Neuroscience  
Veterinary Medicine  
Genetics  
Periodontics  
Nursing  
Cancer Genetics  
Cell & Developmental Biology  

Biochemistry  
Physics  
Robotics  
Biophysics  
Engineering  

History  
East Asian Civilizations  
Classics  

Corporate Law  
Management  
Consumer Finance  
Marketing
Penn’s Research Enterprise

Penn is a world-class teaching and research institution proudly furthering the legacy of its founder, Benjamin Franklin, who believed in the unceasing importance of intellectual innovation.

Sponsored research support is integrally important to Penn’s research enterprise. The University received more than $900 million in total research awards in the 2011 fiscal year and is consistently ranked as one of the largest recipients of funding from the National Institutes of Health. Federal support accounts for approximately 80 percent of sponsored program dollars, while the remaining 20 percent comes from a combination of foundations, state and local governments, associations, and private industry. In all, the University received more than 3,400 awards in the 2011 fiscal year.
Creating the knowledge to move society forward in the 21st century requires research that extends beyond the traditional silos of academic thought.

Researchers at Penn’s 12 schools stand at the forefront of pioneering thought, reaching across campus, across disciplines, and across the globe to tackle the world’s most complex problems. They are making groundbreaking discoveries in laboratories, in classrooms and in the field. Students at Penn are introduced to serious multi-disciplinary inquiry at our Center for Undergraduate Research and Fellowships.

This brochure highlights some of the eminent research at Penn that has occurred in the past year. A team of neuroscientists has discovered that an overlooked cancer drug is effective in fighting the onset of Alzheimer’s. Another researcher has identified the chemical cause of memory gaps and lack of concentration that people experience because of sleep deprivation. In the interdisciplinary field of nanoscience, researchers have developed a way to engineer structures at a minute level that could lead to advances in miniaturization of circuitry as well as medical treatment.

Penn scientists from a wide range of academic disciplines have teamed up to advance “green” research, with the goal of making commercial buildings more energy efficient. A historian has reexamined the fall of the Confederacy at the time of the Civil War, with a focus on the internal politics of the movement. And in business, a researcher casts a critical eye toward the controversial consequences of the Dodd-Frank Act.

At Penn, researchers aim to expand the frontiers of human achievement and understanding, with the ultimate goal of improving the world. To keep up with all of the University’s research news, visit Penn’s research website, www.upenn.edu/researchdir.
In 2010, the Baby Boomer generation began turning 65, the age at which the risk for Alzheimer’s disease doubles every five years.

With costs surpassing more than $600 billion annually, greater than the economies of most of the world’s nations and representing about 1 percent of global GDP, Alzheimer’s disease is a problem with staggering economic implications, beyond its tragic impact on individuals and families.

For more than 30 years, research partners—and life partners—John Trojanowski and Virginia Lee have attacked the problem of Alzheimer’s at its roots rather than its symptoms. In a study published in the *Journal of Neuroscience*, they have shown that an overlooked cancer drug is effective in fighting the onset of Alzheimer’s. Ongoing clinical trials are now investigating whether it may also work in reversing some of the ravages of the disease.

As directors of the Center for Neurodegenerative Disease Research (CNDR) and the Institute on Aging at Penn’s Perelman School of Medicine, Trojanowski and Lee focus on the protein tau, which provides structural support for the cell components known as microtubules. These microtubules are especially important in neu-
Disease

a Cancer Drug

rons, as they transmit nerve signals through long, tail-like extensions known as axons. A stable transport system is necessary to get chemicals from the neuron’s nucleus to the tip of the axon, which can be no small task, given the longest of the cells stretch the length of a person’s spine.

In Alzheimer’s, tau forms incorrectly and produces tangles instead of the usual support structure, causing the microtubules and axons to collapse. The resulting death of neurons produces the mental impairments associated with the disease.

“If the microtubules are railroad tracks, tau proteins are the crossties; they keep the tracks absolutely parallel so trains can run on them,” Trojanowski says. “But if you take those crossties out, then the tracks wobble and trains will run off, leading to train wrecks, and when this happens in nerve cells, the consequences are toxic.”

Trojanowski and Lee theorized that certain cancer drugs that prevent tumor cells from dividing could also prevent tau-deprived microtubules from breaking apart.

Along with Kurt Brunden, director of drug discovery at CNDR, the duo began testing variants of the drug epothilone, finding that epothilone D was the most effective in making its way past the blood-brain barrier. The team also worked with Amos Smith, a professor of chemistry in Penn’s School of Arts and Sciences, who specializes in making synthetic versions of naturally occurring chemicals, as epothilone is derived from sea sponges.

“Having this drug discovery program, and collaborating across schools and disciplines—pharmacology, chemistry, biology, and neuroscience—was critical to the success of this research,” says Lee.

After genetically engineering mice with diseased tau, the research team showed that epothilone D not only increased the number of surviving microtubules but showed decreased memory and learning deficits when the mice were given maze-navigation and other tests. The drug is now undergoing a Phase I clinical trial at Bristol-Myers Squibb and may have applications in other tau-based neurological diseases.

This research was funded by the National Institute on Aging and the Marian S. Ware Alzheimer Program.
Identifying the Genes Associated With Heart Disease

Coronary artery disease is the single largest cause of death of adults in the United States, but despite its prevalence, the genetic basis of the disease is still largely unknown. In this condition, known as CAD, the arteries supplying blood to the heart develop cholesterol-rich plaques which can rupture suddenly, causing a heart attack.

In a pair of studies, a multidisciplinary team of Penn researchers has identified key genetic profiles, some of which increase the risk of coronary artery disease while others uniquely increase the risk of heart attacks in those with CAD. Researchers have discovered about 35 genetic loci that relate to coronary artery disease, heart attack, and plaque buildup in arteries. Of these, approximately two-thirds are novel regions for CAD not known before to relate to heart disease. Though researchers don’t yet understand how these new loci work, they confirmed that most do not relate to the established heart disease risk factors: smoking, high cholesterol, obesity, diabetes, or high blood pressure.

