Each of us has had moments of insight when confusion and questions gave way to new perceptions and knowledge. Greek mathematician Archimedes exclaimed, “Eureka! I have found it.”

In this issue of Inside Research, we share some of the many Eureka moments of our faculty. You will read about the breakthrough research of biologist David Davies to unlock the secrets of health-threatening bacterial colonies, the internationally recognized work of management professor Bruce Avolio on civilian and military leadership styles, and the digital security discoveries by mathematician Jessica Fridrich. You will also learn about the school health report card developed at the Decker School of Nursing that is becoming a national model, and the insights of author Thomas Glave, whose recent work is earning him as well as the University widespread acclaim.

As biology researcher Susannah Gal points out, Eureka moments of insight and discovery come most readily to those who have prepared well. Over the past several years the University has focused more intensely on preparing and equipping our students and faculty to make their own discoveries and to improve those made by others.

We have constructed and renovated new laboratory facilities, created new research centers and academic programs, continued to recruit talented faculty and students, and competed successfully for private and public research funding. Our goal is to prepare our graduates for the challenges of a highly technological, fast-paced global economy and to encourage our faculty to contribute innovations that will extend economic and social benefits to all.

We are proud to share with colleagues and supporters the bounties of our excellence.

Lois B. DeFleur
President

Charles H. Duell, U.S. patent office commissioner under Theodore Roosevelt, said, “Everything that can be invented has been invented.” He recommended that Roosevelt close the patent office in 1899.

Today it’s hard to imagine that anyone could believe as Duell did. As the body of human knowledge expands at an unprecedented rate — some projections suggest that by 2020 it will double every 73 days — we take a more humble approach to discovery. We celebrate our Eureka moments not only for what they make clear to us, but also for what they reveal about how much more we can expect to discover.

At Binghamton, we believe in the enduring power of scholarship and research. Over the past three years we have seen a near doubling of external funding applications to more than $100 million, leading to a record $22 million in awards this year. From our recent hiring of a new assistant vice president for technology transfer and economic development to new programs in the life sciences and engineering, our commitment to redefining “the possible” as a means of promoting vitality and economic diversity is unwavering.

We recognize, too, that research is our stake in the future — that every partnership we pursue, every Eureka moment we enable and every curiosity we quicken becomes a part of the tapestry of discovery. That’s why we aggressively pursue state, federal and private-sector investments to expand core laboratory facilities, state-of-the-art equipment, entrepreneurial faculty and graduate stipends.

The scope of the research and scholarship featured in this publication validates my belief in the importance of the work being done across Binghamton University’s five schools and 35 academic departments. In partnerships on and off campus, it’s clear that our faculty and students are igniting innovation, imagination and invention and beyond the Southern Tier.

If only Mr. Duell could see us now.

Frances E. Carr
Vice President for Research
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**PROJECT WILL TRY TO CORRECT STUDENTS’ MISGUIDED SCIENCE**

When Nancy Stamp asks elementary school children where the “stuff” that makes up trees and plants comes from, many immediately respond “from the soil.” In fact, plants and trees, which consist mostly of carbon, get most of the materials they need to exist from carbon dioxide — a gas from the air, not the ground.

To help end such common science misconceptions, Stamp is using a $1.16 million National Science Foundation three-year grant to team Binghamton University students with K-12 classroom teachers to develop lessons to counter young students’ most common misconceptions about the world.

Stamp, a professor of biology at Binghamton, said, “There are lots of these basic misunderstandings about how the world works.”

**BIG SCREEN PANELS GET A BU BOOST**

Bigger, clearer, cheaper — when it comes to flat-screen television, it’s the hottest ticket in town. The latest developments in the technology are partially the result of research conducted by James Constable, professor of electrical engineering, and Gary Lehman and James Pitarresi, associate professors of mechanical engineering, who have worked together to bond liquid crystal circuitry to glass panel displays to make 38-inch flat-panel TV screens.

The trio, part of the University’s Integrated Electronics Engineering Center, are teamed with researchers at Cornell University and Kaiser Electronics of California as part of a $2 million grant to Rainbow Displays Inc. of Endicott to perfect the technology and bring it to market. The grant is from the National Institute of Standards and Technology’s Advanced Technology Program.

**NIGHTSHADE’S CHEMISTRY IRRESISTIBLE TO HORNWORMS**

Binghamton researchers have found evidence that the eating habits of the tobacco hornworm are affected by a chemical found in one of its favorite foods — leading to perhaps the first clear evidence of chemical sensory tuning in insects.

The work of researchers Carol Miles, an assistant professor of biology, and Marta del Campo, a post-doctoral fellow, regarding the eating preferences of the Manduca sexta moth merited a report in the May 10 issue of the British journal Nature.

Miles and del Campo have discovered that hawkmoth larvae, commonly known as tobacco hornworns, respond to a chemical stimulant in leaves of the nightshade family of plants — tomatoes, potatoes, petunias and eggplants. The stimulant is so strong that the hornworms would rather starve than switch. Nightshade leaves are so beneficial a food that the larvae’s size increases by a factor of 10 in the final four days before they molt into hawkmoths the size of a bird.

The secret, Miles and del Campo have discovered, is that nightshade leaves contain the substance Indioside D, which spurs neurophysiological changes in the larvae that alter their behavior. There is no indication that Indioside D has any significant nutritional value, but the researchers’ next investigative project will look at the possibility that the substance is somehow integral to the insects’ development.

Their work is funded in part by a $98,552 grant from the National Science Foundation.

**THE DRIVE FOR SAFETY WINS A GRANT**

When you’re driving down the road trying to pay attention to traffic, and speed, and weather, and still follow the map, it can get pretty hairy and unsafe. Predicting how drivers react under such trying conditions — and then throwing in the influence of the ubiquitous cell phone — has earned University researchers and a Southern Tier maker of driver simulators a $512,000 grant from the Office of Naval Research.

Frank Cardullo, associate professor of mechanical engineering, and Harold Lewis, associate professor of systems science and industrial engineering, are working with a simulator from Doron Precision Systems, Inc. of Binghamton to construct a mathematical model that predicts how human factors influence tasks such as driving.

“We’ll start with simple driving and navigational tasks; then we’ll make the navigation more and more complex so the driving becomes more and more cognitive,” Cardullo said. The Navy will apply the research to the complex and sometimes dangerous conditions its pilots and sailors face.
COMMON PLANT, UNCOMMON RESEARCH

After almost 10 years of work with colleagues from around the globe, Susannah Gal can take pride in being on the first team to map a complete plant gene sequence. While the research was uncommon enough to be noted in the December 14, 2000, issue of the British science journal Nature, the subject of inquiry was the most common of plants, thale cress, otherwise known as Arabidopsis thaliana.

Thale cress, a cousin of the cabbage and mustard family, was chosen for its small physical and genome size. Its genome, the mechanism that passes molecules of DNA from one generation to another, has about 25,000 genes. Gal concentrated her portion of the research on genes that produce enzymes, or proteases, that break down other proteins. After completion, her results were submitted to the international Arabidopsis database.

"Now everyone in the world can access the research conducted here at Binghamton," Gal said. "My guess is that we’ll start seeing the benefits of our research in less than 10 years."

KUDOS

For his scholarly indictment of the wartime emperor of Japan for war crimes, Herbert P. Bix, a just-appointed professor of history and sociology, was named a winner of the 2001 Pulitzer Prize for general non-fiction. Bix’s provocative work, Hirohito and the Making of Modern Japan, challenges the widely held belief that Emperor Hirohito was unaware of and uninvolved in World War II-era war crimes. Bix, using a broad-brush approach that began with Japan’s pre-war invasion of Manchuria in 1936, asserts that Hirohito was an active force in his nation’s conduct of the war.

A newly discovered multi-millennium-old bacterium that feeds on minerals in the muck of the Dead Sea now bears the honorific name of Alex Shrift, a University biologist who died in 1992. Selenihalanaerobacter shrifti represents a just-discovered genus and species turned up by a team from the U.S. Geological Survey’s Menlo, Calif., laboratory. The team renamed “DSSe-1” to celebrate Shrift’s work on bacteria that feed off the chemical selenium. Their discovery and the new name was unveiled in the Archives of Microbiology earlier this year.

Four faculty members were honored for their distinguished research by State University Chancellor Robert L. King during the past year.

Kathryn Kish Sklar, distinguished professor of history and co-director of the Center for the Historical Study of Women and Gender, was cited for work that uses the complexity of individual women’s lives to understand the historical forces. Sklar recently received a $100,000 grant from the National Endowment for the Humanities to expand her highly acclaimed women’s history website.

Bruce Avolio, a 2000 winner of the University’s Excellence in Research Award and an internationally recognized expert on leadership, was cited for his role in developing a leadership school to help area schools meet a critical need for the next generation of administrators. (See story, pages 22-23.)

