IS THERE AN ENGINEER IN THE HOUSE?
Since its inception nearly 30 years ago, the Watson School has earned a reputation for innovative research that addresses society’s most pressing problems. So it was inevitable that, in response to the significant healthcare challenges facing society, researchers in the Watson School have turned their attention to health systems and the life sciences.

Over the past decade, research in these fields has become one of the most pervasive areas of inquiry within the school. This turn toward healthcare has been driven by the “grassroots,” as individual faculty members used their talents to solve problems related to their own research interests. For example, in this issue of the Watson Review you will read how Professor Mohammad Khasawneh’s work in systems engineering has made hospital emergency rooms more efficient. Watson School faculty have been collaborating on a variety of projects that fall under the health systems umbrella – from innovative electronic records systems, to models that increase our understanding of how cancer spreads, to electronic bandages and improved hearing-aid designs.

Thanks to the efforts of Associate Dean and Distinguished Professor Ron Miles and Vice President for Research and Distinguished Professor Bahgat Sammakia, the University is moving forward with a new healthcare initiative that will bring together faculty researchers from across the campus, with the Watson School playing a critical role. Drawing on Binghamton’s existing strengths, a new organized research center will attract significant federal funding while providing opportunities for collaboration with other universities and hospitals throughout New York state. It will help bring innovation to every aspect of healthcare, so that patients receive care that is efficient, effective, and ultimately, less costly.

Because our students are our primary concern, this initiative will help develop a curriculum that supports students interested in careers related to healthcare, ensuring that more students at both the graduate and undergraduate level can develop their focus in this important and growing field.

I am optimistic about the direction this initiative will take the Watson School and Binghamton University. That we are in a position to move forward speaks volumes about the dedication of the Watson faculty and the quality of their research.

Krishnaswami “Hari” Srihari
Dean and Distinguished Professor, Thomas J. Watson School of Engineering and Applied Science
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DEPARTMENTS

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With the recent announcement of the promotions of Ron Miles and Bahgat Sammakia, both professors of mechanical engineering, to distinguished professor, and James Pitarresi, also professor of mechanical engineering, to distinguished teaching professor, the Thomas J. Watson School of Engineering and Applied Science is now home to five active distinguished faculty and one emeritus, who work extremely hard and have the respect of the entire Watson School family. Dean Krishnaswami “Hari” Srihari and George Klir (emeritus), both of systems science, hold the rank of distinguished professor, and Victor Skormin, electrical and computer engineering, holds the rank of distinguished service professor.

**Ron Miles**, a rare combination of a thinker and innovator with the ability to turn scientific theories into engineering wonders, has successfully interwoven the fields of neurobiology, mechanics and acoustics to develop a biomimetic sensor with exceptional directivity for hearing-aid applications. His work has the ability to improve the quality of life for an estimated 500 million people worldwide who suffer from hearing loss. Miles’ scholarship includes more than 100 publications in leading journals, national and international conferences, invited lectures and workshops. Over the past 11 years, he has received more than $11 million in continuous funding from the National Institutes of Health and another $5 million to date from other federal, state, corporate and charitable sources. In 2003, he received the largest, single-principal investigator grant in the history of Binghamton University — $6.5 million. Miles is also the recipient of the Chancellor’s Award for Excellence in Teaching; the University Award for Excellence in Teaching; the Research Foundation Outstanding Inventor Award; and the Chancellor’s Award for Research in Science, Engineering, and Medicine.

**Bahgat Sammakia**, interim vice president for research, professor of mechanical engineering and director of the New York State Center of Excellence in Small Scale Systems Integration and Packaging (S3IP), is a path-breaking and innovative researcher in the thermal management of electronic devices and in electronic systems integration and packaging. He has published more than 150 well-cited articles in peer-reviewed journals and at highly selective conferences, and has co-authored a book and contributed to seven book chapters. Over the past decade, his research funding from federal sources, industry and New York state has exceeded $30 million. Sammakia holds 14 U.S. patents and has filed over 20 invention disclosures during the past decade. He is an ASME fellow and editor-in-chief of the ASME Transactions Journal of Electronics Packaging. He has received the Chancellor’s Award for Outstanding Contributions to Research, the Chancellor’s Promising Inventor’s Award and the Chancellor’s Award for Excellence in Scholarship and Creative Activities.

**James Pitarresi** has demonstrated teaching excellence at all levels. He has excelled in teaching lower-division courses, advanced undergraduate and graduate courses, and in mentoring professional engineers and faculty. He has a natural ability to connect with his students, which is reflected by the truly outstanding teaching evaluations achieved throughout his career and also by the respect he has earned from colleagues in engineering both within and beyond Binghamton University. His dedication and skill are surpassed only by his ardent commitment to preparing innovative and enthusiastic lectures and the manner in which he devotes extensive out-of-classroom time to teach and mentor his students.

**Industrial Office Connects Resources**

The newly configured Office of Industrial Outreach, led by Director Cheryl Monachino, is the new gateway for the Watson School’s industry resources, including professional development, EngiNet graduate distance learning, the New York Strategic Partnership for Industrial Resurgence (SPIR) program and student work-experience programs.

EngiNet courses are recorded live on campus and streamed online for distance learning students to view at their convenience.
Dreyer Joins Alumni Board

John G. Dreyer, MS ’76, was named to the Binghamton University alumni association board of directors. He received his master’s in computer systems from the Watson School and currently works as a program manager at Quantech Services Inc. in Lexington, Mass. Dreyer serves as vice president of development on the board and joins fellow Watson School alumna Tonya Parris ’92.

Green Engineer

Yu David Liu, assistant professor of computer science, received a five-year, $448,641 grant from the National Science Foundation’s Faculty Early Career Development (CAREER) Program. His research in “green” software development could pare down energy consumption of computers and electronic devices ranging from smartphones to servers. “I think every researcher wants to make the world better, and we just put it into our own perspective,” he says. “Sometime in the future, every computer science 101 class may include a lecture or two on energy-aware programming. As an educator, I’m excited about helping to ensure that next-generation programmers are green-conscious from the beginning of their careers.”

Westgate Honored as Engineer of the Year

Charles R. Westgate, Bartle professor of electrical and computer engineering and director of the Center for Autonomous Solar Power, was named Engineer of the Year by the Broome chapter of the New York State Society of Professional Engineers. Former dean of the Watson School, Westgate was chosen by nominators who called him “a superb engineer, a capable academician and a quiet, yet inspirational, leader.”

