotechnology and advanced modeling techniques to predict — and ultimately reduce — bone fractures in children with osteogenesis imperfecta.

The OI study is one of several research projects that OREC is conducting with funding support from the National Institute for Disability and Rehabilitation Research. Key collaborators are Zaifeng Fan, Ph.D., research assistant professor of biomedical engineering, and Peter Smith, M.D., an orthopaedic surgeon at Shriners Hospitals for Children in Chicago and one of the leading OI experts in the country.

To predict fracture, the team develops computer models of the femur or tibia and fibula specific to each child. A child is then tested in the gait laboratory at Shriners in Chicago, and as he walks, 14 cameras record body movements while twin plates under his feet record ground reaction forces. Using mathematical analysis, researchers can create fracture prediction models and identify the points of high stress in the child's bones.

The research is revealing new information about OI gait patterns, which is quite unique, Harris says.

The team is also the first to analyze the biomechanical properties of OI bone. They remove small chips of bone while the children undergo routine corrective surgery to repair fractures. Under the direction of Fan, researchers test tiny pieces of bone to determine the mechanical properties.

Because OI patients break bones so frequently, in some cases the team will be able to evaluate the load conditions of a bone before it breaks. By understanding more about OI bone structure and points of stress, researchers could help patients modify risky activities and avoid future fractures.

"The amount of information that we're able to discover could be substantial," Harris says. "We're actually putting together a very complete database that looks not only at the specific engineering characteristics of the bones of these children during ambulation, but also looks at the quality of life issues, the day-to-day pain that they experience, fracture occurrence records, ability to integrate in their community and just a plethora of standardized testing." Researchers hope that this could lead to more comprehensive and effective systems for evaluation and follow-up care.

Research could predict — and ultimately reduce — bone fractures in children with OI.

The OI research won't be limited to the children's legs. Thanks to prior research by the OREC and Shriners team on children with cerebral palsy, they have developed and standardized computer models to analyze upper extremity forces. That's useful because kids with OI often use walkers or crutches.

"We might be able to come up with some better designs for assistive devices for those kids, just as we did with cerebral palsy," Harris says.

OREC continues to study walker-assisted gait in children with cerebral palsy, treatment methods for children with clubfoot, and the use and design of pedorthics in the management of foot pathology. Together, the OREC and Shriners motion analysis labs evaluate more than 500 patients a year.

"I predict that within two or three years," Harris says, "we'll be evaluating more adults and children than anyone in the country."

Over the past four years, Marquette faculty have increased external research funding by 36 percent and doubled federal research funding.

Preserving family peace

Is good parenting natural or learned?

Research by **Robert A. Fox**, Ph.D., is demonstrating that committed parents, trained in intervention techniques, can have a profound effect on limiting young children's antisocial behavior.

Fox, professor of counseling psychology, is director of the Behavior Clinic, a mental health clinic for toddlers with developmental disabilities and significant behavior issues. He and a team of graduate students help parents understand and manage children's challenging behaviors, from not listening and temper tantrums to throwing things to hurting oneself or others.

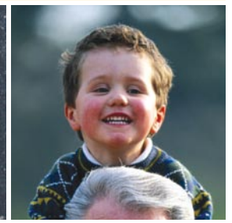
"The field of infant mental health is relatively new," Fox says. "We know early intervention can have a positive impact in changing a child's behavior patterns, thus preventing future, more serious problems."

The clinic uses direct observations of child-parent interactions, child behavior assessments, parental interviews and self-report measures. The most common diagnosis is oppositional defiant disorder.

A licensed psychologist and author of *Parenting Young Children: A Facilitator's Guide*, Fox developed an in-home therapy program. "We concentrate on training the parents — teaching them how to enjoy their children through non-directive play, showing them how to reinforce a child's strengths to encourage positive behavior and provide consistent limits and reasonable consequences for problem behavior," he says.

Fox and his team serve approximately 100 families annually, making more than 1,000 home visits. The average is 12 home visits, but it can be as many as 30. "Our challenge is to get and keep parents committed," Fox admits. "If they complete four or five sessions, they begin to see behavioral changes in their children. Then they're hooked."

After intervention, 70 to 80 percent of the children lose their psychiatric diagnosis. Fox is studying whether the behavioral changes are sustained long-term. He is also working on new assessment tools. "We need instruments for early identification of young children with behavioral and emotional problems that are appropriate for low-income, under-educated parents," he explains.



Why child's play is history

James Marten, Ph.D., says that to understand history fully, historians should pay close attention to the experiences of children. Marten, professor and chair of the Department of History, spent three years assembling a treasure trove of newspaper articles, memoirs, photographs, letters and more, all to capture the history of Milwaukee's children from 1850 to today. Assisted by graduate students, he has posted these documents online for teachers, students, historians and anyone interested in the city's development — as lived by children.

They won't be disappointed. The documents conjure vivid images: Children lugging fireplace ash to frame an ice-skating pond; "newsies" publishing their own newspaper; high school students knowing the despair of the Depression; Mayor Frank Zeidler establishing the Metropolitan Youth Commission after WWII to educate young people to become "proper citizens, instead of embracing teenager culture"; and school children participating in duck-and-cover drills during the Cold War.

The Children in Urban America Project was prompted by Marten's fascination with the experiences of Civil War-era children — the subject of earlier research. "I became interested in children's experiences in urban places and began to explore developing a Web site on that topic," he says. A three-year National Endowment for the Humanities grant funded the project.

The site's 5,400 documents are organized under the themes of work, play, schooling and health. There are common threads joining generations of children, Marten notes, including play and disease. But there also are departures from one era to the next, such as limitations placed on child labor after the 1890s.

"We put the documents where anyone can access them," Marten explains. "It's a different way of approaching history, but there is nothing that you can't understand better when you look at it through the eyes of children."

The mind-body connection

A child gets treated for asthma. Or diabetes. Or chronic constipation.

So where does a psychologist fit in? The connection is more logical than you might think, says **Astrida Kaugars**, Ph.D., an assistant professor of psychology, who studies children with health problems.

"It's become increasingly popular to have psychologists as part of teams at hospitals," says Kaugars. "I like the challenge of considering the medical and psychological perspectives about what life is like for children with health problems. There are many real-world applications, thinking about how psychological factors affect medical conditions and the interplay of your mind and body."