“Our whole understanding of the disease process for atherosclerosis is going through a redefinition,” says lead author Muredach P. Reilly, associate professor of medicine and pharmacology at Penn’s Perelman School of Medicine. Reilly’s group, in a study published in The Lancet, identified a new locus, ADAMTS7, on a gene already implicated in arthritis, which is associated with increased risk of developing CAD. They also found that the same gene that codes for the enzyme that defines people as having the O blood group protects against heart attacks.

In a second study, Reilly helped coordinate the largest-ever international effort to combine and analyze data from all currently published genome-wide association studies on heart attacks and CAD. The study, published in Nature Genetics, included data on more than 100,000 heart patients and healthy individuals, and it identified 13 new genetic risk factors for CAD.

Several of these new heart disease genes are the focus of intense efforts to develop new treatments for heart disease. In addition, the findings could lead to new genetic-based tests to predict CAD in the estimated 40 percent of individuals at high risk for the disease who are otherwise healthy or asymptomatic.

“We don’t do a very good job of personalizing individual prediction of heart disease,” Reilly says. “It doesn’t mean the old knowledge was incorrect; it means it was only part of the story. We used to think we knew a lot, but we actually just knew a little.”

The Impact of Diabetes on Wound Healing

The global rate of diabetes has more than doubled during the last three decades largely due to increased obesity. While the dietary component of the disease is now familiar to most, diabetes affects the body in a complex fashion.

Publishing in the journal Diabetologia and others, Dana Graves, professor of periodontics in Penn’s School of Dental Medicine, is studying wound healing and periodontal disease to examine the role of excessive inflammation in diabetic complications.

Periodontal disease causes the loss of bone around teeth, which is initiated by bacteria in dental plaque that stimulate inflammation of the gums.
The inflammation produces a cycle of bone destruction that is more pronounced in diabetic patients. Similarly, diabetes is known to inhibit wound healing, which is also affected by inflammation.

“If a wound doesn’t heal fast enough there is an inadequate bacterial barrier which increases the likelihood of chronic wound infection. An open chronic wound can lead to amputation if the wound is on a limb,” says Graves.

Graves and his colleagues set out to isolate whether the effect of diabetes on wounds was due to a greater level of associated inflammation or another aspect of diabetes. To test this, they applied a tumor necrosis factor (TNF) inhibitor, which suppresses part of the inflammatory response, to diabetic mice with dermal wounds.

“We found that we could restore the capacity of the cells to proliferate and to decrease the higher level of cell death in diabetic wounds,” says Graves. “We could resolve several aspects of impaired wound healing by simply inhibiting inflammation after the first few days of healing.”

Greater levels of inflammation in response to bacterial plaque may also affect the progression of periodontitis in diabetics.

While the TNF inhibitor may not be used directly as a treatment, it points to a mechanism that is likely to be successful. Likewise, forthcoming research from Graves investigates how diabetes-enhanced inflammation impacts bone loss associated with periodontal disease. Early results suggest that controlling the inflammation can reduce periodontal bone loss and hasten its regeneration.

Can Eating Breakfast Reduce Lead Poisoning?

In the study, parents of 1,344 children 3 to 5 years of age answered a questionnaire about breakfast frequency and family demographics, with findings showing that the blood lead levels of children who regularly ate breakfast were about 15 percent lower than those who did not have breakfast regularly.

“Because lead exposure remains one of the greatest public health concerns for young children, we hope our study will provide some initial evidence for the development of potential nutritional intervention or prevention programs,” Liu says. “To our knowledge, this is the first human study exploring the association between breakfast frequency and blood lead levels in young children.”

The study was funded by the National Institute of Environmental Health Sciences, the University of Pennsylvania’s Center for Excellence in Environmental Toxicology, the Wacker Foundation, the Jintan city government, and the Jintan Hospital.
In an international Phase II clinical study, 54 patients identified as having a genetic mutation in BRCA1 and BRCA2 were given a new drug, olaparib, which inhibits a protein called poly(ADP-ribose) polymerase, or PARP. Both PARP and the BRCA proteins are involved in DNA repair. While cells seem to be able to survive without one or the other, inhibiting PARP in a tumor that lacks a functional BRCA1 or BRCA2 is too much for the cells, causing them to die.

Forty-one percent of women with advanced metastatic breast cancer responded to the therapy, a high percentage considering many had not responded to chemotherapy and other past treatments.

“In women who have BRCA1 and BRCA2 mutations, these drugs seem to be a good match. It doesn’t mean everybody who is taking these medications will respond to the drug, and we’re still in the midst of clinical trials. But the preliminary work has been pretty exciting,” says study co-author Susan M. Domchek, associate professor of medicine at the Perelman School of Medicine and director of the Cancer Risk Evaluation Program at Penn’s Abramson Cancer Center.

The findings may change the way future cancer drugs are developed.

“This drug works because of what DNA you’re born with and why a cancer develops, rather than what a tumor looks like under the microscope. It’s a real change in how we think about developing drugs,” Domchek says.

Penn was one of just six centers in the United States to participate in the clinical trial, which was funded by AstraZeneca. The results were published in The Lancet.
Few scientific issues have provoked such a charged legal and ethical debate as stem cells. Research from Penn’s Perelman School of Medicine has led to the development of a significantly more efficient way of making induced pluripotent stem cells, or IPSCs. In a study published in the journal Cell Stem Cell, a research team led by Edward Morrisey, professor in the Departments of Medicine and Cell and Developmental Biology, and scientific director at the Penn Institute for Regenerative Medicine, showed that a new way of making IPSCs increased yields by more than 100-fold.

Unlike embryonic stem cells, which are derived from fertilized human embryos and have had a tumultuous legal history, IPSCs can be made from adult skin cells. Embryonic stem cells are desirable because they are naturally capable of turning into all of the tissues in the body. With induced pluripotency, something like a skin cell can be reverted to a similar stage where it can then transform into another kind of cell and be cloned.

Scientists have shown that this reversion can be accomplished through a set of four transcription factors. These proteins, which control gene expression, can coax cells into turning into types they normally wouldn’t. Morrisey’s research team has shown that the same effect can be achieved with microRNA, which also plays a role in gene expression, but with much higher efficiency.