Ronald Miles, mechanical engineering professor, whose work in developing an omnidirectional hearing aid, inspired by the ears of a fly, was cited for his ability to turn theory into practical solutions. Miles recently won a $3.15 million grant to continue his work. In addition to the new military uses, his work has civilian applications including security devices, cell phones and teleconferencing equipment. The work will include partnerships with the University of Illinois at Urbana-Champaign, Boeing Phantom Works of Seattle and the Charles Stark Draper Laboratory Inc. of Cambridge, Mass.

Omowunmi Sadik, assistant professor of chemistry, was cited for her work in developing an “electronic nose” so sensitive that it can pick up even trace amounts of organic chemicals. Her work was described as “a watershed in the field of environmental monitoring.” Sadik is seeking patents on new applications for this work that will replace the use of dogs in drug- and bomb-sniffing operations.
Tale of the bones

Not a day goes by that Dawnie Wolfe Steadman isn't boning up on her discipline. A forensic anthropologist, Steadman is trained to identify decomposed human remains, analyze the record of disease or injury etched into skeletons during life, and translate the personal and communal histories revealed by the 206 bones of the human body.

Just five years after receiving her PhD, Steadman has an impressive résumé. At mass graves in Argentina and individual graves in Cyprus, she has worked with human rights agencies dedicated to identifying victims of civil unrest and international conflict. At the request of police agencies in several states, she has differentiated old “trophy” skulls found in basements, attics and pawn shops from possible modern homicide cases.

From skeletal remains, she's helped determine poaching as the cause of an Iowa bear death and dashed the hopes of several Chicago-area hunters who thought they'd stumbled onto instant celebrity and the remains of Jimmy Hoffa until Steadman assured them the remains were those of deer.

Thirty to 80 percent of all remains brought to forensic anthropologists turn out to be those of animals, Steadman said. But sometimes, they are not.

In the summer of 2000, for what was the first time in her career, she gave key testimony in a murder trial. Steadman told the Iowa jury about being called to a scene where police were recovering bones from the bottom of a
well. She testified about how she had stayed topside, putting the recovered remains in anatomical position and guiding the search until a complete skeleton was recovered. She then testified about working in collaboration with a forensic pathologist and x-ray records to positively identify the victim, who had been shot with two handguns and thrown into the well where his body remained undiscovered for about 10 years.

"EVERYTHING ABOUT CULTURE AFFECTS BIOLOGY AND VICE VERSA."

Her reward in such cases, she said, is to help families learn the truth about missing loved ones, help law enforcement officers resolve unanswered questions and, in criminal cases, see the guilty prosecuted.

"Testifying at the murder trial was not something I enjoyed doing," she said. "My examination uncovered more than 50 wounds that were gunshot or gunshot related — wounds due to secondary projectiles: bits of bone or bullets. Essentially, my testimony allowed that person who could not speak to say to the court, 'Look what happened to me.'"

The human rights applications of her work are even more powerful. In 1991, Steadman worked for three months in Argentina with the Argentine Forensic Anthropology Team, at a mass grave where 15,000 to 30,000 people who disappeared during that country’s "Dirty War" of 1976 to 1983 were dumped. The experience had a profound effect on her.

In 1999 she traveled to Cyprus with members of Physicians for Human Rights to identify remains found in 25-year-old graves: victims of the fighting between Greek and Turkish Cypriots. Unaccounted-for Greek Cypriot soldiers have been at the root of major political and social unrest in Cyprus for many years, Steadman said.

Steadman, who was drawn to forensic work from the broader field of biological anthropology (which specifically focuses on the skeleton), came to Binghamton University in 2000 from Iowa State University.

In her research Steadman uses bones, some as old as 1,000 years, to understand the relationship between biology and culture, particularly as it relates to the cause and the spread of disease in prehistoric and modern human populations.

"Everything about culture affects biology and vice versa," she said.

Cultures change in response to disease, ranging from the medieval construction of sanitaria, where afflicted persons were imprisoned and left to die, to public health policies that mandate vaccinations.

"If we're doing epidemiology of past populations," Steadman said, "we count cases and then try to understand what it is about this population that allowed them to support infectious disease. There's a critical mass, a number of people and a range of activity that you have to have for the disease to be propagated, so it tells us about the living conditions of the population."

Because many diseases leave markers on bones, "counting cases" is often possible based solely on skeletal remains. In its chronic form, for instance, tuberculosis disseminates throughout the body and attacks the skeleton, particularly the spine. Likewise, such chronic diseases as syphilis, leprosy and certain types of fungal infections leave a lasting legacy on the bones. Signs of non-contagious diseases, such as some cancers, also show up on skeletal remains.

Steadman's work most often finds itself in the spotlight when she consults with police or disaster management agencies. As a result, her campus space includes a teaching lab, a research lab and an evidence room.

When decomposed remains are found, she works with police and area coroners and pathologists to establish identities as well as cause and time of death. To facilitate that process, she is setting up a research project to determine how quickly bodies decompose in conditions specific to upstate New York.

"These are very important studies," she said. "When remains are discovered, one of the most often-asked questions is 'How long have they been dead, Doc?' Until we do enough studies to understand how fast or slow we can expect things to decay in this particular area of New York, we'll just have to shrug our shoulders with everyone else and say, 'Gee, I don't know.'"

Steadman is also a member of the national Disaster and Mortuary Operations Response Team, a group of experts called in to identify victims of plane crashes, explosions or disasters too large to be handled by local agencies.

The most important message she hopes to get across is that every person, regardless of age or cause of death, has a life history recorded in the skeleton — that every bone, any bone, has the potential to be the key to identifying human remains.

"If a single finger bone has a pathology that can be matched to pre-mortem records," Steadman said, "that's an ID."
An associate professor of biological sciences, Shepherd has been working with the Broome County Department of Environmental Health since last summer, collecting and identifying mosquitoes for virus testing. The University’s unofficial entomologist, Shepherd received additional training in mosquito surveillance and identification before starting his research.

Clark, also an associate biology professor, is extending her studies of crows to determine their role in spreading the deadly virus.

“It’s a common misconception that there are only a few different kinds of mosquitoes,” Shepherd said, pointing out that there are about 65 species in New York state. “Their biology can differ quite a lot.”

It’s important to know the differences, he added. “Different mosquitoes have different likelihoods of carrying the virus,” he said.

Collecting and identifying mosquitoes has become an important element of the fight against West Nile, a mosquito-borne virus that can cause encephalitis, a potentially fatal swelling of the brain. Since 1999, the virus has been responsible for eight deaths and more than 65 serious illnesses in the New York metropolitan region alone.

Using a $2,400 Broome County grant, Shepherd and two undergraduate assistants collect, identify and test mosquitoes.

Shepherd uses small nets to collect mosquito larvae from breeding areas such as sewers, storm drains, swimming pools and other sites where there is standing water. Adult mosquitoes are captured with both nets and traps.

Shepherd uses two types of traps to collect adult specimens. The first attracts mosquitoes through light and carbon dioxide emissions the mosquitoes can smell. Mosquitoes attracted to the trap are sucked into a collection net by a small fan.

The second type of trap, a Gravid trap, is designed to capture egg-bearing females. Gravid-trapped mosquitoes have fed at least once before laying their eggs and are therefore more likely to carry the virus.

The second phase of the research involves identifying captured mosquitoes and larvae. Specimens are frozen with dry ice and identified using mosquito guides. The mosquitoes are sorted by types likely to carry the virus, including Aedes triseriatus, Aedes
vexans, Culex restuans and Culex pipiens, also known as the Northern house mosquito.

C. pipiens is the most likely vector for transmitting the virus to humans, Shepherd says. While it primarily feeds on American crows, it will occasionally feed on humans and other mammals when the need arises. It’s this propensity that increases the likelihood of passing the disease on.

“West Nile has been particularly harmful to crows,” Shepherd said. After collecting and identifying mosquitoes, Shepherd sends selected specimens to Albany for testing. Last fall, he sent in more than a dozen samples, all of which tested negative. He noted that more than a dozen birds tested positive during the same period.

Clark is investigating West Nile from the crow’s vantage point. Clark is collaborating with Kevin McGowan, curator and senior research associate in charge of the ornithology and mammalogy collections at Cornell University, on a project to examine how social behavior can put crows at risk for the virus or, possibly, protect them. They are currently seeking funding for the project from the National Science Foundation and the Centers for Disease Control.

“Essentially, we’re marrying a threat to crows with our interest in avian social behavior,” Clark said.

Since 1998, Clark has collaborated with McGowan on demographic and behavioral research on crows in the Ithaca area.

Clark says she developed a long-term interest in crows and their behavior in part because they aren’t migratory. “They maintain territories all year round,” she said. “Instead of going out and breeding on their own, some of the younger crows spend many years on family territory assisting in rearing. It’s a cooperative breeding situation.”