Kaugars specializes in emotional development in at-risk children and studied children who were prenatally exposed to cocaine for her dissertation. Her work has been published in the *Journal of Clinical Child Psychology*, *Journal of Pediatric Psychology*, *Journal of Developmental and Behavioral Pediatrics* and other publications. Her latest research focuses on children with asthma, diabetes or chronic constipation.

She started researching asthma while at the University of Colorado Health Sciences Center and National Jewish Medical and Research Center, and she continues that research with Mary D. Klinnert, Ph.D., the principal investigator at NJMRC. The study followed wheezing babies through age 7 and tracked the development and progression of asthma. Kaugars examined the influence of emotional and family factors on illness characteristics, and part of the project involved observing mothers and children interacting in stressful situations.

"We think that how well you handle your child's emotions is probably related to how effective you are in managing your child's asthma," Kaugars says.

Early data seems to suggest that a mother's psychological resources — which include intellectual functioning, mental health and belief in her ability to handle difficult situations — play a significant role in how she copes with her child's negative behavior even years later.

Kaugars expects to present preliminary results at the Society for Research in Child Development Conference in April.

Sarah Peck, Ph.D., is an associate professor of finance. She specializes in corporate governance and created a class in investment ethics that is believed to be the first in the nation.

ETHICS

KEEPING BUSINESS HONEST

Sarah Peck, Ph.D., primarily teaches the black-and-white world of numbers and financial formulas. But her research — and her passion — resides in the gray area where ethics and business collide.

Peck, an associate professor of finance, is curious about people's conscious and subconscious motivations. That curiosity inspired more than 20 years of research on corporate governance and recently led her to create a class in investment ethics, believed to be the first in the nation.

Business ethics is getting more attention than ever in the wake of scandals at corporations such as Enron, WorldCom and, most recently, Hewlett-Packard.

"You hear the interviews these people give, and it's clear that they didn't sort of wake up and say, 'I think I'm going to rob the company,'" says Peck, chair of Marquette's Department of Finance. "They kind of convince themselves that what they're doing really isn't wrong initially, and then they go down that path. It's part of being human, I think. People lie to themselves all the time."

Much of Peck's research has focused on corporate boards, including the characteristics of boards that function well and that are associated with high shareholder returns. She considers the size and mix of individuals on a board, including their age. "If they're retired, they have more time to spend monitoring and seem to be better at it," she says.

Incentives are also key. Enron's board members were paid $50,000 a year, but they only received the money if they stayed for five years. And yet every year, they needed the nomination of management to keep their seats. That's standard procedure for most corporations — managers, in effect, control who is on the board, and while shareholders can elect alternate nominees, it's expensive and difficult. Add Enron's deferred compensation to the equation, and it discourages board members from being effective watchdogs.

"Now when they set that plan up, the idea was, 'Well, we want to encourage people to stay for long-term strategic planning.' But the added effect is that they've got money sitting in an account, and if they aren't buddies with the CEO, they lose it," Peck explains.

Enron could be a classic example of how people lie to themselves. "On one hand, they feel that the mechanism is working and that they're doing the right thing," Peck says. "But then they have to think through that there's some unintended consequences, and it may be in fact that they knew that but nobody really wanted to say it aloud."

She has also researched CEO compensation, manipulation of earnings and shareholder rights and published in journals such as *American Business Review* and *Journal of Applied Business Research*. She recently teamed up with Michaël Dewally, Ph.D., an assistant professor of finance, for a preliminary paper titled, "Outside Director Resignations: Causes and Consequences." In the middle of their analysis of 110 cases, HP's director resigned, making the research even more timely.

> "It's part of being human, I think. People lie to themselves all the time."

What they've found so far is that a company's stock price tends to drop after a director announces his or her resignation. This is especially true for companies with slow growth, decreasing profits and a powerful CEO. But if the director resigns with the explanation, "I'm too busy," the stock price tends to rise.

"We view that as the market saying, 'It's good that you're leaving because now we can get directors who can give their full attention to the firm.' It's also occurring in firms that show increased growth, so obviously the firm is doing really well, and they need people who can effectively manage it on the board," Peck says.

Marquette faculty edit a number of scholarly journals, from the *Journal of Orthopaedic and Sports Physical Therapy* to the *The International Journal of Systematic Theology.*

War and peace

Michael K. Duffey, Ph.D., was an undergraduate at Notre Dame University at the height of the Vietnam War. "I was brought face to face with the reality of war and the U.S. Catholic Bishops' late response to it," he says, referring to the Second Vatican Council's stance on justifiable war.

Duffey, an associate professor of theology, is an expert in "just war" tradition, a body of guidelines rooted in the 3rd century Common Era (also known as A.D.) that laid out criteria for justifying or initiating war, as well as how war should be conducted.

After a stint with the Peace Corps in Nepal, Duffey eventually returned to Notre Dame to get his doctorate in theology. Since then, he has written several articles and three books on just war theory, pacifism and, most recently, nonviolent conflict resolution.

By the end of the first Gulf War, the Vatican was advocating national defense through the nonviolent methods of non-cooperation, such as strikes or boycotts — inspiring Duffey to write a book about it.

"I applied the conditions of just war and concluded that it's easy to use them for your own purposes," says Duffey. "For instance, one is that war can only be undertaken as a last resort. But how do you recognize when the point that there is no other recourse has been reached? My research is focused on nonviolent resistance as a Gospel response to injustice: 'Do not return evil for evil, vengeance for vengeance,' but find other ways to respond to injustice."

Duffey's fourth book will reflect his latest research: churches' roles in peacemaking in Guatemala. He is also working on a plan to foster interdisciplinary peacemaking efforts with research and outreach components.

"The call is loud and clear for Catholics to champion human dignity," says Duffey. "Not just talking about it but trying to change the social and political systems so that human dignity is affirmed."

Of humans and cyborgs

A tiny biosensor in a patient's heart signals that he is having a heart attack before he even realizes it. A microchip in a paralyzed patient's brain allows her to turn lights on and off and send an e-mail — just by thinking about it.

Technologies that once seemed impossible already exist. So what amazing frontier is next? And are we ready for it? That's the research focus of **Keith Bauer**, Ph.D., an assistant professor of philosophy who specializes in health care ethics and, in particular, the connection between information technology and health care.

