

Watson Review

A newsletter from the **THOMAS J. WATSON SCHOOL OF ENGINEERING AND APPLIED SCIENCE**

Start-Up Suite boosts faculty entrepreneurs

Every academic researcher hopes his or her discoveries will break new ground. Although the numbers are growing, only a handful of Binghamton faculty have worked to make that ground the foundation of a business.

Howard Wang has joined the ranks of Watson School researchers reaching for commercial success. Wang, associate professor of mechanical engineering, has worked to perfect electronic inks, infused with nanomaterials, that could find their way into wallpaper computer

screens or clothes that regulate body temperature.

He has started a firm to bring his discoveries to market with help from the University's Start-Up Suite.

Housed in the Innovative Technologies Complex, the Start-Up Suite offers fledgling companies low-cost office space, a state-of-the-art conference room, access to business equipment and a receptionist. Companies that occupy the suite must have their roots in technology developed at the University and

work in areas related to the life sciences.

Wang, vice president and chief scientific officer of NanoMas, founded the company last year with fellow researchers and moved into the suite when Wang came to Binghamton from Michigan Technological University.

The NanoMas team has developed efficient, cost-effective processes for manufacturing electronic inks made of silver and zinc oxide nanoparticles suspended in liquid. The inks serve as conductors and semiconductors. Printing them onto thin, flexible substrate,

manufacturers can mass-produce circuitry much as a printing press cranks out newspaper sheets.

Along with paper-thin video screens and clothing that heats and cools as needed, these light, flexible electronics could form the basis for environmental sensors. They could also enable a new, less-expensive generation of radio frequency identification (RFID) tags, which manufacturers will embed in product packaging to help retailers manage inventory.

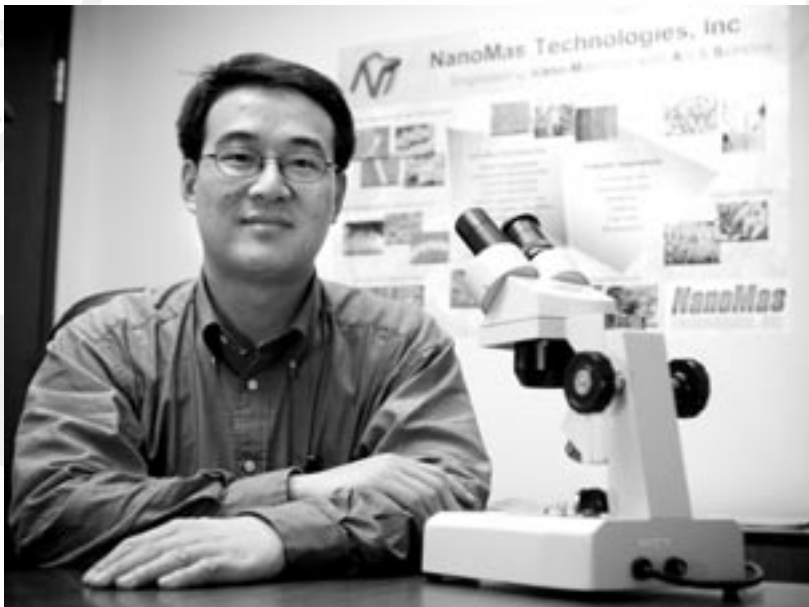
The urge to don the entrepreneur's hat isn't new to Wang and his colleagues: they've talked about founding a company for years, Wang said. "But we didn't get excited enough to say, 'If we don't do it, it's going to be too late.'"

Today, though, manufacturers who are developing machines to print electronic circuitry in high volume are getting ready to bring their products to market, probably by 2008. Once they do, demand for electronic inks will surge. So, for Wang and his colleagues, now is the time to make a move.

"We had our technology pretty much figured out," Wang said. "We had to get out early and let people know they could test on our materials."

Although many researchers work on electronic inks, NanoMas' nanoparticles are ideally suited to that application, Wang said. "For performance, smaller is definitely better," he said, "But smaller also means more unstable — difficult to

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The Start-Up Suite is helping Howard Wang, associate professor of mechanical engineering, establish his high-tech business. Housed in the Innovative Technologies Complex, the Start-Up Suite offers fledgling companies low-cost office space, a state-of-the-art conference room, access to business equipment and services, and a receptionist.