It’s this kind of social behavior that Clark says may help determine how the virus is spread through crow populations and shed some light on whether it’s directly communicable or wholly vector borne. Through observation and blood testing, she also hopes to learn whether the birds are developing antibodies rather than succumbing to the disease.

Clark says diseases like West Nile aren’t unheard of in crows.

“Vector-borne diseases aren’t new to birds in the Northeast,” she said, citing examples such as avian malaria, eastern equine encephalitis and St. Louis encephalitis. “Birds, including crows, just make good reservoirs. They’re an essential part of the virus’ maintenance cycle.”

In the case of West Nile, this cycle typically doesn’t include mammals, Clark said. “West Nile virus is not really a mammalian disease. Mammals get hit by mosquitoes that can’t find a bird or mosquitoes that are very broad in their food preferences,” she said.

Clark looks at West Nile as just another organism trying to fulfill its genetic destiny. She says that viruses like West Nile need mosquitoes to carry them to another organism where they can replicate. The host typically develops an active infection called a viremia, during which the virus circulates through the blood stream and other bodily fluids, waiting to be picked up by another mosquito.

“Mammals are not a very good link,” she added.

In the future, Clark says, she wants to research disease as a long-term selection pressure on animals.

“Everybody studies predators’ quality of food and space, but disease is an under-appreciated selection pressure, especially in terms of the amount of mortality it causes,” she said.

Clark says disease is overlooked because its effects are often invisible. When an animal is sick, it weakens and becomes easy prey for other animals or dies of starvation.

“Pathogens are a much stronger evolutionary force than previously realized,” she said.

Similar to Clark’s, Shepherd’s research has opened new avenues he wants to explore.

“There are some amazing holes in mosquito biology we’d like to fill in,” he said.

Shepherd plans to examine various aspects of egg laying, including the chemical characteristics of the water and how mosquitoes sense the depth at which eggs are laid. He and Clark hope to collaborate on research on the relationship between how high mosquitoes forage and whether birds choose their roosting sites in relation to mosquito attacks.

“Nobody has really looked at that,” Shepherd said. “Just how we’re going to look at it is another question.”
hough Jessica Fridrich’s research career had its foundation in chaos and many of her greatest accomplishments are invisible, scientists and national security officials watch her work closely.

A research professor in the Department of Systems Science and Industrial Engineering in the Thomas J. Watson School of Engineering and Applied Science, Fridrich specializes in steganography, the science of secret communication.

Her work has already helped to spur major strides in the security of digital communications, including digital audio, video and photography, and is expected to lead to even more significant advances, said Richard Simard, a technical adviser to the Air Force Research Laboratory in Rome.

“To be completely honest, I’ve worked in research and development for the federal government for about 28 years, and I have never seen such a brilliant mathematician who also has the unique qualities of being able to translate theory to practical applications,” Simard said.

Some steganographic techniques, such as invisible inks and encryption, have been around for centuries, but the first scientific papers on digital steganography and digital steganalysis — the investigation of hidden information — were published around 1993. Fridrich’s interest in the field grew out of her doctoral studies at Binghamton University, which focused on digital chaos, a process used to encrypt information by chaotically mixing pixel positions and colors in digital images.

A recent $315,000 grant from the Air Force extends a six-year run of consistent Air Force funding for Fridrich’s research. During that period 13 research grants have been awarded totaling more than $1.2 million.

While much of Fridrich’s research focuses on developing mathematical theory and appropriate equipment to hide information in digital communications, she also works on ways to crack encryption schemes of her own and others’ making.

“We need to build data-hiding schemes, but not only that — we also need to attack them to find out how secure the scheme is,” she said. “This is, of course, very important to know in military applications and also in civilian applications.”

Fridrich’s techniques are of particular interest to the military because they help protect against and intercept secret terrorist communications, Simard said. Steganographic communiqués from Osama Bin Laden, termed by the U.S. State Department as “one of the most significant sponsors of Islamic extremist activities in the world today,” have already been intercepted using steganalysis, Simard said.

“When it comes to detecting hidden messages, no one else in the world can do that as well as us, and that’s because of Dr. Fridrich’s work,” he said.

Fridrich, who earned her PhD in systems science in 1995, already holds three patents. She is applying for two more and has developed a Windows-based application, “Securestego,” that offers capabilities not available in other commercial software. Though she is still considering how best to market the package, several companies have already expressed interest in commercializing it. The software includes a self-embedding capability that enables digital images that have been modified to be returned to their unmodified state.

“If you have just used a software product to re-color a car from red to green, thinking that you now have evidence supporting something that is not true, we can tell that,” Fridrich said. “With self-embedded images, the original image can self-reconstruct, though the average user would have no way of knowing that it had survived earlier alterations.”
Detection techniques 10 times better than those used by currently available products to ferret out hidden digital communications are also part of the package, she said.

Fridrich’s latest project, which will have both commercial and military applications, allows data to be embedded in and later extracted from a digital image without altering the original image with “noise” that causes data to be lost during extraction.

Commercial applications might include embedding invisible subtitles in different languages within digital movies for extraction by technologically compatible VCRs. It could also permit the widespread use of “intelligent images,” pictures embedded with the equivalent of an invisible barcode that can be read by a computer to allow the holder access to things like restricted services or websites.

Data embedded in images does not increase the size of the image file. A one-megabyte image with a 250-kilobyte word file embedded within it, for example, would still use only one megabyte of space, a feature that broadens the scope of possible applications.

The technology will also have “disabling” applications, including improved means of digitally water-mark-ing commercial movies, DVDs and MP3s, so that compliant players won’t read pirated media properly.

By protecting “the chain of evidence” and helping to ensure the authenticity of digital images and recordings through steganographic digital watermarking, Fridrich also expects her work to help make digital evidence more acceptable in court rooms.

In a separate $99,200 project involving the Air Force and Eastman Kodak, Fridrich is designing a fragile watermark for digital cameras. Unlike robust digital watermarks, fragile watermarks “break” as soon as anything is done to alter the original signal or image. Cam-eras equipped with fragile water-marking capabilities will help to ensure the authenticity of digital photographs, lending them greater credibility in sen-sitive military and law enforcement applications, Fridrich said.

Simard noted that other possible applications for Fridrich’s work include developing assurances that digital im-ages used by doctors, military leaders and emergency response officials in making decisions are authentic.

“We make a lot of decisions with our eyes, by looking at images,” he said. “The military looks at images, and they’ll make a call based on that image. Doctors make surgical and treat-ment decisions based on x-rays and digital images. Civil leaders make choices based on digital satellite images tracking tornadoes and hurricanes. It’s imperative that we be able to protect these digital products so that we have assurance that we will be deciding based on good data.”

Fridrich’s work, which allowed Kodak to produce its first digital watermarking camera, the DC-290, is also key to Simard’s vision for a University-government-industry consor-tium that can “push the theoretical, mathematical basis behind this new technology, advance exploratory develop-ment concepts of prototyping and then move to build application systems for commercial or military use,” he said.
Although such approaches have obvious appeal for students, many teachers are reluctant to embrace them because they don’t understand or trust the technology. That’s where C. Beth Burch comes in.

“Some of us are quite expert with technology, and some of us are just starting to get over that initial discomfort and don’t like to use it all that much,” said Burch, an associate professor in the School of Education and Human Development.

Burch is using a three-year $359,000 federal grant to bring teachers into the 21st century. The grant, a partnership between Binghamton University and the Sidney Central and Binghamton school districts, has two purposes.

“The first is to create a space for collaborative teaching with technology,” she said. “The second is to prepare education faculty to teach with technology so we can model what we want our (student) teachers to do.”

The project’s first goal has been realized with the creation of EdTech Space, an experimental classroom in SEHD. The room sports a variety of new tools designed to make education flexible, innovative and possibly fun. Features include a console with Macintosh and PC platforms and a VCR, stereo system and projector that displays video — no more boring black-and-white slides. Thanks to 20 laptop computers, students can view course material on the Web, share files and communicate with one another. Instructors connect through their own laptops to project presentations for the whole class or to individual computers.

Burch said one of the best features of the classroom is that information sharing is powered by a wireless transmitter — no more cables strewn across desks or underfoot. “There’s nothing to plug in — you’re just right there at the Internet.”

Connectivity isn’t limited to EdTech Space, adding yet another dimension of flexibility to the project. “Anywhere you move the cart within the radius of the hub, you can have a classroom,” Burch said. “Wireless is definitely where it’s going. It’s the best thing for schools I’ve ever seen.”

Getting the technology in place was
only half the battle; Burch also had to develop a program to teach faculty how to use it. Last fall, she and her project staff surveyed education professors to discover how often they used technology and what kept them from becoming more proficient. She discovered that her colleagues’ comfort levels and expertise varied.