His earlier research on implantable biosensors and microchips led him to study the transhumanism movement and the ethical implications of its mission, which is to use technology to expand human capabilities.

"They're basically advocating that we become post-human through the use of genetic manipulation, the use of nanotechnology, bio-implants," he says. "They figure they can increase our intelligence, our strength and our ability to adapt in hostile environments. So it raises a host of questions. Is this something we should be doing and, if we do, who gets access to these sorts of technologies? It also raises the question of what does it mean to be human?"

One issue he is studying is whether nanotechnology should be used for therapeutic purposes or enhancement. For example, if your eyes are damaged, should doctors use nanotechnology to simply bring you back to 20/20 vision, or should they also give you night vision?

Bauer believes that therapeutic technology has a legitimate moral use. But the line between therapy and enhancement keeps changing.

"What if eventually you get wide-scale adoption of certain genetic modifications? Say 75 percent of the American population is enhancing their child's IQ," Bauer says. "Is that an enhancement anymore or is that just a normal, routine medical procedure?"

Whatever the answer, Bauer is convinced of the need to think about these questions now. "Too often," he says, "ethics is just an afterthought."

Journalism, ethics and the law

Who is a journalist? One who performs a certain function at minimum standards, or one who adheres to best practices?

Erik Ugland, Ph.D., J.D., was one of 12 fellows selected to address those questions at the Media Ethics Colloquium at the University of St. Thomas in St. Paul. Ugland and his co-author, Jennifer Henderson of Trinity University, wrote an article addressing the legal and ethical dimensions of the question, "Who is a journalist?" and explaining how debates within each of those domains are too often conflated.

"We argue that what is routinely treated as a single debate really ought to be five or six," says Ugland, an assistant professor of broadcast and electronic communication.

According to Ugland and Henderson, these include constitutional, statutory and administrative contexts on the law side, and credentials and accountability on the ethics side.

The issue of journalistic identity is also central to some of Ugland's other research, which examines the role of news councils — organizations of media and citizens that hear, assess and resolve complaints by the public against the news media.

News councils are prevalent around the world, but in the United States exist only in Minnesota and Washington. In an age of very powerful institutions — including government, business and media — Ugland believes news councils could make a comeback.

"If the law is not used to restrain those institutions," Ugland says, "then people will turn to ethics to try to appeal to the moral sensibilities of their leaders."

Ugland adds that both of these research tracks are really about "who is entitled to engage in that discussion — who is entitled to shape journalistic practices. Does the public deserve a seat at the table?"

ETHICS

BIOTECHNOLOGY

UNRAVELING THE MYSTERIES OF PROTEINS

Daniel Sem, Ph.D., wanted to put a heart in hard science — something that wasn't always easy when he worked in the profit-driven biotechnology industry.

"Whenever I would talk about tuberculosis, that would always make the venture capitalists cringe … because there's not enough money to be made," says Sem, who was founder and vice president for biophysics at Triad Therapeutics in San Diego. "They told me, 'Your motivation has to be in one place or the other. Are you trying to make money or are you trying to sort of save the world?' And my thinking was, 'Can't we try to do both?'"

Now Sem, an assistant professor of chemistry, can focus on the underdogs: diseases that don't get enough attention and the dangerous side effects of drugs and pollutants. His passion for applied research found a home in Marquette's Jesuit, service-oriented mission.

Sem's specialty is chemical proteomics, which is the study of how chemicals interact with proteins. You could have several thousand proteins in a cell, but only a few might interact with a certain chemical.

"I view it as a constant war that's going on between us and our environment," he says. "Chemicals can be drugs that are attacking certain proteins and having a desired effect, or they could be pollutants that are attacking and having an undesired effect. It's sort of the yin and the yang of chemicals."

At Marquette, Sem has state-of-the-art tools to study that war. He's the founding director of the Chemical Proteomics Facility, which recently received $1.2 million of new equipment funded in part by the National Institutes of Health and the National Science Foundation. The big gun is a powerful 600 MHz nuclear magnetic resonance spectrometer, which allows researchers to study the structure of proteins and their interactions with chemicals. A second new instrument, a 400 MHz spectrometer, has a robotic arm that can analyze hundreds of samples overnight.

Sem's recent work has included researching proteins in Mycobacterium tuberculosis that could be targets for new anti-TB drugs, studying estrogen receptors in zebrafish, and examining a troublesome enzyme that metabolizes nearly one-third of all drugs in humans.

To study a pollutant that is causing birth defects in aquatic wildlife, he designed a fluorescent molecule that binds to the estrogen receptor, which allows him to see what's happening inside developing fish. The binding site for zebrafish is nearly identical to that of humans, so zebrafish could be used to screen for human breast cancer therapeutics or to learn how pollutants are affecting the human body. Next, he'll use nuclear magnetic resonance instead of fluorescence.

"If we could turn this into an imaging probe, an MRI probe, then we could use it as a diagnostic for humans," Sem says.

Sem also developed chemical probes that assess the environment inside a cell.

"It turns out that a lot of diseases — Alzheimer's, arthritis, Parkinson's — all show an imbalance in the oxidation state of a cell," he says. "It's a way of measuring that things are wrong inside the cell."

> "I view it as a constant war that's going on between us and our environment."

Sem was the first to create a fluorescent probe that could measure the oxidation state inside living cells, filling a crucial gap in what scientists understand about cell biology. The probe can also be used to see how drugs are working.

Sem is also researching the enzyme CYP2D6, which metabolizes 30 percent of drugs in the liver. In effect, that enzyme destroys a drug's effectiveness before it's even had a chance to work.

"We want to better predict what kind of chemicals bind to these proteins," Sem says. "Then there's the basic research question of trying to understand how one protein with just one little pocket can bind to hundreds of molecules. If it's like a lock and a key, how can one lock recognize several hundred keys? That's the mystery we're trying to solve."

Daniel Sem, Ph.D., is an assistant professor of chemistry and director of the Chemical Proteomics Facility at Marquette. He was the first to create a fluorescent probe that could measure the oxidation state inside living cells.

The lung: more than gas exchange

When most people think about their lungs, breathing — inhaling and exhaling — is likely the first thing that comes to mind. It's an important function, to be sure, says **Gary Krenz**, Ph.D., but the lungs accomplish much more than that.