Leaping Ahead



Charles R. Westgate

A recent e-mail from the American Society of Engineering Education (ASEE) inquired politely whether the Watson School's research awards had indeed increased by 79 percent in a single year.

The ASEE supports a comprehensive database on engineering schools, and the reported increase seemed too large to include without verification, and it was a pleasure to provide that verification.

Thanks to both a growth in numbers and in productivity of our faculty, the Watson School has indeed achieved a great deal of progress in research funding, enrollments, and more. Readers of this publication can expect more in the near future as the school continues to expand.

By the fall 2007 semester, tenured and tenure-track faculty will have grown more than 60 percent since 2001 to support our growing enrollments and research programs.

There is more to our progress than sheer numbers. While we have grown dramatically, overall, ours is by no means a large school. Quality matters most, and we have had that quality in our faculty, staff, and students since the inception of our school. Our faculty and students have won increasing recognition through best paper awards, through national and international engineering and computer science competitions, and through research partnerships with industry, government agencies and academic institutions.

I am especially proud of our students in successfully competing with those in other leading universities and colleges in engineering design and computing competitions, and I look forward to this spring's competitions.

Another measure of quality is the

success of our alumni. As part of our accreditation visit, we survey alumni on their educational experiences and on their careers, and it is clear that our alumni have done exceptionally well. The feedback we receive is important to our continuing growth as a school, and I encourage our alumni to support us in these surveys and in other ways they can help. We depend on our alumni for financial support, for information on opportunities for our students in internships and employment, and for advocating on behalf of our school to prospective students and to those who can help us move forward. A great deal of program is directly related to the help of our friends and alumni, and I want to thank all who have contributed so greatly to our success.

Charles R. Westgate, dean

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THOMAS J. WATSON SCHOOL OF ENGINEERING AND APPLIED SCIENCE

Charles R. Westgate, Dean

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Program nurtures entrepreneurs *continued from page 1*

make as well as difficult to use."

Meanwhile, Susan Lu, assistant professor of systems science and industrial engineering, is collaborating with C.J. Zhong, associate professor of chemistry and co-founder of NSC Technology, another new enterprise taking advantage of the Start-Up Suite. The new firm has developed nanoparticle-based sensor arrays that could someday monitor air for noxious chemicals, or check diabetics' sugar levels without drawing blood.

Most sensors on the market today are designed to detect only one chemical at a time, Zhong said. But since people may need to monitor numerous substances in the air, these sensors aren't as useful as they might be.

Zhong and Lu are developing ways to package the chips in handheld devices with software to interpret the electronic signals, alerting the user to the presence of the target chemicals. A similar approach could produce a sensor to

indicate blood glucose levels.

While Wang and Zhong were the first occupants of the Start-up Suite, the possibility of moving into a well-appointed, on-campus office is encouraging more faculty to enter the commercial world, said Eugene Krentsel, the University's director of technology transfer and innovative partnerships.

If NanoMas were starting out on its own, it would have to settle for low-rent accommodations.

"We probably would be in a garage," Wang said.

Other services include help finding potential investors, dealing with intellectual property issues and scouting for space in the community when the time comes to expand. Krentsel expects the Start-Up Suite to fill in a couple of years.

NanoMas recently set up a laboratory on the Huron industrial campus in Endicott, where it expects to relocate its manufacturing operations this year.

Cryptographer Scott Craver wins prestigious AF grant



Scott Craver

A Watson School faculty member is one of 21 scientists and engineers nationwide who submitted winning proposals through the Air Force's new Young Investigator Research Program.

Assistant Professor Scott Craver, 33, was chosen from a pool of 145 for the honor, which comes with about \$300,000 in funding over three years. His work focuses on information security.

Craver, who holds bachelor's and master's degrees from Northern Illinois University, earned his doctorate in electrical engineering from Princeton University in 2004 and that year joined Binghamton's Department of Electrical and Computer Engineering. Researchers chosen for the program had to have received their doctorates or equivalent degrees within the last five years.

