DIGITAL BONANZA

RESEARCHERS PROSPECT FOR SOLUTIONS IN THE BOOM TOWN OF BIG DATA
Destroying is part of creating for artist Ronald Gonzalez
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Nearly every facet of our lives could be transformed by Big Data in the next decade. This digital bonanza is already shaping how we shop, what we see on television and even which medicines our doctors prescribe. It has important implications for business, government, security and privacy, too.

In this issue of Binghamton Research, you’ll see that faculty members here are capitalizing on Big Data’s potential to improve hospital care, inform urban planning and develop more accurate predictions of natural disasters. The mountain of metrics they’ve tapped into will yield new ways of keeping patients healthy, smoothing the flow of traffic in big cities and minimizing the loss of life and property during floods. Given Binghamton University’s reputation for all things “green,” I am also pleased to say that we’re finding ways to reduce the amount of energy required to crunch this data.

My own research career has been motivated by a desire to make a transformational impact on society, and these projects are on track to do just that. A boom town atmosphere surrounds Big Data these days, and it’s exciting to see Binghamton innovators prospecting for solutions.

Bahgat Sammakia
NATIONAL SCIENCE FOUNDATION CAREER AWARD WINNER SARAH LASZLO
Neuroscientist’s work may advance dyslexia treatment

Sarah Laszlo wants to understand what’s going on in children’s brains when they’re reading.

Neuroscientist Sarah Laszlo’s research may untangle some of the mysteries surrounding dyslexia and lead to new methods of treating America’s most common learning disorder.

“The brain can reveal things that aren’t necessarily visible on the surface,” she says. “It can tell you things about what’s going wrong that you can’t find out by giving a kid a test or asking him to read out loud.”

Laszlo, who joined Binghamton’s faculty in 2011, received a five-year, $400,763 grant from the National Science Foundation’s Early Career Development (CAREER) Program, the agency’s most prestigious award for young researchers. The funding will enable her to conduct a five-year brain activity study of 150 children with and without dyslexia.

Rather than lumping all children with dyslexia into one group, as many previous brain-imaging studies have done, Laszlo’s project will help to establish types and degrees of the disorder.

She uses electroencephalography, or EEG, as a non-invasive way to measure the electrical signals sent between brain cells when they’re communicating with each other. Study participants — kids in kindergarten through fourth grade — wear a cap outfitted with sensors while playing a computerized reading game.

Laszlo hopes to identify the brain signatures of people with dyslexia and have a clear idea of how to help them. “Once you understand what’s going on in the brain,” she says, “you can do a better job of designing treatments.”

Today, the best-case scenario is that dyslexic children receive interventions and get up to speed on reading aloud. But their comprehension, fluency and speed may remain weak. “The treatments we have now don’t always fix the underlying problem,” Laszlo says. “They just put a Band-Aid on it. And when you go to do more complicated things, like reading larger passages, the Band-Aid doesn’t help.”
Seden Akcinaroglu analyzes trends in domestic terrorist attacks to predict when they will occur in the future.

Akcinaroglu, an assistant professor of political science at Binghamton, specializes in international conflict and rivalries. In the past, she has focused on three general areas: civil wars, international rivalries and terrorism. Her interdisciplinary project with Binghamton University computer scientists homes in on the relationships between major events in a country and its terrorist attacks.

“We are trying to understand, in a very dynamic way, how we can actually predict some terrorist attacks,” Akcinaroglu says. “Right now, a lot of the studies are very static.”

Yu David Liu, an assistant professor of computer science, says Akcinaroglu’s dynamic research direction is “challenging but essential, considering the fast pace of global events.”

He says the project uses public sources such as online newspapers and databases. “It then performs data analysis to correlate individual factors and the historical attack data,” Liu says. “Prediction is made based on findings of these correlations from historical data.”

Liu says computers streamline the data collection and analysis so predictions can be made quickly.

Previously, Akcinaroglu worked to unravel the effect of natural disasters, economic status and militarized disputes on terrorist attacks. “When states are engaged in militarized disputes with other states, terrorist attacks increase,” she says. “The terrorists find it as an opportunity to attack.”

The same is true, Akcinaroglu says, for cases in which a country is weakened economically. When natural disasters hit, however, terrorist attacks tend to decrease.

“It seems that terrorists do care about reputation to a certain extent,” Akcinaroglu says, “so during times of natural disasters, they don’t want to alienate supporters.”

These findings challenge how terrorist organizations are normally perceived to operate. “For us, any atrocity can be attributed to a terrorist organization. The fact that they kill civilians is basically telling us that they don’t care,” Akcinaroglu says. “But they do care about reputation, and some of them care more than the others.”

Her current project uses a complex model to encompass as many factors as possible and look at how those factors affect terrorist organizations’ decisions to attack.

Akcinaroglu, who is from Turkey, says her interest in researching terrorist attacks began when the Kurdistan Workers’ Party (PKK), a rebel organization in Turkey, announced it would not attack the country following the devastating 1999 earthquake. Akcinaroglu says she saw the same thing occur in Indonesia later, and it made her curious about terrorist organizations’ hesitation to attack.

— Christina Pullano
Scientists create first computer-designed superconductor

A Binghamton scientist and his international colleagues recently reported on the successful synthesis of the first superconductor designed entirely on the computer. Their findings were published in *Physical Review Letters*, the leading journal in the field.

Aleksey Kolmogorov, assistant professor of physics at Binghamton, proposed the new superconductor in *Physical Review Letters* in 2010 and then teamed up with European experimentalists to test the prediction.

The synthesized material — a novel iron tetraboride compound — is made of two common elements, has a brand-new crystal structure and exhibits an unexpected type of superconductivity for a material that contains iron, just as predicted in the original computational study.

“Paradigm-shifting superconducting materials have so far been discovered experimentally and oftentimes accidentally,” Kolmogorov says.

Until now, theory has been used primarily to investigate superconducting mechanisms and, in rare cases, suggest ways that existing materials might be modified to become superconductors. But many proposed superconducting materials are not stable enough to form, and those that do form are poor superconductors.

Superconductors, which conduct electric current without any resistance when cooled below a certain temperature, have many interesting applications. For instance, power lines made out of superconducting materials can significantly reduce the energy lost in transmission.

The phenomenon of superconductivity was discovered more than 100 years ago, with breakthroughs in the 1960s bringing it into practical application. The critical temperature, or $T_c$, for superconductors discovered to date is between 0 and 136 Kelvin (−460 and −214 degrees Fahrenheit). Scientists are still searching for new materials that are superconductors at higher temperatures and can be mass produced.

Several years ago, Kolmogorov, then at Oxford University, began studying boron-based materials, which have complex structures and a wide range of applications. He developed an automated computational tool to identify previously unknown stable crystal structures. His “evolutionary” algorithm emulates nature, meaning it favors more stable materials among thousands of possibilities. (Kolmogorov is a computational physicist, but he also dreams of holding a compound in his hands that he predicted in silico.)

The search revealed two promising compounds in a common iron-boron system, which came as a surprise. Moreover, graduate student Sheena Shah’s calculations indicated that one of them should be a superconductor at an unusually high temperature of 15-20 Kelvin for the considered (so-called “conventional”) type of superconductivity.

Months of double-checking confirmed the preliminary results on the stability and superconductivity of the compound. Still, the 2010 theoretical discovery was met with skepticism.

Natalia Dubrovinskaia and Leonid Dubrovinsky, professors at the University of Bayreuth in Germany, undertook a series of experiments and produced a very small quantity of iron tetraboride in the predicted crystal structure, leading to the latest article. Detailed measurements demonstrated the material's predicted superconducting property and, unexpectedly, its exceptional hardness.

“The discovery of this superhard superconductor demonstrates that new compounds can be brought into existence by revisiting seemingly well-studied systems,” Kolmogorov says. Now that this material has been synthesized, it may be possible to modify it and raise the temperature at which it becomes a superconductor.

— Rachel Coker
D. Andrew Merriwether ambles into his lab wearing a green T-shirt, a weathered Binghamton University ball cap and a graying ponytail. He ignores the birthday cake on the bench (chocolate frosting with peanut butter cups) and pulls up a stool.

He has been doing some fieldwork, he says. For this particular molecular anthropologist, that means he was actually in the field — with his alpaca.