Krenz, a professor of mathematics, statistics and computer science, researches various nonrespiratory functions of pulmonary circulation. For example, he studies what happens to blood as it passes through the lungs. "The lung is the only organ in the human body that receives all the blood from the heart," he explains. "The lungs modify the blood composition before it's passed to the rest of the body, and we're studying how and why that takes place."

Specifically, Krenz focuses his research on how chemicals are altered when they pass through this area of the body. "It's as if the lung protects the rest of the body by modifying certain chemicals," explains Krenz, who recently published in the *American Journal of Physiology – Lung Cellular and Molecular Physiology*, *American Journal of Physiology – Heart and Circulatory Physiology* and *Free Radical Biology & Medicine*.

Interestingly, Krenz is not a biologist or chemist by training — he's a mathematician — but he leverages biomathematical modeling to predict the properties of pulmonary circulation. "Our problems are initiated by cell biologists, anesthesiologists, biomedical engineers and others who want to know why the lung is behaving in certain ways," says Krenz. "In our hypertension studies, we examine the number of blood vessels, their sizes, and the combined impact on pulmonary pressures." Already, Krenz has broken new ground in understanding how the number of blood vessels increases and decreases due to external influences.

He splits his time between Marquette and a research lab in the Zablocki Veterans Affairs Medical Center, where pulmonary research is done on rats. Krenz lends his mathematical expertise to formulate models of how the lungs will react to treatments. The National Institutes of Health and Department of Veterans Affairs have supported his work with impressive research grants, paving the way for new discoveries in pulmonary physiology.

Cellular power

Just as any automobile depends upon its engine for movement, so human cells depend upon motor devices, cilia and flagella, for movement. It's the job of **Pinfen Yang**, Ph.D., to reveal how these two similar organelles "power" basic cell function and to understand why their defects result in a host of debilitating disorders — such as infertility, developmental disorder, cystic kidney and hydrocephaly.

Cilia and flagella are only visible with a microscope. But, according to Yang, they are "powerful biological machines" that oscillate with particular waveforms, just as people swim with different strokes using their arms and legs. A tightly regulated propulsive movement is required for cells in many organs to function normally. Only recently have biologists such as Yang tapped into the control mechanism of these similar organelles using green algae as a model organism.

"We did not appreciate the intricacy of these organelles until symptoms showed up because of various defective motilities, and we realized the machinery behind the movement was worth investigating," says Yang, an associate professor of biological sciences. "Now we know that diseases and disabilities could be due to defective motor machinery as well as the control mechanism."

When these motile organelles surrounding the chambers in the brain and spinal cord are defective, for example, headache or expansion of the cerebral ventricles develops. If biologists can restore normal motility, the disorders could potentially be reversed. Cells in other organs hold promise, as well. "This research will have a far-reaching impact if we can use our knowledge learned from green algae to repair or enhance the performance of cilia and flagella in patients," says Yang.

Healing the brain: the new frontier

For **David Baker**, Ph.D., glutamate isn't just another chemical in the brain. It's uncharted territory that could help neuroscientists better understand and treat schizophrenia and other disorders.

Baker, assistant professor of biomedical sciences, is researching a unique process in the brain that may be critical to treating brain disorders. His research is supported by the National Institute of Mental Health, National Institute on Drug Abuse, National Alliance for Research on Schizophrenia and Depression, and the Biomedical Technology Alliance.

While studying glutamate's role in addiction, Baker became intrigued by a mechanism, system xc-, that releases glutamate in a very unusual way.

"Essentially every neuroscientist assumes that neurotransmitters are released into very specialized gaps between nerve endings called the synapse. But system xc- appears to bathe the entire length of the nerve in glutamate," he explains.

Neuroscientists knew about this second pool of glutamate before, but they didn't know why it was important.

"The real discovery is that we are the first to show that glutamate released from system xc- is critical to how the brain functions," Baker says. "We have evidence that it's involved in addiction and schizophrenia. Other people believe it may be involved in Parkinson's Disease." Because glutamate is critical to most aspects of brain function, discovering a new pool may reveal a new treatment target for many neurological disorders.

The researchers initiated clinical trials for an existing drug that targets system xc-, and the results are promising. Baker also is collaborating with researchers from the University of Wisconsin–Milwaukee and the Medical College of Wisconsin to develop new and better drugs. Says Baker, "The new drugs will really be the test as to whether system xc- holds the key to the treatment of neurological disorders such as schizophrenia."

Marquette was one of the founding partners of the Biomedical Technology Alliance, which connects academic researchers with industry partners.

BIOTECHNOLOGY

A BITE OUT OF CRIME

An attacker bites his victim. A criminal munches on a sandwich before fleeing the scene. And those pearly whites might leave just the clue needed to capture the perpetrator.

The value of bite mark evidence became obvious during the trial of serial killer Ted Bundy, whose crooked teeth were imprinted in his victims' flesh. But until now, no matter how distinctive the teeth, forensic odontologists could only say that it was "probable" that the bite marks were made by a particular suspect.

L. Thomas Johnson, D.D.S., is working to change that. Johnson assembled an interdisciplinary team, including Marquette law professor **Daniel Blinka**, J.D., Ph.D., to create a database of dental imprints that investigators could use as a statistical measuring stick.

"Dentistry has always assumed that everybody's teeth are unique. But the problem is, there's no way that scientifically you can justify that," says Johnson, an adjunct professor of dentistry who has worked as a forensic odontologist for more than 40 years. "If we prove what we're setting out to prove with this pilot study, this database could be expanded to thousands of samples. We could have a database that begins to approach that of mitochondrial DNA, which is a virtual identification."

Johnson's team is collecting 400 dental imprints from men ages 18 to 44, the demographic that most often commits crimes that involve biting. Using software developed at Marquette, the researchers analyze the samples to precisely measure six identifying characteristics, including the width of the arch, width of the teeth, alignment and unusual characteristics such as missing or broken teeth. Then they statistically calculate how frequently those characteristics would occur in the population.

So why is all that data important? Suppose a court asks, "How common is it for an adult male to have a lower jaw width of 2.28 centimeters or smaller and to have tooth No. 24 turned at an inward rotation of 10 degrees or more?" Based on Johnson's preliminary data, he could say that he was "highly confident" that less than 3 percent of adult males would have that particular combination. As he accumulates more data, he expects to narrow the field even further.