“We have shown that you can do this with microRNAs and by doing so, be two orders of magnitude more efficient than with the transcription factor cocktail that people have previously used,” says Morrisey, whose research was funded by the National Heart, Lung, and Blood Institute Progenitor Cell Biology Consortium and Division of Lung Diseases and the American Heart Association Jon DeHaan Myogenesis Center Award. “With transcription factors, you only get a handful of clones, maybe 20 at most. With the microRNA reprogramming process, we get upwards of 10,000 clones from the same number of cells.”

With regenerative medicine in the earliest of stages, having more access to such cells is vital for the rapid progression of research in the field.

In a video, Edward Morrisey explains his research on induced pluripotent stem cells.
Neuroscientists Identify Roots of Sleep Deprivation
Anyone who has pulled an all-nighter knows there is a price to be paid the next day: trouble focusing, a fuzzy memory, and other cognitive impairments. For students, these impairments might just result in a bad grade. But for professionals in high-risk industries that require long hours of concentration, such as emergency medicine or aviation, sleep deprivation can have life-or-death consequences.

Many scientists have suggested theories about the causes of such impairments, but Penn neuroscientist Ted Abel has now pinpointed the culprit and its area of effect with a pair of cleverly matched experiments.

Levels of the chemical adenosine, critical to the body’s transportation of energy to cells, build up in the brain the longer one is awake but return to normal after a full night’s sleep. Published in the *Journal of Neuroscience*, Abel’s study is an extension of the theory that this adenosine build-up is responsible for sleep deprivation’s effect on memory and awareness.

“We can tell adenosine is involved in impairment because caffeine blocks its effect,” says Abel, a professor of biology in the School of Arts and Sciences. “But we wanted to know where it’s coming from, where it’s going, and its role both behaviorally and at the cellular level.”

The study involves two sets of mice that were treated to inhibit adenosine in different ways. One set was genetically engineered so that their glia, the non-neuron brain cells that act as a support system, couldn’t produce the chemical. The other set was given a drug that blocks an adenosine receptor, effectively causing their brains to ignore the chemical’s buildup.

The mice were tested for effects of sleep deprivation by seeing how they responded to a new object placed in a familiar environment. Mice will normally explore changes to their surroundings, but when they are sleep deprived, they don’t.

The researchers woke mice halfway through their normal sleep cycle the night before the experiment; both kinds of treated mice behaved as if they had slept the night through. Examining the brains of the mice directly also showed that the brain region responsible for spatial memory had been protected from adenosine’s effects.

“This experiment is showing, for the first time, that this adenosine buildup is happening in the hippocampus and that is affecting tasks that depend on that part of the brain,” says Abel.

More than one-third of American adults are obese, and another third are overweight. Treating obesity, a multifaceted disease that decreases survival and quality of life by increasing the incidences of type 2 diabetes, cardiovascular disease, and cancer, is no easy task.

“Less than 5 percent of human obesity can be attributed to a mutation in a specific gene, similar to type 2 diabetes,” says Kendra Bence, assistant professor in Penn’s School of Veterinary Medicine. “There are so many different causes and ways you can develop this disease, and that makes treating it extremely difficult.”

An interdisciplinary group of researchers from three Penn schools has identified new neurological and cellular signaling mechanisms that contribute to satiety—the sensation of feeling full—and the subsequent body-weight loss produced by drugs used to treat type 2 diabetes.

The group was led by Bence; Harvey Grill, professor of psychology in the School of Arts and Sciences; and Matthew Hayes, assistant professor of nutritional neuroscience in the Translational Neuroscience Program in Psychiatry in Penn’s Perelman School of Medicine.

Type 2 diabetes drugs targeting the hormone glucagon-like-peptide-1, or GLP-1, stimulate insulin production and also reduce food intake and body weight, but researchers have not been able to explain the site of action and the neurological mechanisms that mediate the anti-obesity effect of these drugs.

In the study, published in *Cell Metabolism*, the Penn team identified a part of the brain that mediates the drugs’ food intake suppressive effect, as well as the cellular signaling pathways required for production of GLP-1’s satiety effects.

“The problem about going in and tampering with the normal circuitry is that these regulatory systems for energy balance are so critical for individual survival that targeting one system hasn’t proved to be very effective,” Grill says. “We are therefore focusing attention on identifying common sites of action for different hormonal systems that individually reduce food intake in the hope of developing combination drugs that produce a greater and longer lasting reduction of feeding and body weight.”

Hayes adds, “If we can look at this interaction, this ‘synergy’ on these common pathways and brain nuclei, then we might have opened up a door for new drugs to act in concert with these already approved [type 2 diabetes] drugs.”
Researchers using functional magnetic imaging to illustrate which parts of the brain are active when a person is performing a task have already determined that the ventromedial frontal cortex (VMF) is active when individuals make preference-based choices. A neuroeconomic study performed by Joseph Kable, an assistant professor of psychology in Penn’s School of Arts and Sciences, has taken those findings one step further.

Kable, along with colleagues from McGill University and Penn undergraduate Khoi Vo, has identified the causal relationship between the VMF and the value-based choices people make every day.

Imaging, Kable says, is good at implicating a relationship between brain activity and decision-making, but it cannot determine “whether the brain activity is causally important in that decision, or whether the activity might be correlated for a different reason.”

His study hypothesized that if, indeed, the VMF plays a key role in value decisions, then people with damage to that region of the brain should be less able to make good value choices, and their preferences should be inconsistent. That is exactly what Kable found.

Participants with and without VMF damage were asked to choose between juice boxes and chocolate bars, based on which they liked more. They were given 11 sheets of paper listing various bundles of juice and chocolate. They could, for example, choose a bundle with six juice boxes and two chocolate bars, a bundle with three juice boxes and three chocolate bars, or one with no juice boxes and six chocolate bars. The researchers promised to give each participant a bundle chosen at random from their selections after the experiment.

The researchers were looking for consistency in the participants’ choices, demonstrating that they had clear preferences. For example, a subject who picked no juices and two chocolates should not also choose a bundle with two juices and no chocolates.

As predicted, most of the people with VMF damage made inconsistent choices, and almost all of those without VMF damage were consistent in their selections.

“The contribution of this paper,” Kable says, “is that despite dozens of imaging studies, no one had been able to show the causal importance of this region in decision-making.”
Colleagues from the University of Mississippi went out on a boat to survey the sediment and velocity of the river’s current. The group was able to confirm Jerolmack and Falcini’s predictions.