Grant recipients must show exceptional ability and promise for conducting basic research. The program, Air Force officials said, is designed to foster creative basic research and enhance early career development.

Craver loved codes, ciphers and secret writing as a child in Oswego, Ill., but doubted he'd ever make a living at cryptography. He traces his later interest in computer security to a professor who gave him a problem to work on during graduate school.

It focused on digital watermarks, in which information is secretly embedded in a file. These watermarks can be used as proof of ownership or as copy protection devices; in theory they could also be used to send covert messages.

Craver found a way to attack the copy protection system, and the

technique was later named "The Craver Attack" in a textbook.

The approach remains Craver's specialty. He recently led a team that won a contest in which researchers were challenged to break a digital watermark while preserving the image's quality. Other teams tried to break the watermark simply by adding progressively larger amounts of "noise" to the image. Craver's team exploited the watermark detector provided by the contest to reverse-engineer the information-hiding system.

"It's like 20 questions," Craver said. "Our whole effort was reverse engineering. Then, once we knew how the watermark worked, we attacked it."

Craver plans to use the Air Force funding to develop an automated process that will do what his team did during the watermark contest in a more efficient way.

The work will be relevant to any security that relies on a detection algorithm, including face-recognition and thumbprint-recognition systems. "You're basically trying to circumvent an alarm system," he said.

Coming to Binghamton made sense for Craver, who was attracted by the opportunity to work with security experts such as Associate Professor Jessica Fridrich.

"There's a big demand for computer security, but there aren't a lot of people who know how to do it," Craver said. "It's hard to find a university where you have other people doing the same work, so it's a good environment."

He has taught courses in cryptography, security engineering and information theory.

This is his second grant from the Air Force Office of Scientific Research, which earlier provided \$150,000 for other work in computer security.

"I'm really happy to get this funding," Craver said. "And it comes at just the right time."

Bioengineering seeks first grad program

While the four other engineering departments at the Watson School are accustomed to undergoing formal external reviews, the young Department of Bioengineering is undergoing the process for the first time.

The school's newest engineering program is currently seeking approval to establish its first graduate program — in biomedical engineering. This is a ten-step process requiring campus reviews, external evaluations, and approval by SUNY as well as the State Education Department, explained Kenneth McLeod, department chair. If the process continues to go smoothly, as he anticipates, a master's and doctoral degree program in bioengineering will be in place this year. Students in the biosystems track in the Department of Systems Science and Industrial Engineering will then transfer into the bioengineering department.

Meanwhile, the department is

also preparing for its first accreditation review, which the school's other engineering departments successfully completed last October.

Accreditation — by the Accreditation Board of Engineering Technology (ABET) — is a voluntary process for undergraduate programs. Since ABET criteria include a study of alumni outcomes as a measure of how well a program is meeting its objectives, most engineering departments don't seek accreditation until they have had alumni out in the field for a number of years.

The downside for early alumni, however, is that only those who graduated within one year of accreditation are "grandfathered" in, McLeod explained. To mitigate that, the department, which graduated its first class in May 2006, is seeking accreditation early.

The first class produced 26 alumni, about twice the number anticipated, McLeod said. The fall 2006 class had more than 40 students.

George Klir, pioneer in systems science, ready to retire



George Klir

Great thinkers, especially those in emerging fields, are often unrecognized in their lifetimes. That's not so in the case of George Klir, the distinguished professor of systems science who is retiring after 37 years at the University.

Acknowledged worldwide as a pioneer in his field, Klir has brought international attention to the Watson School, one of a small number of institutions offering graduate degrees in systems science. The author or co-author of 17 books and editor of ten, Klir has received six honorary doctoral degrees. Many of his 300 papers and books have been translated into European languages as well as Chinese and Japanese. He serves on the editorial boards of 19 journals, and he has been editor of the *Inter-*

national Journal of General Systems for 32 years.