He’s looking for genetic links that cause choanal atresia — a disorder found in both the alpaca and humans in which tissue or bone blocks nasal passages. It’s frequently fatal among the alpaca because babies with the condition can’t breathe while nursing.

Choanal atresia has perhaps 20 causes, Merriwether says. Only a couple may be genetic, but understanding the genetics may lead to strategies for prevention or early diagnosis in humans.

That’s a small part of how the alpaca play into his research. “They’re just so neat: curious, quick, smart,” he says. “They survive on almost nothing.”

As a species domesticated by early South American populations, they reflect the culture of the people about whom Merriwether did his dissertation 20 years ago. “For the poorest people of South America, it’s their only source of cash income,” he says. Like those people, Merriwether and his wife shear their alpaca herd.

Genetically, the alpaca had to adapt to life in the 13,000-foot altitudes of the Andes just as people did, says Professor Ralph Garruto, a National Academy of Sciences member whose presence at Binghamton drew Merriwether to the faculty in 2003. How they did that is a question with implications for cultures across the world.

“How do people who are genetically different adapt to the same stressors?” Garruto asks. Women in most parts of the world can’t carry a fetus to term above 10,000 feet, but the people of the Andes do it routinely — as do the alpaca. “All the changes in the alpaca help us see the mechanism in that animal and whether there are parallels in humans. We’re talking survivability and functionality of human beings.”

The alpaca aren’t Merriwether’s sole focus. About a third of his research lies in Melanesia, with the peoples of New Guinea and the Bismarck Archipelago. He has many of the same questions he had about the South American cultures that got him into molecular anthropology in the first place: How did they get there? How long ago? How have they adapted?

“Almost every question I am interested in,” he notes, “has DNA as a way of answering it.”

— Todd R. McAdam
Nanoparticle could help identify heart-attack risk

A Binghamton University researcher hopes to give doctors a more accurate way of determining a patient’s risk of heart attack or stroke.

Amber Doiron, assistant professor of bioengineering, says current methods of assessing atherosclerosis — commonly known as hardening of the arteries — are not terribly accurate. Some 30 percent of deaths worldwide can be attributed to the disease, which occurs when fat, cholesterol and other particles form hard structures called plaques in the walls of arteries.

“It’s really a guessing game right now,” she says. “Doctors use factors like blood pressure and cholesterol level to get an idea of a patient’s risk. Then they use plaque size as a general measure of whether a person has the disease. But there’s a fairly poor correlation between plaque size and heart attack or stroke.”

Doiron, who has an interest in molecular imaging as well as expertise in nanoscience, wants to help physicians do a better job of identifying which plaques are cause for concern.

She and a Temple University colleague recently received a two-year, $418,000 grant from the National Institute of Biomedical Imaging and Bioengineering to support this project. It’s a notable success in part because this was Doiron’s first National Institutes of Health grant proposal.

The researchers will use a combination of polymers and superparamagnetic iron oxide nanoparticles for the study. The nanoparticle is sensitive to oxidative stress, which occurs in atherosclerosis and has been linked to patients who have a higher prevalence of heart attack and stroke. Using an MRI scan, the researchers will be able to see how active the nanoparticle is, which will indicate whether the plaque is stable.

“What happens is, the plaque ruptures and the gunk that underlies the plaque is exposed to blood and a clot forms. The clot builds quickly — on an hour time scale as opposed to over years — and the clot can grow there until it blocks flow, or it can dislodge and block flow somewhere else. Most heart attacks do not occur from a full blockage of plaque. They happen because the plaque bursts. Same thing with strokes. That’s why size isn’t necessarily indicative of how dangerous a plaque is.”

The discovery of a molecule or a cell type that indicated which plaques are safe and which ones are dangerous would be a huge breakthrough, Doiron says. She thinks oxidative stress may be such an indicator.

“Atherosclerosis is an incredibly complex disease that progresses over decades,” Doiron says. “It’s hard to tell who’s walking around with plaques that are stable, relatively safe, and who has plaques that may cause a heart attack tomorrow. For some patients, the first sign of trouble is a heart attack.”

— Rachel Coker
On Aug. 14, 2003, something went very, very wrong in Ohio. Tree branches hit a transmission line during a hot summer afternoon when power demands to feed air conditioners were high.

A software problem meant human operators were unaware they needed to shunt power around the break. Then they couldn’t keep up with relays commanding to break circuits to prevent overloads. Grid by grid, community by community, the cascading power failure shut down the northeastern United States and much of Ontario, Canada.

Fifty-five million people were left without power, and lost productivity and damaged equipment cost between $6 billion and $12 billion.

Eva Wu’s task is to help prevent that from happening again.

Wu, an expert in control systems and a professor of electrical and computer engineering at Binghamton University, is working with NYSEG (New York State Electric & Gas) to understand the best way to monitor and control a power grid that is too complex for current automated equipment to control and sometimes operates too fast for much human intervention.

The federal government has spent $300 million since 2003 to add 1,000 new monitoring devices that are networked and time-synchronized with GPS. Power controllers get system-wide updates 60 times a second, rather than once every five seconds. This also provides the opportunity to make the fast-acting protection system more reliable. “One of the major reliability problems is protection system misoperation,” Wu says.

Current protection systems are designed to protect local equipment, not the entire network. Nothing watching the whole system is capable of making a decision in tenths of milliseconds, which some problems require.

Blink once. Some network actions need to be taken 800 times faster than that.

“Part of my research is to make the best use of that information in an automated manner,” Wu says. That means deciding how to place monitors to greatest effectiveness and how to design a control system that can cost-effectively mitigate the blackout of the power grid, beyond merely protecting local equipment.

To do that, she must measure two concepts: security profile, the ability of the system to respond to a disturbance in a timely manner; and control effectiveness, measuring how well the system can be observed and how well it can be controlled.

The New York State Energy Research and Development Authority funds Wu’s research, which has worldwide implications. Sixty million people in Brazil and Paraguay lost power in a cascade failure in 2009. In 2012, the largest blackout in history hit India, cutting power to 620 million people — twice the U.S. population.

“Control systems enabled by new smart devices have the ability to make the system act in a very robust way,” Wu says. “Obviously, we need to do better.”

— Todd R. McAdam
Liz Rosenberg’s latest novel, *The Laws of Gravity*, pits two cousins against each other. One has cancer; the other holds a possible cure, in the form of umbilical cord blood he has banked for his children.

Rosenberg, a professor of English at Binghamton, says she found inspiration for the book in a real-life drama more than 30 years ago. A Pittsburgh man sued his cousin for a bone marrow transplant after the would-be donor changed his mind about the procedure. “It was just an instant novel in my head,” Rosenberg recalls. “What would it be like to be the surviving cousin? What would that do to a family?”

Rosenberg wrote to the justice who handled the case. They exchanged letters, and he shared his views on the lawsuit. She even drove to Pittsburgh to discuss the case with him. “He knew that he could not force this person to do good,” Rosenberg says. “The powerful are sometimes powerless. And the seemingly powerless are sometimes powerful.”

Life and other projects got in the way, and Rosenberg shelved plans to write the book. But after her first novel, *Home Repair*, was published in 2009, Rosenberg’s thoughts returned to the project. “I was at a book club meeting in Binghamton for *Home Repair* when a book club member suggested to me, ‘What if it were cord blood?’ And I thought, ‘Wow, that’s really interesting.’”

That was one of several changes Rosenberg made for the novel, recently published by Amazon. In the Pittsburgh case, two male cousins went to court. Her story would have one male cousin and one female cousin. And she decided it would take place in the present day on Long Island, where she grew up. “It felt remarkable to me to be able to go home in my fiction,” she says. “This is my hymn to Long Island.”

The setting allows Rosenberg to explore the intense family connections of suburbia, differences in wealth and even the challenges of driving on Long Island. Indeed, traffic serves as a unifying metaphor in *The Laws of Gravity*. “There’s always something in your daily life that is an obstacle,” she says. “On Long Island, it’s traffic. You have to plan around the traffic.”

Rosenberg dismisses the idea that the suburbs are a bland string of strip malls and gas stations. “The suburbs get short shrift,” she says. “I grew up in suburbia. It’s full of passion and it’s full of intrigue and suffering and beauty. It’s not as easy as it looks. Moments of beauty, of clarity, even of redemption, come out of feeling pressed all the time.”

