One of the primary ways in which the University of Pittsburgh continues to build on its strengths as one of the nation’s leading public research universities is by striving for excellence in research. While the University has long been noted for the excellence of its discipline-based research and scholarship, one of Pitt’s achievements also has been the development over time of an environment in which teams of eminent researchers are encouraged to work together on major challenges.

Working from a position of strength in the disciplines and reaching beyond traditional research boundaries to create academic partnerships help Pitt to fulfill its mission as a research university: to advance learning by extending the frontiers of knowledge and creative endeavor. Because key questions often occur at the intersection of various disciplines, it is increasingly important for researchers to work in teams to try to answer these complex questions.

The Excellence in Research series first appeared monthly in the *Pitt Chronicle*. This publication on excellence in research explores the broad multidisciplinary research categories in which Pitt is a leader or is positioning itself as a leader. It takes a large number of researchers—sometimes working together, sometimes separately, but all aware of one another’s work—to define a leadership position. To facilitate that kind of collaboration, Pitt has created a number of new cross-disciplinary, cross-school centers in recent years in such areas as energy, the humanities, and global health, to name a few.

Infrastructure investments also contribute to the progress of the University’s research programs, with a number of major capital projects helping to foster multidisciplinary research, including Biomedical Science Tower 3, a model of functional, flexible laboratory space; the addition and ongoing renovations to the Chevron Science Center that will advance research in chemistry, including collaborative work in drug discovery; the addition to and continuing renovations of Benedum Hall to advance engineering research with a focus on energy, sustainability, and nanotechnology; and the current renovations to the midcampus complex, with a focus on basic and applied research in physics and geology, including nanoscience. Other important projects for research include additions to and renovations in Clapp/Langley/Crawford halls and future work in Salk Hall and in Panan/Crabtree halls, all of which play a critical part in our continued pursuit of excellence in research.

Why is multidisciplinary research of value to us as a university? Because it further enhances the conditions that allow teaching and learning, research and discovery to flourish. It is not only the quality of the faculty that makes a university great; it is also the quality of their interactions with each other and with their students. Leading-edge scholarship and the growth of knowledge depend upon discussion and debate, incorporating multiple perspectives, theories, and approaches. Pitt is uniquely positioned to do this kind of collaborative research, fostering excellence throughout our academic community.
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Forty years ago, a 65-year-old American had only a 14 percent chance of reaching the age of 90. Today, thanks to healthier lifestyles, better medical treatments, and wide-ranging geriatric research, that person’s chances have doubled to almost 30 percent. And that eye-opening statistic certainly is not lost on Allegheny County, Pa., which includes the City of Pittsburgh. With nearly 205,000 residents above the age of 65, Allegheny County boasts the second-oldest population in the United States.

A health care challenge, indeed, for the region—but an absolute boon for the University of Pittsburgh and its collaborative, multidisciplinary teams of geriatric researchers. These teams have worked with the region’s unique demographic population to develop and grow a diverse and world-renowned aging research program at Pitt.

“Given Pittsburgh’s demographic, what we do here matters to the rest of the nation, whether in basic, clinical, social, and economic sciences or in the development of new models of care for older adults and their caregivers,” says Charles “Chip” Reynolds III, director of the Aging Institute of the University of Pittsburgh and the University of Pittsburgh Medical Center (UPMC) Senior Services and a professor of geriatric psychiatry and behavioral and community health sciences at Pitt. “Pittsburgh will be a microcosm for the rest of the nation in 15–20 years. Our opportunity to serve as a pacesetter and innovator in aging science and clinical programs—and in new methods to take them to scale—is second to none.”

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Charles “Chip” Reynolds III
Director, Pitt Aging Institute
The University launched the Aging Institute in 2000 largely to address the burgeoning demographic and the attendant complexity of health care issues. Since then, the institute has grown in scope and renown and is said to provide one of the nation’s largest and most diverse portfolios of aging-related research and one of the most extensive geriatric and gerontological education programs in the country. In addition, the institute’s multidisciplinary network of comprehensive clinical care also is one of the nation’s largest.

In fiscal year 2010 alone, the University received more than $79 million in aging-related research funding from the National Institutes of Health (NIH) to study cellular aging mechanisms, cell death and recovery, prevention and treatment of balance and mobility disorders, mood disorders, health services research, degenerative diseases such as osteoporosis and Alzheimer’s, and even bioethics.

“Nothing has happened that we have learned from aging research that is not relevant to health care,” says Neil Resnick, Pitt’s Thomas Detre Professor of Medicine and chief of the UPMC Division of Geriatric Medicine and Gerontology as well as a founder and former director of the Aging Institute.

Even before the institute’s creation, Pitt had begun laying its foundation for aging research with the establishment of two NIH-funded centers of excellence in aging research: the Alzheimer Disease Research Center and the Intervention Research Center for Late Life Mood Disorders. Other researchers were developing a major research program on sleep, circadian rhythms, and aging. Still others had launched what became known as the Cardiovascular Health Study and the Health, Aging, and Body Composition (Health ABC) Study. To date, thousands of older adults from the Pittsburgh region have participated in those and other ongoing studies.

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“[These are] just a few of the outstanding examples that characterize the long-standing tradition of excellence in NIH-sponsored aging research at Pitt,” says Reynolds, who also is director of Pitt’s Intervention Research Center for Late Life Mood Disorders. “The rich and diverse research base we cultivated throughout the late 1980s and 1990s naturally lent itself to the establishment of a formal aging institute.”

Since 2000, institute-affiliated researchers have established at least 21 aging research-related centers of excellence at Pitt, focusing on everything from Alzheimer’s disease, bioethics, chronic diseases, integrative medicine, and epidemiology to geriatric medicine and psychiatry, rehabilitation technology, health equity research, patient care, and social and population research. The research programs spinning out of those centers have proven broad and diverse.

“Now that we have a generation of people living in their 80s and 90s, the most worrisome thing to them is the loss of cognitive ability. The CHS Cognition Study, one of the nation’s largest studies on dementia, identifies risk factors and brain changes that might predict dementia before its onset.”

A STUDY-RICH DEMOGRAPHIC

Pittsburgh’s aging demographic has served Lewis Kuller and other Pitt researchers well over the years. Kuller, Distinguished University Professor Emeritus of Epidemiology, is known for his establishment of the Healthy Women’s Study, the first and longest study of women from pre- to post-menopause. He also continues to direct the Pittsburgh site of the multicenter Cardiovascular Health Study (CHS), which has been at Pitt since 1988 and is following about 6,000 people ages 65 and older until their deaths. For more than 40 years, Kuller has been studying risk factors in people with heart disease and diabetes and in menopausal women as well as investigating the prevention of cancer and cancer’s risk factors.

Kuller also has championed the use of noninvasive technologies to predict, for instance, the prevalence of disease in populations over time. He was among the first to use bone density measurements to study osteoporosis, carotid artery ultrasound to measure vascular disease risk, and brain imaging to explore dementia epidemiology.

AGING’S NEW CHALLENGE: LONGER LIVES BUT SHORTER MEMORIES

Kuller says that some of his most recent research suggests that the landscape of aging and disease has begun to change rapidly because of healthier lifestyles. But that raises “an interesting new problem now,” he says. “We have gotten so good at treating and preventing cardiovascular disease that we now have a generation of people living into their 80s and 90s, and the most worrisome thing for them is losing cognitive ability. Loss of physical function may be depressing and unpleasant, but there is nothing worse than finding out that you can’t remember or can’t understand something someone said.”

Such findings have motivated Kuller to delve more deeply into cognitive research in collaboration with Oscar Lopez, professor of neurology in Pitt’s School of Medicine and director of Pitt’s Alzheimer Disease Research Center. As part of that endeavor, Kuller over the past 20 years has been leading the CHS Cognition Study, one of the nation’s largest prospective dementia studies, which uses magnetic resonance imaging (MRI) to identify risk factors and brain changes that might predict the onset of dementia long before it manifests itself in patients.

Among the rising research stars emerging from Kuller’s CHS Cognition Study is Cyrus Raji, a newly minted MD/PhD graduate of Pitt’s School of Medicine. In November 2010, at the annual meeting of the Radiological Association of North America, Raji and his colleagues presented findings from the 20-year study, which included 426 elderly adults, linking increased physical activity to greater brain volume and reduced risk for cognitive impairment.

Specifically, cognitively impaired individuals, the study showed, need to walk at least 58 city blocks—a week to maintain brain volume and significantly reduce their risk for cognitive decline. Healthy adults, the study concluded, should walk at least 72 city blocks—or six miles—a week.
AGING MORE GRACINGLY

Since 1996, Anne Newman, a professor in and chair of the Pitt Graduate School of Public Health’s Department of Epidemiology, has led another aging-related study, called the Health ABC Study. It’s a longitudinal investigation of 1,500 older adults nationwide that assesses the relationship between aging-related physical changes and functional decline. Ultimately, her research promotes the benefits of healthy aging, finding that cardiovascular fitness, a healthy body composition, and regular physical activity help to maintain a person’s physical and cognitive health and function in old age. So far, she has parlayed her work into more than 300 scientific journal articles on aging health and longevity.

“When we first started doing our work, many older people were not taking care of themselves,” explains Newman, who is a colleague of Keller. “They didn’t expect to live past 70, so they figured a healthy lifestyle wasn’t worth the effort. This too-late, too-much-trouble attitude was pervasive throughout the older population.”

PLASTICITY AND THE AGING BRAIN

Another professor of epidemiology, Caterina Rosano, has been undertaking her own longitudinal population studies. She uses highly sophisticated neuroimaging methods to better understand the relationship between the aging brain and cognitive and physical function. “There’s something mysterious about older adults,” Rosano muses. “Why do some adults live longer and better, surviving against all odds?”

In a pilot study, which she published in 2010 in the Journal of Gerontology, Rosano reported that seniors older than 70 years who committed to physical activity over a two-year period—defined as walking at least 150 minutes a week—took cognitive tests faster, made fewer errors, and showed higher brain activation on MRI brain scans than those who remained sedentary. However, in another study examining data from the MRI scans and pen-and-pencil tests of 6,000 aging adults, she found that an estimated 20 percent of participants scored poorly on brain MRI scan measures but extremely well on the cognitive tests.

“One-fifth of the people we look at completely escape any sort of prediction, and this is what is fantastic to me,” Rosano says. “These people function and move around very well, but their brain MRIs don’t look good, and we don’t understand why.”

THE EFFECTS OF SKELETAL HEALTH

Also taking a toll on the aging population’s health and quality of life are degenerative bone diseases that can leave sufferers fragile and at greater risk of injury. Jane Cauley, a professor of epidemiology, has spent 25 years studying skeletal health in aging adults and researching ways to prevent fractures in older men and postmenopausal women.

Cauley serves as the principal investigator for the Pittsburgh arm of the Study of Osteoporotic Fractures (SOF), a multicenter study funded by the National Institute of Arthritis and Musculoskeletal and Skin Diseases.

Since 1986, SOF has followed a cohort of more than 10,000 women ages 65 or older to determine what factors lead to the development of degenerative bone diseases such as osteoporosis that increase the risk of bone fractures. Among SOF’s major findings to date is that although women who experience accelerated bone loss are more likely to sustain debilitating fractures, a subset of older women actually maintains bone mineral density for up to 15 years, suggesting that bone loss is not an inevitable consequence of aging. The National Institute on Aging recently extended SOF for an additional 25 years of follow-up research.

Cauley also leads the Osteoporotic Fractures in Men study in Pittsburgh, a multicenter observational study of nearly 6,000 men to determine risk factors for osteoporosis, fractures, and prostate cancer in older men. So far, the study, which began in 1999, has determined that risk factors such as smoking, insulin therapy, and even height can affect different bones.

ANNE NEUMANN

Anne Newman’s work promotes the benefits of healthy aging, finding that cardiovascular fitness, a healthy body composition, and regular physical activity help to maintain a person’s physical and cognitive health and function in old age.
Late-life depression is a chronic disease like hypertension, COPD, or diabetes, says Aging Institute Director Reynolds, and it’s important to take a long-term view: “We can’t cure depression,” he says, “but we can manage it very successfully.”

WHEN OLDER PEOPLE FALL

Of course, osteoporosis and other degenerative bone diseases can contribute significantly to other serious problems in older adults—in particular, falling, which can lead to broken bones and long-term debilitation. But as Stephanie Studenski, a professor of geriatric medicine who has built her research career around the issue of falling, notes, this health threat often stems from several issues.

“Falls are a serious problem and a leading cause of accidental death, disability, and institutionalization in older people,” Studenski says. “Most people who fall, though, fall because they have several conditions that affect their ability to stay upright and have good balance.”

Studenski, an expert on mobility, balance disorders, and falls in older adults, serves as director of Pitt’s Claude D. Pepper Center, a National Institute on Aging-funded center of excellence. She currently leads a group of more than 50 researchers from across Pitt’s schools of the health sciences who have similar expertise.

AGING AND INCONTINENCE

As part of his own aging research, Neil Resnick works to dispel myths, unravel causes, and devise new treatments for one of the most common syndromes affecting older adults: incontinence. Historically, he says, research on incontinence has been focused solely on the lower urinary tract. But after discovering the age- and disease-related changes that occur in the bladder, as well as identifying a previously unknown cause of geriatric incontinence, Resnick says he found that this approach was too narrow.

His research has shown that incontinence results not only from lower urinary tract dysfunction but also from the body’s inability to compensate for it—problems that occur even with relatively normal bladder function.

Resnick’s research has shown that incontinence results not only from lower urinary tract dysfunction but also from the body’s inability to compensate for it—problems that occur even with relatively normal bladder function. His studies further demonstrate that, contrary to popular belief, incontinence in older adults is not part of normal aging or dementia—and a broad diagnostic and therapeutic approach focused on compensatory mechanisms leads to superior results not just for incontinence but for other geriatric conditions as well.

Taken together, the growing aging population, the complexities of aging-related health care, and the politics affecting it provide ample directive for Pitt researchers to continue to make aging research an internationally recognized academic and clinical priority at the University of Pittsburgh.

DESTIGMATIZING DEPRESSION

Recognizing that depression in older adults is an increasingly common problem, particularly among hospitalized patients, Aging Institute Director Reynolds has become an internationally recognized expert on the topic. In short, Reynolds urges older adults and their caregivers to support a less stigmatizing approach to depression.

“We use medications to relieve depression symptoms and psychotherapy to help get and keep people well,” he explains. “Because late-life depression is a chronic, recurring condition, just like hypertension, chronic obstructive pulmonary disease, or diabetes, it’s important that patients and family caregivers take a long-term view. We can’t cure depression, but we can manage it very successfully to the point that people can be symptom free and stay that way for long periods of time.”

Among Reynolds’ depression research projects is his team’s study of potential interventions for medically frail older adults at high risk for full-fledged clinical depression. Reynolds and his research team, with support from the University’s Clinical and Translational Science Institute (CTSI), also recently recruited subjects for a study looking at the effectiveness of teaching at-risk older adults problem-solving skills and improved dietary practices to prevent depression.

The preliminary results are so promising, Reynolds says, that the study has been extended further into old age and to underserved minority populations. In fact, the National Institute of Mental Health recently awarded funding to his team to establish a five-year center of excellence focusing on late-life depression prevention. Reynolds serves as principal investigator and director of the new center.

CHRONIC CARE CONSIDERATIONS

Ultimately, age and a host of debilitating health problems do catch up with some older adults, leaving them to suffer for long periods with chronic illness. As such, Resnick has teamed up with Edmund Ricci, a professor of behavioral and community health sciences and associate director of the Aging Institute, to tackle what he considers one of the toughest problems in health care today: caring for the chronically and severely ill older adult. Out of their research has emerged the Acute Care and Transitions Program, an innovative care model designed to focus on a complex systems approach to geriatric care.

“On any given day, hundreds of elderly patients are admitted to UPMC hospitals who are considered to be at high risk for hospital readmission, frequent emergency room visits, or both,” Resnick explains. “Many of these patients have chronic diseases like congestive heart failure or chronic obstructive pulmonary disease that are associated with multiple symptoms—shortness of breath, weakness, palpitations, poor appetite, incontinence, just to name a few. Often these symptoms are not adequately addressed while the patients are in the hospital, and they end up slipping through the cracks at discharge.”
**AGING**

Addis Ricci, “You really need a full baseline assessment [of such aging patients], including caregiver capacity, financial resources, and the home environment. You also need to include the assessments of multiple specialists. As the current system works, it is very difficult to get all of the specialists to communicate, even with the implementation of electronic medical records. Too often, 911 becomes the patient’s default case manager.”

**CAREGIVER STRESS**

On the other side of the issue of chronic illness are the patients’ personal caregivers, whether spouses or other family or friends, who experience their own quiet suffering. Richard Schulz, professor of psychiatry and director of the University Center for Social and Urban Research (UCSUR), has been researching the connections between mind and body and between caregiver and patient for more than a decade. Schulz, who also is associate director of the Aging Institute, has earned his place among the nation’s top experts on the social behavior and health largely because of his UCSUR-based research team’s study of the impact of disease (Part D) in the spouses of people suffering from illness. Among the 1,330 older married couples in the study, husbands whose wives reported high levels of suffering were nearly twice as likely to have CVD and depression as compared to those whose wives did not report suffering.

In another laboratory-based study, Schulz and a team of collaborators from across Pitt’s academic disciplines explored the physiological pathways by which exposure to a loved one’s suffering leads to increased prevalence and incidence of depression and cardiovascular disease (CVD) in the spouses of people suffering from illness. Among the 1,330 older married couples in the study, husbands whose wives reported high levels of suffering were nearly twice as likely to have CVD and depression as compared to those whose wives did not report suffering. However, until recently, no breakdown by clinical condition, expenditures but also has increased medication use. In January 2006, for instance, a new drug benefit plan from Medicare, known as Part D, expanded access to beneficiaries who previously had limited or no prescription drug coverage. Donohue’s early studies, she says, indicate that Part D not only has reduced out-of-pocket drug expenditures but also has increased medication use. However, until recently, no breakdown by clinical condition, such as depression, had been performed.

As part of her study, Donohue says she analyzed medical and pharmacy insurance claims data throughout Western Pennsylvania over a four-year period from more than 30,000 Medicare beneficiaries with a diagnosis of depression. Her outcome measures included the initiation of antidepressant therapy, duration of therapy, and adequate adherence before and after implementation of Part D. Her results, published in the American Journal of Geriatric Psychiatry, found that Medicare Part D was associated with improvement in antidepressant use and adherence by depressed older adults who previously had no or limited drug coverage. Taken together, the growing aging population, the complexities of aging-related health care, and the politics affecting it provide ample directive for Pitt researchers to continue to make aging research an internationally recognized academic and clinical priority at the University of Pittsburgh.