Still, Klir is much more widely appreciated in Japan and Europe, where interdisciplinary study is more common. Michael McGoff, vice provost for strategic and fiscal planning, recalls traveling to Vienna in 1976 with Klir to attend a conference.

"It amazed me how his followers flocked to see him speak," says McGoff, a BU alumnus and former administrator at the School of Advanced Technology (SAT), the precursor of the Watson School. Klir was treated as an academic superstar, McGoff says, and the two of them were received by the president of Austria at the Maria Theresa Palace.

Systems science is studied more

widely under other names, such as cybernetics, general systems theory or computational intelligence, said Prof. Hal Lewis of the Department of Systems Science and Industrial Engineering. Whatever the rubric, these programs share a common interest in complex systems and are applicable to engineering, computer science, biology, medicine, the social sciences, economics and other fields.

"We [systems scientists] are in engineering schools by default," Klir says. "We do not fit naturally anywhere."

Systems science is the study of knowledge structures and is a bridge between natural language and mathematics, Klir says. As with applied mathematics, systems science is not confined to one field.

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Richard Culver, founding administrator, moves on



Richard Culver

Richard Culver, one of the founding administrators and faculty members of the Watson School, is leaving after 23 years.

Culver, who was hired by founding dean Lyle Feisel in 1984 to be the school's first associate dean, retired more than four years ago but stayed on as a part-time Bartle Professor to teach senior design students and to recruit students from community colleges.

Recruiting students was also a key part of his responsibilities during the school's early years, Culver said. In addition to being new, the school admitted only upper divisional students, and both factors made recruiting a challenge.

"I am proud of the relationship I've helped the school build with community colleges," Culver said. "These students have done very well at the Watson School."

In collaboration with Feisel, Culver wrote the academic policies for the electrical and mechanical engineering departments. After

his seven-year terms as an associate dean, the school was on a firm footing and his role had become largely managerial. He decided he wanted to continue to be a builder and designer — of the curriculum. He returned to the faculty and, in 1996, helped organize the lower division design program, D-TeC (design, technology, communication).

Although the program has changed and been re-named at least twice, it still gives students early experience as builders and designers.

Research had shown that engineering schools were losing too many students because they didn't offer engineering courses until the junior year, Culver said. By then, some students decided that they didn't like engineering, even though they had yet to take an engineering course.

Culver's solution was to offer lower-division students the opportunity to design and build assistive devices for handicapped persons in the community. This was very successful

and was expanded to include senior design projects. As the student body grew, however, this approach became unmanageable when faculty had to supervise more than 30 projects simultaneously. Still, by the time the program ended, students had built about 600 devices for local clients.

Culver's interest in pedagogy led to his service on the board of directors of the American Society of Engineering Education (ASEE), of which he is a fellow. His service on the board overlapped Dean Feisel's term as ASEE's president.

Culver and his wife plan to stay in their home on Binghamton's Westside. With friends, they bike in the summer and cross-country ski in the winter. They are also traveling to engaging places, such as the Galapagos and Machu Picchu. And he continues to design (with stained glass) and build (doing electrical and plumbing work for homeowners whose houses were ruined by last summer's floods).

"There's more than enough to keep me busy!" he said.

BConnected helps alumni, students advance careers

Engineers Week 2007 opened in February with a panel of Watson School alumni who shared details about their professional progress. These and other successful professionals and industry insiders are some of the most important advisers for current students.

When graduates provide information to the Alumni Office, they enable the Watson School to connect current students with professional and alumni activities. Alumni benefit as well because the school can then provide them with news about:

- alumni events in their communities,
- new degree programs in their professional field, and
- invitations to participate in on-campus activities with students.

One of the most valuable tools in developing this service is BConnected, a secure database restricted

to Binghamton graduates. (Go to <http://alumni.binghamton.edu> and click on the BConnected icon on the bottom right of the page.) Alumni can search for class-mates by year or by geography. Users should start by updating their information. Individuals can “hide” details (like unlisted phone numbers or names of their children) that they do not want to share.