— Rachel Coker
Researchers prospect for solutions in the boom town of Big Data
“There was of course no way of knowing whether you were being watched at any given moment. ... It was even conceivable that they watched everybody all the time.”

— George Orwell, *1984*

The government is watching you. So, too, are Google, Amazon and your cell phone company. Supermarkets record your every purchase. Some department stores even track you while you shop. The information joins the global bank of digital information commonly called Big Data, which also includes details about phenomena ranging from rainfall to rush hour.
It has taken less than 65 years for the predictions made in George Orwell’s classic novel to come true. Yet the results of this intrusion often prove far less sinister than Orwell’s Big Brother. For instance, Binghamton University researchers have crunched Big Data to help predict floods, improve transportation systems, save energy and deliver better healthcare for less money.

Binghamton scientists and engineers have done this by mining an information trove that is growing by 2.5 quintillion bytes a day. This digital bonanza is made up of an eclectic mix. Your credit card transactions become part of Big Data. So, too, do images beamed to Earth from the Hubble Space Telescope. Your posts to social networks, every Google search and the digital version of this story are part of the collection as well.

Big Data is a gargantuan field — one that can be mined to solve any number of problems, though sometimes it’s put to nefarious uses. For example, federal charges were brought this year against five high-tech thieves who hacked the computer networks of major companies, stealing financial and personal data.

An early warning system
Big Data projects can bring big benefits. Predicting floods in Binghamton is a case in point.

Historians are fond of saying that events are interconnected, with one event leading to another. It turns out that much of our world operates on the same principle: Floods, for instance, result from patterns of interconnected weather changes. These patterns can be discovered by mining Big Data using a specialized algorithm, says Zhongfei “Mark” Zhang, professor of computer science and director of Binghamton’s Multimedia Research Laboratory.

He believes the same thing holds true for tornadoes, disease outbreaks and various other phenomena, even though they may seem dissimilar.

Rather than develop one data-mining algorithm for each event — one for flood prediction, another for tornados and a third for disease outbreaks — Zhang and his students created a single algorithm that has wide applications. The University placed the formula in the public domain so that it can be put to good use elsewhere.

Flood prediction offers an example of how this data mining works. Zhang and his students mined the giant weather database maintained by the National Oceanic and Atmospheric Administration (NOAA).

“Big Data may help reduce hospital costs and improve profits. But from my perspective, the most important thing is that it improves patient outcomes.”

— Mohammad Khasawneh, professor of systems science and industrial engineering

professor of computer science and director of Binghamton’s Multimedia Research Laboratory.
One aim of their work was to reveal the underlying series of events that led to massive flooding in 2011 in Binghamton.

They analyzed not only Binghamton’s past weather patterns but past patterns for nearby areas and other parts of the country that had similar weather. And they looked at past weather patterns for the United States as a whole. “We believe that things are always related in one way or another,” Zhang says.

Once they found the past pattern of weather events that led to the Binghamton flood, the team looked for a recurrence of the same sequence of events in current weather. Zhang says they correctly predicted flooding in Binghamton in 2011.

“We were not the first to do this kind of prediction,” he notes. But earlier prediction systems were extremely limited in scope. If researchers wanted to predict the weather for Binghamton or Ithaca, for example, they analyzed the weather in Binghamton or Ithaca.

Zhang’s big-picture view required a lot more work. “The bigger the area you take in, the more mathematically complex the project becomes,” he says. But, he believes, it also produces more accurate forecasts.

Zhang, who holds more than a dozen patents related to data mining, believes the algorithm could also uncover the underlying pattern of events behind disease outbreaks if more medical data were made available. Unfortunately, there is no central, public repository of disease data comparable to NOAA’s weather database. Of course, the release of medical records is a much more sensitive matter than the release of yesterday’s weather statistics.
Big Data is a tough subject to wrap your head around because it’s so very big. And it’s getting bigger every day. Every time you tweet, send an e-mail, make a cell phone call or launch a Google search, you create more data. Big Data is growing so quickly that IBM estimates that 90 percent of all data has been created in the past two years.

Big Data also is growing in importance, particularly in business. A recent report from the global management consulting firm McKinsey & Co. concluded, “Leaders in every business sector will have to grapple with the implications of Big Data. ... Data have swept into every industry and business function and are now an important factor of production, alongside labor and capital.”

Big Data has created a trade-off in which we lose a degree of privacy but gain information that can make our lives better, more productive and safer. For instance, the familiar savings card that tracks grocery purchases recently enabled a regional supermarket chain to find Binghamton customers who had bought a certain type of pine nuts. The nuts turned out to be tainted with salmonella enteritidis, which can cause fatal infections in young children, the elderly and those with weak immune systems. The grocery chain was able to alert the buyers.

Zhongfei “Mark” Zhang, professor of computer science and director of Binghamton’s Multimedia Research Laboratory, acknowledges a unique responsibility comes with access to Big Data. “How do we balance the relationship between developing advanced technologies to mine data while at the same time protecting people’s privacy?” he asks. “These two themes are in opposition. We need to develop technology that will keep a balance between the two. This is challenging. But as a researcher, I believe it’s our job.”

“We would like to discover or even predict disease outbreaks, predict where they might spread and whether they will become more virulent over time,” he says. “We would also like to predict the time line for the spread of a disease — like, would it get to New York state in a week?”

Trimming healthcare costs
Another target of Binghamton’s experts is the nation’s $2.7 trillion-a-year annual healthcare bill. They believe Big Data can help curb the costly problem of unscheduled hospital readmissions for Medicare patients. Nationally, almost 20 percent of Medicare patients who are released from the hospital return to the hospital within 30 days, and more than a third are readmitted within 90 days, the New England Journal of Medicine reports. The cost of unplanned readmissions exceeded $17 billion for 2004, the year on which the study was based.

The new federal Affordable Care Act has added carrot-and-stick provisions to cut readmissions. Hospitals get full reimbursement if patients avoid readmission, but they get docked if too many patients with certain diseases end up back in the hospital within 30 days.
“We would like to discover or even predict disease outbreaks, predict where they might spread and whether they will become more virulent over time.”

— Zhongfei “Mark” Zhang, professor of computer science

“This could add up to a lot of money,” says Mohammad Khasawneh, professor of systems science and industrial engineering at Binghamton. He is working on computer models to find out which factors indicate a patient is likely to get sick soon after discharge. In addition to extra care while at the hospital, these patients would be targeted for special outpatient care to keep them out of the hospital. Khasawneh is working with colleagues Sang Won Yoon and Chun-An Chou, both assistant professors of systems science and industrial engineering.

Healthcare researchers have already identified four variables linked to hospital readmissions:

- The number of emergency room visits a patient has had in the past six months
- The number of illnesses a patient has
- The severity of the illnesses
- The number of days the patient has been hospitalized before release

When the numbers are high or the illnesses severe, readmission is more likely. In the past, all four factors have been given equal weight in determining the probability that a patient will be back.

In tests conducted with UHS (United Health Services), however, Binghamton researchers found the accuracy of predictions improves when the variables are weighted differently. Depending on the characteristics of the patient population, they gave the number of illnesses the most weight and the number of emergency room visits the least.

If variables are added, such as a patient’s ZIP code or level of compliance with medication directions, the accuracy of the prediction improves even further. By acting on the data, UHS cut readmissions in one study from 18 percent to less than 8 percent.

Khasawneh says he sees an increasing need for Big Data analytics in healthcare, especially with the enormous amounts of data being collected in hospitals around the globe every minute, thanks to electronic health records.

Next, the Binghamton researchers are turning to artificial intelligence (AI) to refine their model. AI can look at data and capture the interaction between variables that are too complex for the human brain to analyze — for example, how smoking combined with the presence of multiple diseases stacks up as a readmission factor vs. some other combination.

**Algorithm:** A procedure or formula for solving a problem in a certain number of steps.

**Big Data:** This is an ever-evolving term. Rather than choose an arbitrary number of gigabytes or even terabytes as the threshold of “big,” some experts use the term to refer to datasets that are too large to be analyzed or managed with typical software. The National Science Foundation describes Big Data as large, diverse, complex, longitudinal and/or distributed datasets generated from instruments, sensors, Internet transactions, e-mail, video, click streams and/or other digital sources. Another way to think about Big Data is in terms of “the three V’s.” (That is, volume, velocity and variety.)