“Imagination is our only limit.”

*Richard Schulz*

**PALLIATIVE CARE AND COMMUNICATION**

Palliative care, perhaps the most difficult issue along the aging spectrum, often conjures up disturbing thoughts of “giving up,” end-of-life hospice, withdrawal of lifesaving measures, and death, says Robert Arnold, the Leo H. Crep Professor of Patient Care in the Department of Medicine. But he suggests that one of the most pressing shortcomings around such care—and an area in need of improvement—is effective communication.

“Palliative care is about enhancing communication among providers, patients, and supporting suffering caregivers and families,” Arnold explains. “Traditionally, palliative care is offered only as an inpatient consult service. However, we are starting to recognize the need to provide palliative care support services in the outpatient setting, too—in nursing homes and communities—so that patients, their caregivers, and their physicians can all be on the same page with respect to understanding what the patients’ goals are, which may be very different from the physicians’.”

Arnold, who has focused most of his career on improving the communication skills of physicians dealing with patients’ end-of-life issues, actively trains oncologists and internal medicine physicians across the country to engage more effectively in difficult conversations with patients, such as how to share bad news, explain advance directives, and discuss informed consent.

“The problem is that doctors often learn these communication skills two-thirds of the way through their careers by trial and error,” Arnold says. “We’re trying to develop research projects to see if we can help doctors earlier in their careers learn the skills they need to have these conversations with patients.”

As a result of his recent research efforts, Arnold and a nationwide team of expert faculty researchers have developed what they call the Oncotalk Communication Skills Toolkit, an online toolbox of teaching resources for medical educators teaching ethics and communication. He received funding for the project from the National Cancer Institute.

**THE POLITICS OF AGING**

Given the fast-growing population of aging adults in the United States, it should come as no surprise that this demographic and its associated health issues have become a serious political target, particularly with regard to health care reform. As Julie Donohue, a professor in the Pitt Graduate School of Public Health’s Department of Health Policy and Management, can attest, national health care policy changes can affect medical treatment profoundly for older adults suffering from chronic illnesses. She is conducting research on the effects of recent changes in health care policy on medication access and spending among older adults with depression and other chronic medical conditions.

First published in the Pitt Chronicle December 5, 2011
University of Pittsburgh researchers are at the forefront of this surge in innovation. They are applying their expertise to create a myriad of new devices, spurring the creation of start-up companies as well as research partnerships involving an array of industries.

Such accomplishments are in no small part the result of the idea-nurturing environment that researchers find on the University’s Pittsburgh campus and across Western Pennsylvania. In a field that demands collaboration, Pitt researchers find a wealth of leading experts in diverse disciplines within the University’s Swanson School of Engineering, its School of Medicine, and its other schools of the health sciences; the University of Pittsburgh Medical Center (UPMC) health network; and the Pitt-UPMC McGowan Institute for Regenerative Medicine.

The results have been widely recognized, with Pitt in recent years being ranked as one of the nation’s top universities for bioengineering research and education. “We are a national program,” says Pitt’s Harvey Borovetz, “and we’re a national program because we have unique strengths and collaborations.”

In recent years, Pitt has been ranked as one of the top universities for bioengineering research and education, “We are a national program,” says Pitt’s Harvey Borovetz, “and we’re a national program because we have unique strengths and collaborations.”

The science of bioengineering is profoundly changing the world of medicine as we know it. Continued research and technological breakthroughs have revolutionized the discipline, resulting in advances never before thought possible: a tiny cardiac-assist device for infants whose hearts don’t pump adequately, a blood treatment tool that allows ventilator-dependent people to breathe without a ventilator, a high-tech bandage used to successfully repair injured hearts, and materials that help to regenerate bone and then dissolve once the job is done.

Harvey Borovetz

University of Pittsburgh researchers are at the forefront of this surge in innovation. They are applying their expertise to create a myriad of new devices, spurring the creation of start-up companies as well as research partnerships involving an array of industries.

Such accomplishments are in no small part the result of the idea-nurturing environment that researchers find on the University’s Pittsburgh campus and across Western Pennsylvania. In a
the National Research Council, the most comprehensive data-based assessment of research doctorate programs in the United States, Pitt’s bioengineering program was ranked seventh out of 53 programs.

Another indicator of the caliber of Pitt’s bioengineering research is the amount of funding the Swanson School’s Department of Bioengineering receives from competitive federal funding programs. In 2009 and 2010 alone, Pitt bioengineering researchers were awarded $5.6 million to develop a heart-assist pump for infants and toddlers, part of a $25.6 million effort by the National Institutes of Health (NIH)’s National Heart, Lung, and Blood Institute, and $5.1 million from NIH to explore new methods for growing cells from existing tissues and organs. In addition, Pitt was selected as one of the leaders of a national $85 million program to advance regenerative medicine and develop treatments for wounded soldiers. Funding for that program stems from a new federal entity, the Armed Forces Institute of Regenerative Medicine.

“We are a national program,” says Pitt’s Harvey Borovetz, Distinguished Professor of Surgery, and a professor of chemical and petroleum engineering, “and we’re a national program because we have unique strengths and collaborations.”

Bioengineering as a discipline experienced significant growth during the final decades of the 20th century. Its rise in prominence was fueled by funding from the federal government and private benefactors, primarily the Whitaker Foundation. Bioengineering received a broad network of 20 hospitals and renowned programs in such specialties as transplantation, cancer, neurosurgery, cardiology, cardiac surgery, orthopedics, and sports medicine. A case in point: the development of the PediaFlow™ ventricular-assist device for children and newborns with congenital and/or acquired heart disease. Cardiac experts within the medical school were essential during the early research stages for the device, and they continue to spearhead the device’s development as it moves toward clinical trials, Borovetz says. He and a team of experts—who include pediatric heart surgeons and cardiologists from Children’s Hospital of Pittsburgh of UPMC, bioengineering faculty at Pitt and Carnegie Mellon University, and industry partners—are working to refine the device.

And the PediaFlow™ effort is more than an academic exercise. Eight out of every 1,000 infants are born with heart defects, according to a recent report from the American Heart Association. “In many cases, there are few options for these children,” says Borovetz.

Another uncommon resource available to Pitt researchers is the McGowan Institute for Regenerative Medicine, a Pitt-UPMC entity created in 2001 to better position Pitt and the region in the burgeoning regenerative medicine industry. Based on Pittsburgh’s South Side, the McGowan Institute is an outgrowth of the McGowan Center for Artificial Organ Development, which was established in 1992 with an initial focus on cardiopulmonary organ replacements.

ROBUST COLLABORATION

“At the end of the day, what NIH generally chooses to fund is innovative, significant work that will benefit public health,” says Borovetz. “And for many bioengineers, it’s hard to imagine working on innovative, significant work that benefits public health and not working with colleagues who are public health practitioners.”

Bioengineering collaborations with the School of Medicine provide clinical insight into just about every medical specialty. Such partnerships allow bioengineers to identify which clinical issues they may help to resolve. In addition, UPMC offers a broad network of 20 hospitals and renowned programs in such specialties as transplantation, cancer, neurosurgery, cardiology, cardiac surgery, orthopedics, and sports medicine.

A case in point: the development of the PediaFlow™ ventricular-assist device for children and newborns with congenital and/or acquired heart disease. Cardiac experts within the medical school were essential during the early research stages for the device, and they continue to spearhead the device’s development as it moves toward clinical trials, Borovetz says. He and a team of experts—who include pediatric heart surgeons and cardiologists from Children’s Hospital of Pittsburgh of UPMC, bioengineering faculty at Pitt and Carnegie Mellon University, and industry partners—are working to refine the device.

And the PediaFlow™ effort is more than an academic exercise. Eight out of every 1,000 infants are born with heart defects, according to a recent report from the American Heart Association. “In many cases, there are few options for these children,” says Borovetz.

Another uncommon resource available to Pitt researchers is the McGowan Institute for Regenerative Medicine, a Pitt-UPMC entity created in 2001 to better position Pitt and the region in the burgeoning regenerative medicine industry. Based on Pittsburgh’s South Side, the McGowan Institute is an outgrowth of the McGowan Center for Artificial Organ Development, which was established in 1992 with an initial focus on cardiopulmonary organ replacements.

Today, millions of sponsored research dollars flow through Pitt annually to support work related to regenerative medicine. More than 240 faculty are affiliated with the McGowan Institute; their core competencies are broad—cellular biology, gene therapy, imaging, biomaterials, bioengineering, and biomechanics are among them—and they use their expertise to develop medical devices, biomaterials, engineered tissue, and cell-based therapies affecting everything from the heart and vascular tissue to the lungs and nervous system.

Not only does such breadth of expertise provide for rich collaborations within the University, it also attracts privately funded entities, enticing them to form the partnerships that the McGowan Institute views as part of its mission. Pitt is seen as a place where people do serious work in regenerative medicine, serving as a magnet to interested companies.

FROM LAB TO BEDSIDE

The field of bioengineering is recognized for researchers’ ability to move new technologies out of the laboratory and into practical use. The Sonic Flashlight, developed by Pitt Professor of Bioengineering George Stetten, is among the many ideas born in Pitt laboratories that have found their way to the marketplace and patients’ bedside.

STETTEN'S DEVICE

The clinical trials demonstrated the value of the device having a real-time OCT image right where the tip of your needle is is a big advantage.”

Stetten, however, isn’t finished exploring the idea behind his high-profile invention. “The basic concept of taking an image with a mirror and putting that image right inside the body in real time so that you can aim scalpels at it doesn’t just have to involve ultrasound,” he says.

Stetten is now developing guidance systems for eye surgery in collaboration with Joel Schuman, chair of Pitt’s Department of Ophthalmology and a professor of bioengineering. The new device, known as an in-situ guidance system, uses optical coherence tomography (OCT) instead of ultrasound; OCT is an imaging modality that employs light waves to produce high-resolution images. It’s like ultrasound, but with a laser, and it can peer into the cornea and the retina, where it displays high-resolution 3-D images of what is there.

Traditionally, OCT hasn’t been used during eye surgery because the surgeon would have to turn away from the microscope to view images projected on a screen. Stetten’s device, much like the Sonic Flashlight™, displays the real-time images inside the eye, directly in the surgeon’s field of vision through the microscope, as if he or she is wearing X-ray glasses.

Studies of the psychophysics of performing such delicate operations, done in collaboration with engineers at Carnegie Mellon University, found, not surprisingly, that it is much better for surgeons to be able to aim a scalpel or needle at a target they see in front of them than to have to look away from a screen. “It’s more accurate and easier to learn, and it’s generally more comfortable to be interacting with in-situ images,” says Stetten. “To be able to do microunctions on the eye having a real-time OCT image right where the tip of your needle is is a big advantage.”

The Sonic Flashlight™ is a handheld ultrasound probe with a mirror and miniature display attached to it. The design allows images to be viewed directly by medical practitioners without their having to turn their heads to view a screen, as is required in traditional ultrasound imaging. The probe enables users to see what lies beneath the skin as a real-time floating image. UPMC clinical trials demonstrated the value of the device in helping nurses to more comfortably and intuitively insert central catheters peripherally into deep veins in patients’ arms. In 2012, a Pittsburgh-based start-up company, is readying the device for market.
People with lung disease also are finding hope in the technologies being developed by Pitt bioengineers, including devices that could make ventilators unnecessary for some patients.

For patients whose lung function is weakened by disease, ventilators remove carbon dioxide from blood and add oxygen so that the body and its organs can function. While such respiratory support is critical, it presents problems of its own, including the risk that the process causes additional damage to already-diseased lungs.

Alung Technologies, a Pittsburgh-based start-up, is conducting clinical trials in Europe involving a respiratory-assist device that does the job of a ventilator—without the ventilator. The product was developed in the laboratory of William Federspiel, the William Kepler Whitford Professor of Bioengineering, Surgery, and Chemical Engineering.

“It takes a small amount of blood outside the body and runs it through an artificial lung cartridge that was specifically designed to be very efficient at removing carbon dioxide from the bloodstream, and it also adds oxygen into the bloodstream,” says Federspiel.

Federspiel’s laboratory is also exploring the possibility of taking that concept one step further: a device that would perform the same function without having to draw blood from patients. “The idea,” he says, “is to have a catheter that sits in a blood vessel and oxygenates and removes carbon dioxide to provide respiratory support.” This was the dream of one of Federspiel’s early collaborators at Pitt, the late cardiothoracic surgeon Brack Hattler, with whom Federspiel founded Alung Technologies.

Federspiel also is investigating new technologies for treating sepsis, a serious whole-body inflammatory reaction to an infection in blood or tissues. Federspiel’s laboratory is working with John Kellum in the School of Medicine’s Department of Critical Care Medicine to develop a device that filters a sepsis patient’s blood through a cartridge of absorbent beads designed to remove the chemical molecules that orchestrate the body’s innate immune system. “By removing them from the bloodstream, we are able to calm the reaction to this infection and mitigate the effects associated with sepsis,” Federspiel said.

For patients who experience postischemic cardiomyopathy, which is heart failure following a heart attack, the prognosis is rarely good. Scar tissue forms; the wall of the heart thins; and the heart’s ability to pump diminishes to the point where extreme measures, such as a transplant, are necessary. In his laboratory, William Wagner is exploring technologies that could offer such patients a far more attractive option.

One is an injectable gel that at body temperature becomes an elastic girdle to reduce stress on the healing heart tissue. Both materials are being developed with such tissue-regenerative properties as the ability to deliver drugs that spur healing and the capacity to degrade safely within the body. “We’re developing materials that will fulfill a function, often a mechanical function—like an internal crutch or girdle—but will go away over time and allow the body, as it heals, to take over that function on its own,” says Wagner, director of the McGowan Institute and a professor of surgery, bioengineering, and chemical engineering at Pitt. Many materials used in biomedical applications today were originally made for other purposes, such as for hosiery or wire insulation. But Wagner’s lab designs them from scratch for specific medical situations, aiming for better biocompatibility and function.

For the heart patch, which is surgically implanted over the heart’s damaged area, researchers in Wagner’s lab engineered a thin sheet of polyurethane with several key properties: the elasticity necessary to protect the healing heart tissue’s high stress; the molecular makeup to degrade into materials that are not toxic to the body; and the ability to precisely deliver “growth factors,” which are naturally produced proteins that stimulate cell division and promote tissue regeneration.

In addition, Wagner can tweak the material’s molecular design to make it softer or stiffer, degrade faster or slower, break down with a specific enzyme, and deliver a specific drug. Wagner’s team also is exploring a thermoresponsive hydrogel engineered to be a liquid at cold temperatures that quickly forms an elastic patch at body temperature. Such properties make it possible to administer support to a damaged heart by way of injection rather than through open-chest surgery.

“Typically, we’re addressing with all of this is whether there is something we can do to improve the outcomes of these patients before the heart completely fails,” says Wagner.
RESTORING NEURAL FUNCTION

Brain damage from injury or disease can often result in the permanent loss of function, such as the ability to move an arm. But Pitt bioengineers are developing technologies aimed at helping patients to regain such abilities and improve their quality of life.

In Tracy Cui’s laboratory, researchers are investigating ways to convince the brain to tolerate implantable devices that can, it is hoped, restore some lost function. These researchers also are looking into methods of engineering healthy neural tissue.

Devices implanted in the brain can be rendered useless if the brain rejects them or covers them with scar tissue. Cui’s laboratory is trying to ensure a better outcome so an electrode that listens to neurons’ electrical signals won’t have those signals muted by scar tissue. The goal is to develop a device that enables patients who’ve lost a certain function to control, for example, a robotic arm with their thoughts.

Neurons on L1-CAM coated surface

One strategy for creating a more biocompatible electrode is to coat it with proteins that exist in the brain. “Basically, we try to trick the brain tissue into thinking that the chip is not a foreign body,” says Cui, a Pitt professor of bioengineering. Another approach is to put an electrically switchable polymer on the electrode that, when activated, pumps an anti-inflammatory drug to control scar tissue or neurotrophic factors to promote neuron health. The National Institute of Neurological Disorders and Stroke and the U.S. Department of Defense fund the research.

MENDING BONE

Prashant Kumta is developing advanced technologies to help overcome severe bone defects and injuries. Kumta holds the Edward R. Weidlein Chair in the Swanson School of Engineering and is a professor in the Departments of Bioengineering, Chemical and Petroleum Engineering, and Mechanical Engineering and Materials Science. Using his expertise in bioceramics and biometallurgy, he is developing implantable materials and delivery systems for ceramics, natural and synthetic polymers, and metals and novel nanoparticles. The goal? To be able to repair “critical bone defects,” such as a missing segment of bone too substantial for the body to heal on its own.

The U.S. Department of Defense, which funds the research, is particularly interested in this technology as a way to improve the outcomes of soldiers who have suffered severe craniofacial injuries. Kumta’s collaborators on the project include colleagues in Pitt’s Department of Bioengineering and School of Dental Medicine and the McGowan Institute.

The cement comprises a calcium phosphate-based ceramic powder and other additives mixed with a fluid that contains nanoparticles on which researchers are able to bind growth factors and other signaling molecules that help to regenerate bone.

The porous nanostructured cement has the potential to greatly improve the prognosis for those with craniofacial injuries. Kumta also is working toward developing new metal-based technologies to regenerate load-bearing bone, which would enable surgeons to repair defects in the femur, for example. Magnesium, in particular, has shown great potential for such applications, because it possesses mechanical characteristics identical to those of natural bone as well as the ability to safely dissolve in the body. Kumta and his colleagues are designing novel magnesium-based alloys to tap those characteristics for the benefit of patients with critical bone defects. “The ultimate dream,” he says, “is that the metal can be placed into a femur, and in a few weeks’ time, when the surgical incision has healed, the patient will be able to stand up and resume normal activities.”

Prashant Kumta

MORE WORK AHEAD

Pitt bioengineering researchers like Kumta can look forward to continued demand for the kinds of technologies they have developed.

The aging population, a growing focus on health issues, and other factors are expected to sustain the demand for sophisticated materials, devices, and other technologies that emerge from bioengineering laboratories.

First published in the Pitt Chronicle February 21, 2011
Drug discovery is a classic example of translational science, or “bench to bedside” research (or in this case, “bench to bottle”). Advances made in the laboratory lead to new and more effective pharmaceutical products for patients. The road to drug discovery, however, is never a straight path. In the early stages, medicinal chemists and structural biologists dissect the intricate interactions between proteins so they can hypothesize potential drug targets and determine which compounds are likely to disrupt or enhance a biological function. Once they’ve identified an area of interest, that target is screened against thousands of compounds to find one (or several) that might disrupt the protein-protein interaction. When a “hit” is identified, organic chemists find the best and most efficient methods to synthesize and scale up those compounds in the laboratory. Biologists then validate the compounds in the lab and in living things to determine effectiveness, safety, and stability. If any of these qualities is less than optimal, the molecule gets sent back to the chemists for improvement.