The team is following the rigorous standards of the Scientific Working Group on Imaging Technology, and Johnson has several people measuring the dental imprints so that he can test the margin of error. The two-year pilot study is funded by the Midwest Forensic Resource Center in Ames, Iowa. Johnson's team is also working with the Wisconsin State Crime Laboratory.

> "Dentistry has always assumed that everybody's teeth are unique."

Many people assume that DNA is the end all, be all of criminal investigations, but that's not always true, Blinka says. During his time in the Milwaukee County District Attorney's Office, Blinka worked on a handful of bite mark cases, including a nationally prominent case in which bite marks were the sole evidence found at the crime scene.

"This is important because in the cases where bite marks do surface, we'll have the scientific mechanism to exploit any trace evidence that's left behind," Blinka says. "This is a powerful tool not only for pointing a finger at somebody but also for eliminating suspects."

But bite mark evidence has come under fire in recent years because of a handful of highly publicized cases in which it was incorrectly used. In one case, the testimony of a forensic odontologist contributed to the wrongful conviction of an Arizona man whose name was later cleared through DNA.

"Unfortunately, there have been cases where the quality of the evidence didn't meet the strength of opinion, which is what we're trying to counter here," Johnson says. "We want to put some science into this, and it's something only dentistry can do."

Daniel Blinka, J.D., Ph.D., on the left, is a law professor. **L. Thomas Johnson**, D.D.S., is a forensic odontologist and adjunct professor of dentistry. Together, they're creating a database that could advance the field of forensic odontology.

Dissecting financial fraud

Maureen Mascha, Ph.D., is teaching students to steal.

While this may sound incredulous, in a world where financial scandals have destroyed companies, it is necessary. Mascha, who researches fraud, teaches her accounting students how fraud may happen so that they are better prepared to identify it when they are hired as auditors.

"There is criminal liability for auditors who miss or overlook fraud," says Mascha, an assistant professor of accounting.

Mascha's research is partially supported by a grant from PricewaterhouseCoopers, the world's largest accounting firm. She is studying the issue of general versus application controls, which determines who has access to a company's systems. General controls manage all of a company's information technology systems and are essential to ensuring the integrity, reliability and quality of the internal control system. Application controls, which companies have focused on more than general controls, deal with the underlying transactions. While both contribute to the overall internal control environment, general controls are often harder to test and evaluate given their pervasive nature.

"The collapse of Enron was a breach of general controls," says Mascha.

Along with a colleague from DePaul University in Chicago, Mascha is examining internal auditors and external auditors and how well both are able to recognize the difference between general and application controls since each type serves a distinctly different purpose. Their hope is that the findings will determine what auditors know and identify how to strengthen the audit process.

Punishing corporate crime

In the movie *Wall Street*, the character Gordon Gekko declares that "greed is good." Certainly greed is one of the most basic motivations for human conduct. However, the field of corporate and securities law is founded upon the premise that human greed should be channeled toward the more productive ends of capitalism and away from conduct that achieves financial gain through the exploitation of others.

It is this fascination with the concepts behind the punishment of corporate crime that fuels the research and teaching of legal scholar **Edward Fallone**, J.D. "When I was a law student, my corporate law professor treated the study of insider trading, hostile takeovers and corporate crimes as the dry recitation of legal rules to be memorized," explains Fallone, an associate professor in Marquette's Law School. "My approach to teaching is different. I teach these cases as human tragedies (and sometimes comedies) involving greed, betrayal and corruption. In my view, the law in this area serves the classic end of all laws: to protect ourselves from our own worst impulses."

In light of today's dramatic headlines of corporate malfeasance, Fallone is looking at the concepts behind the legal code governing corporate law. Specifically, when most criminal law is premised on determining blameworthiness and the condemnation of an individual's mental state, where is the mind in a corporation? Whose mental state is it? And what punishment will serve the greatest good, for both the injured party and society?

Fallone is examining whether specific corporate statutes should exist in Wisconsin to deal with these issues within the criminal justice system. His research looks at what he calls the "prism of assumptions" that created the laws as they exist today. "Maybe we have been looking at this in the wrong light. If we already go after individuals involved in a corporate financial scandal such as existed at Enron, what does society gain by also going after the company?"

Sex offense — a family tragedy

What helps some families cope when a loved one is convicted of a sexual offense? Criminologist **Mary Ann Farkas**, Ph.D., and sociologist **Gale Miller**, Ph.D., are collaborating in a study designed to answer that question. Their findings may identify key social coping mechanisms for families, lead to the development of policies that improve the experiences of offenders in prison, and ease offenders' transition back into their families and communities.

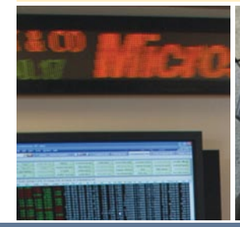
Many families sever contact with a convicted sex offender. Often the emotional stress and logistics associated with traveling to a prison for visitation are simply too difficult to manage. For others, the stigma of the crime is overwhelming. A small segment of families find positive ways to respond. "If we can study them, we can learn how they were able to deal with the problem in ways that most people can't," says Miller, a professor of social and cultural sciences.

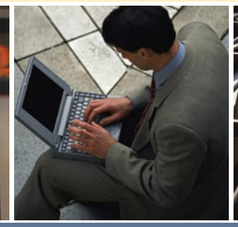
Miller and Farkas, an associate professor of social and cultural sciences, are interviewing adult members of up to 85 families who have maintained contact with imprisoned relatives. Through a series of three conversations with each adult, Miller and Farkas gather firsthand details of the perceptions, experiences and coping strategies the family members employed to maintain relationships after their loved one was arrested, convicted and incarcerated.

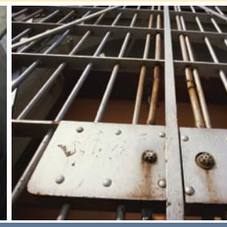
How families cope post-release is another focus of their research, which is endorsed by the Sexual Abuse Treatment Alliance. Registration, public notification and the strict monitoring and supervision of the sex offender may have divisive effects on the families. "Literature suggests that returning to an intact family makes a difference," says Miller. "This is partly about recidivism but also about a successful readjustment in terms of finding a job, locating housing, fitting into a community and being able to make a positive contribution. Family is kind of a critical gatekeeper in that."