**Data mining:** The process of sifting through a large amount of information for useful or interesting patterns or relationships. “Data discovery” or “knowledge discovery” are different terms for the same concept.
When researchers get it right, their efforts produce a measurable impact on the hospital’s finances, but Khassawneh says there’s more to it than money. “It may help reduce hospital costs and improve profits,” he says. “But from my perspective, the most important thing is that it improves patient outcomes.”

Hit the road
In order to build new roads, plan bus routes or organize the emergency evacuation of a large city, officials need to know where people go and where they congregate. That is a complicated matter. In New York City, for example, someone may be on the subway at rush hour, on Wall Street for the workday, at a Chinese restaurant for an hour after work and then at Yankee Stadium for a night game. After that comes a brief stop at a local watering hole and then a taxi ride home.

When huge numbers of people are involved, Big Data can help sort out the details. Researchers in systems science and industrial engineering at Binghamton used anonymous social network data to analyze movement patterns in the city.

The team — Associate Professor Sarah Lam, Assistant Professor Sang Won Yoon and graduate students...
Keith Thompson and Ion Ho — worked with just four pieces of data provided by the Xerox Research Center in Webster, N.Y.

Xerox wanted the team to study movement patterns using 15 million tweets and other social network messages. Xerox provided the data — a user ID that did not include the user’s name, the time a text message was sent, the GPS location from which the message was sent and the message’s content.

With just those four pieces of information, the Binghamton researchers were able to unravel the travel of 270,000 New Yorkers. For instance, the team could tell what kind of restaurants a user preferred and if this preference changed over time, potentially useful information for the restaurant industry.

The researchers could also track movements of large numbers of people. “Why is this information important? With it, we can have better traffic-management systems and better urban planning for subway stations, buildings, parking lots and more,” Yoon says.

But the big payoff may come if New York is the target of another terrorist attack or other emergency requiring evacuation. “This research provides us with data on how many people might be in a given area at a particular time,” Thompson says.

In a second transportation-related project, Krishnaswami “Hari” Srinivasan, dean of the Watson School of Engineering and Applied Science, is working with Lam and Yoon to measure how often truck drivers use cruise control or change lanes. Cruise control saves gas; changing lanes uses more. Sensors implanted in the truck will record the data, which could have a measurable impact on driving habits in the fuel-guzzling trucking industry. Says Yoon, “If they save just a small percentage of the gas they are using, it’s a huge cost savings.”

Using information to save gasoline was not how George Orwell envisioned the surveillance state in 1984. Orwell had lived through the Great Depression and World War II. He confided to a friend that his new book would be “about the possible state of affairs if the atomic war isn’t conclusive,” Britain’s Guardian newspaper recounts.

But atomic annihilation didn’t happen, and the surveillance state didn’t evolve exactly as predicted. Instead of Big Brother, we have Big Data — a wealth of information with which to chart the future.

— Doug McInnis
Here's looking at you
Binghamton University researchers are good friends to have. When they take off their glasses and let down their hair, they find ways for you to eat healthier, lose weight, work more productively and avoid dry skin.

So read up: This is going to be more useful than your next chat over half-caf skinny lattes.

**Leave the plastic at home**
Want to eat healthier? Stop at the ATM before you go to the supermarket.

Marketing Professor Kalpesh Desai found, after a review of four large-scale studies of purchasing habits, that shoppers who use credit cards to do their weekly grocery shopping put more junk food into their carts.

That’s not because credit card users are more likely to be younger (or older), or male or female, or shopping for a family or for one. All of that has been accounted for in the study, which was published in the *Journal of Consumer Research*.

So why do cash shoppers buy less unhealthy food? Cash hurts, Desai says. “It’s a more vivid form of payment,” he says. “Emotionally, credit cards don’t have the same pain as cash.”

And that pain is enough to stop the impulse purchase of double-stuffed Oreos or a pint of Ben & Jerry’s Chunky Monkey.
“Consumers are fairly accurate in estimating the number of items in their cart and the amount of money they spend,” Desai says. “They’re very much aware of their decisions.”

But without some extra disincentive, they just can’t put down that guilty pleasure. And that extra disincentive is the immediate pain of parting with paper, the green kind. The delayed pain of credit cards just isn’t enough.

Other factors can also lure you away from your shopping list, Desai says. In a second paper now going through peer review, Desai argues that distracted or tired shoppers are more likely to cave in to temptation. A cell phone call, your kids or friend, even music can interrupt the thought process that helps you remember that you don’t need those potato chips.

“We live in a fast-paced world and the ability to think is a luxury,” Desai says. “You’re unable to resist that impulse.”

Your health insurance company could help, Desai says, in conjunction with your friendly, neighborhood junk food dealer. He gathered much of his data from studies that analyzed purchases recorded via store loyalty cards. Health insurers could work with grocers to monitor how you make your purchases and give you a break on your premiums for using cash for groceries.

Even more directly, a store could give you a discount for paying in cash. Fresh foods — fruits, veggies, fresh meats and dairy — often carry more profit than the canned, bagged and heavily processed junk food.

If a store were to discount your bill 3 or 4 percent for using cash — about the same as the transaction fee it pays the credit card company — it would take in the same amount of money per transaction. And if that money is in higher mark-up healthy foods, it gets more profit.

And you eat healthier.

When it comes to groceries, paper is definitely better than plastic.
Is it hot in here?
Want to lose weight? Install a hot tub in your office, right next to your desk so you can work from it.

If the boss thinks that’s taking casual Friday a bit too far, then consider bioengineer Kenneth McLeod’s alternative.

McLeod, director of the Clinical Science and Engineering Research Center at Binghamton, is developing a carbon-dioxide, laser-based heater that will keep you hot tub-warm for about 15 watts — a much cheaper alternative to the 1,500-watt space heaters populating the underside of desks all over corporate America. (His heater is less drippy, if also less fun, than a hot tub.)

Furthermore, such a device will make you up to 50 percent more productive at work. That’s because you won’t be getting up to get warm every few minutes.

How does it work? Well, first it’s important to know why it works, McLeod says. You’re gaining weight (and aren’t we all?) not because you’re eating too much or not exercising enough, but because your body is too cold, and temperature regulation accounts for two-thirds of the calories you burn.

“Your body has adapted to its environment,” McLeod says. And your environment today is largely air-conditioned: cars, offices, homes, you name it.

Your core body temperature in a typical 68- to 70-degree room is about 98 degrees Fahrenheit, or 36.7 degrees Celsius. At that temperature, your body produces almost no growth hormone, which regulates whether you burn calories at a higher metabolic rate or store calories in body fat to keep you warm.

But if you raise your core temperature to 100 degrees (or 37.8 C), your body produces enough growth hormone that you burn fat at a prodigious rate. To reach that body temperature, you’d have to keep your living or working space at 78 or 80 degrees.

How does McLeod know this? He put test subjects in a hot tub for 30 minutes. Those who did it a couple of times per week lost weight. In fact, they lost more weight than people with the same diet who exercised — 1.2 pounds a week for young women and 0.8 pounds for middle-aged men.

But because an office hot tub isn’t practical, and a 1,500-watt space heater is a huge waste of energy, McLeod is developing a laser-based body heater. Here’s how it works:

Carbon dioxide lasers are already common and relatively cheap. They produce electromagnetic radiation in the 10-micron range — the very lowest end of the infrared spectrum. That wavelength of radiation heats animal flesh, but not the air or items around it.

McLeod mounted a diffuser to a 15- or 30-watt laser-based heater — about as much energy as a compact fluorescent light bulb. The result is something that heats you, but not your desk, computer, air or anything else. The project is funded by the New York State Energy Research and Development Authority as well as the State University of New York Technology Accelerator Fund. He tested the prototype last spring.

The first devices will operate much like a space heater that you can regulate via remote control. Later devices might monitor skin temperature and regulate themselves to stay within your comfort range.

You could lose weight, increase productivity and save money. “It’s a passive diet plan,” McLeod says. “You don’t have to do a thing.”
What’s on your face?

Guy German used to just sigh to himself when he saw shoppers in the cosmetics aisle, imagining that they were really on their way to cleaner, more youthful skin. “Is it real or is it snake oil?” he would wonder.

As a bioengineer with expertise in fluid and solid dynamics, he decided to find out whether there was more going on than marketing hype. “I’m interested in the underlying physics of it,” he says.