Sitting atop the University of Pittsburgh’s Biomedical Science Tower 3 (BST3), researchers in Pitt’s Drug Discovery Institute (DDI) are searching for new methods to alleviate suffering caused by a variety of diseases. Their research includes studying the delicate protein interactions involved with cancer, designing new drug compounds, and developing automated technologies to enhance existing research methods. Their interests are diverse, yet their mission is the same: to advance global health.
A NOVEL CONCEPT

Pitt’s Drug Discovery Institute opened its doors in 2006, one of the first tenants of the $205 million BSI3, a research tower with modern, open laboratories and a sophisticated floor plan. When Arthur S. Levine, senior vice chancellor for the health sciences and dean of Pitt’s School of Medicine, designed the concept for BSI3, he envisioned collaboration at the most basic levels of science, believing that sharing physical space and technologies would encourage more collaboration. Barry Gold, DDIs associate director and professor and chair of pharmaceutical sciences in the School of Pharmacy, thinks Levine’s concept works: “We really focus on teamwork here at Pitt. In fact, other universities are copying how we’re keeping our experts and their equipment in close proximity. I just wish the cancer center wasn’t so far away,” he laughs. (The University of Pittsburgh Cancer Institute is a five-minute bus ride from Pitt’s Pittsburgh campus.)

Over the years, DDIs has expanded to a high-production facility, capable of holding as many as 5 million chemical compounds and equipped with more than 10 robots for automated assay plating, giving researchers virtually infinite drug-screening opportunities. Its faculty members hail primarily from three Pitt schools—the Kenneth P. Dietrich School of Arts and Sciences, the School of Medicine, and the School of Pharmacy—and create a unique mosaic of scientists, from organic chemists to clinical scientists, who work along the continuum of drug discovery.

Dennis Curran, a Pitt Distinguished Service and Bayer Professor of Chemistry in the Dietrich School of Arts and Sciences, notes that chemists and clinicians often don’t speak the same language, but he believes the key to continuity is having leaders who can span the scientific spectrum. “Everyone has his/her own niche in academia, but we have great leaders who can relate to people up and down the pipeline,” says Curran, who specializes in organic compound synthesis.

THE RESEARCH TEAM

Curran was a key collaborator in the development of AP67, an anticancer drug that is currently in Phase II clinical trials with Amo Therapeutics, Inc. AP67 is being tested in patients with glioblastoma multiforme, a highly aggressive brain cancer. He developed the drug with the late Thomas G. Burke, a professor of medicine at the University of Kentucky College of Medicine. Currently, Curran is working on the synthesis of several compounds: “Being academicians, we aren’t satisfied with just making more of the same compound. If we have a difficult synthesis, we want to make it better. We’re interested in pushing the edge of the possible in moving a compound to a drug candidate. We want new chemistry, new compounds, cutting-edge science.”

Alexander Dömling, professor of pharmaceutical sciences in the School of Pharmacy and of chemistry, came to Pitt in 2006 after founding two pharmaceutical companies and helping to advance Almorexant, a sleep-aid drug, to Phase III clinical trials. Despite his extensive industry experience, Dömling sees himself first as a teacher and researcher. “High-throughput screening [HTS] is very important in drug discovery, but in academia, our priority is to teach. Before they use HTS, students need to understand the science behind drug interactions,” he says. Dömling’s main interest lies in designing antagonists of protein-protein interactions (PPi) that could be used as drug targets. He mines structural models to find small pockets of deeply buried amino acids, which he calls “anchors.” Together with collaborator Carlos Camacho, a professor of computational and systems biology in the School of Medicine, Dömling created an online tool, called anchor.query (anchorquery. ccbdd.pitt.edu), that allows researchers to search easily for these anchors and define promising areas for drug discovery.

Peter Wipf is best known for his groundbreaking work in the total synthesis of complex organic molecules and was instrumental in advancing the use of combinatorial chemistry techniques at Pitt. Combinatorial chemistry is a synthesis method that became popular in the 1990s as a way for chemists to create large numbers of compounds in a very short period of time.

Dömling’s current PPI of interest is the interaction between the cancer-related proteins p53 and MDM2/MDM4. When the proteins interact, they form a small, deep cavity—the type that is ideal for drugs to bind to and effect a change in function. “This PPI is hot topic in drug discovery right now, and no drugs have been approved that disrupt this type of interaction in cancer cells,” Dömling says. Dömling left Pitt to become chair of chemistry at the University of Groningen in the Netherlands but will maintain research collaborations at Pitt via an adjunct appointment.

Peter Wipf is Distinguished University Professor of Chemistry; an associate director of DDIs and director of Pitts Combinatorial Chemistry Center, which was established in 1998. He is best known for his groundbreaking work in the total synthesis of complex organic molecules and was instrumental in advancing the use of combinatorial chemistry techniques at Pitt. Combinatorial chemistry is a synthesis method that became popular in the 1990s as a way for chemists to create large numbers of compounds in a very short period of time. As these new technologies and methods of organic synthesis were further developed at the Combinatorial Chemistry Center, the center was expanded in 2002 as part of a larger National Institutes of Health (NIH) center initiative and became the University of Pittsburgh Center for Chemical Methodologies and Library Development (UPCMLD). UPCMLD is one of five centers in NIHs Centers of Excellence in Chemical Methods and Library Development Program, which fosters innovation in chemical synthesis and drug discovery by developing chemical methodologies and creating diverse compound libraries with a range of physiological properties. As UPCMLD director, Wipf encourages interdisciplinary, multi-investigator research projects that allow the sharing of compounds, resources, and ideas. While Wipf is particularly interested in developing anticancer agents and neurodegenerative disease therapies, he feels that this type of diverse, multi-investigator center of excellence allows scholars to pool their expertise to discover novel therapies for major as well as neglected diseases.

KBB-5-131 strengthens degenerating mitochondria
Joining this systems biology approach is Andreas Vogt, a research assistant professor of computational and systems biology in the School of Medicine. Vogt has done substantial work in high-content imaging technology, which allows researchers to obtain data from individual cells and analyze the effects of drugs on their target of interest in a cellular context. Vogt also performs image-based analysis of whole organisms, such as zebrafish, which are an ideal system for in vivo high-content screens. These tropical freshwater fish are vertebrates and share biological similarities to higher organisms; they are optically transparent, and their tiny embryos can easily be stored in 96-well microplates, a standard format for high-throughput screening. Using his imaging technology and an artificial intelligence-based image analysis method called cognition network therapy, Vogt has detected and quantified structures of interest in zebrafish embryos, including the presence of intersegmental blood vessels, which are used as a measure of angiogenesis. Vogt collaborates with Pitt’s zebrafish superstars, professors of developmental biology Michael Tsang and Neil Hukriede, in developing novel automated imaging assays to measure fluorescence and analyze biological function in transgenic zebrafish embryos.

Pitt researchers employ both HTS, the dominant tool in the drug discovery process, and high-content screening (HCS)—a combination of fluorescence labeling technologies and electronic imaging technologies that enables the study of individual cells on a light microscope. Together, these tools allow collaborators to access Pitt’s massive compound library, where researchers can screen thousands of interesting chemotypes (chemically distinct entities in a plant or microorganism) against their target of interest and visualize protein interactions via live cell microscopy.

Fluorescent cells

“IN THE NEWEST WAVE OF DRUG DISCOVERY, HOWEVER, WE REALIZE THAT YOU CAN DESIGN AN INHIBITOR THAT BINDS WELL AND HAS HIGH ACTIVITY, BUT WE WANT TO KNOW WHAT HAPPENS WHEN YOU PUT IT IN THE BODY. OUR GROUP FOCUSES ON PROTEIN DYNAMICS, OR HOW THE PROTEINS MOVE AND INTERACT. STRUCTURE IS IMPORTANT, BUT IT IS A SNAPSHOT. WE WANT TO OBSERVE HOW THE PROTEIN ACHIEVES ITS FUNCTION—THEN WE CAN DESIGN THE DRUG.”

IVET BAHAR
CHAPPIERSON, COMPUTATIONAL AND SYSTEMS BIOLOGY ASSOCIATE DIRECTOR, DRUG DISCOVERY INSTITUTE

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COMBINING BUSINESS AND BASIC SCIENCE

DDI is in an exciting transition period, as it shifts focus with its new director D. Lansing Taylor, Allegheny Foundation Professor in the School of Medicine’s Department of Computational and Systems Biology. Taylor pioneered high-content screening methods to automate cell and experimental animal drug discovery and marketed these technologies through his company, Celomics, Inc., now part of ThermoFisher. He also founded several Pittsburgh-based biotechnology companies, most recently Callumen and Cemotics, which applied cellular and tissue systems biology to drug safety and diagnostics.

D. Lansing Taylor plans to use his business acumen to reach out to potential partners in the industry. He notes that both Harvard University and Washington University in St. Louis, two national leaders in drug discovery, have recently developed partnerships with large pharmaceutical companies. He is confident that Pitt’s academic prowess will attract the pharmaceutical industry as well: “We have tremendous talent, world-class facilities, and the drive to push discovery into the future.”

As both an entrepreneur and an academican, Taylor provides a unique industrial perspective with a deep appreciation for basic science. “There is no single isolated target that we can perturb with drugs, so it is essential to understand the biological systems and address this complexity up front, using functional model systems such as sophisticated cell models and small experimental animal models, like C. elegans (roundworm) and zebrafish. We can use these live models to gain biological insight very early on in the drug discovery process.” Taylor is energetic about his new role and the future of drug discovery. Even before he began his first day in his new position, Taylor coined this tagline that demonstrates his enthusiasm and vision for DDI: “Novel chemistries and systems biologies to accelerate drug discovery.”

Taylor plans to use his business acumen to reach out to potential partners in industry. He notes that both Harvard University and Washington University in St. Louis, two national leaders in drug discovery, have recently developed partnerships with large pharmaceutical companies. He is confident that Pitt’s academic prowess will attract the pharmaceutical industry as well: “We have tremendous talent, world-class facilities, and the drive to push discovery into the future,” Taylor says. “By combining our intellectual power with their business knowledge, we will gain mutual value that will help our institution and the world. It’s all here.”

Associate Director Gold explains, “Drug discovery is a lengthy, difficult, expensive process. An entire drug portfolio from conception to delivery can cost upwards of $800 million, money that universities typically do not have. At the same time, the big pharma pipeline is not always full, so when that occurs (for example, when they have several drugs go off patent at the same time), they look to universities for real leads on new compounds.” Gold thinks the strength of the University is in studying a diverse set of model systems biologies to accelerate drug discovery.

DDI looks to industry partnerships to help advance the basic research that might lead to new therapies and help society. “The money that comes with an industry partnership is reinvested into the University and supports additional research and infrastructure,” Gold says. This investment has clearly paid off, as Pitt has recruited some of the nation’s top scientists and has remained in the top 10 schools in the nation for National Institutes of Health funding for more than 10 years.

Curnan believes that this upward swing will continue into the next decade: “Our chemistry department is in the process of leapfrogging to the top with our new organic chemistry wing and $2 million NMR [nuclear magnetic resonance] facility that we use to characterize drug candidates. Faculty recruits are looking for three things in a university—a good name, high-quality faculty, and high-tech facilities—and we have all three. Good faculty attract good students, and funding typically follows.” Pitt’s remarkable success in the past 10 years should prove, without a doubt, that Curnan’s belief is true.
ADVANCING GLOBAL HEALTH

While dengue fever is not widely recognized in the United States, it is endemic in more than 100 countries. Caused by a mosquito-borne flavivirus, severe infections can lead to a serious illness called dengue hemorrhagic fever, which is often fatal—particularly in children—and can cause severe complications, such as brain or liver damage, seizure, or shock. CVR researcher Ernesto T.A. Marques Jr., a Pitt professor of infectious diseases and microbiology in the Graduate School of Public Health, travels to Brazil about three times a year to collect data from patients in the South American nation, which is the epicenter of dengue infection. By comparing clinical data with genetic data, he discovered genetic markers that indicate individual susceptibility to dengue infection. Such biomarkers are particularly useful in helping doctors to determine which dengue fever patients may develop serious illness and which may recover quickly.

Flynn’s imaging center is housed in CVR’s Regional Biocontainment Laboratory (RBL), one of 13 federally funded labs that study potential bioterrorism threats and develop vaccines and therapies for such diseases. RBL Associate Director Kelly Stefano Cole, a professor of immunology in the School of Medicine, notes that in the field of biodefense, vaccine development and drug discovery complement each other. “Of course, we need new vaccines, but if there was a bioterrorist attack and a pathogen was intentionally released, we would need quick access to large stockpiles of therapeutics to treat or blunt the effects of the illness,” Cole says. “Likewise, if a researcher is accidentally exposed to anthrax in the laboratory, we also need drugs to quickly treat that person.”

Burke affirms the commonality between vaccine development and drug discovery. “Both the CVR and DD are product-oriented centers—the ultimate in translational science. The ideas bubble up from the ground floor of the BST3 and float through the hallways of the various departments, maturing and evolving, until they get to us. Our job is to translate the science into interventions that will improve public and global health.”

CVR faculty believe that the events that transpired during the H1N1 pandemic demonstrated how unprepared our nation is for a major biological emergency. A vaccine was not made widely available to the public until months after the peak of the outbreak. Hope is that new-generation vaccines will greatly speed up the flu vaccine production process, lowering manufacturing costs and making vaccines more widely available much more quickly. So when or where will the next biological emergency occur? “No one knows for sure, but these CVR researchers will be on the front lines, ready to fight.”

First published in the Pitt Chronicle July 18, 2011
Western Pennsylvania sits atop one of the largest reserves of natural gas in the country. The nation’s oil industry was born here. The region’s vast coal deposits, which led to an industrial revolution that largely began here, continue to feed the region’s electricity needs. Companies such as Westinghouse Electric Company have ensured that nuclear energy research remains firmly entrenched in the Pittsburgh area. And the U.S. Department of Energy’s National Energy Technology Laboratory (NETL) resides squarely within the region.

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Gerald Holder, Brian Gleeson

“This region historically has been rich in energy research and development, and the University of Pittsburgh for years has supported that legacy with its top-quality faculty and research programs.”

GERALD HOLDER
U.S. STEEL DEAN, SWANSON SCHOOL OF ENGINEERING

“...have a robust collaboration of unique talent driving our efforts. We’re really bullish on energy.”

But Pitt researchers are not just researching new ways to harness energy or other high-profile alternative energy solutions, Vice Provost for Research George Klimzing says. Helping to bridge energy’s past and its long-term future, they are delving into challenges surrounding what he describes as some of the most important underpinnings of a successful energy sector. “I call it the guts of energy—what makes the sector work more efficiently and effectively,” Klimzing says of Pitt’s unique focus on energy research. “It’s what makes energy tick.”

The researchers’ tools comprise a unique combination of basic, experimental science and sophisticated computer modeling and simulation that, Holder says, are key to solving some of the world’s most vexing energy challenges.
Indeed, researchers at Pitt today are using that combination to:

• make coal into a more efficient and cleaner energy source and transform it into new synthetic fuels,

• develop power-plant technologies that would lead to minimal carbon dioxide emissions as well as novel methods to effectively reuse this greenhouse gas, and

• design high-temperature valve systems for turbines that generate electricity.

In addition, they’re using new polymers, nanoscale particles, and other advanced materials to capture, convert, and store energy as well as protect energy-related equipment from extreme conditions such as intense heat or ice.

Other innovators at Pitt are studying more efficient ways to integrate sources of electrical power and distribute it to consumers. One research group is inventing new technologies to capture ambient radio-frequency energy to recharge implantable medical device batteries. Still others are developing new computer modeling tools and methodologies to dramatically enhance energy research. And Pitt is helping to lead a national consortium of five universities, called the Regional University Alliance, in a wide range of basic and applied research in partnership with NETL.

The Center for Energy is dedicated to five key areas of research: energy delivery and reliability, carbon management and use, high-temperature and other advanced materials, energy efficiency, and unconventional gas resources. The center is positioned to be a national leader in these important areas of energy-related research.

The Center for Energy researchers are engaged in collaborative research that spans the energy disciplines. They are employing a variety of tools, including basic and experimental science as well as sophisticated computer modeling and simulation. Their goal is to understand and help to create the underpinnings of an effective and efficient energy sector.

PITT’S CENTER FOR ENERGY

Pitt’s Center for Energy, which was created in 2008 under an initiative led by the Office of the Provost, brings together this powerhouse of innovators and their diversity of research—from chemists and geologists to physicists, materials scientists, mechanical engineers, electrical engineers, and environmental engineers. The center is housed in the University’s Swanson School of Engineering.

The center’s director is Brian Gleeson, Harry S. Tack Chair and professor of materials engineering in Pitt’s Department of Mechanical Engineering and Materials Science. Associate directors are Laura Schafer, a professor of engineering in the Department of Mechanical Engineering and Materials Science, and Gregory Reed, a professor of electric power engineering in the Department of Electrical and Computer Engineering. These three top researchers manage their own research programs and provide leadership to the University’s overall energy endeavor.

The center’s goal is to better coordinate the University’s wide spectrum of in-depth energy research and facilitate innovative, multidisciplinary solutions to the world’s growing energy challenges.

“Energy really is the defining social, political, and economic problem of the 21st century,” Holder says in explaining why the University has put such a strong emphasis on energy research. “The University of Pittsburgh has a long history in the energy discipline and will continue to develop it as one of the leading initiatives in engineering. It’s a priority.”

The center also gives the University the ability to collectively and more systematically develop stronger and more collaborative partnerships—including education and research—with such companies as Westinghouse Electric Company, Eaton Corp., CONSOL Energy Inc., and other industry partners from Pittsburgh and beyond, according to Donald Shields, who serves as the center’s executive director. “We’re able to partner with them in both workforce development education programs and technical development, working to solve technical challenges,” Shields says. “One of the things we have an ability to do because of the scope of our collaborative energy research is leveraging the participation of these partners. It gives us bigger opportunities in competing for federal research funds.”

Today, the center’s 70-plus affiliated research faculty University-wide are striving to combine their diverse expertise to strengthen basic and applied research programs in primarily five key areas: energy delivery and reliability, carbon management and use, high-temperature and other advanced materials, energy efficiency, and unconventional gas resources. In the short term, the center also hopes to develop an infrastructure that effectively transforms the research into commercially successful products and processes.