Through BConnected, alumni can sign up for the Online Alumni Career Network. It is a searchable database of alumni who have volunteered to be contacted by other alumni and students regarding career information. Network volunteers can provide direction to those pursuing a first job or changing careers. Although the network is not an employment or placement program, it is designed to help alumni connect and tap each other’s talents and insight.



Students launched National Engineers Week with an alumni panel, “Careers beyond Coding,” sponsored by Upsilon Pi Epsilon. It featured, from left, Michael Mercincavage ’79, executive director of BU’s Strategic Partnership for Industrial Resurgence; Gregg Riedel ’93, ’95, director of broadcast systems at MTV Networks; Lynn T. Harrison, director of engineering at Diamond Visionics; David A. Goldman ’94, ’98, president and CEO at Soft Sight, Inc.; and (not shown) Edward Chin ’02, software engineer at Lockheed Martin Systems Integration.

The Alumni Association also maintains an e-mail forwarding service for all graduates. This allows graduates to create an @alumni.binghamton.edu address.

Alumni can access all of these services by entering the University portal through the Alumni and Parents website at <http://alumni.binghamton.edu>.

Two serving as school’s first residential faculty masters

Until last year, no faculty member from a Binghamton University professional school had served as a faculty master in the on-campus residential communities. Then Robert Emerson, professor of industrial engineering, made BU history

by becoming faculty master for Mountainview’s 1,300 students.

Next, William Ziegler ’76, associate professor of computer science, joined the Newing community as master, a role loosely modeled after that of the faculty dons of Oxford University.

Emerson said that working at a small college has always been one of his career aspirations. He has seven children of his own and, with his wife’s indispensable dedication, has taken in 30 foster children. “I like working closely with students,” he said, adding that he had been visiting small colleges while on sabbatical, with an eye toward moving on.

“Then this position opened up and I got what I wanted without having to leave Binghamton!” Emerson said.

“I knew absolutely nothing

about [opportunities in] residential life on campus. I really enjoy knowing students on a different level.”

Thanks to collaboration with his colleagues in the Engineering Design Division, in the fall 40 freshmen will become members of a Watson School “learning community” at the Mountainview complex. The students, who will be taking the same design classes and math sections, will have access to tutoring in their residence halls, and will take field trips to local industry and other opportunities that will strengthen them academically and support them socially.

“There’s just as much learning outside of the classroom as inside,” Ziegler said. “That’s why

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Professor Ziegler works with Christy Belew, resident director of Chenango Hall, in Newing College.

Graduate student wins top honors in two security events



Alexander Volynkin

Alexander Volynkin '03, a doctoral student in the Department of Electrical and Computer Engineering, has distinguished himself over the last year by earning top honors at two events concerned with security assurance.

First, he wrote a paper about a new way of detecting computer viruses, capturing the prestigious Best Paper Award at the Institute of Electrical and Electronics Engineers' Information Assurance Workshop last summer at the U.S. Military Academy in West Point. His co-authors were faculty members Victor Skormin and Douglas Summerville (his doctoral advisers), and graduate student James Moronski.

Next, he was first place winner in November at Pitney Bowes second annual Network Authentication Challenge held at Polytechnic University, New York City. The challenge was to reverse-engineer an authentication scheme and discover a flaw in its protocol, a flaw in the implementation, or other exploitable property.



More than 130 contestants from 28 universities participated in the network competition. The winner was determined based on the number of vulnerabilities identified, and clearly described, and source code to implement an attack.

"I just love the concept of being a member of the 'good guys' team participating in the arms race that takes place in the field of computer security," said Volynkin, 26, of

Siberia. His method tests software's ability to self-replicate, an approach that can detect previously unknown malicious computer codes.

Volynkin, who holds a master's degree from Siberian State Industrial University as well as a master's in computer science from Binghamton, expects to receive his doctorate in computer engineering this year. He credits his mother, who holds a PhD, with offering crucial help and support.

Volynkin teaches a class he designed focusing on computer viruses and malicious software. The course, for both undergrads and graduate students, also draws students from local industry. He prides himself on constantly updating the class materials to address new threats and vulnerabilities of computers.

"Alex puts in 80 hours per week on his studies, and I'm not kidding," Skormin said. "This is his hobby, this is his work, this is his love and main interest in life."