Most cleansers — from shampoo to floor cleaner to dish detergent — are based on surfactants. Hundreds of them fill products all over the house because they’re a handy way to remove dirt and oil.

Why is that? The surfactant creates a nice, foamy lather. It also works as an emulsifier. “Essentially, oil and water do not want to mix,” German explains. “When surfactants are added during washing, they will sit at oil-water interfaces. This reduces the surface tension at the interface of the two liquids and allows the oil drops to be suspended in the water.”

Voilà! You can then wash away the dirt or oil more easily.

But as your skin gets clean, it may also feel a bit tight. That’s because along with the dirt, you’re also washing away lipids and natural moisturizing factors that are present in healthy skin. That tight feeling, German says, is a mild form of drying that can lead to cracking and chapping.

Washing changes the chemical composition of the dead skin cells that form the outermost layer of skin, the stratum corneum. If you think that’s no big deal, German would like to remind you that this hard, crunchy shell is what protects the soft, tender living tissue — the rest of you — from dehydration and infection.

“You’ve got to thank the stratum corneum for allowing you to live on land,” says German, whose research gained him the nickname “Dead Skin Guy” during a post-doctoral stint at Yale University. “It works to slow down the water escaping from your body, which means we can live on land and not in the ocean.”

In a study funded by Unilever — the makers of Dove and Alberto VO5 products, among others — German developed a technique called high throughput correlation tracking to measure how much the stratum corneum dries out and stiffens after being treated with surfactants. This new technique will make it possible for researchers to test hundreds of surfactants in order to build a better soap.

In his study, German tested four surfactants — sodium cocoglycinate, sodium lauryl ether sulfate, cocomido propyl betaine and alkyl polyglycoside. (The last, known as APG, is more commonly used today in floor cleaners than in facial cleansers.) The APG showed the most deformation, while two others resulted in deformation similar to the control, simply treated with water.

Not all skin is the same, and neither are surfactants. Some surfactants will remove lipids and natural moisturizing factors that are supposed to be present in healthy skin tissue. Different surfactants remove different amounts and, therefore, cause different amounts of barrier damage.

Bottom line, German says: “Your choice of cleanser matters. Read the back of the label.”

His next project? Moisturizers: How do they really work? And do they repair all that damage caused by soap?

Better living through research

Follow the advice of these Binghamton experts and you may find that:

- You’re eating healthier.
- You’re thinner.
- You’re flush from that promotion because you’re more productive.
- You’re saving money thanks to lower energy bills and fewer junk food purchases.
- Your skin is fresh and youthful.

If that doesn’t make you feel more attractive, then there’s only so much that research can do for you.

— Todd R. McAdam
In our candy-colored digital world, there’s no time for rust. Gadgets from five years ago are worthless to a “new-every-two” culture. And a man working long hours alone in a garage is presumed to harbor grand ambitions of becoming a start-up millionaire.

But on Robinson Street in Binghamton, you can pick up a distinctly analog signal. It emanates from the cramped studio of sculptor Ronald Gonzalez, a Binghamton University faculty member who transforms the detritus of the last century into burned and blackened figures that speak to the 21st century’s values, politics and ideas of beauty.

Step inside, and you’ll see a workbench that will never witness the birth of a shiny, high-tech gizmo. It’s dotted with drips of wax and home to ancient coffee cans bristling with tiny paintbrushes. The jumble of not-yet-art objects stacked against the walls includes a red typewriter, bicycle seats, a deer skull, a rotary phone, broken guitars, a doll-sized bathtub and hopelessly scratched 45s. Standing guard among this trove are completed works, figures with names like “Stitch,” “Bug” and “Stir.”
A slight, soft-spoken man in a black T-shirt, dark jeans and gray sneakers, Gonzalez is perhaps more at home among these curiosities than anywhere else. “I've got a great eye for decay,” he says, scanning his treasures. “The more dilapidated something is, the more attracted I am to it.”

**Only in Binghamton**

Gonzalez, a prolific sculptor and recipient of the 2013 SUNY Chancellor’s Award for Excellence in Scholarship and Creative Activities, has had solo exhibitions at world-class museums such as the Corcoran Gallery of Art in Washington, D.C., and the DeCordova Museum and Sculpture Park near Boston. He has mounted shows at the Spoleto Festival, the Purchase Biennial and in places as far away as Peru and Germany. But his roots bind him to Binghamton, where Gonzalez grew up a bit of a street kid in the 1950s and '60s. His mother was religious; his father just the opposite. He was an altar boy who knew how to shoplift. In fact, Gonzalez says, the major dichotomies in his life can all be traced back to his childhood. Contrasts of sex and guilt, rich and poor, God and atheist, imagination and reality, life and death shaped his emotional and psychological outlook.

“I am definitely a TV and telephone kid from the 1950s,” he says. “I am a product of post-World War II existential Binghamton and the Atomic Age.”

Gonzalez was awakened to art through religious statuary stored in the basement of the local church, where he would pretend to be a sculptor. He was intrigued by the idea that someone could use his imagination to manipulate the human form.

Gonzalez went to the 1964 World’s Fair in New York City with his mother when he was 12. He got lost and recalls wandering through the exhibits until he came to Michelangelo’s *Pietà*, which was there on loan from the Vatican. Gonzalez couldn’t see over the people crowding around it, but remembers feeling “a sense of reverence and awe” among the onlookers.

That moment and one other, a few years later, sparked something inside Gonzalez. When he was in his teens, he saw pictures of Auguste Rodin’s *The Thinker*. His first thought was of the sitcom *The Many Loves of Dobie Gillis*, which sometimes featured the main character striking that classic pose. But Gonzalez’s second thought (in a moment of boredom) was to look for art books at the library.

He managed to locate a book about Rodin and another about Vincent van Gogh. “I became fascinated with the presence and power of the swirling sea of figures in Rodin’s *The Gates of Hell*,” Gonzalez says. “I went out and bought a bag of clay that day. I brought it into my bedroom and started making things. I’ve never really stopped.”

It was the late 1960s, but the art books he remembers finding in the public library highlighted figurative sculpture from the 1940s and '50s. He learned about French sculptor Germaine Richier, Alberto Giacometti and Pablo Picasso, artists often concerned with themes of isolation...
Black is striking. It’s monumental, dense, austere, hermetic. Technically speaking, it has a physicality to it, a weight and gravity. At the same time, it’s ephemeral and atmospheric. It’s absolute. There’s a richness to it.

— Ronald Gonzalez
and anxiety. “There was enough there to get my mind going,” Gonzalez says, a slight smile crossing his lips.

In the mid-1970s, he met Ed Wilson, who taught sculpture at Binghamton University. Gonzalez eventually earned a bachelor’s degree in art from Binghamton, where he returned in 1999 as a faculty member. Today, he says, he sometimes feels “good vibrations” while critiquing student work in his office, which used to be Wilson’s. Though Gonzalez came late to teaching, he values the one-on-one contact with students. “I help them develop a personal language in sculpture,” he says. “I’m trying to turn them into themselves.”

Gonzalez says his own feeling for being an artist and making things, which began as a kid, still lives deep inside him. “It’s like I’m 60 going on 6 in some way,” he says. “That same thud of an idea and impulse I had as a child is something I never let go of. It’s still there, and I’m still making things from what I can find in my immediate environment.”

He has adapted to that environment, especially the wintry grayness of the upstate valley that has been his home all these years. “Geographic location defines identity,” he says. “My work is saturated with time and the moments of my life. I remember the black-and-white Twilight Zone qualities of the Binghamton diners, streets and train station growing up. Dorothy from The Wizard of Oz was right when she said there is no place like home. But home sickness is not something you get just when you miss home. It is also something you get because you never left.”

Don’t confuse Gonzalez’s strong roots with provincialism, though. He spent time last summer touring the museums and galleries of London and has made other pilgrimages abroad. “New perspectives are always healthy, even for a self-proclaimed homebody,” he says. “When you stay in one place your whole life, time and space take on a tremendous weight. There is no place like home — and no place like the rest of the world.”

The creative process

A new chapter in Gonzalez’s lifelong project on the personification of things might originate with something like an air filter from a car or a gas mask. He has a special fondness for objects that were designed to communicate and that are now useless. A telephone or speaker, for instance, could become the head of a new figure.

Gonzalez generally begins with a welded metal armature, almost a template, with legs and arms. He wires objects onto this base, starting with the item or items that will form the “head.” “From there, I try to create a persona, an identity for the figure,” he says.