Based on the feedback, Burch and her team designed a technology training program. “One of the things we learned is that people prefer to be taught individually or in very small groups,” she said. “They also would like a lot of support. Sometimes you go to a workshop on a particular topic and come away not remembering how to do something. So, what we’re doing is offering a variety of programs that include technical one-on-one support from research project assistants.”

Currently, four assistants, all graduate students, spend between 15 and 20 hours a week working individually with faculty. The assistants were selected for the project based on their academic strength, interest in technology and ability to work with and teach others.

In addition to providing personal support, the project offers monthly courses to educators. In February, for instance, they were shown how to use library databases for research. Burch said the course was particularly an eye-opener for those who had used databases but weren’t using them to their fullest potential. Other courses have included creation of webpages and uploading course materials to Blackboard, an electronic learning platform. Once educators are on board, classes will be opened to student teachers and other University faculty.

The project also supports other venues for raising technology awareness. Every month Burch holds teaching luncheons open to University faculty, school administrators and teachers from Sidney and Binghamton. Recent topics have included using digital video and Microsoft PowerPoint in the classroom. In June, Burch conducted an intensive technology camp where educators immersed themselves in the new technology.

In the future, Burch would like to see the program grow to include building advanced classrooms similar to EdTech Space in Sidney and Binghamton. She also hopes to see more teachers use technology the way Laura Lamash does. “That’s what we’re looking for,” she said. “That’s the kind of thing we’re trying to do.”

Although an enthusiastic proponent of technology, Burch doesn’t embrace it haphazardly.

“We’re trying to use technology wisely and critically rather than merely adopt a ‘technology-is-good’ stance,” she said. “In all our programs we are careful to note the advantages and disadvantages of the technologies and to realize that the technology is a tool for teaching — a means rather than an end.”
David Davies’ work with one of Earth’s oldest living organisms — bacterial colonies commonly referred to as slime — is helping to improve the odds that humans, among the youngest organisms on the planet, will be able to hold their own in the war against germs.

Davies, an assistant professor of biology, studies biofilms, the ubiquitous bacterial communities that live just about anywhere that water and solids, or solids and gases meet — from contact lenses to ships’ hulls and from hospitals to household plumbing. Davies wants to know what makes biofilm communities thrive despite serious attempts to disperse them.

Davies’ work is supported by a $38,434 grant from the National Science Foundation. He is seeking $451,000 from the U.S. Department of Health and Social Services and is a part of two major collaborative multimillion-dollar grant applications.

His work primarily focuses on Pseudomonas aeruginosa, a biofilm-forming microorganism that is arguably the most common organism on the planet and which, like other bacteria, has spent the better part of the past 3.5 million years evolving successful life strategies.

Biofilms are communities of individual microorganisms created when bacteria embed themselves in a gelatinous structure of their own making. This “slime” is composed of organic polymers that can grow to several centimeters thick and cover large areas. Dental plaque is one commonly encountered biofilm. Anyone who has ever been up-ended by slippery rocks in a stream likely has had a close encounter with a biofilm.

By discovering ways to effectively leave the bacteria either “mute” or “deaf” to the cell-to-cell communication that is critical to their ability to form communities, Davies hopes to make the bacteria more susceptible to antibiotics and the body’s immune system.

Davies has a patent pending on a method that interrupts bacterial communication and inhibits biofilm development. He is also working to isolate a factor that will cause biofilm colonies to disperse, thus leaving individual bacteria easier prey to disinfectants, antibiotics and immune functions.

Preliminary studies show that when the natural dispersion factor is introduced prior to antibiotic treatment, antibiotic efficacy is increased by up to five times. The market potential for a non-toxic, biofilm-dispersing agent is enormous, and Davies’ recent lab results have shown that the dispersal agent is very effective even in mixed-culture biofilms.

If the only consequence of biofilm development were slippery rocks, it would attract little scientific interest. But biofilm colonies have proven to be enormously destructive and their negative consequences can be tallied in both dollars and lives.

Biofilms account for a wide range of
diseases — from cystic fibrosis, an always-fatal condition in which the lungs are colonized by mucoid bacteria, to colitis and chronic ear infections. They lurk on the surface of prosthetic and implanted devices such as pacemakers, artificial hips and intrauterine devices. Also linked to heartburn, ulcers, and intestinal and stomach cancers, biofilms can be impervious to immune system attack and are insensitive to treatment by most antibiotics.

Biofilms are everywhere — even in places where rigorous attention is paid to germ fighting. They grow like wildfire in hospitals and are a leading cause of hospital-acquired infections.

“You’ve got biofilms, antibiotics and nutrient sources all in this one location and you end up with ‘super bugs’ that form biofilms in and on people,” Davies explained. “It’s a real problem and hospitals can’t get rid of them. If you’re not sick when you go to the hospital, you’ll definitely get sick while you’re there long enough.”

Those who stay in an intensive care unit for seven days or longer have nearly a 100 percent chance of developing a hospital-acquired infection, the worst of which are almost always related to biofilms that develop in the tubing of respirators and catheters, Davies said.

For hospitals and for the broad scope of industries plagued by biofilms, the problem is harrowing, Davies said.

“They treat and they disinfect and they dose with antibiotics, but they don’t kill off the biofilms,” he said. “And if you don’t kill them, you make them stronger.”

When bacteria live in biofilm colonies they are able to exchange genetic material with organisms other than their biological descendants by means of horizontal gene transfer — a process in which even highly unrelated organisms can swap genes. One of the most prominent manifestations of this process is antibiotic resistance, Davies said.

Because bacteria don’t have to wait for generations to pass on antibiotic-resistant genes, but can pass them on to bacteria within their same generation, they are able to confound the development of new anti-bacterial drugs.

“Any experience that a microbe can have, it can share with another microbe,” Davies said. “If humans could do that, when you passed people in the hallway who had read a certain book, they could simply bump into you and you would gain their memories for that experience and would know whatever they knew about the book.”

What’s more, bacteria can share information in this way with very distantly related microbial species, he added.

“They could get information or pass information to a microorganism that is more distantly related to them than a monkey or a tree would be to us,” he said.

The most modest estimates of the annual worldwide cost of biofilm infection and remediation are in the high billions, costs borne by industries worldwide. Name a manufacturing process and biofilms are probably a serious and costly issue because they are so hard to eradicate. In fact, biofilms have even been discovered in pipes at factories that produce prepadine, the anti-bacterial, iodine-based solution that doctors swab on patients to “prep” them for surgery.

Until recently, almost all research into ways to control and remediate bacteria had been conducted in laboratories where bacteria were studied in test tubes or on petri dishes.

“In those test-tube conditions, you add a little bleach to the culture and the bacteria are all killed,” Davies said. “Then you go to an industrial system where you have biofilms growing on the walls of the pipes in a soft drink manufacturing facility, or a milk production facility, and you find that these organisms living in a biofilm community just don’t behave the same way.”

In fact, in a stunning display of the old adage “United we stand, divided we fall,” biofilms and their resident microorganisms are unfazed by doses of antibiotics that are 1,000 times greater than the concentration that would kill planktonic bacteria in a liquid culture.

Davies’ work promises to change that by providing new ways of weakening and dispersing biofilm communities.
EUREKA!

PATIENCE, KNOWLEDGE (AND SOMETIMES JUST LUCK) TRIGGER THAT MOMENT OF DISCOVERY

The setting is ancient Greece. For the mathematician Archimedes, it’s been a tough day sweating over equations, getting nowhere fast. Unaware that minor calamity will soon deliver major discovery, he heads for the baths. As he lowers himself into an almost-full tub, the displaced water slowly rises past the rim and spills onto the floor, revealing the answer to a problem that has plagued him for years. “Eureka!” he shouts. “I have found it!” His principle of buoyancy is conceived.

It’s been 15 years since Susannah Gal, then a graduate student working at the National Institutes of Health, experienced her first scientific Eureka moment. Today an associate professor of biology at Binghamton University where her work in molecular genetics and cell biology could lead to more productive crops and advances in medicine, Gal recalls the exhilaration of that experience as if it were yesterday.

“It felt great,” she said. “I remember looking at the answer at 11 o’clock at night in the lab and getting so excited that I called my adviser at home. He was an early morning person. He was very nice and said, ‘Yes, yes, Susannah. Maybe we can talk about it in the morning.’ ”

“Eureka!” remains the classic herald of discovery — in three syllables it uncannily captures the joy and the incongruity of discovery.

Eureka moments, most researchers seem to agree, are those rare, precious instances when old thinking or old ways of being — sometimes inexplicably and often unpredictably — give way to new awareness, meaning and possibility. Whether in large or small ways, these are the breakthrough moments that change the world or the worldview of those who enjoy them.