In 2011, the R.K. Mellon Foundation gifted Pitt’s Center for Energy a $22 million endowment to enhance the energy research and development. “The majority of funds will be used to create four new faculty positions and 10 graduate fellowships and to establish a fund for spurring innovative research. The grant—which also will support research infrastructure and center operations—is designed to bolster the center’s position as a powerful leader in energy research.”

INTEGRATING POWER

The importance of developing a more efficient electrical power transmission and distribution system becomes clear as more sources of electrical power generation begin to contribute electricity for general consumer use. That’s where Reed and his research team at Pitt become an important part of the energy equation.

In fact, Gleeson, referring to Reed’s research, says that “reducing grid instability and integrating renewable energy into the grid are crucial for the future of energy.”

Gregory Reed

Reed has been working for several years to foster educational programs in engineering in partnership with companies such as Eaton Corp., ABB Inc., Siemens Energy, and Mitsubishi Electric, among others. Out of that effort, he says, has emerged a growing research program focusing on advanced power electronics-based transmission and distribution technologies that help to regulate the flow of electrical power throughout the power grid. Reed has more than 25 years of industry and academic experience in the electric power and energy arena. His research program, supported by at least six research faculty and more than a dozen full-time graduate students, targets several main areas. Among them are power electronics technologies for large-scale power delivery applications, including Flexible AC Transmission Systems, FACTS, High-Voltage DC Transmission Systems (HVDC); and Medium-Voltage DC Systems (MVDC). In addition, the group also is studying new energy storage systems, smart-grid technologies, energy efficiency, and power quality. The research is supported by grants from the U.S. Department of Energy, the U.S. Department of Commerce, Pennsylvania’s Ben Franklin Technology Development Authority, the National Science Foundation, and a number of industry partners.

“There are a lot of applications to explore based on renewable energy integration and grid infrastructure development,” Reed says. “As a result, we are one of the fastest-growing university programs in the country in this area at this time. Our potential for growth is tremendous, and the contributions that we are making are having an impact on technology developments for our industry partners and other constituents.”
Optimal operation of building systems and assessing hybrid new algorithms and sensors for what she describes as the hydrokinetics, and thermoacoustics. The energy systems she analyzes are absorption cycles, fuel energy systems from a fundamentals viewpoint and within diversification for increased sustainability. She examines with an emphasis on improving energy efficiency and the analysis, design, and optimization of energy systems, as well as hardware and software for running simulations. High-speed minisupercomputers and graphic systems as exhaust emissions.

A defining characteristic of the center is its accurate and comprehensive computer models of turbulent reacting flow and other efficiency targets.

Peyman Givi, meanwhile, has been focusing his research on turbulent combustion as part of an effort to increase fossil fuel efficiency and reduce pollution associated with exhaust emissions. Givi, William Kepler Whiteford Professor in the Department of Mechanical Engineering and Materials Science, conducts much of his research in the Swanson School’s Laboratory for Computational Transport Phenomena. The lab, which he oversees, boasts high-speed minisupercomputers and graphic systems as well as hardware and software for running simulations. Its state-of-the-art technology has allowed Givi to develop more accurate and comprehensive computer models of turbulent reacting flow and other efficiency targets.

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Another promising technology—and one that also has emerged from a direct research partnership with NETL—is a new fuel sensor technology developed by Joel Falk, a professor of electrical and computer engineering, and his research team. The sensor measures and controls the composition of gases going into and coming out of gas power plant turbines, allowing for maximum efficiency. The technology is in the process of being commercialized with an outside commercial partner.

Also tackling efficiency issues with gas turbines is Minkiu Chyu, the Leighton and Mary Orr Professor and chair of the Department of Mechanical Engineering and Materials Science. Chyu focuses primarily on thermal and material issues related to energy, power and propulsion systems, material processing, and micro/nanosystem technology. Recent research projects include convective cooling of gas turbine airfoils, nanofluid applications in heat transfer and oil and gas exploration, and thermal measurement and imaging techniques.

Jeff Vipperman, William “Buddy” Clark

Jeff Vipperman, William “Buddy” Clark, and research collaborator Jeff Vipperman, both professors of mechanical engineering and materials science, have a partnership with NETL that has helped to set the stage for a strong long-term relationship with the locally based federal energy lab. The pair was asked to develop a valve system for power plant gas turbines that would decrease emissions, control combustion instabilities, and provide fuel flexibility, allowing the turbines to burn conventional fuels such as methane as well as gases derived from coal, hydrogen, petrochemicals, cow manure, and other sources.

Clark and Vipperman’s research yielded a set of valves that could rapidly adjust fuel flow rate based on information obtained from a combustion sensor developed by NETL. Clark says. The research team now is working with Pitt’s Office of Technology Management, along with NETL, to commercialize the innovation.

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Jeff Vipperman, William “Buddy” Clark
The center is ideally situated to accomplish its mission, given the region’s abundant natural resources, the presence of leading energy companies, Pitt’s long-term relationship with NETL, and the experience of more than 70 faculty members from multiple disciplines University-wide.

Funding some of Meier and Gleeson’s research is the U.S. Office of Naval Research (ONR), which is interested in better aircraft and ship performance and is cognizant of the fact that a hotter turbine amounts to more thrust from an engine. But the research collaborators also contend that the same science can be applied to turbines in power plants to make them more efficient.

Gleeson and Meier also are working on a number of research projects to improve the performance of materials used at high temperatures and in other severe environments. These projects, funded by the U.S. Department of Energy, ONR, and other federal agencies and industry, focus on surface projects, funded by the high temperatures and in other severe environments.

Harnessing (More) Sun
In the University’s Department of Chemistry, other researchers are developing new materials to better harness the immense spectrum of sunlight by using the finest of particles. David Waldeck, a professor in and chair of the Dietrich School of Arts and Sciences Department of Chemistry, is exploring ways to provide a systematic and modular approach to creating a new generation of solar energy conversion devices using nanoparticle-based materials.

His research team, which includes researchers from Duke University and the Weizmann Institute of Science in Israel, is working to design, synthesize, and provide characterization of linked nanoparticle assemblies that will provide a charge separation “engine” in solar cells. The cells, in turn, then should be able to capture the entire available range of solar irradiance.

Back in the Swanson School, meanwhile, nanoscientist Hong-Koo Kim has developed a new method of light coupling in solar cells using nano-optic structures. His innovation, which is being characterized as a platform technology and referred to as “solar-nano,” has the potential to significantly increase the efficiency of solar cells in capturing photons and converting them to electrons via photovoltaic cells. Kim is the Bell of Pennsylvania/Bell Atlantic Professor in the Department of Electrical and Computer Engineering and codirector of Pitt’s Petersen Institute of NanoScience and Engineering. Kim has struck a research partnership with Pennsylvania-funded Innovation Works and its energy initiative to commercialize the technology.

“It would be a paradigm shift in how light is captured [in solar cells],” says Harold Swift, a licensing manager with Pitt’s Office of Technology Management (OTM), who is helping to facilitate the commercialization effort with Kim. “Hong-Koo Kim really is a pioneer in nanotechnology, particularly in the area of nano-optics.”

Mingui Sun, a professor of neurological surgery, bioengineering, and electrical engineering, likewise is targeting the sun, but with a novel wireless energy transmission technology that can transmit significant levels of energy, captured via solar panel systems, safely through walls (or roofs) and spaces without any direct wire cable connections. His innovation, Sun says, uses uniquely designed oscillating thin-film coils and resonators to convert electrical energy to magnetic energy over short distances to either electricity storage devices or directly to electrical devices.

The value proposition of the innovation, Sun contends, is that it alleviates the traditional need for complicated—and expensive—solar panel installation procedures that require, for example, holes in a rooftop through which to run wiring into a home. Sun also is working with OTM to commercialize his technology.

Unconventional Gas
Few could argue that the Marcellus Shale geologic formation spanning Pennsylvania and parts of Ohio, West Virginia, Maryland, and New York has proven a boon for the energy industry, particularly in Pennsylvania. It’s considered unconventional, of course, because of the nature of the deposits—and the way natural gas must be extracted, which includes deep and then horizontal drilling before pushing a pressurized water slurry into the hole to “fracture” the shale deposits and release the gas from the rock.

The process has provided many new opportunities for the use of natural gas and has created new jobs and even new industries in the region. But it also has created a gusher of new scientific challenges—which means lots of collaborative research opportunities for University researchers, who happen to sit in the heart of Marcellus drilling country. Perhaps one of the most pressing issues is the proper management of water used in the process, according to Radias Vadic, William Kepler Whiteford Professor and chair of Pitt’s Department of Civil and Environmental Engineering, who has added this issue to his portfolio of research endeavors. Horizontal drilling and multistage hydraulic fracturing require the use of millions of gallons of water mixed with other materials. Vadic is studying the resulting polluted water, including its movement before, during, and after the fracturing process.

Gleeson and others at Pitt currently are in the early stages of developing increased research focusing on unconventional gas, covering everything from flow-back water management and naturally occurring radioactive matter to health, safety, transportation, and even workforce development issues.

The Marcellus Shale geologic formation has created a gusher of new scientific challenges—which means lots of collaborative opportunities for University researchers.
CARBON CHALLENGES

Despite a national push toward new and renewable energy sources, coal and other fossil fuels still predominate when it comes to energy production. Thus, Pitt researchers also continue to study coal: its carbon properties, uses, byproducts, and environmental impact; and other related issues. Such coal research remains imperative, at least in the foreseeable future, because the nation’s plentiful coal reserves continue to fuel the generation of at least 50 percent of the nation’s electricity, according to the U.S. Department of Energy’s Information Administration. As such, Pitt faculty members, many supported by research partnerships with NETL and its fossil fuel research interests, are discovering better ways to burn coal, convert coal into cleaner-burning synthetic fuels, and build better turbines and fuel cells that would use those synthetic fuels. University researchers also are tackling such issues as how to reduce or eliminate the emission of carbon dioxide produced by power plants that burn coal and how to store, use, or reuse greenhouse gas rather than releasing it into the atmosphere.

Badie Morsi, a professor of chemical and petroleum engineering at Pitt, offers his own vision for coal’s future, saying it begins with developing much cleaner and energy-efficient coal-derived fuels. Morsi, who serves as director of the University’s petroleum engineering program, says he is applying 21st-century innovation to a technology that was first developed and used in the 1920s.

Morsi is working to improve the gasification process to work more effectively and cleanly with modern coal gasifiers. As he explains, today’s gasifiers use high pressure and temperature; add oxygen or steam to break down the coal into its original components; and then set off a chemical reaction that produces hydrogen, carbon monoxide, and carbon dioxide. The resulting hydrocarbons then can be used to produce diesel, gasoline, jet fuel, and lubricating oil, among others. Morsi’s current research focuses on designing and scaling up multiphase reactors, such as bubble columns, slurry bubble columns, high-pressure/temperature-stirred vessels, membrane reactors, and trickle-bed reactors. He also is conducting computer modeling and optimization tests on these chemical processes.

William Harbert, a professor of geophysics in Pitt’s Department of Geology and Planetary Science, believes that capturing carbon dioxide (CO₂) from power plants and safely sequestering it underground in the long term is possible. After all, oil recovery workers already pump CO₂ into reservoir rock made from compressed sand, forcing hydrocarbons out of the ground. The big question, he asks, is, “Is it staying there?”

The geophysicist and his research team are using 4-D seismic data to study such CO₂ sequestration sites before and after CO₂ is injected into the geological reservoirs—and then six months later, to see whether the CO₂ is staying there.
Mycobacterium tuberculosis, the rod-shaped bacterium that causes tuberculosis (TB), is carried by 2 billion people on the planet. It hides out in tiny, oxygen-deprived pockets deep inside the carrier’s lungs and can be transmitted by a sneeze.

The H1N1 virus is the latest in a series of influenzas that have mutated in pigs, birds, and people. Its 1918 predecessor killed more than 50 million people worldwide.

These diseases affect billions of people. They can thwart economic development, roll political systems, and dislodge whole societies. And in today’s increasingly global and mobile society, they can spread within hours.

To combat these and other diseases, a growing scientific field has emerged: global health. Once thought of as a cottage industry within medicine—the domain of a few daring medical missionaries and biomedical explorers—today the field is attracting the interests of epidemiologists, virologists, biostatisticians, and computer modelers.

“We’re much more interconnected, and the health challenges we face in this country can’t be separated anymore from the rest of the world,” says Helene Gayle, president and CEO of CARE, the global humanitarian nonprofit organization. “It’s not so much that we’re doing something to take care of these people and exotic diseases in faraway countries. We all have something to learn, and it’s in our own interest to focus on a more global way of looking at disease.”
GLOBAL HEALTH

PITT’S CENTER FOR GLOBAL HEALTH

The University of Pittsburgh, a national powerhouse in the health sciences, added its considerable weight to these efforts with the creation of the Center for Global Health. Developed with a grant from the University, the center was established to coordinate, support, and expand global health research at Pitt by bringing under one umbrella the institution’s many renowned scientists and medical researchers working in the global health arena.

This University-wide multidisciplinary center combines existing strengths in health and biomedical research with those in other disciplines by partnering with schools across the University. “Most global health problems are rooted in a combination of health, education, social, economic, political, and environmental factors and call for integrated, multidisciplinary approaches,” says Joanne Russell, director of the center. “We want the center to be a portal for academics across the University as well as a bridge between disciplines.”

“For an academic institution like Pitt to have a long-term impact, it must focus on the problem-solving aspects of worldwide health issues—with a central agenda on global research. From HIV and TB to mental health and the genetics of birth defects, the University’s robust research engine is helping to discover novel therapies, interventions, and diagnostic tools using a broad array of techniques.”

DONALD BURKE
ASSOCIATE VICE CHANCELLOR FOR GLOBAL HEALTH, GRADUATE SCHOOL OF PUBLIC HEALTH

In the health sciences, the Pitt schools that collaborate with the center include medicine, public health, nursing, pharmacy, dentistry, and health and rehabilitation sciences. In addition, there are existing collaborations with the School of Law, the Graduate School of Public and International Affairs, and the Dietrich School of Arts and Sciences as well as with the University Center for International Studies.

“The center is a catalyst for change,” says Donald S. Burke, associate vice chancellor for global health and LUPMC-Jonas Salk Professor of Global Health. Burke, who also is dean of Pitt’s Graduate School of Public Health and a veteran epidemiologist in the field of infectious disease, is the driving force behind the center. “The center is designed to foster action. We are not trying to be the problem solvers ourselves, but we help academic researchers get what they need to pursue some of these important health questions in international settings.”

HIV, TB, genetics, and maternal and child health are just some of the areas studied by Pitt’s global health researchers. The center helps Pitt—the number five-ranked biomedical research university in the country, as measured by total National Institutes of Health (NIH) grants received—to export its considerable bank of expertise by training researchers worldwide.

The center links graduate students with mentors and host sites around the world through which they pursue global health projects. This includes working in health clinics or providing primary care in the developing world. But Burke stresses that the ultimate focus of the center is research.

“A lot of the time when people think of global health, it’s from a missionary and humanitarian perspective,” Burke says. “It’s noble, it’s important, and it’s useful, but I think that we, as an academic institution, have as our job the definition and solution of problems, and to do that we need a research focus.”

Burke began his career as a medical officer with the U.S. Army, retiring with the rank of colonel. While researching infectious diseases with the Army, Burke helped to conduct pioneering trials in Thailand for a Japanese encephalitis vaccine. The trials proved the effectiveness of a drug that now protects 30,000–40,000 children from paralysis or death each year.

In 2006, Burke came from Johns Hopkins University to Pitt because “what I saw was a university that had an extraordinary potential to make a difference in people’s lives around the world,” he says. “I thought, ‘Here you’ve got this combination of outstanding people and growing expertise that could be brought to bear on some of the world’s biggest problems. This is a great place to help make important things happen.’ ”

GLOBAL PARTNERSHIPS: BREAKING AN ANTIOUATED CYCLE

Many of the developing world’s biggest problems are exacerbated by severe medical crises. High rates of HIV, TB, and malaria in sub-Saharan Africa, for example, contribute to the region’s toxic brew of poverty, political instability, and dislocation. These problems, in turn, worsen many countries’ ability to fight public health problems. Half of the deaths in the developing world are caused by infectious diseases, almost all of them either treatable or preventable.

“It’s a vicious cycle,” says David Heymann, a longtime World Health Organization (WHO) official and current chair of the British Health Protection Agency, the United Kingdom’s equivalent of the Centers for Disease Control and Prevention (CDC). “Only healthy people can help their countries move out of poverty, and when these countries move out of poverty, they contribute to global production and the world market.”

To climb out of poverty, developing nations must build the human capital necessary to monitor, treat, and prevent public health problems. This is an area where academics, like those in Pitt’s Center for Global Health, can have an impact. An example of building this kind of capacity can be seen in a Pitt-led project in Brazil. Lee Harrison, a professor of medicine, epidemiology, and infectious diseases and microbiology, has helped to train scores of Brazilian HIV researchers over the past two decades. Many of these researchers now receive CDC and NIH grants to conduct their work.

For Harrison, a senior investigator affiliated with the Center for Global Health, the project highlights the public health field’s progress. Decades ago, “parachute research” was the norm in the developing world: “Somebody from the United States or Europe parachutes in, does his or her research project, and leaves, and the country’s no better off than it was when he or she got there. That has totally changed.”

A partnership with a host institution, Harrison says, is a way to leave a lasting effect on the public health infrastructure of a country. One by one, the parachutes are being mothballed. Today, the Brazilian researchers trained through Pitt are testing new HIV vaccines and conducting studies to improve the delivery of anti-HIV medications in the developing world.

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The newly renovated St. Luke's Health Center in Beira already has provided primary care to more than 1,200 local residents since opening in June 2009. "In the beginning, the center saw only a few dozen patients a day," says McMahon. "Now there are between 75 and 100 patients a day. It is getting increasingly busier as the community learns about the center."

At St. Luke's, nurses, physician's assistants, medical students, and other health care workers receive hands-on mentored training, the backbone of Western-style medical education. It eventually will become a one-stop location for HIV patients.

"Medical staff see patients with diarrheal illnesses, parasitic infections, fever, pneumonia, HIV, TB, malaria, and chronic conditions like diabetes and high blood pressure," McMahon says. At least one Pitt faculty member is at the center every day to supervise training and care. "This hands-on training helps these health care workers on the front lines of primary care in Mozambique, where care is needed the most."

Countries like Mozambique have a tremendous need not only for trained caregivers but also for homegrown researchers who can identify and solve problems. Each country or region faces different problems—strains of HIV vary from country to country, for instance, and drugs developed in the United States may not work the same way in Mozambique. Exporting a therapy developed in one country to another may require adaptation.