Miller and Farkas are interviewing families in states that enforce a range of policies regarding conjugal and other visits, sentencing practices, post-release conditions and post-prison detention for some offenders.

We believe collaboration is an asset. In fiscal year 2006, Marquette faculty received $1.4 million for research equipment that will benefit not only Marquette faculty and students but also those at neighboring institutions.







CRIME

AGING

UNDERSTANDING THE DAMAGED BRAIN

Timing is everything. But for stroke survivors, poor timing and rebellious muscles can make even simple movements difficult. **Brian Schmit**, Ph.D., associate professor of biomedical engineering, and **Sheila Schindler-Ivens**, Ph.D., assistant professor of physical therapy, are searching for new tools to help stroke survivors conquer those challenges.

Although Schindler-Ivens and Schmit are supported by the American Heart Association and the National Institutes of Health for their own stroke studies, their collaboration is key in advancing what is known about the interaction between a damaged brain and impaired movement.

"What we know about people with stroke is that they don't produce enough muscle activity, and when they do produce enough, it's abnormally timed," Schindler-Ivens says. "In other words, muscles turn on and off at the wrong point in the cycle. So we're trying to figure out two things: One, why is their muscle timing poor, and two, what can we do to fix it."

Schindler-Ivens' earlier research yielded a surprising discovery: Stroke survivors performed better when pedaling backward on a stationary bicycle than when pedaling forward. Now she's trying to understand why.

While the subjects pedal, she magnetically stimulates their brains and records responses in their legs. She also uses electrical stimulation to activate nerves in the legs to see how the sensory information is controlled.

Stroke reduces excitability in the brain. But Schindler-Ivens believes that a novel task, such as pedaling backward, could counteract that effect.

"We think when the brain excitability goes up, the sensory feedback is improved and that also improves the muscle activation pattern," she says. "If it's the case that a more difficult or novel task actually increases brain excitability and improves walking, it could change the way we think about rehab."

With Schmit's help, Schindler-Ivens is adding a motor to the bike so she can control the speed and distinguish between changes in the post-stroke nervous system that are caused by simply being moved as opposed to locomotion, or the act of physically pedaling.

But to truly understand what's happening in the brain, the researchers need to be able to peer inside the brain while stroke survivors are pedaling — something they can do with an MRI. That's the next stage in their collaboration.

"Nobody has ever looked at locomotion in people with stroke while they're scanning the brain," Schindler-Ivens says. "And one of the reasons it hasn't been done is technically it's very challenging."

"The problem is if you take a bicycle into an MRI room, it becomes a ballistic missile because the metal from the bike is rapidly drawn into the magnet," Schmit explains. To prevent that, he and a biomedical engineering graduate student are building a bike out of plastic.

"This whole idea of building devices that can be used in an MRI environment is really interesting," Schmit says. "It could have a lot of applications."

Nobody has ever studied locomotion in stroke survivors while scanning the brain.

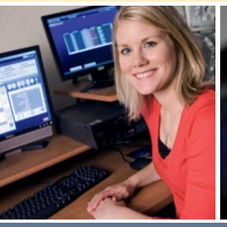
Schmit is also examining the role of sensory feedback. For stroke survivors, simply reaching out and grasping something is difficult. Schmit is experimenting with different devices and techniques, such as applying vibration to a muscle, that modify sensory feedback and make the brain think the arm is in a different place than it really is.

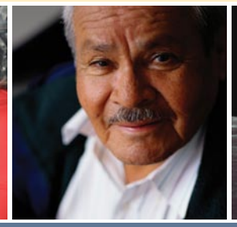
"What we're trying to do is trick the brain," Schmit says. "It seems kind of backward, but at least the subconscious part of the brain is going to be fooled, and that will make it easier for them to reach out and grasp."

Schmit's four-year study is exploratory, but he hopes to end with a design for a clinical trial. By unlocking the key to improving sensory feedback, he and others could accelerate stroke survivors' recovery.

Brian Schmit, Ph.D., is an associate professor of biomedical engineering, and **Sheila Schindler-Ivens**, Ph.D., is an assistant professor of physical therapy. Their research could help accelerate the recovery of stroke survivors.

More than half of the 120 research awards won by Marquette faculty in fiscal year 2006 included funds for student participation, reflecting Marquette's commitment to the teacher-scholar model.





Scrutinizing elder law

Alison Barnes, J.D., had a clear mission: after caring for her dying mother while she was in her mid-20s, she wanted to use her law degree to make a difference for people late in their lives. Today, as a leading scholar in the area of elder law, she has done just that.

Barnes' expertise is often sought after. She served as a senior policy analyst for the U.S. Senate Committee on Aging and then spent a year conducting research at the University of Cambridge. Soon after, she co-authored the first edition of *Elder Law*, the law text that defined the academic field and is used at more than 80 law schools. Barnes is completing the fourth edition with new cases and analysis of issues such as "reverse" age discrimination, intergenerational responsibility and elder care quality.

Barnes' research targets elder law and public policy questions, particularly health law and benefits. The Medicare prescription drug benefit implemented in 2006, for example, presents a multitude of issues, including the law's prohibition of drug price negotiation by federal government and the difficulty many seniors have in comparing the complicated plans. "You can't have competition among the plans if you can't compare them," she says. "And you can never compare them effectively when your health care needs and the plan itself are subject to change — as they are — every year."

Barnes is also examining the 2005 restrictions on Medicaid planning for long-term care. "This is an issue polarized by stereotypes that depict the rich elder as willing to hide assets to get that government-paid nursing home bed," she says. "The truth is far more complex, so understanding is stalled." The Law School is holding a national symposium on the topic in 2007.

She is the founder and adviser of the law review *Elder's Advisor*, which examines topics ranging from tax and estate planning to nursing home emergency preparedness after Hurricane Katrina. "Some of our most extraordinary students staff this law review," says Barnes. "They bring their intellect and passion to this field critical to us all."

Bringing clarity to delirium

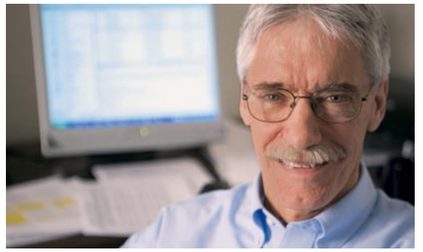
For aging patients, delirium can be a frightening and potentially dangerous condition. But it often goes undetected in hospitals, nursing homes, home health care and adult day centers.