Jerolmack says it may be possible to construct diversions off the Mississippi channel to redirect water and sediment into the bays surrounding New Orleans to combat wetland loss.

“We think that our theory, and even, ironically, this catastrophic flood, may actually help us save the wetlands of Louisiana in the vicinity of New Orleans because of what we’re learning about how wetlands are built by river channels,” Jerolmack says.

Due to its prolific infectiousness and small genome, the virus mutates constantly, forcing public health professionals to guess which variant will dominate each flu season. Making better guesses would give researchers a head start on vaccine production and, in turn, save lives and money.

Taking a statistical approach to the wealth of flu genome data collected over the last 40 years, Joshua Plotkin, associate professor of biology in the School of Arts and Sciences and computer and information science in the School of Engineering and Applied Science, has led a study that connects pairs of mutations that must happen in tandem for a strain of flu to survive. Published in the journal PLoS Genetics, the study could give vaccine producers the edge they need to defend against the deadly virus.

“If there’s ever going to be a biological system whose evolution we can predict, influenza is it,” says Plotkin. “Every year we sequence hundreds, even thousands, of strains, and scientists have identified the sites in those proteins that evolve the most rapidly and are adaptive to the virus.”

Flu Genome Study Provides Predictive Power

The proteins in question are adaptive because they form the structures on the outside of a flu virus that allow it to infect cells. By identifying correlations between mutations in these sites, a phenomenon known as epistasis, Plotkin’s team developed a list of the pairs in which one mutation is an early warning sign for the other.

An independent laboratory confirmed that several of the epistatic pairs Plotkin’s team had discovered were involved in the H1N1 strain of the flu that acquired resistance against the drug TamiFlu.

“That raises the question: When will the recent pandemic flu acquire drug resistance? What mutations should we be looking for before we’re really worried and require a backup plan to the existing drugs? That’s something we can predict from this analysis,” says Plotkin.

The research was supported by the Burroughs Wellcome Fund, David and Lucile Packard Foundation, James S. McDonnell Foundation, Alfred P. Sloan Foundation, Defense Advanced Research Projects Agency, and U.S. National Institute of Allergy and Infectious Diseases.
Experimentation in the rapidly growing field of nanoscience is helping scientists better understand how the world operates at the smallest possible scale.

An interdisciplinary team of Penn researchers has developed a method of engineering structures at a minute level, using molecules and individual atoms as building blocks.

On their own, molecules in living cells come together and self-organize into structures that encode the necessary functions. Proteins are one major type of molecule that perform this task.

Penn scientists wondered: Can the ability of certain proteins to assemble and self-organize be useful from a nanoengineering perspective?

The researchers set out to design proteins that could wrap around single-walled carbon nanotubes. Consisting of a cylindrical pattern of carbon atoms tens of thousands of times thinner than a human hair, nanotubes are enticing to nanotechnologists because they are extraordinarily strong and could be useful as a platform for other nanostructures.

“We sought to create proteins that organize themselves around nanotubes and form specific structured assemblies, where we knew the
structure atom by atom,” says lead author Gevorg Grigoryan, who worked as a postdoctoral fellow in the Department of Biochemistry and Biophysics in Penn’s Perelman School of Medicine. “The goal is to turn nanotubes from what they are now—boring, naked, featureless surfaces—into something that’s very addressable, very manipulatable, that could be used to grow further structures that organizes on the tubes.”

Team members Grigoryan; William DeGrado, professor in the Department of Biochemistry and Biophysics; and graduate student Yong Ho Kim of the Department of Chemistry in Penn’s School of Arts and Sciences, liken it to erecting scaffolding for a building. The challenge is that there are databases containing hundreds of thousands of actual and potential protein structures in atomic detail. To select compatible blocks with which to build, the researchers created an algorithm that, given the parameters of the desired scaffolding, successively eliminated proteins that will not self-assemble into the desired shape.

To test the protein they designed, the researchers modified it to create specific binding sites for further assembly, allowing them to create an image of the assembly.

“We were able to create binding sites for gold nanoparticles, which were on the surface of the nanotube/protein sandwich, and we showed that these gold nanoparticles arrange in exactly the kind of symmetry and geometry as we encoded,” Grigoryan says.

Being able to make scaffolds out of a customizable array of proteins in a variety of shapes could lead to advances in everything from miniaturization of circuitry to drug delivery.

Their research was published in the journal Science and was supported by the National Science Foundation and National Institutes of Health.
A Robot Learns to Read

It’s not unusual to see robots rolling or flying around the general Robotics, Automation, Sensing, and Perception (GRASP) Lab at Penn’s School of Engineering and Applied Science, but now there’s a robot that reads as it rolls.

Research by graduate student Menglong Zhu and postdoctoral fellow Kosta Derpanis, along with advisor and GRASP Lab Director Kostas Daniilidis, professor of computer and information science, has made Penn’s PR2 robot the first of its kind to be literate.

The PR2, named Graspy, is a customizable robot built by Willow Garage that has been distributed to institutions like Penn for research. While other GRASP teams work on the robot’s ability to manipulate objects with its highly articulated arms and hands, Zhu’s research focuses on the cameras that serve as Graspy’s eyes and the programming that serves as its brain.

Graspy locates words by looking for groups of closely-packed lines with similar widths and spacing, which tend to represent letters. The robot can then perform optical character recognition on what it thinks are words, checking them against a customizable dictionary.

To improve its accuracy, Graspy uses an algorithm similar to those found in spellchecker programs. While those programs make assumptions about misspellings based on the proximity of letters on a keyboard and common human errors, Zhu’s program must account for Graspy viewing words at an angle or words that are written in fonts that have two identical looking characters.

Once the words are digitized, Graspy can read them aloud with a speech synthesizer.

Zhu says the algorithm used on Graspy could potentially be used to assist those who are blind or visually impaired.

“If you have a camera mounted on top of a blind person, then he or she can walk into someplace and look around, and the camera can capture images and find certain destinations,” he says. “That would make it a lot easier for them to navigate.”
How Stress Disrupts Cell Activity

As the heart pumps blood through the body, blood cells constantly stretch and collide with each other. Yet not much is known about the forces cells can sustain before protein assemblies that establish cellular structure fall apart. Now Penn biophysicists have developed a groundbreaking process for studying how mechanical stress disrupts cell structure and activity, which may help researchers better understand diseases like anemias and blood formation from stem cells.