Seeing an opportunity to take advantage of some intriguing synergies between Brazil and Mozambique, Harrison and other Pitt faculty members explored opportunities to begin a research training program in Beira. Pitt's Twinning Center in Beira offered a ready-made host site. In addition, both Brazil and Mozambique share a common language: Portuguese. Harrison is now planning "south-to-south" training that will allow Brazilian researchers to train their counterparts in Mozambique.

The program is funded by a $2.8 million grant from NIH's John E. Fogarty International Center for Advanced Study in the Health Sciences, which focuses on improving medical research in the developing world. With the grant, Pitt is developing a research training site in Mozambique and expanding programs already under way in Brazil and India.

Through its research, the Center for Global Health is making an impact at the highest levels of public health policy. Pitt researchers were at the forefront of helping to steer the U.S. government's response to the H1N1 virus as well as to other infectious diseases around the world. And as computer power has increased, modelers have been able to simulate how a broad range of variables might impact the outcome of a disease.

PROVIDING NEW TOOLS: RESEARCH COLLABORATION

While Harrison and others train physicians around the world in infectious disease research, another Pitt researcher and Center for Global Health scholar is training doctors to study another epidemic that is more difficult to detect. For the past 20 years, Vishwajit Nimgaonkar (below, far left), professor of psychiatry and human genetics, has been training researchers in India and Egypt in the genetics of psychiatric disorders.

VISHWAJIT NIMGAOINAKAR (SECOND FROM THE RIGHT)

Nimgaonkar says the research is badly needed: WHO reports that mental health disorders, like schizophrenia and bipolar disorder, are the third-leading cause of disability worldwide. About 1 percent of the world's adult population suffers from schizophrenia. Advances in computational biology and gene mapping now allow researchers like Nimgaonkar to plumb millions of DNA base pairs to look for genetic markers for mental health disorders.

These methods work best with a broad spectrum of genetic samples, so the team is collaborating with psychiatric researchers around the world to increase the pool of DNA being studied. In the process, team members are looking at whether environmental factors—nutrition, exposure to disease, and traumatic episodes—play a role in the development of psychiatric disorders.

Nimgaonkar-trained psychiatrists at India's University of Delhi are now conducting research of their own; one initiated an intriguing study of the effects of yoga on people with schizophrenia. "These researchers bring insights that we may not necessarily have, because they have different experiences and backgrounds," Nimgaonkar says. "Clinicians in these countries are likely to have more experience than we do because they see many more patients than we do. What they're lacking are the tools to do research, and they want to be researchers. They realize there is a benefit to doing research."

INFORMING POLICY: MODELING INFECTIONOUS DISEASE PATTERNS

In addition to providing education and training in many locations worldwide, the Center for Global Health is making an impact at the highest levels of public health policy through its research.

The Vaccine Modeling Initiative, a group of researchers based at Pitt, was at the forefront of helping to steer the U.S. government's response to the H1N1 virus as well as to other infectious diseases around the world. The project has commanded the attention of the world health community, and it has received a $10 million grant from the Bill & Melinda Gates Foundation, which funds projects dedicated to the eradication of infectious disease.

The initiative is headed by Burke, who began using computer modeling in the 1980s to predict the behavior of diseases. "Computer models allow us to test our theories in silico," Burke says. "For a number of reasons, you can't test these hypotheses in a live population."

Computers are useful, Burke says, because diseases behave according to a set of numbers—transmission rates, latency periods, and the length of time a carrier remains contagious. As computing power has increased, modelers have been able to simulate how a broad range of variables might impact the outcome of a disease. Population density, the distance people travel to work, and the speed at which a virus spreads can all be plugged into an algorithm.

WHO, CDC, and the U.S. Department of Homeland Security used Burke's simulations in 2004 to plan for a possible avian influenza outbreak. That same year, WHO arranged to keep 3 million vaccine doses on hand in Southeast Asia based on the model's calculation of the number of doses that would be needed to thwart an outbreak. "We basically built an artificial society of millions of persons based on census, transportation, and other demographic and sociological data," Burke says.

In 2009, the U.S. Department of Health and Human Services asked Pitt's modeling group to derive a model for the H1N1 virus, or "swine flu." Over the summer, the group began inputting new data on how the virus behaved in the Southern Hemisphere's flu season in Australia, New Zealand, and South America. At the time, Burke said that initial reports showed an excess of mortality rates in young adults, which "will help us determine where we should be putting our resources." The models do not tell policymakers what to do, Burke notes. Rather, they provide detailed information on the likely ramifications of the decisions they make.

The group also uses modeling to help simulate vaccine delivery in West Africa for a variety of diseases, including dengue fever and measles. "By modeling the vaccine supply chains of entire countries, we can help decision makers test how different strategies and changes may affect vaccine delivery and disease control," says Bruce Lee, Pitt assistant professor of medicine, epidemiology, and biomedical informatics. Working with WHO and host country health officials, the group incorporates all the variables necessary to get a vaccine to a clinic—right down to the number of doses in each package and the size of refrigerated storage space.

THE CENTRAL AGENDA: PUSHING THE BOUNDARIES IN RESEARCH

As Burke noted earlier, for an academic institution like Pitt to have a long-term impact, it must focus on the problem-solving aspects of worldwide health issues—with a central agenda on global research. From HIV to TB to the genetics of birth defects, the University's robust research engine is helping to discover novel therapies, interventions, and diagnostic tools using a broad array of techniques.
GLOBAL HEALTH

BRUCE LEE, DONALD BURKE

More and more, researchers are working in a global context, says Sharon Hillier, Pitt professor of obstetrics, gynecology, and reproductive sciences and of microbiology and molecular genetics. Hillier is head of the Microbiocide Trials Network, which is plotting a study of 5,000 women in five countries in sub-Saharan Africa to test the efficacy of topical microbicides and prophylactic use of antiretroviral drugs (ARVs) to prevent sexual transmission of HIV.

“The old idea was that when you worked in global health, you were really trying to develop and deliver medicines to populations that didn’t have enough doctors or enough medicine. Many people thought it wasn’t possible to do good clinical research in those settings because there wasn’t sufficient research infrastructure,” says Hillier. “What we’ve learned is that you can do outstanding clinical research with these populations in the developing world as well as for women living in wealthy countries like the United States. Many people are surprised to hear that the trials done in the developing world will help find ways to reduce the spread of HIV in American women, too.”

NO MIRACLE CURE FOR HIV

BRUCE LEE, DONALD BURKE

Hillier’s research comes at a time when perspectives on the HIV pandemic are shifting. An AIDS vaccine, once thought to be on the near horizon, is now considered to be many years away. And while ARVs have helped millions infected with HIV to live longer, they are not available to everyone who needs them. The pandemic continues to grow—33 million people worldwide, two-thirds of them in sub-Saharan Africa, are HIV positive—even as the public’s fear of the disease has ebbed.

“People like to embrace the notion that HIV transmission has leveled off and AIDS is more manageable,” says Hillier. “The problem is that when people become infected, they are infected for life, and there’s a huge health cost and personal burden for people who carry HIV. For every two people who begin treatment, four or five people are newly infected. Without new methods of prevention, we cannot gain ground against the epidemic.”

For proof of the epidemic’s staying power, Hillier points to South Africa, where several Microbiocide Trials Network sites are located. In the city of Durban, of the young women screened for the trials, between 35 and 40 percent test positive for HIV.

“When you meet people in South Africa, it’s very hard to find someone who doesn’t have a cousin, a brother, an aunt, or an uncle who’s been affected by AIDS,” she says.

Hillier’s is the first study of its kind to examine both a microbicide and an oral ARV pill in high-risk women. These prevention methods, if proven effective, could be particularly powerful in sub-Saharan Africa, where women make up 60 percent of the adult HIV population and, in many instances, have difficulty negotiating condom use with their partners.

“We’ve spent a lot of time thinking of ways to give women drugs to stop transmission from the HIV-infected mother to her baby. But how much better it would be to prevent moms from getting infected in the first place,” Hillier says. “That’s a much more powerful goal, I think.”

HOW NEW VIRUSES EMERGE: THE VIRUS HUNTER

Genetics: Tracking the Origins of a Birth Defect

Viruses are among the most abundant and successful species on earth. They also are responsible for much of human suffering: HIV, influenza, encephalitis, and a host of other deadly diseases are by-products of viral success. What makes viruses especially dangerous is their ability to mutate and “jump” from one species to the next. Severe acute respiratory syndrome (SARS), avian influenza, H1N1, and HIV have all entered the human population from other animal carriers. One Pitt researcher is traveling around the world to find out how new viruses are created and what specific mechanisms they use to jump carriers.

James Pipas, professor of biological sciences, is traveling to swamps and meadows looking for clues to virus mutation. He is testing a hypothesis that viruses can interchange large swaths of their DNA. Called recombination, these gene swaps could explain how viruses mutate and jump species. A virus carried by a zebra, for instance, could conceivably swap DNA with a rhinoceros-borne bug and equip itself to jump carriers. Pipas developed an algorithm based on factors like biodiversity and the prevalence of rare species to predict the most likely hot spots for gene recombination.

The first place the model told him to look was southern Siberia, an area covered with shallow marshes and endless expanses of tick-filled grassland. As ticks are notorious virus hosts, Pipas is now trying to organize the largest tick-collection in the world. “We think this type of genetic exchange could be contributing to emerging infectious diseases,” says Pipas. “We want to go to nature and look for this process.”

Pipas also has begun research on viruses in Borneo, Malawi, and Tibet. What he finds there could yield clues as to how new viruses emerge and why the diseases they cause continue to confound us.

GENETICS: TRACKING THE ORIGINS OF A BIRTH DEFECT

Cleft palate and cleft lip are among the most common birth defects in the world, and in developing countries, they can be deadly if not treated properly. Clearly, these are genetically based defects, but scientists are still uncertain about the exact mechanisms by which parents pass them along to their children. The defects occur in about one in 700 births.

“That’s a huge number,” says Mary Marazita, professor of oral biology, human genetics, and psychiatry. “In contrast, most birth defects affect about one in 5,000 or even one in 100,000 births.”

Marazita’s group has found other more subtle facial defects that could signify whether a parent has a greater risk of passing on cleft lip or palate to his or her child. She collaborates with researchers around the world, from big-city surgical wards in China to rural clinics in Patagonia, to compile as much genetic detail on clefts as possible. Assembling a wide variety of study participants from Europe, Asia, and the Americas is helping Marazita and her collaborators to track down the genetic clues to clefts.

“To gain a full understanding of the genetic and environmental factors that lead to clefts depends on getting to other parts of the globe,” Marazita says, “and it’s really bearing fruit for our research.”

“Facial defects are really hard on families,” explains Marazita. “There’s a lot of stigma around facial differences because humans are very attuned to faces. Anything to do with the face can have a big impact on your relationship with other people.”

The impact of these birth defects is particularly daunting in the developing world, where one in three newborns with a cleft palate doesn’t survive because it is extremely difficult for them to ingest food.

A series of surgeries can greatly reduce both the defect and the number of years of dental procedures and speech therapy. The average cost of caring for a child born with a cleft palate in the United States is between $100,000 and $200,000.

Excellence in Research
PROBING THE DEPTHS OF TB

Among the world’s most dangerous diseases, tuberculosis (TB) has been with us for a long, long time. The bones of Egyptian mummies showed signs of tubercular decay. In the 1940s, U.S. researchers discovered powerful antibiotics that controlled the disease in the Western world, but the emergence of HIV has made TB an ever-more deadly disease in less-developed countries. When HIV suppresses the immune system, an otherwise resistant TB carrier succumbs more easily. This double epidemic of HIV and TB is prevalent in the developing world, where 1.6 million people die annually from TB.

So, understanding TB’s molecular pathways is crucial in developing ways to slow this resilient disease. Among those at the forefront of the field is Johnanne Flynn, Pitt professor of microbiology and molecular genetics, medicine, and immunology.

Flynn says that the reason TB is such a resilient killer is that the bacterium that causes it, Mycobacterium tuberculosis, is uniquely designed to hide inside the body. “It’s evolved incredibly with humans,” says Flynn. “It’s been in people since we became people. What you have is a really successful pathogen. It has a lot of ways to survive.”

One way TB survives is by lying in wait. It lies dormant in about 95 percent of its carriers. Flynn and her collaborators discovered that the bacterium can survive within a cluster of immune cells called granulomas inside the body. “It’s evolved incredibly with humans,” says Flynn. “It’s been in people since we became people. What you have is a really successful pathogen. It has a lot of ways to survive.”

Thanks in part to the efforts of scientists at Pitt, global health is increasingly becoming centered on long-term collaborations between institutions with similar missions and goals. A new project supported by the Center for Global Health involves collaborative research with Wuhan University in Wuhan, China, one of Pittsburgh’s sister cities.

Flynn says that the Center for Global Health will help lab researchers like her by allowing for closer interaction with other researchers who deal with TB in the developing world, where rates are much higher than they are in the United States: “We can ask them, ‘What are you really seeing on the ground?’ We can get access to places where there are a lot more people with TB. It will also help us with our ultimate goal of putting on clinical trials in the field.” Ultimately, Flynn thinks, this research could lead to a cure.

PAYING THE WAY TO THE FUTURE

Many, many more Pitt faculty members than have been mentioned here are working in various facets of global health, from researching the root cause of illness, to training others to fight disease; to helping to guide policymakers in product development, public preparedness, and other policy matters. The University’s researchers are committed to fighting disease, improving the quality of life, and creating a healthier world.

Thanks in part to the efforts of scientists at Pitt, global health is increasingly becoming centered on long-term collaborations and partnerships between institutions with similar missions and goals. A new project supported by the Center for Global Health involves collaborative research with Wuhan University in Wuhan, China, one of Pittsburgh’s sister cities. Pitt faculty members are sharing their expertise as Wuhan works to address environmental issues, particularly air pollution. The goal of the project is to examine the relationship between various pollutants and hospitalizations for specific cardiovascular and respiratory diseases in Wuhan. The center also supports a collaboration with the University of Pittsburgh Medical Center (UPMC) International in Palermo, Italy, in which researchers are investigating ways to prevent liver transplant recipients from being reinfected with the Hepatitis C virus. Future partnerships also are expected to include joint programs with UPMC International in Ireland, the United Kingdom, and Qatar. In addition, the Center for Global Health expects to play a major role in creating leaders for a global society and was approved as a host institution (along with Pitt’s Graduate School of Public Health) for the Hubert H. Humphrey Fellowship Program.

If all of this sounds like a big challenge, Burke says, that’s because it is: “We need to bring every tool at our disposal to this job, because the job is too important, and these problems are too serious for us to take them lightly. We are entering a period where we are all learning to work together on these problems because we have to. That is the vision for this Center for Global Health.”

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The concept of a global, intricately networked consciousness is widely accepted in areas such as economics, political science, public health, and climatology. But a similar evolution also is taking place in a not-so-expected area: the humanities.

The University of Pittsburgh is at the forefront of exploring a new vision for the study and teaching of the humanities. It’s a vision that encompasses a global, multilayered perspective across time, place, and cultures.

With unprecedented advances in digital technology, social media, and global travel, the world stage is more accessible than ever—to everyone. A financial scandal in London, England, distresses international stock markets within minutes. The jailing of a Chinese dissident creates overnight global celebrity for the cause of human rights. An outbreak of bird flu in Vietnam’s Mekong Delta quickly generates anxiety in major cities worldwide. The melting of glaciers in Greenland boosts sea levels on faraway continents.

The Wonders of Human Exchange

In 1300, when The Travels of Marco Polo was written, by hand, by an Italian author, it was originally titled A Description of the World, recounting the adventures of Venice’s Marco Polo and his brothers in Asia, Persia, China, and Indonesia. When it first appeared, it became popular among those who could read and had access to the manuscript. Today, seven centuries later, it is referred to by Barnes & Noble as the “all-time worldwide bestseller” and is now available on digital e-readers like the Kindle and Nook.

A lot has changed, but essential human issues remain dynamic. Would those in the cultures visited by Marco Polo agree with the European perspective presented in The Travels of Marco Polo? How did politics and socioeconomic factors affect the lives of those he encountered? What was the status of women in these cultures? Was there violence, plague, the concept of human trafficking? Who was in power and who was excluded?
The humanities offer a lens through which to understand and grapple with the entire range of human experience as expressed through disciplines such as art and architecture, language, literature, cinema, music, and philosophy—and the ways they intersect with all of the other crosscurrents of human experience everywhere.

Those at the University of Pittsburgh who are engaged in an understanding of the humanities offer transformative answers about the nature and substance of our contemporary world, in part because the humanities offer a lens through which to understand human experience everywhere. The humanities offer a lens through which to understand and grapple with the entire range of human experience as expressed through disciplines such as art and architecture, language, literature, cinema, music, and philosophy—and the ways they intersect with all of the other crosscurrents of human experience everywhere.

GLOBAL STUDIES: EXPLODING HUMAN TERRAIN

The Global Studies Center at Pitt, led by the distinguished film and Russian culture scholar Nancy Condee, stimulates interdisciplinary, cross-cultural exchanges to foster and advance global competence among faculty, students, and the community at large. The center—a joint venture of the University Center for International Studies and the Graduate School of Public and International Affairs—brings together the University’s many international resources to enrich academic research, education, and scholarship around global themes. Pitt’s Global Studies Program is one of only 11 nationally recognized resource centers in international studies, as designated by the U.S. Department of Education.

NANCY CONDEE

Professor, Slavic Languages and Literature
Director, Global Studies Center

“THE HUMANITIES THRIVE ON AMBIGUITY, WHEREAS THE NATURAL AND THE SOCIAL SCIENCES OFTEN STRUGGLE TO CONSTRAIN AMBIGUITY. MUCH OF CULTURE IS PRECISELY WORTHY OF OUR ATTENTION BECAUSE IT’S AMBIGUOUS, BECAUSE IT MANAGES SOMEHOW TO STIR THE WATERS IN CREATIVE WAYS.”

NANCY CONDEE

Professor, Slavic Languages and Literature
Director, Global Studies Center

Unlike many such enterprises at other universities and institutions, Pitt’s Global Studies Center actively involves the humanities rather than principally the social sciences and other nonhumanities disciplines. Typically, says Condee, when people think of global studies, they think of economics, political science, international relations, and global health. But it’s rare, she notes, for a subject like the global circulation of culture to be anywhere near the top of that list, even though that’s rich scholarly terrain.

Condee, who is a professor and director of graduate studies in the Department of Slavic Languages and Literatures, is working through the Global Studies Center to forge a common language of scholarship that will be meaningful across disciplines, including those in the humanities.