"What keeps me motivated every day," Volynkin said, "is the understanding that both computer security professionals as well as the 'bad guys' work constantly, day and night, all over the world. If I skip one day of work, I will be one day behind the rest of the world."

CS teams shine in web design contest

Two teams of computer science students have placed in the top ten in a worldwide competition sponsored by the Institute of Electrical and Electronics Engineers (IEEE).

As part of a semester-long project in Professional Ethics and Communication, a class taught by Prof. William Ziegler '73, two teams of four students entered CHC60: The IEEE Computer Society 60th Anniversary History Competition. It required teams to design and build a website that covers, in depth, a topic related to the history of computing.

Both Watson School teams advanced to the final round of the competition and finished in the top 10. Nearly 70 teams from 63 universities in 27 countries participated.

One of the Binghamton teams (Jeffrey Gibat, Matt Kornher, Peter Meyer and Allan Rysin) created a website called "Fast

Times: A History of Automotive Computing." The site (www.madconsultants.com/fastimes) includes engaging information of interest to a non-technical audience. For example, it notes that the number of cars worldwide is increasing at three times the rate of population growth. In World War II, Chrysler built engines for B-29 bombers while Mitsubishi built Zero fighters to shoot them down, but today the two companies build cars jointly at their Diamond Star plant.

The second Binghamton team (Chad Evans, Bryan Latten, Arin Lipman and Michael Perry) created a site about the "History of Evolutionary Computation" (<http://bingweb.binghamton.edu/~cshist2/>).

Prof. Ziegler was faculty adviser for both teams.

Junior engineer makes his mark as a first-class violinist

Akira Maezawa is making a lasting impression at Binghamton as a standout student in more than one area of study. The junior from Scarsdale, N. Y., is an electrical engineering major and talented violinist.

Douglas Summerville, associate professor and computer engineering undergraduate program director, has had Akira as a student.

"He can process new information faster than any student I've known," Summerville said. "In class, he immediately understands complex ideas and quickly synthesizes them into coherent thoughts."

A typical day for Maezawa includes engineering classes in the morning, rehearsals in the afternoon and making time to attend concerts. He practices violin every day and enjoys studying about electric acoustics in his free time.

Professor Timothy Perry, director of the University orchestra, believes Maezawa is one of the finest under-

graduate violinists he has seen in 21 years conducting at the University.

Maezawa began playing the violin 14 years ago and decided to join the University orchestra as a freshman. Today, he is concertmaster of the orchestra, a member of five chamber groups and a quartet, and collaborates with piano students.

One of his role models is Miller Puckette, a professor at University of California, San Diego, who created signal-processing software and plays the violin.

Maezawa, 20, hopes to go to graduate school to study acoustic engineering.

"When I first look at music, I break it up into smaller pieces, just like with engineering, because you are faced with one big problem that needs to be broken up and solved one by one," Maezawa said. "By the end, you have the culmination of one finished product, which is what music is about."



Akira Maezawa, a junior majoring in electrical engineering, is one of the finest violinists to attend Binghamton University.

He appeared as a soloist with the University Symphony Orchestra in spring 2006, and has won two campus music competitions as well as three scholarships.

"He possesses a great curiosity and joy for music, and his open mind and creativity make him a great musician," Perry said.

"You need to do what you enjoy even if it gets brutal sometimes," Maezawa said. "Don't quit, because in the end it will be rewarding."

College masters work closely with students

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we want to bring academic life into the residence halls."

Ziegler, who grew up in Vestal, was a computer engineer at IBM before he began teaching at Binghamton 29 years ago. He has often been a confidant for his students and has helped young people after difficult breakups and even a suicide attempt.

"I tend to be the kind of person who encourages students to come see me," he said. "I think I've seen a lot. I'll probably find out that I haven't seen it all."

Ziegler and his wife have three children. One of their sons is in college, the other is a high school senior and their daughter is a high school sophomore.

"My whole life revolves around college-age people," Ziegler said.

"Every night of my life has to do with the kids."