New Sustainability Minor Offered

The Watson School has a new minor in sustainable engineering. This interdisciplinary program will make it possible for engineering students to explore sustainable engineering principles, sustainable engineering design and sustainable technologies.

Read more online at binghamton.edu/watson/review
New to the School

SANG WON YOON
ASSISTANT PROFESSOR, SYSTEMS SCIENCE AND INDUSTRIAL ENGINEERING

Formerly a research scientist at the Watson Institute for Systems Excellence, Yoon is from South Korea. He received his industrial engineering degree from Chonbuk National University, his master’s in operations management from Korea University and his doctorate in industrial engineering from Purdue University. His research interests include healthcare systems engineering, integrated production and service systems, and collaborative control theory.

MICHAEL ELMORE, PhD ’04
DIRECTOR, ENGINEERING DESIGN DIVISION

Elmore received his bachelor’s degree in philosophy and master of education degree from the University of Vermont. He taught high school math for five years and later returned to the University of Vermont for his bachelor’s degree in electrical engineering. Hired by General Electric in Johnson City, Elmore stayed in the area for the next 25 years working at Celestica Corporation, BAE Systems and Lockheed Martin. He received his master’s in electrical engineering from Syracuse University and his PhD in electrical engineering from Binghamton.

The Engineering Design Division is a common freshman program that provides key communication and team-building skills while introducing students to the various opportunities in engineering before they select a major.

SYLVIA LOWEN, widow of School of Advanced Technology Dean Emeritus Walter Lowen, passed away Dec. 19, 2010, at 89. She was predeceased in 2006 by her husband of 62 years. The school, founded in 1967, was the precursor to the Thomas J. Watson School of Engineering and Applied Science. Contributions in honor of the Lowens may be made to the Walter Lowen Student Endowment at givetowatson.binghamton.edu.

Changhong Ke, assistant professor of mechanical engineering, was among just 43 researchers nationwide chosen by the United States Air Force for this year’s Young Investigator Research Program. His research on low-density, high-strength materials could allow the Air Force to reduce the weight of vehicles such as fighter planes and spacecraft.

The program supports scientists and engineers who have received a PhD in the past five years and show exceptional ability and promise for conducting basic research. Grants of $120,000 annually for three years support creative basic research, enhance early career development and increase opportunities for the researchers to recognize the Air Force mission and related challenges in science and engineering.

Ke Lands $120K USAF Grant

Read more online at binghamton.edu/watson/review
Healthcare gets WISE

Industrial and systems engineers help cure some of healthcare’s ills

Suddenly you’re dizzy, unsteady, your eyes aren’t focusing, and you’re having trouble talking. You could be having a migraine or, even worse, a stroke. Your family rushes you to the hospital. Then you wait. And wait. And wait.

Watson School Associate Professor Mohammad Khasawneh has had similar emergency room experiences and is now working to make healthcare more efficient and effective. Through the Watson Institute for Systems Excellence (WISE), an institute for advanced studies at Binghamton and part of the Watson School’s Systems Science and Industrial Engineering Department, Khasawneh and his colleagues have been working on a wide spectrum of applied research projects to improve hospital operations and patient experience.

Mohammad Khasawneh, associate professor of systems science and industrial engineering and assistant director for health systems for the Watson Institute for Systems Excellence.
The goal was to make healthcare more efficient, more effective, with higher quality and fewer errors — and, in the process, save lives.

—Mohammad Khasawneh
Poranki compliments WISE for its academic qualities and its ability to prepare students. “It is more than an education, it treats every student special. Because you work with regular employees and industry, you learn how it is in the real world and what it takes to succeed there.”

Hanh Nguyen ’07, MS ’09, who worked with WISE as a graduate research associate several years ago, believes the most valuable aspect of WISE’s academic approach is that it can be applied to just about any field. Nguyen, who is currently working with Montefiore Medical Center, a 1,500-bed teaching hospital in New York City, says “the WISE program is unique, it brings a lot of advantages to the table.” It has helped him learn to “take the context out of the problem. You can apply the same math and science to your subject whether you are looking at widgets made in a factory or reducing the number of falls in a hospital ward.”

Nguyen is currently helping redesign Montefiore’s pneumatic tube system, which transports light-weight carriers at high speeds. The technology is old, but it is still the fastest way to transmit physical samples and other information through the hospital. Unfortunately, the system’s design is inadequate for its traffic. Nguyen describes it as being like an old-fashioned highway system, with one-way streets and crowded intersections. His team is now working with the tube manufacturer and hospital administrators to implement a new system that will significantly increase efficiency among hospital employees.

Nguyen believes that systems engineering helps improve the quality of healthcare and helps reign in skyrocketing costs. “Better data allows us to be more efficient. It helps reduce the length of stay, which is good for both the patient and the provider.” But he recognizes no system will be perfect: “Another Binghamton and WISE grad, Joshua Bosire ’07, taught me that there are no ‘clean’ data, no normal distribution in healthcare, so your job is to reduce uncertainty.” Nguyen emphasizes, “If you limit uncertainty, you are helping the managers and physicians make better-informed decisions. That’s your job as a systems engineer.”

Research associates Fatima Irshaidat, Marybeth Attanasio ’10 and Osama Almeanazel at SUNY Upstate Medical University Hospital in Syracuse.

WISE FACTS

Watson Institute of Systems Excellence has:

- More than 50 projects in industrial, medical and public service research areas including electronics manufacturing and packaging, healthcare systems, manufacturing engineering, systems simulation, productivity enhancement, small-scale systems and decision-support analysis
- Several new projects and partners, including SUNY Upstate Medical University in Syracuse
- Research funding that topped $2.6 million in fiscal year 2010 and more than $2 million through March 2011, with healthcare awards accounting for 15% to 25%
Emotions

Lijun Yin wants computers to understand inputs from humans that go beyond the traditional keyboard and mouse. “Our research in computer graphics and computer vision tries to make using computers easier,” says Yin, associate professor of computer science. “Can we find a more comfortable, intuitive and intelligent way to use the computer? It should feel like you’re talking to a friend. This could also help disabled people use computers the way everyone else does.”