Gal’s first Eureka moment — discovering that what she thought was a protein was actually a protease, or enzyme that chews up protein — led to the last two chapters of her thesis and generated years of research. Her breakthrough was the outcome not only of hard work, but of good fortune. “Chance favors the prepared mind,” Gal noted, borrowing a quotation from Louis Pasteur.

Exactly how researchers and scholars define, experience and arrive at their own Eureka moments may differ across the disciplines, said Christopher Fynsk,
SUSANNAH GAL’S WORK ON PLANT PROTEINS BENEFITED FROM A BREAK-THROUGH MOMENT THAT CHANGED THE SCOPE OF HER RESEARCH.

“The scientific’ language that is used to talk about fertilization, for instance, is commonly filled with sexual metaphors and gender constructions of passivity and activity, all of which are dubiously pertinent to the chemical processes that are going on.”

For Gal, who this year was one of an international team of biologists that sequenced a plant’s genome, a kind of serendipity-aided leap is part and parcel of a Eureka moment.

“Sometimes in research,” she said, “things creep up slowly and all support a particular hypothesis that you are building. It just feels like walking forward, step by step. It’s rewarding, but it doesn’t carry with it the excitement of ‘Eureka!’”

Some very clear result that refutes major presumptions or a serendipitous outcome that leapfrogs experimentation over hundreds of other possible approaches — “that’s what I consider the Eureka moment,” Gal said.

Biology professor Nancy Stamp, whose course on research strategies helps students develop research and career approaches, is never surprised to hear colleagues vividly recall their Eureka moments.

“That’s a hugely fun part of science,” Stamp said. “But you can’t plan for it. If you’re lucky, your career is punctuated by a few of those ‘Eurekas!’ That’s the icing on the cake.”

Stamp advises prospective researchers not to focus on Eureka moments as their primary goal.

“If they focus on that, then they’re not focusing on all the details that can occasionally provide that,” she said. “What we try to do is to get them to...
think more of a career strategy, so that if they don't get to that "Eureka!" they won't be stumbling around in the dark."

Omowunmi Sadik, an assistant professor of chemistry whose research focuses on microelectrode biosensors able to detect trace amounts of organic materials, agrees with Stamp. With two patents pending for her work, Sadik finds the enduring “desire to know” much more compelling than the short-lived excitement of discovery.

“The most rewarding thing in my career is sharing the excitement of this ‘desire to know’ with students,” she said.

“Science,” she said, “is the great equalizer. In science, it’s not who is right, but what is right.”

Gal, Stamp and Sadik say Eureka moments refer as much to discovering new connections as concrete discoveries. Each has experienced these new connections at Binghamton, where interdisciplinary approaches to research are both encouraged and supported through organized research centers, seminars and workshops. Gal notes that conversations in two different meetings clicked for her in a way that she expects will soon lead to a leap in her DNA-computing collaborations with mathematics professor Thomas Head.

“I really believe in interdisciplinary approaches for just this reason,” Gal said. “When you get people talking to each other who don’t have preconceived notions of how you do something, big leaps are very possible.”

Stephen Gilje, associate vice president for research, says the 19 organized research centers are one of the primary ways that Binghamton University promotes intra- and inter-disciplinary communication that provides a platform for discovery. “We also offer a wide range of support services that can help faculty make connections among their colleagues and to identify and apply for external funding to support their work.”

Nearly a third of the new faculty have also availed themselves of an orientation program that offers training on everything from teaching strategies to research support services, Gilje said. “One of the things we try to do is to help interested faculty frame their research questions in ways that will have the best chance of being understood by sponsors,” he said. Often that means narrowing the focus, he said, “making sure they don’t use too large a frame.”

Ronald Miles, chair of the Mechanical Engineering Department, knows something about Fynsk’s “resistance of the object” notion. Miles, whose current research in acoustic sensors and systems was inspired by the ears of the parasitoid fly, said it took him a while to figure out how the fly managed directional hearing with ears located so closely together.

“It was very mysterious for a very long time,” he said. “A lot of things that turn out to be very simple require an awful lot of work to get to,” he joked. “What that probably means is that we’re not all that smart.”

Miles’ Eureka moment with the fly has led to a series of multi-million-dollar grants and is expected to result in the commercial availability of the world’s smallest directional hearing aid within the next four years.

Like Miles, chemist Wayne Jones, whose work focuses on molecular architecture that could lead to the next-generation of miniaturization in electronics, said he has experienced several Eureka moments. All have involved some degree of serendipity and none has been a “capsule” experience.

“I hope the Eureka moments keep coming,” he said. “They’re awesome. I like breaking through. I like the feeling of understanding. But it’s as if you’re on the inside of an onion, peeling your way out. As you get through each layer, the whole sphere behind you becomes clear, but the sphere in front of you is larger, and that becomes your next set of questions.”

Echoing Fynsk’s notion about the constrictions of culture and language, Jones said, “We all have structures, pre-defined constructs that we’re coming from. In research, as in life, to discover something new, you’ve usually got to break out of the constructs. You have to let go of something that you’ve held on to.”

The “Ah-ha” moment becomes possible, Jones said, when individuals become willing to let go of the assumptions that have guided their thinking and framed their perceptions to that point.

“I would like to think,” Jones said, “that the euphoria you get from really understanding something, from truly grasping it, exists regardless of what ‘it’ is.”
Richard Plumb, professor and chair of the Watson School’s Department of Electrical Engineering, doesn’t wear a superhero’s cape, but his work involves something akin to x-ray vision. It’s that work that promises to make the world a safer place.

Plumb’s expertise is in ground-penetrating radar (GPR), or subsurface imaging, a technology that holds significant promise in a number of military and civilian applications. On the military side, among other uses GPR can be expected to help ferret out underground command and control bunkers, land mines and unexploded ordnance. On the civilian side, it can help locate and monitor underground storage tanks, as well as ensure the quality and integrity of road construction.

With $160,000 in funding from a Defense Advanced Research Project Award, Plumb is working with Lockheed Martin in Syracuse to develop models and algorithms that will provide the best possible images from GPR readings. This is a challenge because radar behaves differently when it is aimed at the ground than it does in the air. He also recently completed work on a separate $732,367 grant for the U.S. Army.

In the air, where it is traveling through a relatively homogeneous medium, radar is effective in tracking objects from hundreds of miles away. Even Doppler radar, which monitors water particles in the air, works with targets “in the far field” — that is, distant from the key elements of any radar system: the transmitter and receiver.

Unlike air radar, GPR deals with a very heterogeneous medium, the ground, and seeks targets “in the near field,” generally within 10 meters (approximately 33 feet) of the surface. From one location to the next, when GPR is aimed at the ground, it can encounter different soil types and conditions, each of which may differently affect the transmitted electromagnetic signal. Geological features can also cause scattered signals, sometimes creating significant interference in a search for underground manmade objects.

“Our challenge is to try to develop algorithms that take the raw data and generate — based on the electrical and magnetic properties of the soil — the best possible image of whatever is in the subsurface,” said Plumb.

Like all types of radar, ground-penetrating radar involves the transmission of an electromagnetic signal and the reception back of a scattered or echo signal that can be recorded and analyzed.

“You transmit a particular waveform, receive back a waveform, and by comparing the transmitted to the received waveforms, you try to infer something about the object,” Plumb said. “It’s like taking a CT scan of the ground.”

Ground radar signals can be transmitted and received from both ground-based and airborne systems or a combination of the two. Setups include monostatic systems, in which the transmitter and receiver are both in the same location, and bistatic systems, in which the transmitter and receiver are allowed to move separately, as is the case when a transmitter is mounted on a plane or helicopter and a receiver is located on the ground. Determining the best method to configure the sending and receiving units based on conditions is also key to Plumb’s research.

“Using computer modeling, we’re trying to determine the best configuration of transmitter receiver locations for different kinds of terrain and soil conditions,” he said.

Maximizing performance and data gathering based on conditions is important because ground radar image quality is poor to begin with, Plumb said. GPR uses low-frequency signals to achieve the best penetration, but low-frequency wavelengths are generally large compared with their target objects, guaranteeing a fuzzy image.

“If I take a picture of your face, I see the minutest detail, because in terms of wavelength, we are enormous in size,” Plumb said.
About 2,000 people are injured in landmine accidents every month, one victim every 20 minutes. Around 800 of these will die, 30 to 40 percent of them under 15 years of age. The remainder will be maimed.

The current state of the art for land-mine detection consists of two methods: scouring a potential mine field with dogs, which can sniff out the explosive because their sense of smell is 1,000 times better than that of humans, or sending out people with metal detectors to scour suspected areas.

"Basically we’re talking a souped-up Radio Shack metal detector,” said Plumb, who calls the method unsafe and inefficient.