"Now that my own children are moving out," he joked, "I thought maybe I need to adopt a thousand. I'm having a great time. And the people I work with from Residential Life are absolutely wonderful."

Faculty masters play key roles in the University's living and learning environment, said H. Stephen Straight, vice provost for undergraduate education and international affairs. Straight said he is pleased to see faculty members from one of the professional schools step into this role.



Robert Emerson

Keesler named assistant dean

Alumna Janet Keesler, MBA '00, has joined the Watson School's Dean's Office staff as an assistant dean.

Keesler, who earned a bachelor's degree in chemical engineering from SUNY Buffalo, comes to the Watson School from the BU Office of Financial Planning and Analysis, where she interned and worked for six years. She also has worked for IBM as an accountant and was a planning and water chemistry engineer for NYSEG.

Graduate School cites two for excellence

Two computer science students have received 2006 Graduate School awards.

Joe Sharkey received the Excellence in Research Award and Sameer Tilak received the Distinguished Dissertation Award.

Systems pioneer George Klir to retire continued from page 4

When he was studying electrical engineering in post-Stalinist Czech-oslovakia, Klir noted that sophisticated methods for analyzing electrical circuits led to a new mathematical theory.

"I began to realize that there were profound similarities between phenomena investigated by diverse disciplines of science or engineering that allow us to transfer knowledge from one discipline to another," he said. "The boundaries between disciplines started to lose some of their significance in my mind."

In the early '60s, when computers were in their infancy and he was teaching at the Institute of Computer Research in Prague, there was widespread interest in computers, but only a small number of researchers were familiar with them. Consequently, he was invited to speak to a wide range of audiences. This led him to work with biologists, physicians, economists, linguists, psychologists and even musicologists.

These collaborations strengthened his belief that "systems and problems were not completely different from one discipline to another." Each system shares fundamental concepts such as information, control, organization, structure, invariance and change, learning and pattern recognition.

Meanwhile, censorship and dogmatism reigned in Czechoslovakia,

making research difficult. Klir seized an opportunity to teach at Baghdad University, where Western media were readily accessible.

When his two-year assignment in Iraq came to an end, he managed to immigrate to the U.S. and taught computer science at UCLA and Fairleigh Dickinson University, but interest in systems science was still lukewarm. Two of Klir's books were already in translation when he was enthusiastically recruited by the late Walter Lowen, dean of the SAT.

"For the first time, my work in systems research was really appreciated and encouraged," Klir says. He served as department chair for 16 years (1978 to 1994).

To lay people, systems science can seem impenetrably abstract. Traditional engineering is much easier to understand: it designs and assembles the components of complicated systems, which can be understood in isolation. But the failure of a key component can crash a *complicated* system. A *complex* system, however, is more adaptable and robust, and can't be controlled for laboratory study.

For example, it's difficult to unravel public health problems by setting up highly controlled trials — the controls that ostensibly give trials credibility, render the outcome useless in the real world. The experimental method strives to eliminate or equalize variables but, in systems

science, the layers of variables in human populations can be a resource for analysis.

Although he prefers developing theoretical foundations, Klir can be down to earth: he has collaborated with Binghamton geologist Robert Demicco to apply fuzzy theory to problems in Earth science. Their collaboration produced an anthology, *Fuzzy Logic in Geology*.

"George Klir has been at the forefront of applying fuzzy logic to Earth science problems," Demicco says. "Geology is a curious hybrid of very precise measurements and less rigorous, but nonetheless true, qualitative descriptions of landforms, storm events, tsunamis, etc."

"Fuzzy logic is ideally equipped to integrate both kinds of data. Klir has been instrumental in developing models that can faithfully predict the depositional patterns in such complicated areas."

After one year as a Bartle Professor, Klir plans to write a well-researched history of fuzzy logic, based on interviews with its founders, whom he knows personally. Lotfi Zadeh, the father of fuzzy logic and one of Klir's colleagues at the University of California in the '60s, was ridiculed when Zadeh introduced his theories. "It is a wonderful example of a grand paradigm shift in mathematics that affects everything," Klir says. "In retirement, I will be busier than ever."

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