Yin’s team has developed ways to provide information to the computer based on where a user is looking as well as through gestures or speech. One of the basic challenges in this area is “computer vision.” That is, how can a simple webcam work more like the human eye? Can camera-captured data understand a real-world object? Can these data be used to “see” the user and “understand” what the user wants to do?

To some extent, that’s already possible. One of Yin’s graduate students shows how to give a PowerPoint presentation using only his eyes to highlight content on various slides. When Yin demonstrated this technology for some Air Force experts last year, the only hardware he brought was a webcam attached to a laptop computer.

Yin says the next step would be enabling the computer to recognize a user’s emotional state. He works with a well-established set of six basic emotions — anger, disgust, fear, joy, sadness and surprise — and is experimenting with different ways to allow the computer to distinguish among them. Are there enough data in the way
the lines around the eyes change? Could focusing on the user’s mouth provide sufficient clues? What happens if the user’s face is only partially visible, perhaps turned to one side?

“Computers only understand zeroes and ones,” Yin says. “Everything is about patterns. We want to find out how to recognize each emotion using only the most important features.”

He’s partnering with Associate Professor of Psychology Peter Gerhardstein to explore ways this work could benefit children with autism. Many people with autism have difficulty interpreting others’ emotions; therapists sometimes use photographs of people to teach children how to understand when someone is happy or sad and so forth. Yin could produce not just photographs, but three-dimensional avatars that are able to display a range of emotions. Given the right pictures, Yin could even produce avatars of people from a child’s family for use in this type of therapy.

Yin and Gerhardstein’s previous collaboration led to the creation of a 3D facial expression database, which includes 100 subjects with 2,500 facial expression models. The database is available at no cost to the nonprofit research community and has become a worldwide test bed for those working on related projects in fields such as biomedicine, law enforcement and computer science.

Once Yin became interested in human-computer interaction, he naturally grew more excited about the possibilities for artificial intelligence.

“We want not only to create a virtual-person model, we want to understand a real person’s emotions and feelings,” Yin says. “We want the computer to be able to understand how you feel, too. That’s hard, even harder than my other work.”

Imagine if a computer could understand when people are in pain. Some may ask a doctor for help. But others — young children, for instance — cannot express themselves or are unable to speak for some reason. Yin wants to develop an algorithm that would enable a computer to determine when someone is in pain based just on a photograph.

Yin describes that healthcare application and, almost in the next breath, points out that the same system that could identify pain might also be used to figure out when someone is lying. Perhaps a computer could offer insights like the ones provided by Tim Roth’s character, Dr. Cal Lightman, on the television show Lie to Me. The fictional character — based on the real-life discoveries of Paul Ekman — is a psychologist with an expertise in tracking deception who often partners with law-enforcement agencies.

“This technology,” Yin says, “could help us to train the computer to do facial-recognition analysis in place of experts.”

Lijun Yin speaks about the possibilities of facial-recognition software. Visit go.binghamton.edu/yin to see the video.
Programming may not be the most glamorous of computer science pursuits, but that’s where the heavy lifting occurs — and when you put 80 students in a room and give them three hours to answer a handful of programming problems, a unique and fun learning environment emerges.

It’s all about practice and hard work, says Patrick Madden, associate professor of computer science in the Watson School and advisor to the Association of Computer Machinery (ACM) student group that holds competitions each semester. “The students who excel are the ones who buckle down and work at it,” he says.

Some problems are based on number theory or geometry, while others involve advanced mathematics. “You want to have questions that everyone can do and some that not even the most talented students can get,” explains Tyler Stachecki ’11.

“Learning doesn’t have to be boring or stressful,” Stachecki adds. “At our competitions you’ll see people talking and enjoying themselves. Then they’re frantically working and getting frustrated. And laughing when they figure a problem out.”

According to Madden, the skills to be competitive — problem solving, math, composure and precision — are the same needed to be a successful computer scientist. And industry leaders recognize this. Binghamton students who do well in ACM competitions are being scouted and recruited by industry giants including Bloomberg, Google, IBM and Microsoft.

“Companies are looking for superstars. Everyone in the stack of résumés is going to have a good GPA,” Madden says. “These competitions are a great way to set yourself apart. You’re either the fastest or you’re not, and that can help a company focus its recruiting efforts.”

Binghamton University’s ACM student chapter has been sponsored by Bloomberg for several years. “We attend competitions each semester and then hold on-campus interviews,” explains Alex Jaspersen ’10, who was himself recruited by Bloomberg. “It gives us the opportunity to spread the word about Bloomberg and chat with motivated students about potential career opportunities.” In return the club gets much-needed funding. “Having funds to send 10, 15, even 20 students to a competition is a big deal,” Madden says.

Campus competitions are individual, but regional and national competitions require teamwork. “As with a job, they have to be able to listen, provide useful feedback and be able to share resources,” Madden says, adding that there is strategy in choosing which three students make up a team. “Good coders have a little ego, but they also know what they’re good at and can admit when they don’t know something.”

More than 50 Watson School students gathered to compete in the first ACM competition of the spring semester sponsored by Bloomberg®.

A MAGICAL CONNECTION

What began as a summer internship for mechanical engineering senior Corey Juliano ’11 blossomed into three senior design projects for the Magic Paintbrush Project. “I wanted to help out as much as possible. Most people don’t have any idea what it’s like for a family with a physically disabled individual to try to do any fun activities,” Juliano says.

Read the full story at binghamton.edu/ar/from-one-to-10.html
Industrial and systems engineering graduate Erika Rollins ’11 was born and raised in Rio Hondo, a small community of about 100 people in San Marcos Ocotepeque, Honduras. The town’s primary source of income comes from harvesting coffee beans. There’s a church and a one-room schoolhouse, and only two years ago they got electricity.

When it came time to pick a senior design project, Rollins, Adam Noel, Coralie Brutus and Meange Adeclat (all ’11 industrial and systems engineering), and Siobhan Alban and Roger Wan (both ’11 mechanical engineering), chose to address the inadequate water system in Rollins’ hometown.

“When pipes break all the time and they’ll leak for weeks,” Noel says. “There are no procedures to fix them.”

“When we started this project back in October, we started from zero,” Rollins says. With nothing more than a 40-page overview that talked more about agriculture and land use than water, they started talking with community members and members of the Ecological Association of San Marcos Ocotepeque.