“If you think about it, land mines are usually used in battlefields, and what’s inside a battlefield but scattered metal and shrapnel all over the place? So you send two guys out, one with the detector. If the detector goes off, the second guy gets down on his hands and knees, gets out his bayonet and checks the ground until he finds the land mine.”

At the current rate at which land mines are being removed, assuming that no more are laid — and until recently, 2 million more were being planted every year — it would take 1,100 years to rid the world of them. Using the currently available techniques, one mine clearer is killed and two are injured for every 5,000 mines cleared.

The only other way to remove mines is countermining or blowing a path through a suspected minefield, a method that has obvious limitations in populated areas.

Ground radar also has engineering applications such as ensuring that road contractors lay down the proper depth of asphalt, determining subsurface deterioration on bridge decks or locating buried storage tanks, Plumb said.

Plumb said his research on GPR happily marries the experience he gained working on radar systems at General Electric in Syracuse and his doctoral studies in electromagnetics at Syracuse University. Plumb came to Binghamton in 1998 from the University of Kansas, where he was an associate professor.

Plumb’s field has mushroomed in the past seven years with the growth in potential military and environmental applications. The field has also gotten a boost from the technological advances that allow for small, portable radar systems. All this makes GPR a wave (form) of the future.

**Richard Plumb’s work in perfecting the usability of ground-penetrating radar systems has wide applications — from uncovering buried land mines and underground storage tanks to detecting unseen weaknesses in steel bridge decking.**
Quirky

Charles A. Nelson spends his time looking for quirks in quarks. At the end of the day, if he ends up with more questions than answers, he’s done his job well.

Nelson, a theoretical physicist who explores the world of quarks and leptons — the basic particle building blocks of the universe — was awarded the 2000 University Award for Excellence in Research.

Not content to rest on his reputation, Nelson thinks his latest research question could be the most important of his 33-year career. The question is rooted in some curious results obtained while working with data regarding top quarks, a mercurial variety of one of the two elementary building blocks of matter, quarks and leptons.

While “tuning” a calculation regarding the polarity of the top quark, Nelson realized that three resulting numbers, in which he originally had no particular interest, were agreeing to a tenth of a percent.

“This is the thing I am most curious about in my career,” he said. “This three-number puzzle is potentially very important. It is an inconsistency not explained by anything heretofore known.”

Nelson suspects that the numbers could mean that top quarks, which are produced only in particle accelerators and decay almost instantly (10^{-24} seconds — which would be expressed as a decimal point and 24 zeroes followed by a 1), have a property analogous to each electron having a built-in “magnet” that arises because of their charge and spin.

If Nelson is correct, his work could spur a change in the standard model of particle physics, the name given to the theoretical framework that describes the current level of human understanding about the interactions between the elementary building blocks of matter and energy.

Discovered experimentally in 1995, top quarks are the sixth and, according to the standard model, possibly the last, of the quarks. They are as small, compared to the atom, as the atom is to the human body. Other members of the quark family bear the names “up,” “down,” “charm,” “strange” and “bottom.” Up and down quarks make up protons and neutrons. Electrons are a...
variety of leptons which, along with up and down quarks, make up the entire periodic table.

Looking for quirks in quarks isn’t the only thing Nelson does. As a theoretical physicist, he is always looking for new holes in the standard model, hoping, like all physicists, that a gap might prove to be a doorway to a deeper understanding of the basic interactions of matter and energy.

“I’m sure there is much more that we don’t know,” Nelson said. “I don’t think we’ll ever find a theory of everything. I’m excited, however, to be involved in the process. I guess that it really is a lot better to be on the journey than to have arrived.”

If Nelson’s major challenge was simply to find holes in the standard model, his work would be easy. Physicists universally agree that the model is inconsistent and incomplete. Gravity, for instance, the most familiar force on earth, is still not accounted for. Even the particle that carries it, while already named graviton by theorists, has yet to be discovered experimentally.

“The standard model has about 20 parameters that you just stick in by hand — the mass of the electron, the mass of all these quarks,” Nelson noted. “The standard model doesn’t explain why these things exist, and it doesn’t explain the value of the numbers that you stick in to make things work. Ideally, you’d like to have a theory that explained these numbers.”

For theorists like Nelson, then, the real work is not in coming up with questions, the challenge is proposing possible answers. The answers take the form of questions that are plausible enough to pique the interest of experimental physicists, who ultimately must validate or invalidate the work of theorists. Theorists attract the attention of experimentalists by publishing their work in refereed journals. Nelson has seen close to 100 of his articles published.

Experimentalists who have taken up Nelson’s theories look to prove or disprove his work by colliding atoms at high speeds and then analyzing the results. These collisions are staged in the world’s largest laboratories — superconducting particle accelerators and colliders like those at Fermi National Accelerator Laboratory in Chicago and CERN in Geneva, Switzerland. Particles are raced around circular underground tracks that range from about four to 10 miles in circumference until they reach velocities near the speed of light. They are then slammed together so that the particles split into their component parts — and in some instances end up forming new particles. These violent collisions are recorded by particle detectors the size of apartment buildings that gather a record of the collision and its particle byproducts.

“If you were to collide two Lamborghiniis at high speed,” Nelson said, “you’d get everything flying out — the steering wheels, the trunk lids, everything. In this particular case, because you’re colliding them with so much energy, it’s as if you can make a whole different car by doing this.”

While the experiments to validate Nelson’s work typically involve large international collaborations and teams of more than 300 people, Nelson and other theorists generally work alone or in small groups, often with paper and pencil or a personal computer. Federal funding for theoretical particle research is competitive. Over the past seven years, Nelson has secured more than $400,000 in federal grants.

In Nelson’s parlance, even the simple question “What’s the matter?” becomes a double entendre. His work, populated as it is by quarks, leptons, fermions and bosons, sounds to many like some alien landscape. His calculations look, to untrained eyes, like a troubled marriage between hieroglyphics and algebra.

Nelson’s feet, nevertheless, are securely planted and his curiosity is keenly focused on the nature of matter and energy in this universe. In fact, it’s his appreciation for the balance in the world that awakens in him such questions as, “Why are there not particles other than fermions and bosons?”

Fermions are particles, such as electrons, protons or neutrons, that obey statistical rules requiring that no more than one occupy a particular quantum state. Bosons, such as the photon, pion, or alpha particle, obey statistical rules permitting any number of identical particles to occupy the same quantum state. Nelson wonders why it is that there are no particles in a middle camp, where two or three could pile into the same “telephone booth,” he said. He is currently working on that algebraically complex question with associates in the People’s Republic of China.
Leaders. They’ve existed in every culture and every period. Their names flow off the tongue — Sun Tzu, Joan of Arc, Winston Churchill, Martin Luther King Jr. But what makes them tick? What makes people leaders, and how do they influence others to follow?

For more than 15 years, Bruce Avolio has been trying to answer these and other questions. A professor of management and co-director of the Center for Leadership Studies, Avolio has made a career of studying leaders. His research earned him the 2000 University’s Excellence in Research Award.

“Leadership can be difficult to define,” said Avolio. “There isn’t just one definition, nor should there be. One of the challenges in defining leadership is that it’s often described differently in terms of expected behaviors by different cultures. For example, what may be an inspirational and motivational behavior in one culture may be frowned upon or not understood in another.”

Over the last 10 years, Avolio and his team have developed a universal model of leadership. Called the Full Range of Leadership Development, the model examines how leaders, using the same styles and behaviors, influence followers across cultures. The model identifies three leadership styles — transformational, transactional and laissez-faire.

Transformational leadership is most often associated with leaders like Mohandas Gandhi, Martin Luther King Jr. and Nelson Mandela, Avolio said. Transformational leadership falls into four categories: idealized leaders who set high moral and ethical standards; individualized, consideration-focused leaders who bond with and challenge the people they work with to exploit their potential; inspirational leaders, who motivate followers through the example they set; and intellectually stimulating leaders who challenge others to think differently.

“Studies have shown that leaders who use transformational skills are more likely to produce significantly better results and be rated higher by their followers,” Avolio said.

In the middle of the model are transactional leaders who establish “contracts” with their followers. The contract clearly defines each party’s roles and performance expectations, rewards and consequences. The American military uses transactional leadership widely in addition to the transformational style, Avolio said.

Transactional leadership includes two additional categories of leaders — those who actively manage by exception and those who take a more passive approach. Leaders who manage by exception closely monitor and correct deviations from the established set of rules. These leaders tend to spend a great deal of time dealing with performance and the process of how work is actually accomplished, Avolio said. Passive management by exception occurs when leaders step in to fix problems after they occur. Passive-exception leaders are just as concerned with performance, but less concerned with process.

At the bottom of the model are leaders who take a laissez-faire approach. These leaders are typically avoidant — they delay decisions and often lack direction. “They may be nice people to work with, but they don’t foster much productivity,” Avolio said.