“The humanities thrive on ambiguity,” says Condee, “whereas the natural and the social sciences often struggle to constrain ambiguity. Much of culture is precisely worthy of our attention because it’s ambiguous, because it manages somehow to stir the waters in creative ways.”

In her previous role as director of the Cultural Studies Program at Pitt, she routinely looked for ways to connect people without the typical boundaries set by academic specialization and depth of knowledge in a discipline—and this philosophy now extends to the Global Studies Center.

For instance, says Condee, a young social worker from one of the poorest political enclaves of the world—Lesotho—came to the University of Pittsburgh in fall 2012 on the Carl Maimberg Fellowship in Global Studies. The social worker, Lindive Scosananyana, spent a semester here engaged in a series of internships involving HIV/AIDS, geriatrics, migrant refugees, and troubled youth in partnership with Pittsburgh’s Jewish Healthcare Foundation.

As the 2012 Maimberg fellow, she also participated in public health courses and will engage with the Departments of English and Africana Studies through faculty who teach Swahili and the cultures of East Africa.


Another intriguing example of the Global Studies Center’s involvement with the humanities, education, and scholarship comes through the study abroad venture PittMAP, or Multi-region Academic Program. Each spring term, PittMAP offers a globally comparative and academically rigorous study abroad experience involving three countries, each on a different continent, with students taking courses taught by Pitt faculty. Each trip varies in theme and sites.

In 2010, the theme was “State Memory, Private Memory,” which looked at the way in which the state, or national government, remembers things differently from the way private citizens remember things, particularly in times of political crisis. In Buenos Aires, Argentina, how do state memories differ from the memories of family members who lost loved ones, “The Disappeared,” during the Dirty War of the regime’s brutal oppression and murder of citizens? In Cape Town, South Africa, how does the state’s understanding of apartheid differ from that of the citizens who were oppressed during its imposition? In Beijing, China, how has state memory and private memory diverged around issues of the Cultural Revolution or Tiananmen Square or the government’s human rights policies?”
During their PittMAP journey, the students and faculty together viewed films, read literature and poetry, and explored personal diaries, yet they also had to consider issues of political science, psychology, and economics. The students had to synthesize these ideas through cogent writing and discussions, just as would happen during any term of academic work.

“It’s an example of collegial collaboration that draws on our strengths, puts us in dialogue with each other, and includes a global dimension of contemporaneity that nevertheless demands of us historical depth,” says Condee. “It answers the quest for relevance in the humanities in a meaningful way.”

But, says Condee, integrating these ideas while traveling and living on three different continents is very different from learning them while sitting in a campus classroom in Pittsburgh. “What would a global configuration of my field be, or what are the global implications of the work that I do?” she asks. “You begin to speculate about such questions in ways that, for the younger generation, will stand them in good stead in 21st-century literacy about globalization.”

Tapping into this brainwave also is the point of a new series of 90-minute faculty gatherings hosted by the Global Studies Center on topics that have a global range for people in many different disciplines. One of the first such events focused on the African diaspora, for instance, on the continent and abroad. The book The African Diaspora: A History through Culture (Columbia University Press, 2009) deals with the great migration of African peoples out of the continent over time and how those movements have transplanted and influenced cultures worldwide. The issues raised through such study include enslavement, population movement; and a full range of issues in the African experience, both at home on the African continent and abroad. The book begins in the 16th century but also looks at parallels and interactions in the 17th, 19th, and 20th centuries. What influences the African diaspora had, for instance, on American culture through the contributions of African Americans?

“We look to build in a deep historical base through the World History Center that also allows us to value the work of the humanities differently,” says Condee. “Normally, global studies would be heavily ‘present tense.’ Our interaction with the World History Center produces a research environment in which the presentism in much of global studies interacts with a newly expanded humanities, beyond a localized history of literature or art or music.”

The synergistic work of the Global Studies Center, the World History Center, and the Humanities Center offers an expansive way of looking at global connections through time, using a contemporary lens. “That is very productive for us,” says Condee, “and makes us as different from global studies centers elsewhere in the United States. It’s a very good collaboration.”

**WORLD HISTORY CENTER: HERE, THERE, AND EVERYWHERE**

Pitt’s World History Center draws on the University’s long and celebrated tradition of international and interdisciplinary studies to address this era’s significant need for global historical analysis. The center—directed by Patrick Manning, Pitt’s Andrew W. Mellon Professor of History—encourages worldwide collaboration in analysis of the global past, also looking for patterns and themes that remain vitally relevant to the 21st century.

The discipline of history at Pitt falls into the category of social sciences. However, it’s clear that there are few boundaries here when it comes to examining the humanities in relation to history. Indeed, Manning is a historian with a focus on Africa, but his research inevitably leads to intersections with issues involving many disciplines. “I’m more a social scientist by training and inclination,” says Manning. “On the other hand, I’m a globalist, so I’m interested in connections among places and issues. I have no interest in losing connection with the humanities.”

**“I’M MORE A SOCIAL SCIENTIST BY TRAINING AND INCLINATION. ON THE OTHER HAND, I’M A GLOBALIST, SO I’M INTERESTED IN CONNECTIONS AMONG PLACES AND ISSUES. I HAVE NO INTEREST IN LOSING CONNECTION WITH THE HUMANITIES.”**

Patrick Manning, Professor, World History Center, Director, Pitt World History Center

“I tell stories about politics and political exclusion and civil rights and decolonization and so forth. What’s interesting to me is to be able to tell larger stories about this,” says Manning, whose stories include aspects of art, literature, and other humanities as well as encompassing regions such as the Middle East, North Africa, Europe, and India, where Black heritage carries on.

Last year, the World History Center cohosted, with several other Pittsburgh groups, the sixth International Conference of the Association for the Study of the Worldwide African Diaspora (ASWAD). The conference—titled African Liberation and Black Power: The Challenges of Diasporic Encounters across Time, Space, and Imagination—brought well-known scholars from a variety of disciplines to campus for discussion and collaborative exchange on this multilayered topic. Clearly, the humanities were a vital aspect of this cross-disciplinary conversation.

In addition, Manning is searching for ways to help graduate students feel more comfortable crossing disciplines. In his course Interdisciplinary Methodology, he brings together graduate students from different disciplines, including those in the humanities, to explore other scholars’ areas of interest. It’s a course that’s geared to help students move beyond their own specific academic terrain and begin to feel comfortable engaging with colleagues who have scholarly interests in many other fields.

Not surprisingly, the World History Center actively collaborates with those in the humanities, including Terry Smith in the history of art and architecture department; Jonathan Arac, who leads the University’s Humanities Center; and Condee, who leads the Global Studies Center.

“In global terms,” says Manning, “we’re talking now about big challenges involving governments, economics, society, even individual psychology. Shouldn’t we use the knowledge that we have about the global past to see whether there are some recurring patterns? Shouldn’t we look at the interplay among all of these different levels?”

One particular aspect of the World History Center’s work offers broad potential for innovation in these collaborations. The center’s World-Historical Dataverse Project is creating a global data resource—through collaborations with other universities internationally—that will offer consistent historical data for all regions of the world over the past several centuries, enabling global studies over time from any number of perspectives or disciplines.

“We’re trying to solve global problems,” says Manning, “and we need global information.” Largely, adds Manning, what’s typical and available right now is national information. Often, too, traditional data sets are confined within disciplines or very specific ranges of knowledge for depth, not breadth.
The Dataverse Project aims to mine large data sets, gathered internationally, as a means to find patterns and themes that are global in scale. One might suggest, says Manning, that it’s another way of revealing humanities’ connections to the world in ways that may not yet be obvious.

**HUMANITIES CENTER: INTRIGUING DIALOGUE, CREATIVE SCHOLARSHIP**

The reach of Pitt’s Humanities Center goes far beyond alliances with history. “We create a culture of active intellectual exchange across a range of different departments and disciplines,” says Jonathan Arac, Pitt’s Andrew W. Mellon Professor of English and founding director of the University’s Humanities Center. The center fosters advanced research in the humanities and cultivates collaborative study, programming, and teaching.

A key feature of the center is the award of fellowships to distinguished global scholars in the humanities from a broad range of disciplines. The fellowships spend time here, in residence, conducting research and sharing their insights through faculty seminars and, sometimes, teaching of graduate students. There’s a yearlong Early Career Fellowship, in which the center selects a fellow from a substantial number of capable applicants from around the nation and the world. There’s also a senior visiting fellow who typically arrives for one term and is someone very highly regarded for innovative research and scholarship.

“One of the things I can say with perfectly appropriate local pride is that when we bring these various distinguished scholars to Pittsburgh for the conversations we invite them to have with us, they’re really impressed,” says Arac.

Fellowships also are offered to Pitt faculty, allowing time for more intensive research and writing apart from teaching duties. In addition, the center provides grants aimed at fostering research projects that bring together faculty from different departments and institutions for collaborations that enrich campus intellectual activity and lead to specific scholarly results. Among the many other collaborative activities of the Humanities Center is a weekly faculty seminar each spring in which an exceptional scholar is invited to Pitt for a discussion of research that integrates thinking across disciplines.

Today, an implosion in one place may well have effects in many other parts of the world. But this also involves different perspectives and different ways of being in time at the same time, says Pitt’s Terry Smith. Contemporaneity is thinking about all of these things in terms of how they move and change through time. “These are the very large questions that artists and architects deal with,” he adds.

All of these currents of thought and scholarship are also reflected in the periodical boundary 2, an international journal of literature and culture edited by Pitt’s Paul Gove, who cultivates ties with the Humanities Center. An annual editorial meeting on campus brings together up to 30 scholars from 10 or more disciplines internationally. The most recent issue of boundary 2 offered a collection of documents from the 2011 Tunisian revolution, gathered and largely translated by Ronald Judy, who is fluent in Arabic, in Pitt’s English department.

“It has always been possible to have a conversation across disciplines at Pitt,” says Arac, “but the Humanities Center is a place designed to make that possible. It’s a place that invites people to come here, physically, and exchange ideas. And that is very crucial.”

**ART, ARCHITECTURE, AFTERMATH, ALL OF IT**

Terry Smith, a leading global thinker on art and culture, is well versed in ways of seeing. He is widely known for his innovative ideas about the world in which we live. He also is Pitt’s Andrew W. Mellon Professor of Contemporary Art History and Theory in the University’s Department of History of Art and Architecture. But Smith’s views of art history are not encased in the past. In fact, they live in the present yet encompass the future and the past. This reflects the fact that the study of art and architecture at Pitt has few limits or boundaries.

Works of art, says Smith, are full of visual information that connects to all sorts of other things. “They’re the most complex and reflective forms of visual information you’ll ever get,” Terry Smith says. The whole perspective is not just about the contemporary, but it has become much more global and much more to do with art from all over the world and how it connects with us all.

By the end of World War II, says Smith, many of the great value systems had either betrayed people and disillusioned them or had simply disappeared. Now, he says, the situation is even more complex because there is a sense of building an individual self but in the context of very large, competing narratives, ideologies, or sets of beliefs, many of which are incompatible with each other but all claim to be universal.

“Artists are constantly making art works about the nuances of these relationships,” he says.

And, sometimes, a shift occurs that’s far beyond nuance.

**Works of art are full of visual information that connects to all sorts of other things. “They’re the most complex and reflective forms of visual information you’ll ever get,” Terry Smith says. The whole perspective is not just about the contemporary, but it has become much more global and much more to do with art from all over the world and how it connects with us all.**

Among Smith’s many publications is the book The Architecture of Aftermath (University of Chicago Press, 2006), which was written in the wake of 9/11—a day that changed not only Smith’s worldview but also the perceptions of many others globally. “The imposition of the World Trade Center towers had a huge effect on my thinking,” says Smith. “Architecture itself evaporated. The implosion demonstrated that even the most enduring images from our collective identity can disappear instantly.”
Today, an implosion in one place may well have effects in many other parts of the world. But this also involves different perspectives, different ways of being in time at the same time. Contemporarily, says Smith, is thinking about all of these things in terms of how they move and change through time.

“These are the very large questions that artists and architects deal with,” says Smith. “You can’t just talk about artworks as things that are in museums or on the wall; or wall little objects over in the corner.” To fully understand art and architecture, says Smith, one must understand how it has agency, how it has energy and changes things, how it connects to contemporaneously through time, and how it relates to things like ritual behavior. “These are all qualities that art has had forever,” says Smith. “These are the reasons why art is important in the world.”

It’s not surprising, then, that Pitt’s Department of History of Art and Architecture is structured to encompass such big ideas, placing it at the forefront of contemporary art departments worldwide. The department is organized to ensure that faculty and graduate research occurs in a highly collaborative and interdisciplinary environment related to six overarching “constellations” as described on the department’s Web site: visual knowledge, agency, identity, mobility/exchange, contemporaneity, and environment. The development of this innovative approach was led by Professor Kirk Savage. As envisioned and implemented by the department, these constellations don’t replace the depth of specialized knowledge in individual disciplines but rather connect them in more imaginative ways. Through these connections, innovation is stimulated and new knowledge is discovered.

According to Smith, most art history departments are committed to teaching the history of artifacts as they become works of art, from the most ancient time to the present, in as much of the world as possible. But, says Smith, if art has any of the qualities suggested in the department’s six constellations, it’s no longer adequate to do things only this way.

The study of art and architecture, says Smith, ought to reflect a rich sense of history and change through time and a deep sense of what art can do. It should, he says, “take on those qualities that art and art history have and then connect them with all of the qualities of the present and the ways in which art and film and visual imagination are profoundly relevant to the world in which we live.”

MOVING IMAGES

As a graduate student at Columbia University, with an undergraduate degree in literature from the City University of New York, Lucy Fischer was increasingly drawn to the visual image during the heyday of the New Wave film movement. She was reading widely but also was enthralled by the films of Jean-Luc Godard, Francois Truffaut, and many other directors working beyond U.S. shores. She spent hundreds of hours watching moving images in the dark of Manhattan cinema theaters and many more hours discussing film with friends and colleagues. Eventually, after teaching at a New York City high school, she turned her passion for film viewing into a career as a film scholar, beginning with a doctoral degree in cinema studies from New York University.

PITT IS UNRIVALED IN ITS GLOBAL CINEMATIC REACH, WITH FACULTY WHO HAVE IMMERSED THEMSELVES IN THE FILM CULTURES OF MANY COUNTRIES AND RELIGIONS: MEXICO AND LATIN AMERICA, BRAZIL, GREAT BRITAIN, IRELAND, AUSTRALIA, NEW ZEALAND, RUSSIA, SPAIN, FRANCE, ITALY, GERMANY, CHINA, JAPAN, INDIA, AND MUCH OF AFRICA.

Today, as Distinguished Professor of English and Film at Pitt, Fischer guides graduate students through a maze of issues related to film history, theory, and criticism. She also works to bring the complexly varied perspectives of films into the lives of undergraduates, graduate students, and the Pittsburgh community.

“Film can be extremely useful in making cultural issues more concrete,” says Fischer. And it’s particularly valuable, she adds, for making such points in the short term versus long-term study. A film, for instance, can vividly express human experiences involving poverty, migration, social injustice, loneliness, and the quest for self.

At Pitt, those issues are inextricably intertwined with global issues, just as cinema—arguably the first global modern art—has been since its beginnings in 1895, when the Lumière brothers projected the first moving images for a paying audience in Paris. One year later, the film had been projected in many countries around the world.

Now, in an environment where many film studies programs look primarily at Hollywood, the University of Pittsburgh is a premier university for research and teaching across the range of cinema, experimental to popular, and in original languages. In fact, a course in world cinema for Pitt undergraduates who specialize in film studies has been a required course since 1980, and in 2011, Pitt instituted a formal PhD degree in film studies with a strong international focus.

Pitt is unrivaled in its global cinematic reach, with faculty who have immersed themselves in the film cultures of many countries and religions: Mexico and Latin America, Brazil, Great Britain, Ireland, Australia, New Zealand, Russia, Spain, France, Italy, Germany, China, Japan, India, and much of Africa.

“The global theme is a continuation of what has long been an international focus of the University and of film studies here,” says Fischer, who emphasizes the highly interdisciplinary expertise of film studies faculty. “The extent of our international global profile is unusual,” she says. Faculty aren’t appointed to the Film Studies Program at Pitt but rather to individual departments within the humanities. This, however, enables the Film Studies Program to draw upon a particularly rich range of cultural knowledge and scholarship in film.

“In terms of global connections,” says Fischer, “these faculty are fluent in the languages of their disciplines, and most of them have spent time living in the cultures in which they’ve been hired to teach the language, cinema, or literature.” Drawing from this milieu of experts, the Film Studies Program offers a number of courses that develop an understanding of human experience from multiple global perspectives.

Each year, Pitt’s International Film Series draws students, faculty, and the public together with local ethnic communities to digest and discuss a variety of films from diverse nations, regions, and points of view. Often, the films raise transnational issues involving migration, human trafficking, discrimination, sexual identity, and cultural conflict. There’s a separate Russian Film Symposium and an Israeli film festival each year as well. And sometimes graduate seminars are run in conjunction with a film series.

In 2010, the Film Studies Program sponsored an international conference titled Film and the End of Empire, organized by Pitt’s Colin MacCabe, Distinguished Professor of English and Film. This drew to campus scholars who not only studied British film but also Indian, African, and Sri Lankan film from any of those places that were once part of the British Empire. MacCabe, a former head of research and education at the British Film Institute, has recently been involved in a huge project to annotate, catalog, and digitize more than 6,000 films around the theme “Colonial Film: Moving Images of the British Empire.” The completed archival project includes an Internet portal and online catalog, accessible widely to a global academic community (www.colonialfilm.org.uk).
While a focus on international film has always been the case at the University of Pittsburgh, study and discussion in recent decades has been influenced by the larger trends of postcolonialism, multiculturalism, race studies, and the inclusion of emerging nations and regions, not primarily developed nations. All of this, of course, has been influenced by the pervasiveness of new technologies, especially the World Wide Web.

“Different technological devices suddenly make the world smaller, right?” says Fischer. She cites the evolution of new media from VHS to DVD to On Demand digital viewing on TVs, computers, and smartphones. Now, Bollywood films are available everywhere. Now, people can go to Ebay France and purchase a French film that hasn’t been distributed in the United States. Now, there are tribute sites on YouTube to little-known cult actresses. “How can we be unaware of these influences?” asks Fischer, who is the author of nine books and many other publications about film. “We can’t be unaware.”

Fischer, who travels frequently to lecture internationally, also is involved in a venture to expand opportunities for Pitt students studying abroad in London, England, where she is working to augment the academic film studies component and establish more internships in the film industry. A lot of students who have higher aspirations feel that it’s a plus on their résumés and as job applicants to have experience with other cultures, she notes.