The team traveled to Honduras in December with an initial written proposal. They saw firsthand the biggest culprit: a system of pipes that wasn’t constructed or buried properly. “There are 90-degree elbows set at 70 degrees and a lot of electrical tape,” Noel says. And some pipes are exposed — one lies just a foot from the road and has been damaged by the weight of cars. With these issues come concerns of contamination and E. coli, which is potentially lethal to 67 percent of the town’s residents who are children under the age of 18.

The trip also brought a design requirement to light. Given the history of the community and the locals’ knowledge of other water systems, they believe that a “good” water system must include a tank — something the group had discussed but did not consider a necessity.

On both sides of the globe, the team has found guidance from engineers and professors. In Honduras, a Peace Corps civil engineer has donated his time and experience to take measurements. In Binghamton, the students have worked with Computer Science Professor Yu David Liu, Industrial and Systems Engineering Associate Professor Sarah Lam on modeling and with their advisor, Raymond Barnes, PhD ’05, to secure and learn a continuous modeling software that’s not part of their typical education.

In April, Rollins, Brutus and Noel returned to Honduras to finalize crews and plans before the group returned with additional volunteers after Commencement, to kick off the build. While the project probably won’t be completed during their final two-week trip, they hope to leave with the community well underway and fully prepared to finish on their own.

“Often, projects there aren’t followed through to completion,” Noel says. “Our goal is to make sure that it gets done properly, completely, on time and on budget.”
n the tense days after Sept. 11, 2001, The New York Times reporter Gina Kolata introduced readers to a new and decidedly scary way to communicate. “The investigation of the terrorist attacks ... is drawing new attention to a stealthy method of sending messages through the Internet,” Kolata wrote.

“The method, called steganography, can hide messages in digital photographs or in music files but leave no outward trace that the files were altered.”

When Kolata’s article was published, Watson School Professor Jessica Fridrich, PhD ’95, had just created for the United States Air Force a powerful tool that made it possible to search, with a high probability of success, for one of the most commonly used technologies used to conceal information. Fridrich, a professor in the Department of Electrical and Computer Engineering, developed complex algorithms that could analyze the numbers used to encode pixels — short for picture elements — the miniature dots of which visual images are composed.

Pixels are the smallest individual units of a picture that can be controlled in the reproduction process. They are so tiny that a single photo may contain thousands, or even millions, of them. So looking for messages hidden within a photo is daunting.

But Fridrich’s novel algorithms were up to the task. Designed to scan the numerical sequences of the pixels, they looked for anomalies. Those variations, which produce slightly altered images — too small for the naked eye to detect — reveal whether an image is clean or contains secret messages.

Researchers uncover hidden messages

BY JIM H. SMITH
Hidden Writing

Steganography, the process of burying messages within other messages, is not new. Concealing written information using strategies such as disappearing ink and codes has been around for centuries. Until recently those techniques were known, collectively, as cryptography.

What makes steganography (from the Greek for “hidden writing”) of special interest today, Fridrich says, is “digitization and use of the Internet to transmit messages. It’s essentially a brand new field.”

Among those who’ve contributed to the rapid advancement of that field, few have made a greater contribution than Fridrich. When her first-generation algorithms had trouble with JPEG images, she quickly retooled them. In the process she discovered a method for identifying digital cameras from their “fingerprints.” She was as amazed as everyone else when she learned that every digital camera leaves a unique, random-looking low-amplitude pattern on the images it produces.

A native of the Czech Republic, Fridrich earned her master’s in applied mathematics from Prague’s Czech Technical University in 1987. She completed her PhD in systems science at Binghamton in 1995 and was honored with Binghamton’s Distinguished Dissertation Award. Her work in steganography came about by serendipity, however.

“I’ve always liked puzzles,” she says, and, in fact, her Binghamton website features a “cubing page” that describes her unique method for solving Rubik’s Cube in a breathtaking 17 seconds! It was because of her interest in solving puzzles that she began researching chaos theory in the 1990s.

But, in 1998, she received her first research grant on steganography, from the Air Force. Since then she has devoted her research to the cat-and-mouse business of inventing better and better technologies to embed information digitally — and find it. She has been awarded more than 20 grants by the U.S. Air Force, the National Science Foundation and industry, and she has published more than 100 papers, as well as a book, on the subject. Several of her students have gone on to positions in industry and academia, where they are applying and building upon her work.

Thanks to her, Binghamton is almost synonymous with hidden writing research. Just ask Electrical and Computer Engineering Assistant Professor Scott Craver.

The Next Generation of Covert Communications

As an undergraduate at Northern Illinois University, in 1997, Craver discovered a flaw in a digital watermarking security system. The ingenious method he invented to exploit the flaw made him famous. By the time he arrived at Princeton to work on his PhD in electrical engineering, the “Craver Attack” was already being cited in textbooks.

When Craver began to seriously contemplate a career in what he describes as “information hiding,” though, he encountered a problem. “Not many schools are working on information security,” he says. “Some have a single faculty member with an interest, but few have a department.”
BREAKING HUGO

In the game of steganalysis, learning is always about trying to up the ante. Is there a better, less detectable way to hide information? And, if so, what’s it going to take to find the hidden information?

Those were the essential questions posed last year by the first major international scientific steganalysis contest. Three prominent steganalysis researchers — Tomas Filler, PhD ’11, from Binghamton University, Tomas Pevny, PhD ’08, from the Technical University of Prague and Patrick Bas from the Centre National de Recherche Scientifique in Lille, France — collaborated on BOSS (Break Our Steganographic System). The team was well qualified to design a tough puzzle. Two of the three — Filler and Pevny — learned from the master, Jessica Fridrich, PhD ’95, professor of electrical and computer engineering.

What the three researchers wanted to test was the security of HUGO (Highly Undetectable SteGO), the steganographic technique they had developed for the contest. Last September they made 1,000 images available on the BOSS website. Teams from all over the world pitted their steganalysis skills against the challenge, trying to determine which of the images contained hidden messages and which did not.

So difficult was the task, in fact, that the HUGO images remained online for four months.

And that was barely enough time to complete the analysis, says Fridrich, whose team of students, the Hugo-breakers, ultimately won the contest, discovering more than 80 percent of the hidden messages.