In normal cells, folded strings of proteins below the membrane surface bind together, and the unfolding of these strings under external forces makes the cell resilient. But in some mutated blood cells, the proteins “disassociate” rather than unfold, compromising overall stability and causing blood cell destruction and anemia. Dennis Discher and Christine Krieger in Penn’s School of Engineering and Applied Science first sought to identify what causes these proteins to unfold and then snap apart.

“There’s been great interest in understanding whether proteins unfold under the stresses of everyday life. And we find they do,” says Discher, a professor of chemical and biomolecular engineering.

To measure stress on an atomic level, the team needed a way to “stretch cells” and track changes to protein shape. They found an ideal proxy in the amino acid cysteine, an oxidizable component of most proteins. Discher reasoned that measuring the degree to which cysteine is exposed and oxidized would in effect measure the stress-distorted shape of each of the different proteins in a cell.

Just as the bonds between synthetic polymers used to manufacture rubber tires break down over time, causing tires to wear out, so too do the molecular interactions within highly stressed human cells, the team reported in the journal Proceedings of the National Academy of Sciences.

“That’s a new view of structural changes of proteins in cells,” Discher says. “Unfolding is the physiological normal process, and only under very high stresses do you get the more permanent cracking of protein-protein interactions.”
Always interested in engineering, Kumar began studying to become an aerospace engineer before developing a fascination for robotics. He studied mechanical engineering at Ohio State University, and has been at Penn since 1987. His current research focuses on robotics and networked multi-agent systems. Kumar is a professor of mechanical engineering and applied mechanics, as well as computer and information science. He also serves as the deputy dean for education in Penn’s School of Engineering and Applied Science.

The first industrial robot in history was commissioned around the time Kumar was born. For the first 20 years or so, he says, robotics was focused on what are now considered very mundane actions, such as how to get robots to assemble, pick up, and package things. Robots were viewed as a way to improve productivity, bring down wages, and cut the cost of labor by replacing human beings. Engineers, however, eventually realized that human interaction is essential.

“Robots can never replace human beings, and it took us about 50 years to figure that out,” Kumar says. “The new initiatives that are out there are really about how robots can work with human beings, whether it be in homes or in industry or defending the country. This idea of synergy is very, very prominent now when people think about new ideas, new strategies for robotics.”

Q: HOW HAS ROBOTICS CHANGED OR DEVELOPED OVER THE YEARS?
A: The first part was really about cost reduction, which actually never happened. A lot of American companies invested in robotics [in the late 1970s], and by the late 1980s they went out of business or they divested themselves of robotics. The second phase was mostly about mobility. How do you make robots mobile? And I think that really caught on. There was no industry driving it at that time, but there were a lot of applications in the service domain, in the defense domain.
Certainly in the services industry, you wanted robots to be patrolling warehouses, you wanted robots to be monitoring temperature in computer server farms, you wanted robots to be monitoring oxygen levels for environmental applications. One big thing happened as a result of all of this: People developed cars that could drive themselves. My goal would be to read newspapers while my car drives me to work.

Q: ARE THERE CERTAIN HUMAN TRAITS THAT ROBOTS CANNOT EMULATE?
A: I think humans are much, much smarter. In particular, one of the things that humans do very well that robots cannot do is work in an unstructured environment. What do I mean by unstructured? If I tell a robot to go down the hall, pick up something, and bring it back, the robot can do it. But if things change just a little bit, it may not be perceptible to you and me, but the robot will notice it and get confused, so you have to build in that intelligence. We kind of know how to do that now. Going back to the early applications in the ’80’s when people were trying to get robots to assemble products on a shop floor, people realized the hard way how small changes in the environments, the parts, resulted in down times and lost efficiencies. The Japanese realized this early on. They never intended for the robot to replace humans; humans were always there and they were interacting with robots, and they knew exactly at what level to make the robots interact with humans. Robots would do things that humans could not, and humans would do things they didn’t want robots to do. And that was the right solution. Anytime you have uncertainty in the environment, things that you don’t know exactly up front, you want humans there.

A: The lab actually brings together three different engineering departments. There’s Mechanical Engineering, there’s Electrical Engineering, and there’s Computer Science. Broadly speaking, a mechanical engineer thinks a lot about how to create robots, how to build robots, the physical structures, the physical models that allow these robots to operate. Electrical engineering is mostly about creating the brains, creating the sensors; and computer science is about creating the intelligence and the software that drives all these robots. During the time that I was director, the lab became known as a place where these three different disciplines blended into each other. Even today, you walk around the lab and you look at students and you know they’re from the lab, but you have no idea which department they belong to because they get this well-rounded training. There’s this association across departments that is very unique to our lab and something we’re very proud of.

Q: IS ROBOTICS MORE MATH-DRIVEN OR SCIENCE-DRIVEN, OR A COMBINATION OF BOTH?
A: Nothing we do in this school can be done without math. Clearly there’s math inside, there’s basic science inside. I think this is true of many engineering applications. I think the one thing that is unique about this lab is that we are creating things that don’t exist. Robotics is a synthetic discipline. It’s about creating novel artifacts, novel devices, novel software, new capabilities, new paradigms of thinking about things. That’s something that distinguishes us from many other labs around campus. Penn has a large medical school and a large School of Arts and Sciences, but not many of these labs actually think about building things or creating things; they’re more about analyzing things and trying to discover things. We discover things too, but we discover it by building and by synthesizing.

Q: HOW DO YOU ENVISION THE FIELD OF ROBOTICS GROWING IN THE FUTURE?
A: Obviously, technologically there are lots of interesting things we can do for the country, for the economy, and so on, but the biggest impact of robotics is in science, technology, engineering, and math education. I think [grade school] students get excited by robots. When I talk to them, I have no trouble convincing them that you have to be good at math to learn how to do robotics. You have to be good at science. It’s the one discipline that I think can be taught fairly early on that makes the connection and motivates kids to learn math, so I think it can truly make a difference.