Margaret Bull, Ph.D., a leader in elder health care, wants to change that. Bull is researching the prevalence of delirium in elders attending adult day centers. "Delirium is marked by a sudden change in cognitive status. If delirium is detected and treated early, it can usually be reversed," says Bull, a professor of nursing. "But if left untreated, it can lead to quicker decline in functioning or even death."

Previous research showed that health care providers are often "not tuned in to assessing for delirium," says Bull. Hospitals frequently discharged patients without detecting their delirium, which further deteriorated the patients' health and created confusion and worry for their caregivers. To prevent that, Bull is using a four-minute screening that could lead to early detection of delirium. She is the first researcher to use the screening in community settings.

Why is delirium so often missed? The nationwide nursing shortage means that often the same nurse does not interact with the patient for long enough to recognize the sudden onset of confusion or disorientation that marks delirium. Family members often dismiss the symptoms as part of the aging process. Shorter hospital stays also mean that providers might not notice a change in cognitive status.

Bull hopes her research will lead to improved understanding of care for elders in community settings. "As adult day care and similar arrangements become part of long-term care plans for those living at home or with relatives, this information is important," she says. "People in contact with elders on a regular basis are key to recognizing symptoms of a condition that can be readily treated."



Protecting muscles on and off Earth

What does growing older have to do with floating in space? Just ask **Robert Fitts**, Ph.D., a space biologist whose research on astronauts could apply to the elderly on Earth.

Fitts, professor and chair of the Department of Biological Sciences, has studied muscle wasting for NASA for more than a decade. His team was the first to study astronaut muscle at the molecular level and one of just two in the world to ever biopsy astronaut muscle.

NASA is counting on researchers such as Fitts to help astronauts go to Mars. Going to Mars would likely be a three-year mission, and after just six months in space, astronauts lose an average of 20 percent of their calf muscles. Researchers need to find ways to stave off muscle wasting and determine whether the rate of atrophy levels off after time.

Their solutions could help more than just astronauts.

"Muscle wasting in space is more accelerated than what you get from aging," Fitts says. "But with aging, especially from age 50 and onward, one loses a lot of lean body mass, which is mainly muscle. So the type of exercises that we will ultimately develop to prevent the wasting of the astronaut muscle will ultimately be applicable to aging populations."

It's particularly important for bed-ridden patients. In Fitts' earlier research, he used bed rest studies with subjects' heads tilting slightly downward, mimicking the effects of space flight. The cardiovascular response and bone and muscle atrophy were similar to that of astronauts.

Diet is also important. Fitts and collaborators have found that an essential amino acid supplement used during bed rest can protect muscle power.

"A lot of elderly don't eat right, and some lose their appetites, which is exactly what happens to astronauts," Fitts says. "So what happens is when they exercise, they use their muscle as fuel. It's sort of a vicious cycle: The aging process loses muscle anyway, and then you get a little more inactive, and that accelerates the loss, and then you don't eat properly, and that accelerates it further."

STUDENTS

UNDERGRADUATE STUDENT RESEARCH

A Marquette education challenges students to explore and innovate. And that means that undergraduates don't just read about research in the library — they jump into labs and get their hands dirty. Working side by side with faculty mentors, they advance their fields while getting critical experience. Then they take that knowledge into the world, presenting on campus and at professional and academic conferences across the nation.

Brian Kaster has conducted so much research over the past four years he can hardly keep it straight.

First there was the radio astronomy study. Next came the high-altitude balloon project, the functional magnetic resonance imaging study, the magnetic nanowire research. In between, there were conferences and poster sessions.

Such is the life of a 22-year-old senior physics major at Marquette. But even at a university ripe with research opportunities for undergraduates, Kaster's story is a little unusual. He started participating in research as a freshman, working under Christopher Stockdale, Ph.D, an associate professor of physics.

"What we were doing was looking at the supernova, the death of a massive star, and seeing how it progressed through time," says Kaster, who got a grant from the Wisconsin Space Grant Consortium for the project. "Then we used the information about how the signals change over time to get an idea of what the star looked like and what it was made up of before it exploded."

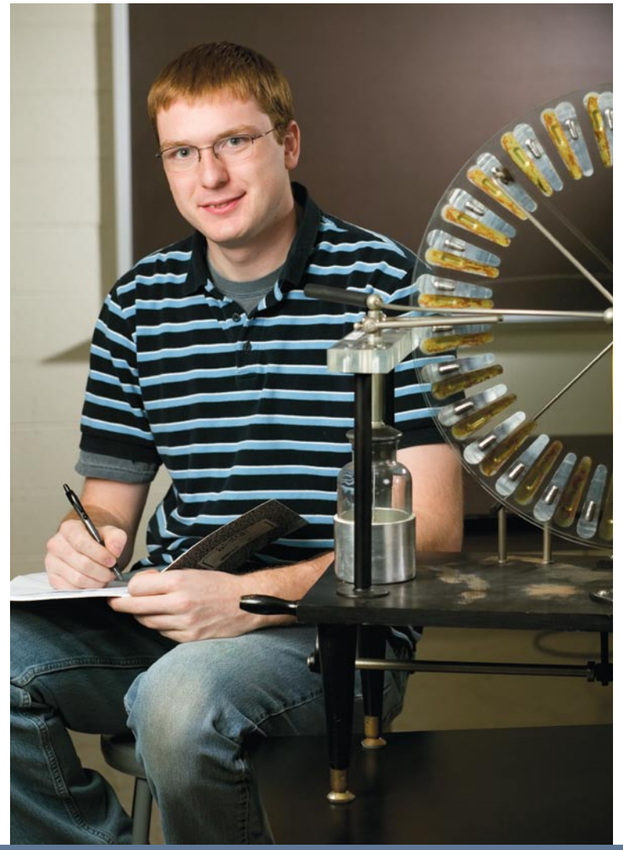
Using radio wave information from giant satellite dishes in New Mexico, Kaster converted the raw data into computer images.