“I was somewhat skeptical about the educational value of the contest,” Fridrich concedes. “It took a huge time commitment. But in the end I became a big believer and supporter of such competitions as the means for advancing the field. We all learned a lot from participating in it, and I think this sort of exercise can be a powerful learning tool.”

WE WORK ON COUNTER-DECEPTION PROBLEMS. YOU’RE TRYING TO GET AWAY WITH SOMETHING AND I’M TRYING TO CATCH YOU.”

—Scott Craver

The Watson School was the exception. He joined the faculty in 2004, and it has turned out to be a mutually beneficial relationship. A specialist in evading, breaking and reversing digital watermark security, Craver landed a three-year $300,000 grant through the Air Force’s Young Investigator Research Program two years after arriving in Binghamton. In 2009 he won the prestigious Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government to researchers early in their careers.

PECASE provides Craver with $200,000 a year for five years, and with that money he and his students are researching the next generation of covert communications. “We work on counter-deception problems,” he says. “You’re trying to get away with something and I’m trying to catch you.” One of the best ways to do that, he says, is to break codes and information hiding screens. Consequently, he and his students strive to create increasingly difficult codes to break and ever-improving technologies for doing so.

Using computer simulations, they design proof-of-concept software to illustrate their techniques for concealing encrypted messages in a range of media. Recently they discovered a way to manipulate the imaging of a simple screen saver so as to conceal messages that evade detection by any pattern-based algorithms. If they can figure out what kinds of tools hackers will be using next, they can develop methods for countering them.

That task will require a new generation of covert communications experts to follow Fridrich and Craver’s lead. Toward that end, Binghamton established the Center for Advanced Information Technologies (CAIT), directed by Professor Victor Skormin, in July 2005. In addition to Craver — its deputy director — and Fridrich, the CAIT has seven other faculty members and three research assistants.

“The research being done by professors Fridrich and Craver and their colleagues is cutting-edge,” says Ron Miles, Watson School associate dean for research. “Few universities can match it. It’s a real point of distinction for Binghamton and the Watson School.”

When Binghamton’s new Engineering and Science Building opens in the fall, the Seymore Kunis Media Core will enhance both Fridrich’s and Craver’s work. Named with a gift from Gary Kunis ’73 in honor of his father, a strong supporter of public education, the lab will provide flexibility for physical experiments that Craver says are often constrained by the limits of his current lab space. And it will feature the advanced computing capacity needed to solve the powerful algorithms that (as prominent computer scientist Rafael Alonso once said in describing the potential of Fridrich’s work) shine “a flashlight in the sewers of the Web.”
Some of the most meaningful undergraduate academic experiences come from research. Not only do students delve into a focused area of interest, they gain hands-on experience applying technical skills while putting their analytical and critical-thinking abilities to practice.

For students in the Watson School, opportunities abound; there are independent projects with faculty or organized programs such as the Research Experience for Undergraduates, the McNair Scholars Program, the Louis Stokes Alliance for Minority Participation summer research programs, the Undergraduate Interdisciplinary Research Program funded by the Howard Hughes Medical Institute and the Summer Undergraduate Research Fellowship Program offered through the National Institute of Standards and Technology.

Highly motivated students are entering the workforce with a jump on their fellow graduates. They’ve worked with leading researchers, co-authored published papers and given conference presentations. Could you ask for better real-world preparation?

This spring, we asked four graduating seniors and a recent alumna about their exciting and unique research experiences as undergraduates.

**R&D**

**Undergraduates dig deeper with research**

BY ASHLEY R. SMITH

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**Jesse Elwell ’11**

**COMPUTER SCIENCE**

**HOW DID YOU GET INTO RESEARCH AT BINGHAMTON?**

Junior year, I took advanced computer architecture and it piqued my interest in the low-level details of modern computer design. I inquired with Professor Dmitry Ponomarev about his research in secure architecture in modern computing systems, and he offered me a position as project assistant. I was also accepted into Binghamton’s Research Experience for Undergraduates program to continue my research over the summer.

**WHAT ARE YOU WORKING ON?**

My two active projects concern security in modern computer architectures. One evaluates performance and use of trusted platform modules and has yielded a paper that was accepted to the Design Automation Conference 2011. The second project is a hardware bounds-checking solution that utilizes multiple cores — we hope to have a paper ready soon.

**OUTCOMES TO DATE?**

I’ve co-authored two published papers in the last year. I was very involved in crafting the second, so it was a really great feeling when it was accepted.

**HAS YOUR EXPERIENCE INFLUENCED YOUR PLANS?**

I was inspired to pursue my PhD in hopes of becoming a professor of computer science with an active future in both teaching and research. I never considered a career in academia until I became a project assistant, but now I will be attending Binghamton’s graduate school in the fall.

**WHAT ADVICE WOULD YOU GIVE TO OTHER STUDENTS?**

Research is a challenging yet rewarding experience in which you can work on global issues, from computer security to cleaner energy. Remember that research is incremental — a simple idea, when combined with others, can produce beautiful results.
Julian Baldwin ’11  
BIOENGINEERING

HOW DID YOU GET INVOLVED IN RESEARCH?  
As I continued through the core curriculum, I started talking with my advisor, Professor Jacques Beaumont, about research opportunities within the department.

WHAT ARE YOU WORKING ON?  
Atrial Fibrillation (AF) is an abnormal heart rhythm affecting more than two million Americans each year. Effects of preventative healthcare are not immediate and we will never be able to fully switch to preventative measures, so we must continue to hone treatments for patients who have developed the condition.

Our goal is to determine the design specifications for a cardiac stimulator that will detect the presence of AF and deliver the appropriate amount of current at the right time to re-initiate normal electrical activity in the heart.

WHAT HAS BEEN MOST REWARDING?  
Getting accepted to and presenting at the National Undergraduate Conference on Research this semester. Research requires a lot of work that doesn’t always return dividends quickly, so when something good happens it keeps the work interesting and on focus.

WHAT ARE YOUR FUTURE PLANS?  
My research interests have swayed toward public health. I applied to a graduate program in public health microbiology and, if accepted, I want to examine the disease transmission shortcuts introduced to the human network by globalization.