He fills journals with possible titles for sculptures, and so sometimes he has a name in mind right from the start. “Stitch” features footballs with the stitching as a scar; several change purses were transformed into a piece called “Tabernacle,” suggesting an internalized sacred space.

Often the source material can be identified immediately, but other figures challenge the casual observer to look more carefully. The head of a piece titled “Stir” was made from stirrups you’d use to ride a horse, but they’re obscured by the sculpture’s insect-like quality. Gonzalez wants the objects to be recognizable if you look at them long enough.
At this point in the process, Gonzalez critiques the figure. Some will be thrown away. The ones he likes will be coated with paint, metal filings and carbon from a settling tank. Next, he scuffs the figure with steel wool and coats it with beeswax. For a final touch, he sets fire to the piece in a small courtyard next to his studio. That burns off the extra wax.

“I like the idea of corrosion because of its expressive power,” he says. “Destroying things is part of making things. It’s part of the process. A lot of things fall away.”

Sculpture is a day-in, day-out process for Gonzalez, who estimates that he has produced hundreds and hundreds of figures during the past five years.

While he’s in the studio, he keeps a schedule that bears more than a little resemblance to his father’s day when he was cutting soles for shoes at an Endicott Johnson Corp. factory. “I get up in the morning and come to work, take a break, come back, work,” he says. “At 5, I usually go home, have half a glass of wine and eat something and go to bed early. I think that assembly-line mentality is something I developed early in life. There are days when I think of my studio as a figure factory.”

Gonzalez isn’t a happy-go-lucky kind of guy. He says he doesn’t even like jokes. But in the studio, this introvert finds a sense of balance, one that energizes him. “There have been times in my life when things were horrible,” he says, “and I could come to my studio and be resurrected through my work.”

Forging ahead

His time in that studio, which he likens to a part of his body, may be coming to a close. The property, owned by Gonzalez’s elderly mother, recently went up for sale, and he has begun to consider losing the place that has informed the spirit of his work for nearly four decades.

This spring, he plans to create a new work space at his home. He’s carving out room in an outbuilding, tucked into the lush, beautifully landscaped yard where his old dog likes to play.

There are the challenges common to all sculptors: where to store the work that’s not on display, how to transcend small studio spaces, buying a pickup truck that’s big enough to haul pieces to shows.

And there are the challenges more particularly his own: the paucity of Atomic Age objects available at flea markets and garage sales these days, chief among them. Younger generations often don’t value older things, he says, and at the same time eBay has given people a different way to make money on antiques.

“I’ve done things the hardest way possible,” Gonzalez says. “I work by myself. I make everything by hand. I’ve never been very strategic.”

Art carries a huge risk, he notes. It’s not just a lack of money or a traditional career trajectory. It’s hard to live through rejection. “Artists work out of a need for self-expression, not a need for recognition,” he says, possibly echoing conversations he has had with himself over the years.

Only a small sliver of artists achieve fame or even real recognition, Gonzalez says. And even those with tremendous ability may not get the attention of the art world. He draws a comparison that few artists would be likely to make: Artists toiling in obscurity are like Jimmy Bivens, a talented heavyweight boxer who never managed to get a title fight.

Gonzalez sees 21st-century digital culture as a colorful, hypnotic place in which a confusing visual experience is presented as reality. “It’s a kind of mummified world now,” he says. “There’s a loss there.”

He’s determined to keep sending out his unique analog distress signal and hopes his blackened minions will stand their ground against the electronic tidal wave. After all, he says, “I am from the world of mud.”

— Rachel Coker
WASTE NOT, WANT NOT
NANOMATERIALS TURN HEAT INTO ELECTRICITY
Bruce White worked with semiconductors and transistors at Motorola and Texas Instruments. But when he left industry for a position on Binghamton University’s faculty, the materials scientist decided to take his research in a new direction. “I didn’t want to just continue to work on transistors and memory,” White says. “I wanted to try to apply those tools to big problems that impact society.”

Energy is one of those big problems; in the United States, more than half of the energy we burn each year gets lost as heat instead of being put to use.

“We do all this work to get oil out of the ground and to refine it, but when we try to do some work with it, most of the energy goes out the exhaust pipe of a car or out the smokestack of a power plant,” White says. “Even if we could reclaim a small fraction of what we throw away as heat, that would have a significant impact on our energy use.”

There are ways to turn heat into electricity. If a material is hot on one side and cold on the other, the flow of heat from hot to cold can be turned into electricity. But most of the thermoelectric materials on the market today are not very good at doing that. The tricky part, White says, is getting the heat to flow through the material on the backs of electrons. In most materials, the heat flows in a wave that simply makes the material’s atoms vibrate faster. That’s not a useful phenomenon, and it ends up destroying the important hot-cold differential. In many materials, the
White's goal is to create materials where the vibrational effects are minimized — or, in other words, where a larger percentage of the heat gets shuttled by electrons, creating a flow of electricity. He also thinks it's important to make sure those materials are abundant and nontoxic.

White may have found a candidate in zinc oxide, a substance used in many brands of sunblock. Zinc oxide is abundant, cheap and safe, and it happens to be really good at moving electrons around. Unfortunately, in its normal state, zinc oxide has a molecular structure that transports heat by vibrating atoms instead of turning it into electricity.

By manipulating zinc oxide at the molecular level, White and his colleagues are able to make it better at generating electricity. First, they stretch the material into wires that measure 50 nanometers across. (That's roughly 10,000 times thinner than a human hair.) That incredible thinness changes the way heat spreads through the material. Next, they embed the nanowires in a silica aerogel, a substance that's terrible at conducting heat. Because of the interesting and unique interactions that occur at very small scales, nanowires can take on the properties of surrounding materials. In this case, the wires became very poor heat conductors. Their ability to conduct heat through atomic vibrations decreased by a factor of 10, so their efficiency in turning heat to electricity shot up.

The results were published in April 2013 in *Applied Physics Letters*, the top journal in the field.

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**TRANSDISCIPLINARY AREAS OF EXCELLENCE**

Bruce White’s research related to smart energy exemplifies a new Binghamton University initiative designed to promote collaboration across disciplines.

The University recently identified five Transdisciplinary Areas of Excellence in which it has significant existing strength and can achieve international prominence:

- Citizenship, rights and cultural belonging
- Health sciences
- Material and visual worlds
- Smart energy
- Sustainable communities

All five areas address critical social, scientific, technological, economic, cultural and policy issues. The campus intends to hire about 150 new tenure-track faculty members by 2017. To ensure that Binghamton makes the most of this rare opportunity, a significant portion of these new faculty positions will be allocated to these areas of research and scholarship.

Learn more at binghamton.edu/tae.
What’s particularly exciting about this discovery, White says, is that the materials of the wires and the aerogel can be mixed and matched to customize the thermoelectric properties for different applications — such as harnessing waste heat from a power plant, car or household furnace. Since aerogels are nearly transparent, White even envisions making window coatings that exploit indoor versus outdoor temperature differences to generate electricity.

With the right materials, it may be possible to eliminate the internal combustion engine altogether. White and his lab members think they may have a way of doing that. It all comes down to silicon, which is an excellent semiconductor — that’s why our electronic devices are silicon-based — but is also really good at conducting heat via atomic vibrations. White’s group is getting rid of those vibrations by building a silicon-tin composite using a new fabrication technique that grows the material layer by layer.

The work caught the attention of the Naval Research Office, which provides funding for White’s research. “It’s his fabrication method that really makes it different,” says Robert Walters, head of the Naval Research Laboratory’s Solid State Devices Branch. “Bruce has developed the fabrication technique that we feel will actually achieve the layered silicon-tin structure, which we think we really need to have to de-couple silicon’s thermal and electrical properties. … It’s a very good idea. It’s innovative and it’s different from other things that we’ve seen.”

The new composite material has a thermal conductivity that’s 1,000 times lower than regular silicon. The group hopes to make it three times lower still by making the crystal purer and more evenly patterned. If the thermal conductivity gets that low, the material would be so good at turning heat into electricity that it could power a car with the burning of a flame. That’s far off in the future, though. As they work on refining the materials they’ve already developed, White’s group is on the brink of creating less extreme materials that could still have a big impact. Heat-harnessing materials, which could be retrofitted onto a car’s tailpipe or radiator, could soon generate enough electricity to power the car’s electronics. “That alone could increase the fuel efficiency by a few miles per gallon,” White says. “When you think about integrating it over the entire automotive fleet, that makes a huge difference.”