Using the full-range model, Avolio and colleagues have worked with organizations around the world to train leaders to be more transformational. Recent projects have included a four-year $750,000 grant funded by the U.S.
Teaching teachers to be leaders

One of the newest efforts of Bruce Avolio and the Center for Leadership Studies is a cooperative venture with local school districts to identify and encourage teachers to become administrators.

Begun last November, the Southern Tier Leadership Academy was created in response to an expected wave of retirements among school administrators over the next five years. Nearly 60 percent of the state’s 800 superintendents are eligible for retirement during this period, said Richard Mills, New York’s education commissioner. The state needs to recruit leaders rather than wait for teachers to decide to pursue school administration, he said.

The academy uses interviews and a series of assessments to identify teachers with leadership abilities. Teachers are evaluated on their ability to set priorities, work in teams and handle difficult issues. Those who continue with the program are paired with current school administrators in a mentoring program and asked to develop leadership plans to enhance their potential as future leaders.

Academy participants also attend four leadership seminars and participate in peer learning groups that discuss issues via the Internet.

The academy won’t replace the certification process that traditionally generates administrators, said Avolio. “The objective is to identify teachers with leadership potential and spark their interest in making the transition from teacher to administrator,” he said.

Many e-leaders must also overcome cultural differences.

“A particular approach or style of leadership that works in one culture may not work in another. E-leaders have to take this into account when interacting with their teams,” Avolio said.

“For example, we’ve found that anonymity in groups, especially early on, tends to lead people to be more challenging and collaborative. This has proven particularly true in Asian cultures where people are normally very uncomfortable with challenging someone in higher authority. It’s like entering a chat room on the Internet. People may say things they would never say face-to-face.

“There’s still a lot we don’t know,” he said.

Avolio and his colleagues were recently notified they will receive a two-year $150,000 grant from the National Science Foundation to study e-leadership and virtual teams working in partnership with the UNISYS corporation.
he remembered associations surrounding an infant’s first meal — smells, sounds and taste — are so deeply embedded and powerful they can last a lifetime.

For more than 30 years Norman Spear and his colleagues have been attempting to figure out how learning and memory develop for infants and whether early memories of alcohol exposure might contribute to later abuse of alcohol.

The work by Spear, distinguished professor of psychology, and colleagues Evgeniy Petrov and Elena Varlinskaya, both physicians and research professors at Binghamton University, and Juan Carlos Molina of the Institute Ferreyra in Argentina may help unlock the secrets of alcohol dependency. The research has been funded for more than 30 years by the National Institute on Alcohol Abuse and Alcoholism and the National Institute of Mental Health. Current NIH grants to Spear exceed $2.5 million.

Working with rat pups, some only hours old, Spear and his colleagues have discovered that even at its first meal, the newborn’s behavior can be influenced by olfactory and taste cues. The next question is how well the rats remember those lessons as they mature.

Spear says that Sigmund Freud had it wrong when he postulated that adults could not remember things learned as infants — he termed it “infantile amnesia” — because those events were associated with socially undesirable events.

“Freud was wrong about it,” Spear said. “It was not a social problem. All altricial mammals, those born with very immature brains, forget the events of their infancy more completely than later events, and with animals it is unlikely that social standards are involved.”

However, Spear is finding that the memory for things learned in conjunction with the infant’s first meal may not be forgotten as rapidly as other events of infancy. “Things learned then seem to be special,” he said.

Spear and colleagues have tested their theory on hours-old rats that were delivered by cesarean section. The rat pups were given a drop or two of milk, preceded by a sniff of lemon oil. “That gives the odor a lot of power,” said Spear.

Later, when presented with a dry nipple after a lemon-scented cotton swab, the rats suckled for about 80 per-
cent of a 10-minute period. Rat pups in control groups not exposed to the lemon-milk pairing suckled only about 20 percent of the time.

Spear's team repeated the lemon-milk pairing with another group of rat pups, but this time allowed a minute to lapse between the presentation of the lemon scent and the milk. In spite of the time lapse — which in older infants would not result in a conditioned pairing — the rat pups became conditioned to suckle in response to the lemon scent.

Spear concludes that the conditioning in the newborn might be especially robust for at least two reasons. First, in natural circumstances an odor and a nipple are the cues that direct rat pups to their first meal, so newborn rats might be predisposed to learn the odor-nipple association. Or, Spear says, it could be that the pups are blank sensory slates aside from their fetal experience, and the first significant sensory information they encounter — the lemon odor and the milk taste — forms a special bond due to its primacy.

In either event, the experiment demonstrates that even primitive events, such as suckling at a newborn's first meal, are learned and offer clues as to how the mechanics of memory and reinforcement operate.

Spear is working on a concurrent series of experiments with rat pups and ethanol, the form of alcohol that is the basic ingredient in commercial alcoholic beverages.

“What we're working on now,” he said, “is the question, ‘Is alcohol rewarding to infant rats and fetuses?’” In particular, he is asking how early exposure to alcohol, both prenatally and postnatally, affects later responsiveness to alcohol, including alcohol abuse.

The first challenge in the postnatal-exposure experiments is to get the rat pups to drink alcohol. (Spear notes that older rats don't like alcohol: “You have to trick them into it.”) Then he charts the physiological and learning effects under various conditions when alcohol is the reward for learning.

“What we're finding is that within the first two weeks after birth, infants readily drink more alcohol,” he said. “They consume two to three times more alcohol than water. What we're able to show is that alcohol is rewarding, and at some concentrations, it's as rewarding as milk.”

The second form of exposure that rat pups get to alcohol is via the mother during gestation or nursing. During gestation, alcohol gets into the amniotic fluid and the fetus is exposed directly to both the flavor of alcohol and alcohol's pharmacological “buzz.” Or, when the rat pups nurse, the milk is contaminated with alcohol.

While Spear's work is with rats, the implications extend to humans. For instance, the research involving rat fetuses that absorb alcohol via an intoxicated mother may have implications for understanding Fetal Alcohol Syndrome and the less extreme Fetal Alcohol Effect, two conditions that affect children born to alcoholic mothers. Spear notes that Fetal Alcohol Syndrome was only definitively identified and labeled as such less than 30 years ago, so research into the underlying issues of alcohol and fetus-infant development is still in its infancy.

Scientists have judged that more cases of mental retardation are due to prenatal exposure to alcohol than to any other single cause. Fetal Alcohol Syndrome generally affects one of every 1,000 newborns and two per 1,000 births in some socioeconomic groups. Fetal Alcohol Effect, which has milder symptoms, is far more prevalent. Because of structural and neurochemical changes in the brain caused by the prenatal ingestion of alcohol, these children have learning and behavioral difficulties that hamper them their entire lives. In many instances these children also have a high predisposition toward alcoholism in later life.

Along with the basic research regarding alcohol, Spear is advancing science's understanding of the role of prenatal learning, the importance of senses in learning, and the link between the senses, memory and learning.

Spear, who came to Binghamton in 1974, received a bachelor’s degree in mathematics and another in psychology from Bowling Green State University. He earned his master’s and doctoral degrees in experimental psychology from Northwestern University. Prior to teaching at Binghamton, Spear served on the faculty of Rutgers University, one of the nation’s premier schools for alcohol studies.

“What the newborn rat can tell us about the human condition is very, very important,” said Spear.
The answer may lie in a report card that grades public school health services that was developed for New York state by the Roger L. and Mary F. Kresge Center for Nursing Research of the Decker School of Nursing. The research team was led by Gale Spencer, director of the center; A. Serdar Atav, manager of the center’s information and research systems; and Yvonne Johnson, a research associate. "We tended to grade tough," said Johnson, who helped to analyze how school health services fared in 11 key areas.

Johnson said that while most of the schools received a passing grade, many performed very well on high profile tasks such as policies for handling infectious diseases, but did less well in ensuring that their students had vision screenings.

The data were gathered from 140 public schools across the state, excluding New York City. Locally, the random sample included schools in the Johnson City, Deposit and Margaretville districts. The sample included high-, average- and low-need schools in both urban and rural areas. Using school nursing practice and national health education standards as the guide, schools were judged to be below standard, standard, proficient or distinguished. The $9,150 study was funded by the Statewide Advocacy for School Health Services Center, a unit of the State Education Department. The center had used a previous $7,500 grant to develop and refine the final survey.

Looking at the overall results, schools in New York rated a C+ (a 2.87 score on scale of 4.0), said Spencer. None of the 140 schools was in the distinguished class; 39 percent (55 schools) were rated proficient; 50 percent (71 schools) were standard; and 10 percent (14 schools) were below standard. Some schools rated distinguished in individual categories but had lower overall scores.

Spencer said the grant’s purpose went beyond just grading the schools and sought to correlate the grades with the funding needs and grade levels.
The study also linked health care quality grades to such variables as attendance rates and educational performance measures.