WORDS OF ADVICE FOR OTHERS?  
When we’re curious about how something works, we really have two choices and sometimes have no option to choose. We can either Google it to find out what other people have done, or be one of the first to figure it out.
Maureen Gundlach ’06
MECHANICAL ENGINEERING

HOW DID YOU GET INTO RESEARCH AT BINGHAMTON UNIVERSITY?
I applied to the Summer Undergraduate Research Fellowship program at NIST, the National Institute of Standards and Technology. The Watson School chooses a few students each year who express an interest in research and assists in preparing their applications for the rigorous review process.

WHAT WERE YOU RESEARCHING?
A polymer called PBO – the main material in bulletproof vests. PBO is a very long-chain polymer that is spun into high-tensile strength yarn and woven into sheets of fabric. Many layers are then encased and worn as bulletproof vests. PBO degrades in the presence of heat, moisture, acid and mechanical damage, so the long-term project was to quantify these effects, and then contribute to national life-cycle standards of vests and legal cases regarding failures. I determined the effects of mechanical damage (such as repeated bending at the waist when sitting and standing) on the tensile strength of PBO fibers.

WHAT DO YOU REMEMBER MOST?
Sometimes we would bring our bulletproof vests to the ballistics lab. An intact vest would be strapped to a huge block of clay and shot at. When I stuck my thumb into the indentation and saw that the depth of penetration into an officer’s ribs correlated with the tensile strength of PBO, I had a great moment of, "Wow, my research can really affect people’s lives!"

HOW DID YOUR EXPERIENCES INFLUENCE YOUR FUTURE PLANS?
Although I found the subject of my research very interesting, the daily work of research didn’t fit my personality. You learn from every experience and it can be just as helpful to eliminate possibilities as to find them.

Isaak Ghebremicael ’11
SYSTEM SCIENCE AND INDUSTRIAL ENGINEERING

HOW DID YOU GET INTO RESEARCH AT BINGHAMTON?
In 2009, I began working with Professor Daryl Santos though the McNair Scholars Program and the Louis Stokes Alliance for Minority Participation summer research programs. These programs pair minority students with a faculty research mentor to prepare students for graduate school.

WHAT ARE YOU WORKING ON?
I’m working with Professor Santos on electronics packaging. We’re conducting a comparative study of different soldering systems used in electronics assembly by looking at the reliability (measured in hours to failure) of a soldering tip and the energy consumption of the different stations.

HAVE YOUR EXPERIENCES AFFECTED YOUR PLANS?
Working with Professor Santos has been a great experience that will prepare me to pursue my master’s and PhD in engineering. After, I would like to get involved and help other minority students graduate from engineering or science fields.

WHAT HAS COME OUT OF YOUR RESEARCH?
We received third place in the Best Paper category at the 2010 ASEE NCS Spring Conference in March for our paper, “A Comparison of Performance between Distance Learners and On-Campus Learners in a Graduate Level Quality Assurance Course for Engineers.” In July, I also presented our research at the 16th Annual University at Buffalo McNair Research Conference.

ADVICE FOR CURRENT AND FUTURE STUDENTS?
Take advantage of opportunities to work with professors during long breaks. You’ll develop good relationships with your professors and gain valuable experiences that will help you to be successful.
There are 10,500 miles between Menlo Park, Calif., and Roodepoort, South Africa. Yet, the distance is easily spanned by the mentor-mentee relationship of Kathi Kelly Lutton ’90 and Susan Rammekwa.

Lutton is a principal at Fish & Richardson, combining her undergraduate and graduate education in electrical engineering and early work in systems and software design engineering at GE with high-tech patent litigation. She covers technologies such as semiconductor technology, telecommunications, circuits and systems, computer technology, software and Internet applications.

Invited to attend Fortune’s Most Powerful Women Conference, Lutton joined the Fortune/U.S. State Department Global Women’s Mentoring Partnership three years ago. The program pairs emerging women leaders from around the globe with women leaders in the United States for a month-long internship. “I was intrigued by the program and the idea of giving back,” Lutton says. “It’s powerful to align these women from other countries with a network of women who all want to help each other.”

Lutton’s first mentee, Rammekwa, founded and runs the Tshepang Programme for Orphaned and Vulnerable Children in South Africa. The orphanage provides food, access to education and daily care for more than 200 children from 3 to 17 who have lost their parents to AIDS or other illnesses.

In May 2009, Rammekwa came to California for the better part of a month, and Lutton kicked her network into high gear. She brought Rammekwa and women from the Bay Area together to brainstorm ideas for the business. “She wanted to become self-sustainable, so we came up with ideas, and well known venture capitalists were able to point out the viable options,” Lutton says. “I’m a lawyer, so I can certainly help with leadership and running an organization effectively,” she says. “But I can also connect them to a network — with different backgrounds, experiences, thoughts — and that’s a lot more powerful.”

The relationship has stayed strong over the past two years, and in June 2010 Lutton traveled to South Africa with Pattie Sellers, editor at large at Fortune and renowned photographer Asa Mathat to deliver Rammekwa and her kids a new bus that was purchased through fundraising efforts. Lutton calls the experience “incredible.” “They live in a shanty town in...
After 16 years with Ford Motor Company, Jerry Lavine ’91 decided to shift gears by joining Next Autoworks, a startup car company that has yet to release its first car. Details of the new vehicle are coming soon, and Lavine is excited for what’s to come.

At Ford, he gained experience and responsibility working on various car lines, including Taurus (his first program), Fusion, Thunderbird, Mercury Milan and others.

Lavine was project manager for the Thunderbird program, working with people in engineering, design, marketing and public affairs to manage the business of launching and delivering the product. With the Fusion, he led the body engineering team, working from feasibility to launch. It was his favorite project, he says, because it was a “clean-sheet” design — all new.

“When you’re inside, you see cars differently,” he says.

Which is why he joined Next Autoworks. “I have the ability to start from scratch and help create a new car company,” Lavine says. “That’s what drove me to say, ‘I have 16 years at Ford, but I’m going to walk away. Can it be done, and can I be part of it?’

Lavine believes it can. As the vice president of engineering, he leads the entire engineering team. The company is small but boasts considerable experience, with employees averaging 20 to 25 years in the auto industry.

“We have a diverse team of people from every major car company on the road, so we’re able to leverage the expertise and learn from Honda, Toyota, Chrysler and Nissan.”