Watch Penn Engineering students demonstrate state-of-the-art haptic human-computer and human-machine interfaces.
A new project hopes to tap into the creativity and innovative spirit across fields of study to focus on the challenge of achieving energy efficient retrofits in average-sized commercial buildings. Researchers from Penn are collaborating with scholars from other universities, professionals from for- and not-for-profit companies, and officials from governmental agencies to tackle the issue.

The resulting project, the Greater Philadelphia Innovation Cluster (GPIC), is funded by a $129 million grant over five years from the federal government’s Energy Regional Innovation Cluster Initiative, including $122 million from the U.S. Department of Energy. The project includes researchers from the School of Design, the School of Engineering and Applied Science, and Wharton, and is situated at the Philadelphia Navy Yard, a publicly owned cluster of buildings with an independent electric grid.

Buildings account for about 40 percent of the total energy and 70 percent of electricity that is consumed in the United States. Given these numbers, making commercial buildings more energy efficient is a daunting task.
The project is informed by the best research on efficient building technologies, designs, and systems, and is focused on putting that technology to use in the world, says Mark Alan Hughes, a distinguished senior fellow in architecture at PennDesign and the lead investigator for the GPIC team of universities and corporations studying Policy, Markets & Behavior. “We appreciate this call to talk across disciplines about what is already known but not always shared,” says Hughes. “We can get most of the way towards our goals with existing technology. The question is, ‘Why isn’t it being used?’ We’re going to try to do it here.”

Four other GPIC teams will focus on Design Tools, Integrated Technologies, Workforce and Training, and Commercialization and Deployment. Penn is the only university leading one of the five substantive areas.

Hughes and the approximately 40 investigators on the Policy, Markets & Behavior team will examine barriers to energy efficient projects, and incentivize ways to make changes. Included in that work is Penn’s Institute of Urban Research (IUR), which will pull together a comprehensive, useful database about building codes, energy efficient technologies and other specifications that will be accessible to everyone from design professionals and building managers to the general public.

This multidisciplinary project has already created opportunities for new partnerships. Penn IUR is examining energy usage in other city centers, says Eugenie Birch, professor of urban research and education in PennDesign and co-director of the Institute. Penn IUR is also working with the Taiwan Institute for Economic Research to help create a knowledge-sharing platform for that country.

Susan Wachter, professor of real estate and finance at Wharton and co-director of Penn IUR, adds that scholarship gets better when it’s tested in the real world. “Practitioners and scholars are now engaged,” she says of the GPIC project.

Hughes says that talking about buildings is a way to rally people with different backgrounds around a common issue. “Whether it’s the environment, or economy, or politics, buildings can engage everyone’s interests,” he says. “We all live and work in buildings, so they’re a tangible platform for integrating knowledge.”

Psychologists Examine Motivation’s Role in IQ Testing

IQ tests have been around for a century, but the long-standing assumption that they are pure measures of the ability to learn has recently been questioned by a Penn psychologist.

“Scientists can never measure anything with 100 percent fidelity, and I think that goes doubly in psychology, where there’s nothing you can do to remove all of the other factors: whether the subject likes you, whether they are in a good mood that day, how much they care about doing well on the task you’ve asked them to complete,” says Angela Lee Duckworth, assistant professor of psychology in Penn’s School of Arts and Sciences. “Some of these factors have minimal impact, but others can substantively influence behavior.”

Duckworth believes IQ tests have useful predictive power, but determining how much of that power comes from measuring intelligence is difficult due to the confounding factor of test motivation. In a study published in the Proceedings of the National Academies of Science, and supported by the National Institute of Mental Health and National Institute on Aging, Duckworth and her colleagues attempted to disentangle intelligence from motivation.

The researchers did both a meta-analysis of previous IQ studies and an experiment in which observers watched video footage of adolescent boys answering IQ test questions and rated the boys’ motivation while taking the test. The observers looked out for standardized behaviors indicating low motivation, such as ignoring questions or answering at random to make the test go faster. The IQ test was conducted in 1987 and had more than 500 participants, so the researchers could examine the relationship between motivation, IQ, and real-world outcomes.

While Duckworth says it’s clear that high IQ scores are effective predictors of future academic and professional success, it’s not necessarily the case that this is exclusively because success depends on intelligence.

“When you adjust for test motivation, the predictive power of the IQ test goes down,” says Duckworth. In research settings, when there is no material incentive to perform at maximum capacity, higher IQ scores represent both high intelligence and high motivation, but lower IQ scores may represent lower intelligence, lower motivation, or a combination of both.
IN MANY LOW-INCOME AREAS OF THE WORLD, FETCHING WATER IS A CHORE THAT TAKES A LOT OF TIME AND EFFORT. Finding a safe, clean, and reliable source of water can be difficult. Figuring out the best receptacle for the water can be a challenge, and lugging the heavy load over rough terrain, or alongside unsafe roadways, can be dangerous.

It’s a burden, according to research led by Penn public health expert Susan B. Sorenson, most often shouldered by women, with considerable ramifications for their health, economic productivity, and safety.

In a paper published in the journal Social Science & Medicine, Sorenson, a professor in the School of Social Policy & Practice, joined with Christiaan Morssink of the School of Nursing and undergraduate Paola Abril Campos to use data from 44 nations compiled by UNICEF’s Multiple Indicator Cluster Survey to create a study examining the gender gap in water fetching.

The findings, Sorenson says, help create a more complete picture of the societal costs of the task of collecting water. Previous studies have examined the contamination or scarcity of water, as well as the economic cost of the time spent fetching water. But, she says: “The water fetchers themselves have been almost an afterthought.”

Often, women will walk for more than an hour to collect enough water for one person for the day—five gallons—which weighs about 44 pounds, the data show.

"I’m interested in women’s status around the globe. There is a tendency to undervalue the work that women do to simply ensure the survival of themselves and their families,” Sorenson says. “The amount of work these women go through to find the right container, get to the water source, sometimes when there are no roads, is tremendous.”

With a recent increase in global initiatives aimed at improving women’s health and economic empowerment, Sorenson hopes her findings will be “immediately relevant.”
MODERNITY HAS LONG BEEN EQUATED WITH THE WESTERN WORLD. But the Arab world is modern too, in a unique way.

In his book, “Reality Television and Arab Politics: Contention in Public Life,” Marwan Kraidy, a professor in the Annenberg School for Communication, explores modernity in the Arab world through the contentious politics of reality television.