— Sarah Fecht

ABOUT BRUCE WHITE

Bruce White received a bachelor’s degree in physics from Binghamton University before studying at Cornell University, where he earned master’s and doctoral degrees in condensed matter physics. He holds 27 U.S. patents. During his career in industry, White was recognized with Motorola’s Distinguished Innovator Award and the Motorola High Impact Technology Award. He returned to Binghamton as a faculty member in 2007. White is now an associate professor of physics and associate director of the Center for Autonomous Solar Power.
Self-destructing e-mail. A camera that can tell whether a driver is sleepy. New techniques to enable people with disabilities to make art.

These are just a few of the projects bubbling up from the new Seymour Kunis Media Core, a facility in Binghamton’s Engineering and Science Building that’s part research lab and part movie studio.

“It has some theatrical equipment and it also is a configurable research space,” says Scott Craver, an associate professor of electrical and computer engineering who helped design the large room without walls. “I worked at Intel, and at our microprocessor research lab we had a media space like this, but it was smaller. Here, we can designate space for students to work in and even leave experiments set up for two years if we need to. That gives us the opportunity to take ideas further.”

Craver, a recipient of the prestigious Presidential Early Career Award for Scientists and Engineers, conducts research related to information security, especially digital watermarks and ways to break them. He and doctoral student Idris Atakli are developing the Brief-lifetime Ink (BLINK) system. The device, designed to sit on the cable between a computer and a monitor, can temporarily decode an encrypted document, achieving the goal of self-destructing e-mail that can’t be copied or shared.

BLINK is just one of the futuristic projects Binghamton researchers are working on in the media core. Craver and doctoral student Alireza FarrokhBaroughi have found ways to fool speech- and facial-recognition systems. Recent master’s degree recipient Kenneth Weimer worked on that project and on a steganographic operating system — an OS and file system that is concealed in documents and files like PDFs.

The media core has a green screen; an overhead grid for hanging lights and cables; a storage room that doubles as a control room; power and data ports in the walls, floor and ceiling; and a rear-projection video wall ideal for testing human-computer interaction.

“The lab is a good space for new collaborative research,” says Lijun Yin, an associate professor of computer science who also works there.

Yin envisions outfitting the lab with hidden cameras ideal for experiments in facial recognition, eye tracking and gesture-based computing. For now, a couple of cameras and a large monitor provide a way to test a new eye-tracking technology with applications in gaming, education and healthcare.

“Eventually, computers will be able to read people’s intentions,” says Yin, who plans to combine eye tracking with physiological data to measure stress levels and other factors.

Yin’s working with doctoral student Shaun Canavan on a simulation project designed to measure drivers’ gaze and determine whether they’re sleepy. Another project, combining speech, video and 3D graphics, could enable people with physical disabilities to create art or compose e-mail messages more easily.

Undergraduate engineering students also find inspiration in the media core. Craver oversees several senior design teams each year, and their projects add a touch of whimsy to the
space. The current crop of students is working on an interactive design table as well as an electronic slide trombone.

On a recent afternoon, Craver pulled apart a tape measure while talking with a few undergrads about the components they’d need to build the trombone. “How fast is fast?” he asks as they discuss reaction time, gesturing as if he’s playing the instrument.

Other recent student creations include a wearable musical instrument with what Craver calls a “Spiderman interface” as well as an instrument that can be played with what looks like a bouquet of computer mice.

— Rachel Coker

Computer scientist Lijun Yin, here and above with an undergraduate, develops facial-recognition technologies with applications in gaming, education and healthcare.

Scott Craver, a recipient of the Presidential Early Career Award for Scientists and Engineers, says the Seymour Kunis Media Core compares favorably with a research facility he used when he worked at Intel.
The Seymour Kunis Media Core

INSIDE THE SEYMOUR KUNIS MEDIA CORE

For a 360-degree view inside the lab, visit go.binghamton.edu/kunis360.
The Seymour Kunis Media Core provides facilities for multimedia research including security, forensics, biometrics, steganography and steganalysis, immersive displays and virtual and augmented reality.

Special features of the lab include:

- An overhead grid for hanging lights and cables
- A rear-projection video wall designed to test human-computer interaction
- An open floor plan with highly reconfigurable spaces for experiments
- A green screen
- Room for multiple student groups to set up experiments for testing
- Electrical outlets in the floor, walls and ceiling

“Not many people have this kind of space,” says Scott Craver, associate professor of electrical and computer engineering. “It’s halfway between a research lab and a movie studio. There’s a lot we can do here.”
Nurse tests therapy that may benefit fibromyalgia patients

Lynn Baniak crosses her arms when she gets anxious. What does she have to be anxious about? She is a nurse in a building full of engineers. She is studying a treatment for a common yet poorly understood musculoskeletal disorder. She is years away from the oncology nursing she’s familiar with and the doctorate that will label her an expert.

Nothing to be anxious about.

“I don’t follow the herd. It makes you kind of fearless,” she says. “And I don’t like failing.”

The treatment she researches has too much potential for her to accept failure. It would help 12 million Americans with fibromyalgia enjoy a better quality of life.

No pressure.

Fibromyalgia, which causes widespread pain and tenderness, has been linked to depression, stiffness and a host of fatigue-related symptoms either caused by or in conjunction with poor sleep.

Working with data and theories developed by her Binghamton University advisors — Carolyn Pierce, an associate professor of nursing, and Kenneth McLeod, a professor of bioengineering — Baniak began testing an observation: that stimulating a nerve cluster around the balls of the feet provokes the soleus muscle in the calf to greater activity.

The soleus pumps body fluids from the legs back toward the heart. Poor circulation is linked to poor sleep in patients with disorders ranging from fibromyalgia to congestive heart failure.

Baniak recruited hundreds of people in 2011 and 2012 and began tests on 31 of them with a device that stimulates the Meissner’s corpuscles by vibrating the feet back and forth 45 times a second for an hour each day. Ten finished the trial.

The result? It works. Patients went from an average score of 53 on the FIQR scale — a measure of a fibromyalgia patient’s quality of life — to 33 in just 12 weeks. A typical nonfibromyalgia score would be below 10.

Next Baniak must explain why it works.

Why does it improve sleep? Does improved sleep in itself reduce pain? Or does it improve the ability to cope with the same pain?

Pierce says Baniak’s work requires a flexibility of interest, unlike colleagues who base their research on prior nursing experience, like the oncology that filled Baniak’s career at the Mayo Clinic in Minnesota. “Lynn was very open to doing the hands-on clinical research with engineers,” Pierce says. “She was particularly able to see what the applications were.”

And to what can this treatment be applied? Fibromyalgia, sure, but how about congestive heart failure? Edema? Sleep apnea? That will come later. Baniak is already considering post-doctoral research.

The possibilities leave Baniak a little anxious: “It’s almost a test to me,” she says. You can’t be productive or successful if you can’t face your fear.”

— Todd R. McAdam
Patricia Moat gets a thrill from protecting people. As a youngster, she trained in martial arts. Later, she ran into burning buildings as a volunteer firefighter. Now she’s finding new ways to protect American computer networks.

“This is like catching an intruder coming into your house,” Moat says. “And it excites me to do something most people have never done.”

Moat, a doctoral student in electrical and computer engineering, is part of a Binghamton University team working to create a real-time monitor that can spot intrusions into computer networks.

The project, funded by the Air Force Office of Scientific Research, connects several threads in Moat’s life. She’s an electrician’s daughter who was as interested in coding as wiring. Her brother is a career soldier. And she survived a house fire when she was a child.

Her work is critical to every nation and most corporations. Already, South Korea has found North Korea hacking its networks. Saudi Arabia and Israel have weathered cyber attacks from Iran.

Now imagine an attack that causes planes to land short of the runway, says Victor Skormin, a distinguished service professor and Moat’s advisor. Imagine nuclear power plants shutting down or overheating. How about power grids misdirecting electricity? It’s not just some amateur hacker against a national or corporate network; many attacks are sponsored by other nations or large criminal organizations. And they can target computer-controlled machinery.

“Actually, it’s a war taking place in cyberspace, and it requires many different weapons and defenses,” Skormin says. “There are many existing attacks that our application works against very successfully.”