Lavine is excited to be promoting American manufacturing. Next Autoworks has purchased a former GM plant and hopes to employ 1,400 employees in Louisiana. “As an engineer, I never wanted to be a part of getting rid of jobs and people, but I did it for a year an a half, and it’s a very sobering experience. To say that I’m part of doing just the opposite is more important than anything else.”

Little has been released about the mystery car. But Lavine is confident that people are going to like what they see. “The shocker is going to be how we deliver such great safety, such great fuel economy and so much content at such a great price — and manufacture and engineer it here in the United States.”

“How many opportunities will you have in your life to start a new car company and actually build a car for mass America?” he says. “To create a new plant, a new work force, a new brand, a new car from a clean sheet of paper is an engineer’s dream. And, we’re going to do it.”

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Battling the Big3

The all-new, all-American-made engineer’s dream

single-room structures with no heat. They’re staying with friends, and some barely have a bed to sleep on. But they’re focused on the moment, singing, smiling and enjoying life. It was so beautiful to see the positive energy.”

“The enthusiasm that Kathi brings to this project is something we are seeing more of within the student body,” says Peter J. Partell, MA ’97, PhD ’99, associate dean for administration and academic affairs. “From Engineers Without Borders and the Society of Hispanic Engineers, to student projects, Watson School students are global citizens making a difference.”

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See more photos at binghamton.edu/watson/review

Battling the Big3

Read more online at binghamton.edu/watson/review
Once upon a time, when you dropped a radio, camera or phone and it broke, there was only one person to blame for its destruction: the klutz who dropped it.

But now that these products have melded into one, shrunk to the size of a deck of cards, virtual extension of our bodies — and drops are commonplace — we expect our phone/television/camera/video recorder/music player/daily planner to endure a mere 3-foot fall.

“Consumers are getting pickier,” says Seungbae “S.B.” Park, associate professor of mechanical engineering. “They say, ‘Hey, my friend dropped Product A more than a dozen times, and it’s still working fine; and I dropped mine once from not very high, and it’s broken. Mine must not be as good.’ Consumers are demanding manufacturers to make devices more robust, while at the same time attractive, thin and light.”

Today, manufacturers don’t have to worry about longevity as much as they...
it hits the floor. The world’s second-
largest cell-phone manufacturer,
Samsung, turned to Park to analyze
how its products fared.

“During a drop, there are many
things happening in a fraction of a
millisecond,” Park says. “The manufac-
turer needs to understand those very
high-speed drop sequences.”

To slow the action down, Park and
his team of students in the Watson
School’s Optomechanics and Physical
Reliability Laboratory record drops
with a high-speed camera that can
take up to 300,000 frames per second,
allowing them to see precisely when
parts such as chips and solder connec-
tions flex and break. They quantify the
deformations and enter the data into a
computer program so they can simulate
drops from all possible positions and
look at how all the potential drop
energy is consumed — through the
case breaking, sound generation,
circuit-board flex, etc. They then
try to come up with ideal solutions
that minimize damage of the critical
components inside the case.

“Then we try to understand the best
way to rearrange the chip location,
model shape, battery position, battery
size,” he says. The battery alone offers
seemingly endless possibilities. “With
the same amount of juice inside a
battery, there are many different ways
of making that chunk inside a

Call

Once did because people don’t expect
their cell phones to last more than a
couple of years. However, the biggest
challenge to reliability is the ability to
withstand the impact of being dropped.

Of course, the easiest, cheapest way
to make a product sturdier is to add
thickness and padding, but consumers
don’t want big, fat phones. So manufac-
turers are looking more deeply into the
mechanics of how a phone breaks when

Battery alone offers
seemingly endless possibilities. “With
the same amount of juice inside a
battery, there are many different ways
of making that chunk inside a cell phone — put it up, down, in the
middle; chubby or thin and wide. There are many
variations we can come up with.”

Finding the ideal
balance informs design from the
early stages of product develop-
ment. Park realizes that “designers are
designers,” artists

who want to create a thing of beauty
first and a thing of utility second. His
work gives them and the engineers they
work with a starting point.

Trying to understand the breaking
process better, Samsung brought its
products to Binghamton University
several years ago when it joined the
Integrated Electronics Engineering
Center (IEEC). The center is cutting-
edge, and the engineering advice is
second to none, says Samsung Senior
Engineer Soonwan Chung.

“Binghamton University is known to
have a lot of capability in faculty, facility
and industry network,” Chung says.
“Professor S.B. Park is so specialized
in electronics reliability, and Samsung
wanted to get his experience and
consult. His research output helped
us to make Samsung mobile phones
robust in view of mechanical reliability.”

The Samsung—University relationship
is a win for everyone, says Mechanical
Engineering Chair James Pitarresi.

Samsung receives valuable insights; the
University acquires greater visibility;
faculty members have access to
products that won’t be released to the
public for a couple of years; and students
earn real—industry experience.

The relationship also is good for the
public because it creates knowledge
that is useful across industries. When

the lab started looking at how cell
phones react to drops, Pitarresi was
amazed to find that there was hardly
any published literature.

“There’s one of two reasons,” he
says. “Number one, it’s because
we’re developing products so fast that
research hasn’t caught up, and we all
have our fingers crossed. Or number
two, it’s because some companies have
done some testing, but they keep it
very proprietary. So we’ve been able
to do some fundamental work here
and publish it, which helps the entire
industry.”

It also helps consumers because
companies don’t have to spend money
repeating investigations already
conducted. So Park’s work helps
industry make cell phones more
reliable and less expensive.

Mechanical Engineering PhD student
Da Yu, who wrote his master’s thesis
about the drop impact on reliability,
says the Watson School’s close working
relationship with industry also gives
him a leg up on his competition. As
a student he’s already worked on
real—industry issues, sat in on industry
conference calls and understands
industry needs and methods.

This spring, Yu interviewed with Apple
Inc., whose iPhone revolutionized cell
phones, and was offered an internship.

The area the company was most inter-
ested in was his work on drop impact on
product reliability.

“Binghamton University isn’t as well
known as some of the larger schools,
but companies are interested in our
work,” he says. “It’s mainly because of
those industry projects.”