Kraidy says the book was written with several kinds of readers in mind: specialists in global communications, those interested in Middle East media, and people interested in the connection between media and politics.

The book is based on five years of fieldwork and a wealth of primary sources from a half-dozen countries.

One of Kraidy’s examples is a reality show called “Super Star,” the Arab world’s version of “American Idol.” The main difference is in the Arab version the contestants for “Super Star” represent two-dozen nationalities.

A Syrian woman made it to the finale of the second season, when Syria and Lebanon were in the midst of political conflict.

“[Benjamin] Franklin’s original conception of Penn not just as a place that would serve children of the wealthy, but all students of ability, and prepare them to make a difference in society, exemplifies that ideal that has been carried out,” adds co-author Matthew Hartley, an associate professor in the Graduate School of Education.

In their paper, published in the American Journal of Community Psychology, the authors explain that today, service learning is embedded in the missions of many universities. These programs took off at the end of the Cold War, with the increased focus on domestic, particularly urban, problems, as well as growing concerns that the civic purpose of higher education institutions was in danger of being lost.

Harkavy and Hartley cite the Moelis Access Science project, a partnership between Penn and the Philadelphia community, as a prime example of a “reciprocal, democratic partnership” that can help further an institution’s core mission.

“It’s not just engagement,” says Harkavy. “It’s the idea of improving society, helping America realize its democratic promise.”
In her book “Confederate Reckoning: Power and Politics in the Civil War South,” Stephanie McCurry, a professor of history in Penn’s School of Arts and Sciences, argues that the Confederate loss was not just a military defeat but also a political failure. McCurry says it wasn’t just the Union Army that brought about the defeat of the Confederacy, but a political challenge from its own people, including the majority—men and women, enslaved and free—who had no vote or formal political power.

The South had set out to build a “white man’s republic” and extricate itself from the “old quarrels about the nature of the Constitution and Union” and the impermanence of slavery. A supermajority of the Confederacy, however—about two-thirds of the population—did not own slaves. To convince non-slaveholding whites to support a pro-slavery view, McCurry says slaveholders used “a very organic Christian defense of conservative society,” arguing that abolitionists wanted to destroy slavery and marriage, and introduce a form of communism.

Pro-slavery forces also appealed to white privilege, cautioning that if slavery ended, poor black men would be equal to poor white men. Under slavery, all white men, rich or poor, were the elite.

Of the South’s 10 million inhabitants, 4 million were slaves. While waging a war against the North, McCurry says the Confederacy was also fighting an insurrection in the rear among the enslaved men and women.

The Confederacy also had to cope with a revolt among poor Southern white women who were responsible for ordinary life activities while their husbands and sons fought in the war and had no slaves to support them. The women wrote to Confederate governors demanding that their husbands and sons be released from the army to help them at home. During a starvation crisis, Southern women participated in food riots, high-jacked army convoys, and insisted on government policy changes.

“I see it as women breaking into the making of history,” McCurry says. “They become a force to be reckoned with in the Confederacy.”

McCurry spent 12 years researching and writing “Confederate Reckoning,” utilizing archives in North Carolina, Louisiana, Mississippi, Georgia, South Carolina, and the National Archives in Washington, D.C. Funding was provided by the Guggenheim Foundation. The book was a finalist for the 2011 Pulitzer Prize in History.
Not Everything That Is Chinese Stems From Confucianism

Goldin also familiarizes readers with two of the most famous sages who followed in the master’s footsteps—Mencius and Xunzi—and examines how the popularity of Confucianism waned and then resurfaced during the past two centuries.

“...is that he did not leave behind any written work,” Goldin notes, adding that it wasn’t until after the sage’s death that his disciples wrote down the most important exchanges they could remember. Two of those influential texts, “Great Learning” and “Canon of Filial Piety,” are presented.

The book’s discussion of the disciples Mencius and Xunzi presents critical differences between the two sages’ interpretations of Confucius’ teachings. But, Goldin concludes, a close examination of their writings shows that ultimately the two classical thinkers agree on the fundamental belief that Confucianism stresses moral development through moral cultivation.

Historical & Literary Views of Rome’s Civil Wars

Amherst, and featuring an essay by Campbell Gray, assistant professor of classical studies at Penn, scholars bring new perspectives on Roman civil wars through the lenses of history and literature.

The book is divided into four sections: “Beginnings, Endings”; “Cycles”; “Aftermath”; and “Afterlife,” and features discordant papers from different perspectives. The first section, “Beginning, Endings,” explores how citizens found themselves in civil wars and managed to pull themselves out of conflict. As a counterpoint, scholars in the “Cycles” section suggest that the wars did not have defined start or end points.

In “Aftermath,” researchers investigate how Romans tried to put the world back together again after a civil war. Two essays look at the “Aeneid,” and the role of poetry in healing the wounds of civil war. In “Afterlife,” scholars examine how Rome’s civil wars were dealt with in later historical and literary periods, including in Shakespeare’s play, “Antony and Cleopatra.”

While Damon cautions against using Roman civil wars as a blueprint for modern conflicts, she says that thinking about the Republic’s fights may be useful.

“Classicists can offer a set of responses, a set of reconstructive attempts, failures, successes—a whole world of experiences,” she says.
Stories of impropriety, fraud, and rampant greed on Wall Street fueled the call for meaningful reform of the nation’s financial regulation system. Congress took note. And in July 2010, after months of contentious, politicized debate, President Barack Obama signed into law the Dodd-Frank Wall Street Reform and Consumer Protection Act—the Dodd-Frank Act for short.

Yet nearly two years later, with the country facing the prospect of a double-dip recession, proponents and critics of the Dodd-Frank Act continue to debate whether the law can deliver on its promise of preventing the next collapse and put an end to government bailouts of private institutions.


“Its first objective is to limit the risk of contemporary finance—what critics often call the shadow banking system; and the second is to limit the damage caused by the failure of a large financial institution,” he says.
The Dodd-Frank Act introduces new regulatory structures for the trade of financial derivatives, or contracts, requiring they be publicly exchanged, a way of increasing transparency while reducing the risk of a collapse. Financial institutions most likely to cause system-wide problems if they fail are also subject to more intensive regulation. Hedge funds must now be registered.