So what are Moat and her teammates doing? Instead of reviewing all programs run by a network to find the signature of one of millions of known malware programs — some of which mutate to avoid detection — they have developed a technology to assess behavior of individual computers. This is done by monitoring system calls, the internal signals that accompany every computer operation and can reveal every function performed by the computer.

First, they create a profile of the network’s normal operation. When a network is attacked, a review of system calls can reveal functionality that does not match this “normalcy profile.” This approach can address the most advanced attacks, some of which are skillfully designed to corrupt just one strategically chosen computer system.

Think of it this way: Instead of looking for an intruder in your home by checking every room to see if anything has been taken or left behind, the Binghamton algorithm checks to see if anyone opened a door or window.

— Todd R. McAdam
Joy Hallmark began conducting research in high school. Now, she studies treatments for Parkinson’s disease in a Binghamton University laboratory.

Parkinson’s is treated with a compound called Levodopa, or “L-dopa,” which causes abnormal involuntary motions after prolonged use.

Hallmark works with Christopher Bishop, an associate professor of psychology, to test several compounds that may allow Parkinson’s to be treated without this side effect. They rely on an animal model, observing the effects different Parkinson’s treatments have on rats’ body movements.

“The thing that attracted me most about this research was the fact that it was translational, so what you do in the lab applies in the field,” says Hallmark, who plans to pursue a doctorate or go to medical school after graduation. “We take what we’re learning now, and we can apply it by making new drugs and helping people.”

For the past year, Hallmark has been researching two compounds to see how they would affect Parkinson’s patients. As a part of the Undergraduate Research Center’s Summer Scholars and Artists program, Hallmark completed an eight-week fellowship with a postdoctoral student studying the serotonin system and its relationship to Parkinson’s.

“I’ve always had an interest in neurodegenerative disorders, so it was cool to come here and find Dr. Bishop’s lab and be able to take my interest a step further,” Hallmark says.

When she was in high school, the Queens native studied Alzheimer’s disease for three years at the Albert Einstein College of Medicine as part of the Intel Science Talent Search program.

Hallmark’s “prolonged interest” in medicine began even before that, though. “From a young age, I always wanted to be challenged,” she says. “I used to sit in the medical section at Barnes & Noble and just read the medical dictionary and learn new terms that I didn’t know.”

Bishop says Hallmark seemed like a great fit for his lab when they first met, and her work since has been “a testament to that fit.”

“She has demonstrated a commitment and growing knowledge base that has made her not only increasingly autonomous, but a true asset,” Bishop says. “Joy has proven herself to be an excellent young scientist, and her trajectory is outstanding.”

Hallmark says her passion for studying neuroscience stems from her curiosity and her willingness to explore uncharted territories. “The brain, I think, is just so intricate and there are so many things that we have yet to know about it,” she says. “I love going into the unknown and trying to figure things out.”

— Christina Pullano
Entrepreneur gets an education on a break from school

The phone is so old-fashioned. So, for that matter, are e-mail and even Facebook. Aleksandar Vukasinovic envisions living in a world of seamless communication. In that world, sensors will gather information about how we’re feeling. That data will inform the music we hear, the way rooms are lit and more.

Vukasinovic, a Binghamton University junior studying computer science and neuroscience, recently took a semester off to address some health concerns. When he recovered more quickly than expected, he did what many young scientists and engineers dream of doing: He created his own company.

Now he’s CEO of a start-up called Emozia with 10 employees, many of them also Binghamton students. “Entrepreneurship is a quintessential aspect of our education,” Vukasinovic says. “I’m 21. I haven’t even had a real job. And suddenly you’re thrown into a whirlwind.”

Scott Hancock, director of IP management and licensing at Binghamton, has seen rising interest in entrepreneurship among students and recent graduates. Vukasinovic, he says, is among the most indefatigable of the bunch. “He’s relentlessly upbeat,” Hancock says. “He’s fearless and not afraid to take chances in pursuit of his passion.”

Vukasinovic smiles broadly as he describes building his network, beginning on campus and continuing with a New York City meeting of the nonprofit StartOut, which fosters LGBT entrepreneurs. From there, it was on to the Founder Institute, which bills itself as the world’s largest start-up accelerator.

Emozia, Vukasinovic explains, will harvest data via a user’s phone to “learn” whether he or she is feeling happy, sad, irritable, stressed or tired. Sensors in the phone will do some of the work, in concert with data from the user’s apps and calendar. Emozia will then share this information with service providers and friends selected by the user.

The result? Upbeat music starts playing when she gets in the car after a miserable day in the office. The lights dim automatically when she’s getting ready to go to sleep. Her best friend gets an alert when she’s feeling down.

“Obviously, we are pushing boundaries,” says Vukasinovic, who also sees applications in gaming. “Our company is based on trust. This doesn’t work unless people trust us with their data. And users will control how information is shared.”

Facebook, he notes, makes money by selling information about users to advertisers. Emozia is different, at least in his view, because third-party service providers will have to convince users that they offer enough value that they should have access to personal information.

Vukasinovic would love to see Emozia grow into the next dot-com sensation. But he doesn’t fear failure. In fact, he’s already talking about what things will be like when he starts another company.

“What I’ve already learned,” he says, “is so amazingly valuable.”

— Rachel Coker
Patents awarded to Binghamton University faculty between October 2012 and March 2013:

Nael Abu-Ghazaleh, associate professor of computer science, patent 8,380,846: Automatic Clustering for Self-Organizing Grids


Kartik Gopalan, associate professor of computer science, patent 8,280,976: Distributed Adaptive Network Memory Engine and patent 8,291,034: Centralized Adaptive Network Memory Engine

Ronald Miles, distinguished professor of mechanical engineering, patent 8,276,254: Surface Micromachined Differential Microphone and patent 8,374,371: Miniature Non-Directional Microphone

Bahgat Sammakia, vice president for research and distinguished professor of mechanical engineering, patent 8,277,112: Devices and Fluid Methods for Improving Mixing

Zhongfei (Mark) Zhang, professor of computer science, patent 8,285,719: System and Method for Probabilistic Relational Clustering

Chuan-Jian Zhong, professor of chemistry, patent 8,343,627: Core-Shell Nanoparticles with Multiple Cores and a Method for Fabricating Them

Ronald Miles develops directional microphones for hearing aids that are inspired by the ears of a fly. He tests the devices in this new facility, an anechoic chamber that is one of the quietest places on the planet. To watch a video about it, visit go.binghamton.edu/acoustics.
A little ‘Downton’ in Binghamton

The late Tilly Losch, an Austrian dancer and artist who briefly lived in the real-world castle that now serves as a backdrop for *Downton Abbey*, donated her personal memorabilia to the Binghamton University Libraries’ Special Collections. Losch was married to the sixth earl of Carnarvon, whose family seat is Highclere Castle.

The collection includes letters and telegrams from Hollywood legends Fred Astaire, Joan Crawford and Orson Welles. Other photographs and correspondence are receiving fresh scrutiny in light of the popularity of *Downton Abbey*, now in its fourth season on PBS.

British fashion photographer Cecil Beaton, who went on to a career as an Academy Award-winning costume designer, captured the countess on several occasions.

Tilly Losch and Lord Porchester, the sixth earl of Carnarvon, were married from 1939 to 1947 and endured long periods of separation during World War II. In this letter from “Porchez” to his “Beloved Pink Pearl,” the earl writes: “Marcus and I have been trudging round for miles in a freezing north east wind and have shot about 100 head of game. We talked a lot about you and as always I think of you the whole time. I doubt if you are out of my mind for more than 5 mins: in any of the hours I’m awake, I mean.”

Highclere Castle, which is still home to the Carnarvon family, serves as the setting for the British TV drama *Downton Abbey*. This photograph appeared in the family’s 1963 Christmas card.

Beth Kilmarx, curator of rare books, describes some of the treasures of Binghamton’s Tilly Losch Collection in this brief video. To watch, visit go.binghamton.edu/tilly.
Anthropologist turns to the alpaca for genetic research
Digging Deep

FOR HISTORIC PRESERVATION

Binghamton’s Public Archaeology Facility recently conducted fieldwork at the Revolutionary War’s Chemung Battlefield.

Learn more about this and other Binghamton University research in Discover-e: discovere.binghamton.edu.