"Dropped Call"
Fluid dynamics plays an integral role in the propulsion of a jet engine. Engineers know how the properties of fluids — density, pressure, temperature and velocity — work in engines to achieve compression, injection and thrust. Jacques Beaumont, Watson School assistant professor of bioengineering, hopes to one day have that same level of familiarity with biological tissues and systems.

“When we design the engine of an airplane today, the simulation is absolutely phenomenal. It’s reliable to the point where we have eliminated the need for wind-tunnel tests,” Beaumont says.

Creating computer models of the human heart is bringing that kind of progress to medicine as well. “We can simulate blood flow in an aneurism to predict the risk of rupture,” he says. “Or even simulate excitation of the heart.”

Beaumont uses modeling of the heart to develop noninvasive methods for assessing the risk of life-threatening arrhythmias. He notes that one in 2,500 people lives with a gene mutation that causes inherited heart arrhythmia, a life-threatening condition without a simple solution.

Virtual heart brings hope for rhythm disorder

BY ASHLEY R. SMITH
A healthy heart has a stable rhythm set in motion by electrical signals. When a mutation causes those electrical impulses to malfunction, the heart can beat irregularly.

Patients are typically diagnosed in their early 20s when they first visit a clinic complaining of weakness, frequent nausea and, in severe cases, syncope or a loss of consciousness. “From that point on, they need to be monitored very closely,” Beaumont says. “If an episode of arrhythmia lasts too long it can cause death.”

The particular mutations are often difficult to diagnose as they can differ from person to person. A certain number of elements are common, but variations in the mutation can cause different triggers of arrhythmias. For some patients, rapid changes in adrenaline — caused by such things as fear, anger or even the surprise of an alarm clock — can short-circuit their heart’s rhythmic beating.

“When the field started in the late 1980s, we had identified three mutations that put an individual at risk. Now we have 200,” Beaumont says.

But current treatment options are unreliable. While there are a number of drugs, Beaumont says their outcomes vary widely. “What works for one patient doesn’t necessarily work for the next.”

Another common treatment is the use of an implantable cardioverter-defibrillator (ICD). This device sends a strong electrical shock to resynchronize the heart’s cells. However, “it has to cover the entire volume of the heart, so the shock has to be strong. When you send a shock like this, you also excite nerves, and that causes pain,” Beaumont says.

“Every single shock produces pain. And when there are a number of false positives — we know it’s at least 20 percent — patients often elect to get their ICD removed despite the risk of cardiac death.”

As time passes, the probability of dying from cardiac arrest increases exponentially. According to Beaumont, by age 40, the probability of death for symptomatic individuals is 80 percent.

Thus, he and PhD student Ashley Raba ’07, MS ’09, are working to develop computer-simulated testing methods that will allow clinicians to assess the cause of a person’s arrhythmia and potentially cure it. If their research proves definitive, current treatments could be rendered unnecessary.

Once you know the mechanism, the cure follows,” Beaumont says, citing another heart condition known as Wolff-Parkinson-White syndrome. Wolff-Parkinson is caused by an extra electrical pathway in the heart that results in severe arrhythmia in young children and teenagers, limiting their ability to exercise. But once the problem was understood, finding a cure was simple. “We now have a protocol to stimulate the heart and, depending on how the heart responds, we locate the zone and apply radio frequency to scar that tissue.” The children are cured.

For their research into inherited arrhythmias, Beaumont and Raba are developing a computer heart model that will reconstruct an individual’s cardiac beat by personalizing the building blocks of the heart. “We know how human cells generate electrical impulse, and we know how they’re transmitted. The template model can then be modified with information collected clinically, including images of the heart through CAT scan and with message RNA through a blood sample,” Beaumont explains.

With this virtual heart, they will be able to run large-scale simulations. “The model will show where the arrhythmia is initiated, what conditions trigger it, and whether the patient will respond to certain therapies,” Raba explains.

“The modeling aspect of medicine could change everything,” says Ron Miles, Watson School associate dean for research. “It’s an area that is hopeful, but biological tissues are very different, and this kind of research is extremely difficult. But the promise is there.”
Offices and laboratories have begun to move into the new Engineering and Science Building, set to open this fall. Designed to LEED standards, the building integrates a number of sustainable features into collaborative and multifunctional spaces:

- The building’s main entrance, rotunda and bridge utilize in-floor radiant geothermal heating and cooling while a two-story photovoltaic wall of solar panels converts sunlight to electricity.
- The green roof insulates the building, helping to lower heating costs in the winter and cooling costs in the summer.
- Skylights offer the same insulation as a regular roof but allow for natural light to flood hallways, laboratories and shared spaces.
- Offices are located around the perimeter of the building to take advantage of maximum sunlight.

The overall design of the building is based on a model of shared lab spaces to encourage and facilitate collaboration. The labs are outfitted with chilled beams — a radiant HVAC system installed in the ceiling that uses water to heat and cool air at the source, saving electrical and heat energy. And the building is prepared for growth, boasting approximately 25,000 data drops (Internet ports) — more than any other building on campus.

See photos and more at binghamton.edu/watson/review
Hugo Uyttenhove and Kris Conrad support the Watson School

“I’m quite impressed with the state of the art of the Engineering and Science Building at the Innovative Technologies Complex and with Dean Srihari’s commitment to general systems theory — my field. My donation is a recognition of the faculty and the quality of education that they empower Watson students with, as they did for me.

“Your degree is something you refer to constantly because people want to know where you got it and in what field. It’s been fun to say Binghamton because since 1978, Binghamton has really been put on the map education-wise. It’s one of the best universities in the Northeast. It’s not just a reference; it’s an honor that I graduated from there.” — Hugo Uyttenhove, MS ‘75, PhD ‘78, Founder and CEO of IT-Sentry, Inc.

Bold.Brilliant.Binghamton — The Campaign for Binghampton University helps extraordinary students access the American dream through one of the best academic programs in the nation. With time running out on the campaign, please join the 30,000 people who have already contributed to bold.brilliant.binghamton.edu. Make your gift today!

$100,000 to the Watson School Equipment Endowment
Mike McGuinn demonstrates his team’s Mach-180 Power Laces — an auto-lacing sneaker — at the freshman engineering exposition. Eighty-two teams showcased their interactive objects built using Arduino as part of the common first-year engineering program.

See more photos at binghamton.edu/watson/about/galleries/arduino