These reforms, Skeel says, could prove beneficial.

However, he is troubled by a consistent theme he sees in the legislation: government partnering with the largest Wall Street banks. The law creates special regulatory oversight for a “club” of super banks, as well as a handful of other financial institutions also deemed too large to fail. “Unlike in the New Deal, there is no serious effort to break up the largest of these banks or to meaningfully scale them down,” he says.

While proponents of the legislation backed greater oversight of the Wall Street giants, the creation of a class of financial institutions that receive special treatment worries Skeel. Government regulators have great discretion on how they enforce the new rules, and there will be opportunities for negotiating with the heads of the largest banks.

The ultimate effect, he predicts, is that the financial landscape will continue to be dominated by a few, large institutions that will “bend to the will of the government when asked to do so in return for being able to dominate American finance.” In such an environment, Skeel argues, it’s likely we’ll see more government bailouts in the future.

A Critical Eye on Dodd-Frank

Companies claim they crave creative leadership. Managers say they prize employees who display it. But research led by Wharton management professor Jennifer Mueller has found that in the real world, workers who dare to express creativity are often perceived as having less leadership potential.

“People have powerful and ambivalent feelings about creativity,” Mueller says. “And they aren’t just positive; they are also negative. There is an implicit theory that creative people are quirky, unfocused, and unreliable.”

Working with fellow researchers from Cornell University and the Indian School of Business, Mueller conducted three related studies to examine what colleagues thought of co-workers who presented novel and highly useful ideas. The findings were published in the paper, “Recognizing Creative Leadership: Can Creative Idea Expression Negatively Relate to Perceptions of Leadership Potential?” in the Journal of Experimental Social Psychology.

The first study involved employees at a multi-national refinery in India, where the company explicitly encouraged creativity. The researchers asked 55 employees to evaluate the leadership potential of 291 of their co-workers, based on their presentation of creative ideas. The study found that “perceptions of creative performance did negatively and significantly relate to perceptions of leadership potential.” The second study, conducted at an American university, also found that participants who pitched “novel and useful” ideas were seen as having less leadership potential than those who proposed “simply useful” ideas.

In the third study, which was also conducted at an American university, the evaluators were specifically instructed to define a “charismatic leader” and then evaluate people presenting creative ideas. This was the only time creative types were more likely to be accepted as potential leaders.

“There is an implicit theory that creative people are quirky, unfocused, and unreliable.”

When companies think about increasing creative leadership, they focus on developing leaders’ creative thinking skills,” Mueller says. “But these studies suggest there is another skill needed, and that is trying to overcome stereotypes and bias against creative people to more accurately recognize leaders who also have the ability to be creative.”
THE MAJORITY OF CONSUMER LITERATURE ADDRESSES MARKETING AND CONSUMER BEHAVIOR OF INDIVIDUALS, with very little focus on how couples jointly make financial decisions, and how attitudes about money influence marital well-being.

But Deborah Small, an associate professor of marketing and psychology at the Wharton School, says important, real-life financial decisions are not usually made at the individual level.

“Oftentimes, we’re making decisions not just for us, but for our families, and we’re making them jointly in relationships, especially in this day and age when women have more resources,” Small says.

In her paper “Fatal (Fiscal) Attraction: Spendthrifts and Tightwads in Marriage,” published in the Journal of Marketing Research, Small investigated how consumers vary in attitudes towards spending, and how the differences play out in interpersonal attraction and marital satisfaction.

“Spendthrifts” generally spend more than they would ideally prefer. “Tightwads” generally spend less. And they are often attracted to each other. An important element of the attraction is their own emotional reactions towards spending money.

“Implicit in the definition, and the way that we measure ‘tightwad-ism’ and ‘spendthrift-ness,’ is that dislike,” Small explains. “We’re not measuring absolute spending, we’re measuring the psychological feeling.”

Along with colleagues at the University of Michigan and Northwestern University, Small studied 458 married couples who completed the Tightwad-Spendthrift scale, which consists of four items assessing the extent to which respondents experience emotional distress when contemplating spending money.

The researchers concluded that people with opposing emotional reactions toward spending money will be attracted to each other, but this complementary attraction is ultimately bad for their marriage.

“Although opposite couples may balance each other’s spending, unsurprisingly they argue more about money and therefore are less satisfied with their marriages, on average,” Small says.
Stereotypes Sway Consumers’ Views of For- and Nonprofits

“Individuals stereotype people all the time, dividing them into categories of friend or foe.” One Wharton researcher has found that people make judgments about companies in similar ways—and these judgments can drive decisions about whether to purchase a product or service.

Sometimes, for- and nonprofits alike can achieve what Mogilner calls the “golden quadrant,” being perceived as both warm and competent.

Cassie Mogilner, assistant professor of marketing and co-author of a paper published in the *Journal of Consumer Research*, found that people assume nonprofit companies are warm, generous, and caring, but less capable and competent than for-profit firms. Conversely, for-profit businesses are seen as more competent, but colder and less socially aware than nonprofits.

These perceptions drive the marketplace behaviors of customers: People are less inclined to buy products from nonprofits because of the perception that they lack competence.

“What our results suggest is that there’s an assumption that merely because a firm is a nonprofit, it is less capable, less competent, and less able to fulfill its goal,” says Mogilner, who worked with colleagues from Stanford University and the University of Minnesota.

But the authors also found that people’s perceptions of competence can improve with a few subtle cues. In one experiment, Mogilner and her fellow researchers found that an outside endorsement positively influenced the impression of a nonprofit, particularly when it comes from a reliable source such as The Wall Street Journal. In another experiment, researchers altered the perception of nonprofits by exposing participants to a banner advertisement related to money. Prior research has shown that the concept of money is closely tied to productivity.

Sometimes, for- and nonprofits alike can achieve what Mogilner calls the “golden quadrant,” being perceived as both warm and competent. “It’s not necessarily a tradeoff between being seen as competent or warm,” says Mogilner. “When a firm is perceived as being both, it engenders admiration and long-lasting relationships with customers.”
The University of Pennsylvania, in Philadelphia, is one of America’s premier research and teaching universities. As a member of the Ivy League, Penn has a proud history of academic excellence with 12 schools that offer undergraduate, graduate, and professional degrees to more than 24,000 students.
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