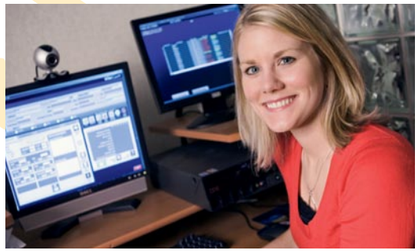
He later spent a summer at the Medical College of Wisconsin, where he wrote and ran computer simulations of neurons in the brain, a project he's continuing. That study's goal is to glean more useful information from FMRIs. MRIs give two pieces of information: How strong the magnetic field is, and what direction the magnetic field is pointing. Doctors usually only pay attention to the field's strength, which is much more precise, he says.

"What I'm trying to do is take that other data and get some sort of information out of it," Kaster says. "Because the majority of people just ignore that part of the data, there's a lot of room for growth."

He hopes his research experience gives him a head start in graduate school.

"It's taught me a lot," says Kaster, an aspiring professor. "You can get a lot from class, but with research, you learn from experience, you run into roadblocks and learn how to overcome them."





Heather Seubert knows the power of music.

As a sophomore, she started working with Jill Winters, Ph.D., R.N., associate professor of nursing, on a three-year study that examined how music affects heart rate after a heart attack. The experience inspired her to pursue a career as an advanced nurse practitioner.

"Research planted the seed of curiosity," she says.

Working in four different hospitals, the research team played low-rhythm music for patients recently treated for coronary thrombosis and then monitored the patients' heart rates. Seubert helped analyze the data, looking for patterns.

"Everyone knows that nurses provide care," says Seubert, "but the research helped me understand why we perform certain practices over others."

In the ever-changing medical field, there is a growing emphasis on evidence-based nursing practice. Seubert incorporates her research findings into her everyday work in the cardiac unit at Waukesha Memorial Hospital and the intensive care unit at St. Joseph's Hospital in Milwaukee.

When patients are anxious and tense, Seubert will limit activity in the room to reduce a rapid heart rate.

"I close the door, dim the lights, and offer to play music," she says. "The results are definitely there."

For a second study, Seubert worked with patients suffering from congestive heart failure who were treated with exercise therapy. Many of the subjects could not lift a basket of laundry or push a vacuum cleaner. After an increased exercise routine, patients could do more.

Working with patients' exercise habits stresses the education component in nursing. Seubert helps patients assess how to make individual lifestyle changes in order to stay healthy. This includes meeting the social, psychological and physical needs of each patient.

"Nursing is care for the whole patient, not just the disease," she says. "As a nurse, you have to take time out to make that one-on-one connection."

Anthropology major **Andrew Ozga** spent his senior year in the basement of Lalumiere Hall, sorting through boxes of human skeletal remains and looking for clues to the past. Who were these people? How did they live? How did they die?

It started when he took a class from Norman Sullivan, Ph.D., an anthropology professor. For years, Sullivan has studied the remains of a 19th-century Milwaukee County almshouse cemetery, which is the largest skeletal collection ever exhumed in North America.

"That really sparked my interest," Ozga says. "I worked in the bone lab, and it just clicked right away. I could see myself going on and doing something in this field for the first time."

As part of class, students studied the bones, taking measurements and noting other features such as sutures, gun shot wounds and broken bones that never healed.

Ozga got so into it that he started coming in outside of class. Classmates Ben White and Tara Cepon joined him. The trio already co-authored a paper for a bioarcheology conference, and they'll present at three more conferences this year. Ozga and White are also organizing a symposium on demography for the Central States Anthropology Society conference.

Next, they'll do an inventory of all the grave goods found in the collection. Artifacts include engraved rings, rosaries, buttons and shoes.

"Seeing those kind of puts a face with the bones," Ozga says. "It's kind of like traveling back in time."

The almshouse collection also inspired his senior thesis. He's focusing on a condition called diffuse idiopathic skeletal hyperostosis, which is a form of arthritis.

"It's an ossification of some of the ligaments in the spine, and it causes, at times, four or five vertebrae to fuse together," he explains. "It's really present in this population because of all the manual labor that people did."

Ozga is grateful for the research experience, especially since he's bound for graduate school.

"Working under Dr. Sullivan made me like this field even more," he says. "And the research aspect of it has made grad school that much more accessible."

ABOUT MARQUETTE UNIVERSITY

Marquette University is celebrating 125 years of faith and learning in action. We're proud of our rich history as a Catholic, Jesuit institution, and we're excited about our next 125 years. Recent accomplishments are only adding to Marquette's momentum:

- Our 12,000 undergraduate and graduate students come from every state and 80 countries. Student interest has never been higher with more than 13,000 students applying for just 1,800 seats in the 2007 freshman class.
- Rigorous academic programs in 100 undergraduate majors are recognized for challenging students to grow intellectually, spiritually and ethically.
- Excellent advanced education in 36 master's degree programs, 16 doctoral programs, 10 certificates and nine joint master's programs. Marquette is also home to the state's only School of Dentistry and a Law School with a reputation as a forum for public policy debate.
- $25 million given to the College of Engineering as the first part of a gift that could provide the university with an additional $1 million a year in perpetuity.
- *U.S. News & World Report* ranks Marquette 81st among the nation's top 100 universities in the 2007 edition of *America's Best Colleges* and highlights the programs in dispute resolution, biomedical engineering and education.
- Launch of a new Graduate School of Management offering M.B.A., executive M.B.A., and master's programs in accounting, applied economics and human resources.
- *BusinessWeek* ranks the College of Business Administration among the top 50 undergraduate business schools in the nation.
- Applied Investment Management program is the first undergraduate business program selected as a CFA Program Partner by the CFA Institute, an organization committed to maintaining the highest ethical standards in investment practices and education.
- *U.S. News & World Report* recognizes Marquette as one of the best examples of service learning in a feature characterizing Catholic, Jesuit education as one "that translates into granting students more than just degrees; it means, in the Jesuit tradition, no less than shaping the moral and spiritual character of young men and women."
- A sense of serving our community that's so contagious that 85 percent of graduating seniors report participating in service while at Marquette.
- Faculty scholars, including dozens of Fulbright Award winners and 2006 Wisconsin Professor of the Year Dr. Donald Neumann.
- *Washington Monthly* lists Marquette at No. 49 among 250 national universities noted for "contributions to society as engines of social mobility, fostering of scientific and humanistic research and promoting among students an ethic of service to country."
- National recognition of Marquette University student Tim Kummer for humanitarian outreach with an award presented by a national coalition of university presidents dedicated to fostering civic responsibility and community engagement.





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