Spencer said the study, now being analyzed by state policy-makers, garnered considerable national interest after the research was presented to the American Public Health Association last November. A paper describing the study and its findings is also being prepared for submission to the *Journal of School Nursing*, and Spencer is seeking funding to conduct a national study.

While it is not surprising that nearly a quarter of the high-need schools — as determined by the State Education Department — were below standard, the study found that 15 percent of the low-need schools also fell below the standard.

Johnson noted that while these schools did quite well in many areas, they were deficient in the scoliosis-screening category. In fact, said Johnson, most schools fared relatively poorly in this category, pointing out one of the study’s key findings. How well a school performs in certain categories depends on what grade level is involved and how “routine” the task is — such as performing screenings or recording a student’s height and weight.

Scoliosis screening, which detects abnormal curvature of the spine, is typically done only in junior high (sometimes referred to as middle school) or high school. In general, Spencer said, health needs in middle school or junior high suffered, often because school nurse staffing levels were inadequate. The study found a direct correlation between the number of registered nurses a school had, its grade span and its performance on the school report card.

Staffing levels tend to be highest in elementary schools and high schools and lower in middle schools, which often share one nurse between several buildings, Spencer said. Middle schools had the lowest average overall grade, 58.2 percent, when compared to elementary schools, which had a 71.3 percent average, and high schools, which had a 68 percent average. Schools that encompassed pre-kindergarten through 12th grade had the highest average of all at 73.5 percent.

Spencer added that the health needs of pre-teens and adolescents often get short shrift. “Health is taken care of in small children. Adolescents are really a lost population unless there is some crisis.”

Johnson cited another example from the report card: “Routine” tasks such as recording student heights and weights were not as well attended to as such higher profile tasks as having procedures for administering medicine. In fact, said Johnson, height and weight screenings are often ignored completely. While this is often a function of short staffing as the work is time-intensive, she noted that height and weight screenings can be important tools in spotting health problems early.

Researchers found a significant relationship between a school’s health ranking and its scores on the eighth-grade language arts test, meaning that lower scores and higher scores on each test tended to be related or parallel one another.

A similar significant relationship was found between the percent of Regents diplomas earned in a school and its performance on the health test. No correlation was found between the grades on the fourth-grade language arts and math benchmark tests and the health grades. These correlations, the researchers agreed, were further proof that as students progress through school, health resources decrease.

Looking ahead, the researchers believe that the survey rubric they developed is capable of generating a solid health report card for larger pools of schools — regionally or nationally. Reflecting on their accomplishment of taking a rough draft of a self-survey originally crafted by others and turning it into an instrument capable of successfully measuring and analyzing large amounts of data, Atav said, “What came to us was a shell and we were able to develop it.”

The project also gave Decker graduate students the opportunity to participate in a full-fledged research effort. In addition to the research team, six master’s and doctoral students assisted with various components of the project over the two-year period. “Our students are very lucky that way,” said Atav. “They work with real data and real people and get to see the results of their work.”
Singing out

WRITER USES STORIES TO ADVANCE HUMAN RIGHTS

In the middle of February Thomas Glave found himself at the top of the cultural bill of fare in frigid Stevens Point, Wisconsin — a small college town in the middle of the state — more than 100 miles from “liberal” Madison, but only a third of that distance from the home of the late Sen. Joseph McCarthy, right-wing political icon.

For Glave, 36, assistant professor of English and newly published author, it was a far cry — literally and figuratively — from the Bronx where he was born and Kingston, Jamaica, where he spent much of his childhood. But with his book, Whose Song? and Other Stories, published in October 2000 by City Lights Books, hitting its stride in the marketplace, the tour was worth a semester off from teaching and writing.

Whose Song? is a collection of nine stories set in locales that include Bronx and Jamaican cityscapes, the rural South and — in an eerily brutal story, “The Pit” — a country that could be any of a number of Caribbean or Latin American venues where political mass murder could occur. The stories are by turns expansive, almost free-form, and tight. Some are tender, but most have themes of dark violence — emotional and physical.

Glave’s work has excited considerable attention. Months before the book was published, the Village Voice’s Literary Supplement named him one of eight “Writers on the Verge.” Once published, the book was reviewed by the New York Times Book Review, The Washington Post and many major papers, and featured on National Public Radio.

The acclaim is Glave’s second brush with literary notoriety. In 1997 he won the O. Henry Award for fiction, becoming the second black, gay writer to win the award. The first was James Baldwin in 1959.

While he finds the attention gratifying, Glave admits it distracts from his writing. Glave is in love with words — listening to them, writing them, and, on tours, reading them aloud.

“I’ve always loved the power of voice, written and spoken,” he says. “Whenever I hear a character’s voice, I feel their energy and try to translate that energy — the voice itself — with integrity onto the page. It’s difficult.”

A dancer for several years with the Dance Theatre of Harlem, Glave is acutely conscious of the rhythm in words. The writer’s job, he says, is to capture those rhythms.

In his classes, Glave pays particular attention to how students hear and see as a means of expanding their listening and seeing skills in concert with their writing. He has asked students to memorize prose passages and recite them to him during weekly meetings.

“They often know song lyrics by heart, so why not texts?” Glave asks. The practice, he says, helps the students absorb the ebb and flow of the words into their very being.

“I want them to be able to get different forms of writing into their body,” he says. “I strive to familiarize them with how language is processed — paragraph by paragraph, sentence by sentence, word by word.”

Memorization and recitation, he says, offer “a way of exposing the mechanics of language, of getting intimate with narrative forms, of reading with dedicated intent and focus.”

When Glave talks about “dedicated intent and focus,” he’s getting at the heart of his view of the world. His worldview reflects the intersection of being gay, African, American and Caribbean.

Before graduating with honors from Bowdoin College in 1993, Glave traveled throughout Central and South America, including visits to Peru, Colombia, Chile, Ecuador, Argentina and Bolivia. He became attuned, first-hand, to the political repression faced by many, and by gays in particular.

Those experiences led Glave and others (in 1998-99 while he was in Jamaica on a Fulbright Fellowship) to found J-FLAG, a forum for the island’s gay, lesbian and straight communities, to do human rights work.

These concerns find their way into Glave’s classroom. “I think about the importance of being ‘out’ as a gay man, a politically conscious gay professor, and a gay professor of color,” Glave says, adding, “The students, really appreciate that openness.”
Binghamton University Organized Research Centers

CENTER FOR COGNITIVE AND PSYCHOLINGUISTIC SCIENCES  
Director: Richard Pastore, Est. 1987

CENTER FOR COMPUTING TECHNOLOGIES  
Director: Kanad Ghose, Est. 1993

CENTER ON DEMOCRATIC PERFORMANCE  
Director: Edward M. McAhon, Est. 2000

CENTER FOR DEVELOPMENTAL PSYCHOBIOLOGY  
Director: Norman Spear, Est. 1987

CENTER FOR THE HISTORICAL STUDY OF WOMEN AND GENDER  
Co-Directors: Kathryn Kish Sklar and Thomas Dublin, Est. 2000

CENTER FOR INTELLIGENT SYSTEMS  
Director: Harold Lewis, Est. 1995

CENTER FOR LEADERSHIP STUDIES  
Co-Directors: Bruce Avolio and Francis Yammarino, Est. 1988

CENTER FOR LEARNING AND TEACHING  
Director: Wayne Jones, Est. 1996

CENTER FOR MEDIEVAL AND RENAISSANCE STUDIES  
Director: Charles Burroughs, Est. 1966

CENTER FOR RESEARCH IN ENVIRONMENTAL SYSTEMS  
Director: TBA, Est. 1987

CENTER FOR RESEARCH IN TRANSLATION  
Director: Marilyn Gaddis Rose, Est. 1987

FERNAND BRAUDEL CENTER FOR THE STUDY OF ECONOMIES, HISTORICAL SYSTEMS, AND CIVILIZATIONS  
Director: Immanuel Wallerstein, Est. 1976

ROGER L. AND MARY F. KRESGE CENTER FOR NURSING RESEARCH  
Director: Gale Spencer, Est. 2000

INSTITUTE FOR BIOMEDICAL TECHNOLOGY  
Director: John Baust, Est. 2000

INSTITUTE OF GLOBAL CULTURAL STUDIES  
Director: Ali Mazrui, Est. 1991

INSTITUTE FOR MATERIALS RESEARCH  
Director: M. Stanley Whittingham, Est. 1988

INSTITUTE FOR PRIMARY AND PREVENTATIVE HEALTH CARE  
Director: Gary D. James, Est. 1998

INTEGRATED ELECTRONICS ENGINEERING CENTER  
Director: Bahgat Sammakia, Est. 1988

PUBLIC ARCHAEOLOGY FACILITY  
Director: Nina Versaggi, Est. 1972