Pitt’s Film Studies Program is offering that opportunity not only on campus but also beyond. Like most other humanities disciplines here, the program has links to various other University centers that stimulate thought, discussion, and research about human experience and exchange through time.

One upcoming project in progress, still in its infancy, is the Global Cinema Project in collaboration with Pitt’s Global Studies Center. The venture will bring together the annual film programming of several different international communities in Pittsburgh and support and promote them as they occur throughout the year. The project may also approach organizations like Amnesty International or groups like the gay lesbian bisexual transgender (GLBT) community to participate in wider discussions that examine global themes. It’s another way for film studies, as part of the humanities, to express its many connections and intersections with the world at large.

MUSIC: AN EXPRESSION OF CULTURE

It’s like the opening of a door, says Professor Andrew Weintraub about how his undergraduate students respond to a fuller understanding of music. He is an ethnomusicologist, a humanities scholar who uses the tools of social science to understand the nature and cultures of music.

As an undergraduate student, he became intrigued by Indonesian gamelan music, which originated on the island of Java. The music blends the sounds of gongs, chimes, xylophone, and drums in what has been described as haunting, chant-like melodies. “I wanted to know a lot about music, and it was my own curiosity that drove my explorations,” says Weintraub. He was so intrigued that, as a college student majoring in music, he visited Indonesia for the first time and fell in love with the archipelago nation, which encompasses more than 300 distinct ethnic groups and about 700 distinct languages. Since then, he has lived and studied in Indonesia for more than six years, becoming a well-known scholar of the region’s music and cultures.

Andrew Weintraub

In addition to gamelan, his research interests include Sundanese performing arts, Wayang puppetry, the music of Southeast Asia, popular music across cultures, and music and cultural theory. Currently, he is involved in explorations of the social relationships of power and music, music and the formation of nation-states, and gender and popular music.

Ethnomusicologists like Weintraub and other music faculty conduct fieldwork. They immerse themselves in other cultures, they participate, they observe, they interview the people involved, they analyze and write about their experiences. It doesn’t only involve music on the page or in performance; it also involves the exploration of literature, theater, art, history, anthropology, political science, sociology, and psychology.

Weintraub, a Pitt professor of music and acting chair of the music department, shares his profound understanding of music and culture with both undergraduate and graduate students. He even directs the Gamelan Ensemble, in which students from across the University learn and perform traditional gamelan music. Part of the educational experience is that students must imagine and empathize with a Sundanese musician from Indonesia. “They have to take off their shoes and, play the music, and they have to move their bodies in a different way. It’s all about embodying a different culture,” says Weintraub.

University of Pittsburgh

Underlying the whole process, he explains, is the concept that students should be involved in thinking about the world not just as musicians or composers or scholars but as human beings. “They should be aware of the world, and what’s going on, and their place in the world, and music helps teach us that,” says Weintraub.

Pitt’s Department of Music focuses on four areas: ethnomusicology, historical musicology, jazz studies, and composition and theory. Students at both the undergraduate and graduate levels get exposure to all of these areas. And, in addition to the more traditional opportunities to study and perform music—in the University Orchestra or various choral groups—students also may become involved in ensembles, like the University’s Gamelan and Pitt Jazz ensembles. The Department of Music at Pitt also offers courses in which students learn to play and perform the music of Africa and Eastern Europe.

One of Weintraub’s recent books, for example, explored the popular culture of Islam—TV shows and other media, fashion and style, music, and more. In essence, in Islam and Popular Culture in Indonesia and Malaysia (Routledge, 2011), he examined aspects of what it means to be a Muslim today in the contemporary world. In his most recent work, he grappled with music and cultural rights—how music becomes caught up in debates about human rights and social justice. In the age of the internet and the ease of digital reproduction, he’s also interested in the global problem of piracy of music, something that involves the links between politics, economics, and culture.
All of these issues illuminate the ways in which the study of music at Pitt extends far beyond traditional vaxes of music scholarship, instead requiring a familiarity with many forms of knowledge and exchange globally.

"Ideally, students will see these opportunities and be able to synthesize and interpret the information that they have access to, and we can teach them how to do that," says Weintraub. "We can teach them different ways of seeing things." That's true in music, he adds, but it's also true in areas such as literature, art, and philosophy. "We can provide the context to think about and understand the global connections and influences reflected in humanistic ideas, beliefs, values, and practices."

A UNIVERSITY IS A PLACE WHERE PEOPLE THINK ABOUT THE MOST DIFFICULT QUESTIONS THAT HUMANS FACE AND SEEK SOLUTIONS, WHICH ARE MOST LIKELY TO COME FROM THE HUMAN IMPULSE TO SHARE AND EXCHANGE. THE HUMANITIES AT PIT are vital in that journey.

CREATING GLOBAL CITIZEN-SCHOLARS

"In my classes, I’m seeing a movement toward students who are thinking more about becoming global citizens," says Todd Reeser, a professor of French studies at Pitt. "They want to take courses that reflect the notion of what it is to think about their particular discipline in dialogue with the globe."

As the inaugural associate director of the Humanities Center, Reeser also is aware of a general movement, intellectually, toward the breakdown of disciplines. "As a scholar and teacher, you can no longer just think about French studies or French literature without putting it into dialogue with a whole bunch of other contexts from around the world and, therefore, with all kinds of other disciplines."

This past spring, Reeser was involved—along with Arc, Manning, and Conde—in organizing an experimental gathering of faculty to consider new ways of thinking about global study. In a one-day seminar titled Naming the World: Global History, Global History, Global Literature, Pedagogy, Pitt faculty brought together by the Humanities Center, World History Center, and Global Studies Center grappled with similarities and differences in their approaches to global scholarship and teaching. Where are the intersections of themes over time, setting, and human narratives?

Literature scholars offered perspectives on history readings, and history scholars analyzed literature readings, all spanning global studies. As the day lengthened and the discussions continued, more and more faculty found common ground and significant intersections for future dialogue.

For instance, says Reeser, in his own field of French studies, what would happen if dialogues arose where France wasn’t even involved—say, instead, between the cultures of French Indochina and West Africa—and what issues of human experience would that raise, such as migration? And how are those things experienced, written about, thought about, put on film?

CULTURAL SCHOLARSHIP, NOT COLONIZATION

Or, in the field of translation studies, how does one deal with the notion of the "untranslatable," concepts that simply cannot be translated from one culture to another and therefore are objects worthy of study for that very reason?

These kinds of questions reveal rich new terrain for exploring complex aspects of the human experience—and the questions are endless. A major goal of the seminar was to foster more such discussion and, ideally, stimulate faculty to begin organizing new research clusters on their own, which might then be supported by the efforts of the three Pitt centers and, potentially, by external funding sources. Such clusters might involve themes that have intriguing possibilities for wide-ranging study within a global framework, such as gender and sexuality.

Todd Reeser

Another aspect of the seminar, given the discussion about global thinking in research, was: What are the implications in the classroom? How might specific courses be given a global perspective, and what are some of the techniques that could be used to impart that approach into other humanities classes and beyond?

As it happens, Sharon Kinochita, the Humanities Center senior fellow in spring 2011, offered an example from her own teaching experience at the University of California, Santa Cruz. She had her students read segments of narrative from The Travels of Marco Polo and then compare them with texts written within the cultures Marco Polo visited by people living in those cultures. Systematically, the point was to compare what Marco Polo was perceiving about his experience in culture X versus what people from culture X were saying about their own experiences there.

There are all kinds of ways to focus on themes that transcend time and place and culture. Those who study the Middle Ages, the Renaissance, the Enlightenment, colonization, or the relation of gender to sexuality can all find valuable intersections that have the potential for discovery of new knowledge.

A university is a place where people think about the most difficult questions that humans face and seek solutions, which are most likely to come from the human impulse to share and exchange. The humanities at the University of Pittsburgh are vital in that journey.

First published in the Pitt Chronicle September 24, 2012
In the Indian Himalayas, where earthquakes wreak havoc on concrete and masonry buildings, Pitt engineering students ally themselves with students from the Indian Institute of Technology in Kanpur to promote building with bamboo, which is well suited for the environmentally sensitive region, even as they develop comprehensive building standards for the use of bamboo in Himalayan structures.

In the United States, amid concern surrounding the global spread of the H1N1 influenza, health officials call upon Pitt’s Graduate School of Public Health (GSPH) to assemble a team of experts to perform computer modeling and simulation of epidemic control strategies.

In sub-Saharan Africa, where the spread of HIV lingers as a public health crisis stunning in its scope, Pitt professor Sharon Hillier leads a study to test the effectiveness of topical microbicides and antiretroviral drugs in stopping the spread of the virus.

An established leader in international education and research, Pitt recognized more than a half century ago that an American academic institution of merit cannot isolate itself from issues and opportunities that arise beyond U.S. borders and set in motion a strategy that over time made the University one of the most highly regarded in international and global research and education.

With the world drawing ever closer—infecious diseases moving like lightning from an isolated outbreak to a pandemic, sovereign debt crises roiling international markets, and remote bands of extremists disrupting international travel—Pitt has long understood the need for its students to have a mature awareness of the world in which they live and for all to realize that gifted faculty members have the expertise to help solve complex global problems.
Because a well-educated student should be prepared to function in an increasingly integrated world, we want every student receiving a Pitt diploma to be sophisticated in international issues,” says Provost and Senior Vice Chancellor Patricia A. Beeson. “We also want our faculty to be highly qualified to educate our students on those issues, and we encourage and support them to pursue research questions that involve other parts of the world.

To those ends, Pitt embeds global and international research and education within its disciplines, schools, and departments—and ensures that those initiatives are adequately supported—so that today, an international research component is found in nearly every department and school, from anthropology, history, medicine, and public health to engineering, law, and business. (Image: Antioch Café)

Pitt’s International Coordination Council—comprising the leadership of Pitt’s schools and other academic units—developed a University-wide plan to guide global and international initiatives across Pitt’s campuses, ensuring that such initiatives are today inextricably woven into the fabric of the University and lie near the core of its mission. The key network for these endeavors is provided by the University Center for International Studies (UCIS), which focuses on specific fields of study or regions of the world and offers operational support.

Each year, UCIS helps hundreds of faculty members and students across a wide spectrum of disciplines to conduct field research abroad; leverages the support that allows a growing number of students to study in foreign lands; and provides resources that enable professors to bring the world to the Pitt campus through specialized courses, visiting professorships, seminars, conferences, and exhibitions.

Created in 1968 in recognition of the growing importance of applying faculty expertise to the fluid and complex issues beyond U.S. borders, UCIS has emerged as a leader in advancing international research and education programs in the arts, sciences, humanities, and professions, with an emphasis on multidisciplinary collaboration.

“UCIS is designed to pull people together to work on common questions,” says UCIS Director Lawrence Feick. “It is intrinsically multidisciplinary and driven by a set of global, regional, and thematic foCs.”

At UCIS’ core are four centers renowned for their expertise in regional studies: the Asian Studies Center, Center for Latin American Studies, Center for Russian and East European Studies, and European Studies Center. Each ranks among the elite in its area of study, having in the past earned designation as a National Resource Center (NRC) by the U.S. Department of Education. This year, UCIS’ Global Studies Center was designated an NRC for the first time, and two other centers were redesignated. UCIS also is home to a European Union Center of Excellence (EUCE), one of only 11 such institutions in the United States funded by the European Union.

The mission of UCIS is to integrate and support international scholarship, including research and teaching, in addition to public service. Comprehensive in scope, UCIS’ reach extends to schools and other jointly sponsored and affiliated units across campus, it coordinates international education curricula and provides a home to support such services as Pitt’s study abroad program. Many other U.S. research universities have since adopted this design, which was unique when UCIS opened its doors more than four decades ago.

UCIS does not have its own faculty; it has faculty affiliates from across the University, connecting more than 600 members with opportunities to advance their work in international scholarship. It awards academic certificates to students who successfully complete specialized courses of international study while pursuing degrees from schools across the University.

From 2005 to 2009, the number of undergraduate and graduate students earning certificates increased by nearly 60 percent, reflecting both the steady rise in student interest in international studies as well as the heightened emphasis within the University on providing such international opportunities. UCIS’ organizational structure has helped to create highly developed international areas of expertise; an intellectual environment that attracts top talent; and educational resources that, in many cases, are second to none.

The majority of the faculty affiliated with UCIS and its international centers of study are from the Dietrich School of Arts and Sciences, including the directors of the four regional studies centers. Many are distinguished professors who are leading experts on international and global economics, history, art, architecture, music, literature, and the sciences, among other disciplines. When, for instance, the University of Oxford wanted a comprehensive history of Afro-Latin America, the distinguished British academic institution turned to George Reid Andrews, Pitt Distinguished Professor of History, who not only is an expert in Afro-Latin American history but also is fluent in Spanish and Portuguese.

Many Dietrich School faculty members are leaders in international and global research, including, for example, Distinguished Professor of Archaeology Robert D. Drennan, a member of the National Academy of Sciences who has focused on the origins and development of complex societies in northern South America, Mesoamerica, and China; Andrew W. Mellon Professor of Contemporary Art History and Theory Terry Smith, who is investigating the contextual influences on the creation, analysis, and viewing of art across the world; and Distinguished University Professor of History Evelyn Rawski, whose research has included the examination of the historical evolution of a northeast Asian tradition of political and social organization that affected politics in ancient and premodern Korea and Japan as well as several dynasties in early China. European studies students benefit from such renowned faculty as EUCE Director Alberta Sbragia, the Mark A. Nordenberg University Chair and Jean Monnet Chair ad personam, whose expertise includes European integration, public policy, transatlantic economic relations, and comparative European-American politics. Sbragia also is the vice provost for graduate studies.
The Joseph M. Katz Graduate School of Business founded its International Business Center (IBC) more than two decades ago as a joint venture with UCIS to build international competence among business students, faculty, and practitioners. It was one of the first such centers funded by the U.S. Department of Education. In the years since, IBC has fostered the ongoing development of the business school’s global character. The Katz School, for example, operates executive MBA programs in major cities in three far-flung countries—Pittsburgh in the United States, Prague in the Czech Republic, and São Paulo in Brazil—and is considering opening another one in Asia. Such resources not only deepen the school’s international education offerings but also provide faculty researchers with contacts, collaborators, and case studies.

IBC fosters research by helping to fund, for instance, a study on the role of human networks in bringing about industry globalization. Coauthored by Pavi Madhavan, Pitt associate professor of business administration, the study shows that the rate at which U.S. venture capital is invested in start-ups in other countries is predicted by the rate of professional emigration from those countries to the United States, with a time lag of several years. A newer research initiative, the Business of Humanity Project, led by John Camillus, the Donald R. Beal Professor of Strategic Management in the Katz School, and Bipaya Bidanda, Ernest E. Roth Professor and chair of the Department of Industrial Engineering in the Swanson School of Engineering, examines the idea that companies benefit economically when they effectively address such issues as quality, safety, diversity, social sustainability, and environmental impact, especially in developing nations.

Like the business school, other schools across the University recognize that the realities of a shrinking world mean that, for them to remain vibrant, they must continually strengthen their international character.

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The School of Law, for example, offers the International and Comparative Law Certificate Program, which gives students a foundation in the application of legal regimes to transnational and international relationships. In addition to hosting international conferences and lecturers, the Center for International Legal Education (CILE) provides opportunities in the study of foreign, comparative, and international law, including courses taught by Pitt faculty and visiting foreign law professors. Perhaps most important is the depth of expertise, scholarship, and experience in international legal issues and environments that is found within Pitt’s law school faculty, as exemplified by CILE director and law professor Ronald Brand, who represented the United States at special commissions and the Diplomatic Conference of the Hague Conference on Private International Law that produced the 2005 Convention on Choice of Court Agreement.

International research and education opportunities are key features of the Mascaro Center for Sustainable Innovation in the Swanson School. This center of excellence was established in 2003 to provide research, education, and outreach initiatives with the intention of inspiring innovations that lead to a more sustainable community infrastructure. The Mascaro Center has developed a number of international experiences for undergraduate and graduate engineering students with the understanding that today’s practicing engineers must work effectively on multinational teams and within cultures and nations other than their own. One such experience is an ongoing project in India in which Pitt students work with a team of students from the Indian Institute of Technology in Kanpur in the steep, earthquake- and flood-prone mountains of Sikim and Darjeeling. They are trying to return to popularity the traditional bamboo-frame structure known as the kwa, replacing the more favored building material of reinforced concrete, considered by many as more modern and of higher status. Although bamboo is native to the region; affordable; largely resistant to earthquakes; and gentle on the steep, loose-soil hillsides, it suffers from an image problem in a region where people associate it with the poor. Under the direction of Pitt’s William Kerper Whittledom Faculty Fellow Kent Harris, the students hope to overcome such skepticism by demonstrating bamboo’s value as a sustainable and cost-effective option by working with a local sustainable engineering and design organization.

On the University’s campus, the number of visiting scholars and international graduate and postdoctoral students attending Pitt programs increases yearly. The global reach of the School of Medicine, for example, extends to every continent but Antarctica. Each year, the medical school attracts hundreds of postdoctoral scholars, graduate students in biomedical science, and visiting scholars from more than 80 nations, among them Canada, China, France, Germany, India, Italy, Japan, South Korea, Lebanon, Peru, the Netherlands, the Philippines, Poland, Russia, Spain, Turkey, and the United Kingdom. In 2009 alone, about 58 percent of the postdocs studying in the School of Medicine were from countries outside the United States. Drawn to Pitt by the breadth and depth of the expertise of Pitt scientists and physicians and the leading research facilities found within the School of Medicine, the University of Pittsburgh Medical Center (UPMC),

"We have extensive resources and opportunities here that are attractive to someone who is competitive and interested in being a leading scientist," says Steven Kanter, vice dean of Pitt’s School of Medicine. "The bonds that are made here at the University are lasting. There are research collaborations that develop, for example, and when medical school graduates go back to their homelands, they take a little bit of the University of Pittsburgh with them. In a sense, that means the University exists all over the world."
Global security, a high priority in the United States and throughout the world, is an area of study in which GSPAs is particularly strong. More than a decade before the September 11, 2001, terrorist attacks in the United States, Pitt opened the Matthew B. Ridgway Center for International Security Studies to educate the next generation of security analysts, conduct research, and provide impartial analysis to help policymakers make more informed decisions when confronted with complex international security challenges.

Ridgway Center Director Phil Williams is a widely recognized authority on transnational organized crime and terrorism and financial cybercrime. His recent research focuses on alliances between criminal organizations and on terrorist finances, drugs, and violence in Mexico. Williams formerly worked at the Strategic Studies Institute at the U.S. Army War College, with which Pitt is now expanding its long-standing ties in an effort to develop a program of faculty and student exchanges and other cooperative ventures.

GSPAs Ford Institute for Human Security conducts research on such issues as the causes of violent conflict; displaced populations; and the challenges of rebuilding political, social, legal, and economic institutions in the aftermath of violence. The work of the institute is based on the idea that national security and the security of a nation’s citizens are mutually reinforcing—that governments face their greatest challenges when the lives and livelihoods of their people are threatened from inside or outside the country.

A GLOBAL VISION IN PUBLIC HEALTH

In 2010, Donald Burke coauthored a commentary published in The Lancet, and the title alone—“Global Health Is Public Health”—explains why Pitt’s Graduate School of Public Health (GSPH) is moving more deliberately than ever to extend its reach beyond the United States.

“When you talk about public health, it’s about issues of population, disease prevention, sanitation, environmental health, aging, and population. All of the public health issues in the United States are played out in the world with the same kinds of problems,” says Burke. GSPH dean, UPMC-Jonas Salk Chair in Global Health, and Pitt’s associate vice chancellor for global health.

GSPH leadership has long recognized the importance of public health in a global context. The school’s first dean, Thomas Parran, a former U.S. surgeon general, chaired the committee that drafted the constitution of the World Health Organization. Burke, who came to Pitt from Johns Hopkins University in 2006, began his career as a U.S. Army medical officer and, while investigating infectious diseases, helped to conduct trials in Thailand for a Japanese encephalitis vaccine that today protects as many as 40,000 children from paralysis or death each year.

Under Burke’s direction, the University in 2009 created the Center for Global Health to coordinate, support, and expand global health research by bringing under one umbrella University scientists and medical researchers working on projects throughout the world—projects that are of increasing importance to the health and well-being of children and families here and abroad. As of 2009, the center was represented in more than 60 locations worldwide.

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The University offers a number of study abroad programs and scholarships, including the President’s Scholarship for Study Abroad; the Nationality Rooms Scholarships; and the Vira I. Heinz Scholarship Program for Women in Global Leadership, a competitive program Pitt administers for the Heinz Endowments that provides an opportunity for international study as well as mentoring, supervision, and leadership development training.

A DOOR TO THE WORLD OPEN TO ALL STUDENTS

The role of a university today clearly includes making sure its students graduate with the skills, knowledge, attitude, and experience to competently navigate a world that is increasingly interconnected. This phenomenon of connectedness is leading students in record numbers to seek educational experiences that enrich their understanding of other cultures.

People need language skills, but they also need an in-depth understanding of particular cultures and should be exposed to comparative methodologies,” says N. John Cooper, the Bettie J. and Ralph E. Bailey Dean of the Dietrich School of Arts and Sciences. “We prepare our students by not only giving them certain sets of knowledge about how the world is but also by giving them ways of thinking about the world and its structures that are grounded in good comparative methodologies and theoretical frameworks.”

LEADERSHIP, ADOPTING AN INNOVATIVE APPROACH TO GLOBAL EDUCATION

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EXCELLENCE | IN RESEARCH
Among the University’s innovative, homegrown study abroad opportunities is the Multiregion Academic Program (PittMAP). This new comparative study abroad initiative enables 30 students a year to spend a term in three countries exploring a common theme. The inaugural PittMAP cohort of students traveled earlier this year to Argentina, South Africa, and China to explore the theme “State Memory/Private Lives”; they looked at ways memory systems are constructed and sustained across cultures. Future themes include exploring epidemiology and examining economic issues related to global health.

Key to that preparation are the Dietrich School faculty, resources, and opportunities that are made available to students. Some of those opportunities can be quite uncommon. In Cuba, for example, the Center for Latin American Studies collaborates with the University of Havana so students can study in the only Western Hemisphere nation that’s been under continuous Communist rule for nearly 50 years. There, they spend a term exploring Cuban history, politics, health and environmental policy, economics, culture, and society from a Cuban perspective while living in the country to gain a comprehensive and balanced view of contemporary Cuban life. Pitt students also are offered a wide range of opportunities to study or conduct research in other nations and regions of the world. Statistics suggest that students are taking advantage of those opportunities at a rate similar to that of students at comparable leading public universities. Pitt’s participation rate in study abroad was about 27 percent in 2009–10, according to Open Doors, an annual report published by the Institute of International Education, which looks at the number of undergraduates studying abroad in an academic year as compared to the number of undergraduate degrees awarded that year.

“Students are seeing study abroad as part of their education, part of the college experience,” says Cooper. “And that has not slowed down in the post-9/11 environment.”

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“It’s another way of thinking altogether,” says Nancy Condee, Pitt professor of Slavic languages and literatures. “The world is accessible to you in a very different way.”

In Argentina, for example, students witnessed how the “disappeared”—young political activists murdered in the 1970s and ’80s by the ruling military dictatorship—receive scant public commemoration. In South Africa, local faculty helped the students to examine the contradiction of a state-promoted “rainbow nation” image and the racial tensions and legacy of apartheid that still exist today. In China, local faculty compared the state image of a harmonious society in which civil activism is unnecessary to contradictory experiences and attitudes among citizens.

“It’s not so much a criticism of those three countries,” says Condee, who accompanied the students. “It’s a question of what sense do you make of the gap between what the state would like you to remember and what you remember, and what the state would like you to forget and what you remember anyway.”

ACADEMIC PARTNERS AROUND THE WORLD

Pitt students are seeing study abroad as part of their education, part of the college experience,” says Cooper. “And that has not slowed down in the post-9/11 environment.”

The University offers a number of study abroad programs and scholarships, including the Provost’s Scholarship for Study Abroad; the Nationality Rooms Scholarships; and the Vira I. Heinz Scholarship Program for Women in Global Leadership, a competitive program Pitt administers for the Heinz Endowments that provides an opportunity for international study as well as mentoring, supervision, and leadership development training.

Among the University’s innovative, homegrown study abroad opportunities is the Multiregion Academic Program (PittMAP). This new comparative study abroad initiative enables 30 students a year to spend a term in three countries exploring a common theme. The inaugural PittMAP cohort of students traveled earlier this year to Argentina, South Africa, and China to explore the theme “State Memory/Private Lives”; they looked at ways memory systems are constructed and sustained across cultures. Future themes include exploring epidemiology and examining economic issues related to global health.

“It’s another way of thinking altogether,” says Nancy Condee, Pitt professor of Slavic languages and literatures. “The world is accessible to you in a very different way.”

In Argentina, for example, students witnessed how the “disappeared”—young political activists murdered in the 1970s and ’80s by the ruling military dictatorship—receive scant public commemoration. In South Africa, local faculty helped the students to examine the contradiction of a state-promoted “rainbow nation” image and the racial tensions and legacy of apartheid that still exist today. In China, local faculty compared the state image of a harmonious society in which civil activism is unnecessary to contradictory experiences and attitudes among citizens.

“It’s not so much a criticism of those three countries,” says Condee, who accompanied the students. “It’s a question of what sense do you make of the gap between what the state would like you to remember and what you remember, and what the state would like you to forget and what you remember anyway.”

Round out Pitt’s global and international research and education initiatives are a growing number of academic partnerships with universities in countries ranging from Switzerland to China—partnerships designed to facilitate faculty research and enrich undergraduate and graduate students with international learning opportunities.

These partnerships offer a number of Pitt schools and departments stable ties to universities abroad that offer such benefits as research collaboration, contacts, data access, and student and faculty exchange programs. In Germany, for example, Pitt’s English and German departments, School of Law, and Katz School have those kinds of partnerships with the University of Augsburg.

PITT/UFM MEDITERRANEAN INSTITUTE FOR TRANSPLANTATION AND SPECIALIZED THERAPIES (ISMETT) IN PALERMO, ITALY

EXCELLENCE | IN RESEARCH

Wuhan University in China is the base for the Pitt in China study abroad program and works in partnership with Pitt’s Confucius Institute to advance language and cultural studies. GSPH is another partner. Pitt researchers, for example, are investigating issues related to environmental health in the Wuhan region, which is undergoing the kind of industrial development Pittsburgh experienced many decades ago.

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GSPH has similar partnerships in Europe, Asia, and the Pacific, including one in China with Nanjing University’s School of Government. Nanjing University has a center similar to GSPH’s Center for Disaster Management that has led to research and study opportunities for both students and faculty with specialists who have worked on such projects as the May 2008 Sichuan earthquake.

“We have a large number of critically important one-on-one relationships between our faculty and programs abroad, and these will always play a crucial role in our global approach,” says UCD Director Feick. “But, institutionally, we are developing and nurturing a set of multifaceted relationships with key institutional partners abroad, involving Pitt faculty and students in the best academic programs the world has to offer.”

First published in the Pitt Chronicle September 7, 2010
Researchers at the University of Pittsburgh are building powerful models to simulate complex phenomena. Armed with these new models and aided by the help of more and increasingly powerful microprocessors, they are asking essential questions that would have been unthinkable to ask computationally as recently as 10 years ago. Pandemics, climate change, banking meltdowns—all can be described by algorithms, and all can be simulated with powerful computers.

Pitt researchers tackle some of the most complex issues of our times in the University’s new Center for Simulation and Modeling. Infectious disease. Global warming. The world economy. These are vastly different subjects, yet all have some things in common. All are complex systems influenced by multiple external stimuli. All have intense importance for humanity, deciding who lives, where they live, and how they live. And our understanding of all three can be advanced through computer simulation.

Growing cohorts of researchers from a broad array of disciplines have used computer modeling to tackle some of the biggest challenges in their fields. Yet, despite the phenomenal increase in the power of computers, traditional simulation tools have been limited because they do not adequately address multiscale processes occurring across large space and time scales.

A GIANT STEP FORWARD IN SIMULATION AND MODELING

This limitation is being addressed on a large scale at the University of Pittsburgh through the Center for Simulation and Modeling (SAM), a multidisciplinary research center established in fall 2008 that works with Pitt researchers to develop new multiscale approaches for simulation and modeling. The center also helps to foster collaborations across disciplines in modeling and simulation.

“Multiscale modeling has the potential to revolutionize the way science is conducted; to foster transformational research; and to stimulate the advancement of new technologies that can have an unprecedented impact on materials, energy, medicine, and many other fields,” says George Klimzing, Pitt’s vice provost for research.
Researchers at the University of Pittsburgh are building powerful models to simulate complex phenomena, armed with these new models and aided by the help of more and increasingly powerful microprocessors, they are asking essential questions that would have been unthinkable to ask computationally as recently as 10 years ago. Pandemics, climate change, banking meltdown—all can be described by algorithms, and all can be simulated with powerful computers.

SAM is directed by Kenneth D. Jordan, Distinguished Professor of Computational Chemistry, and J. Karl Johnson, W.K. Whiteford Professor and Interim Chair in the Department of Chemical and Petroleum Engineering.

SAM has available a computer cluster with 2,000 cores connected by a high-speed Infiniband network, which greatly speeds up demanding calculations that require simultaneous use of multiple CPUs (central processing units). A unique feature of the center is its team of PhD-level consultants with expertise in various facets of computer modeling and simulation. The consultants work closely with research groups, assisting in improving the performance of their computer codes and in making the transition to parallel computing platforms.

SAM engages in a wide range of other activities on campus, e.g., developing and teaching new graduate-level courses on scientific computing, organizing workshops on emergent computing technologies, and selecting software applications of interest to researchers in multiple disciplines, and running a multidisciplinary seminar series on high-performance computing. An exciting new development is a partnership with the University's Computing Services and Systems Development (CSSD) group in making available a new computer cluster with the latest generation of CPUs and AMD CPUs as well as NVIDIA GPUs (graphical processing units, which are specialized coprocessors that enable extremely fast floating point computations).

The center serves as a focal point where almost 50 faculty members (plus more than 100 graduate students) from diverse fields share their experiences and expertise with one another. The thematic focus areas of SAM are energy and sustainability, nanoscience and materials engineering, medicine and biology, public health, and economics and other social sciences.

LEAVING THE SERIAL WORLD

Computers traditionally have operated serially, processing one line of code, then another and another. But microchip speed is topping out, and chip designers are now putting more CPUs, or cores, on a single chip—meaning that even desktop computers have parallel computing capabilities. The benefits to this kind of programming are obvious: A simulation that takes a year to complete on one processor would take less than a day if one could get it to run efficiently on 512 processors.

"Leaving the serial world behind is no small task," says Johnson, who adds that he grew up in a serial world. "When the University asked its faculty what they needed in a computational center, Kington says, their answer was, "We need high-level consultants; we don't just need hardware." In response to that need, SAM was created to provide in-house PhD-level computational consultants who advise faculty and their students.

The center allows researchers from across the University to be able to tap more easily into experts like Liz Marai, assistant professor of computer science. Marai’s specialty is data modeling and visualization, the conversion of mountains of numbers into visual representations that can then be used for interpretation.

THE THREATENING AREAS OF THE CENTER FOR SIMULATION AND MODELING ARE ENERGY AND SUSTAINABILITY, NANOSCIENCE AND MATERIALS ENGINEERING, MEDICINE AND BIOLOGY, PUBLIC HEALTH, AND ECONOMICS AND OTHER SOCIAL SCIENCES.

For example, Marai has recently teamed up with SAM as part of an interdisciplinary research group led by Caterina Rosano in the Department of Epidemiology in Pitt's Graduate School of Public Health (GSPH). The project aims to provide practical computational tools for analyzing the correlation of mobility characteristics in older adults with brain pathophysiological processes. Marai and her students are developing advanced visualization strategies and tools for analysis of magnetic resonance imaging (MRI) data and their correlation to mobility measurements.

"We take numbers and measurements and try to generate insight," says Marai. "We run a tight loop between data, visualization, and analysis." Marai believes that the center has enabled computational research at Pitt to take a big step forward. "It fosters collaboration between experts from different fields. It’s not just adding computing power; it’s combining methodologies across disciplines to look at these really important questions—how galaxies are formed, how the human body works. Expert collaboration across disciplines can solve really big problems."

TOWARDS ENERGY AND SUSTAINABILITY

Other important questions include those being asked about energy, sustainability, and the environment.

Jordan uses models to analyze the structure of methane hydrate, a compound formed from water and methane under high pressures at low temperatures. It is most abundant in deep ocean water and under the permafrost near the Arctic. The methane embedded in these deposits contains more potential energy than all known oil and natural gas reserves on the planet. It also represents a major potential contributor to global climate change. Methane is a potent greenhouse gas, 20 times more potent than carbon dioxide (CO2) and, as the polar region warms, the melting permafrost may release the vast supply of methane beneath it.

Either way, understanding methane hydrate’s mysterious properties is crucial. Jordan is working with the U.S. Department of Energy’s National Energy Technology Laboratory to simulate the structure and dynamics of methane hydrate. In hydrates, water molecules form polyhedral cages around methane molecules. Simulations allow Jordan’s team to explore questions about methane hydrate that would be nearly impossible otherwise. "On the computer, we can study the network of cages without the methane molecules—something that cannot be done experimentally," he says.

Jordan’s group also is studying a hydrate that is formed from water and CO2 molecules, which may be useful in sequestering CO2, the world’s most abundant greenhouse gas.

Like many researchers at the University, Jordan collaborates with experimentalists at numerous institutions, including Yale and Purdue universities, to combine his research with state-of-the-art experimental approaches.

Carbon dioxide also is an area of inquiry for Johnson, who is using computational modeling to understand how CO2 interacts with many other materials. Johnson and his collaborators are hoping that the materials they help to design will one day be used to capture CO2 and slow global climate change.
For the next 30–50 years, we’re going to be relying heavily on fossil fuels for energy,” Johnson says. “How can we use that resource without releasing CO₂ into the atmosphere?” Johnson’s group is modeling a class of nanoscopic material compounds with “pores” 1/1,000th the width of a human hair in diameter to understand how they interact with CO₂. He hopes their modeling will lead to the design of a material that can capture CO₂ from power plant emissions. The captured CO₂ could then be stored through carbon sequestration. Modeling is helping one Pitt researcher to tackle another aspect of the energy challenge: how to make solar power more affordable. Geoffrey Hutchison, assistant professor of chemistry, uses computation to study a class of conductive plastics called polythiophenes. These materials can be used as photovoltaics and could become a cheaper alternative to silicon-based solar cells. Just as intriguing to Hutchison is that polythiophenes can be processed like wires. “You could paint this on the roof of every car and every building and have solar cells in all these places,” Hutchison says.

Hutchison is experimenting with these plastics on the computer, simulating conductive properties of different molecules. “We can look at what happens if we change, say, a carbon atom into a nitrogen—you can do that on a computer, and to do that experimentally would take months.”

Hutchison and his collaborators put together a group of 100 potential molecules and, through simulations,cleaned five or six that could be good candidates for solar cells.”A lot of these molecules look like things we could make, but we want to understand whether to put in the effort to make them,” he says.

“PITT CAN BE AN INTERNATIONAL LEADER IN THIS EXCITING NEW FIELD. WE’RE DEFINITELY ON THE FRONT EDGE. MY INTUITION IS THAT, SOON, VIRTUALLY EVERY ASPECT OF PUBLIC HEALTH RESEARCH AND POLICY DEVELOPMENT WILL BE SUPPORTED BY MODELING AND SIMULATION, AND PITT IS EXTREMELY WELL POSITIONED TO LEAD THE FIELD.”

DONALD BURKE
ASSOCIATE VICE CHANCELLOR FOR GLOBAL HEALTH DEAN, GRADUATE SCHOOL OF PUBLIC HEALTH

Laura Schaefer, a professor of mechanical engineering and materials science, BioXterional Board of Visitors Faculty Fellow, and deputy director of the Mascaro Center for Sustainable Innovation at Pitt, uses computer modeling to develop green alternatives to chlorofluorocarbons (CFCs) and related polymers.

CFCs have long been used as refrigerants in air conditioning because their chemical profile allows them to draw away heat from the air around them efficiently and safely. But CFCs deplete the Earth’s ozone layer, which blocks harmful solar radiation, and these chemicals will be phased out completely this year.

Hydrochlorofluorocarbons (HCFCs), the chemicals used to replace CFCs, are more environmentally friendly but still have a negative impact on the ozone layer. Regulators also will begin phasing out the most common HCFCs this year.

Schaefer, who also has used computer modeling to study the use of acoustics for refrigeration, is simulating how different combinations of chemicals would react to find a safe, efficient alternative. Her work involves multiscale modeling that predicts how the system as a whole will perform.

The urgency to develop a safer, more energy-efficient refrigerant is great; air conditioning accounts for one-sixth of U.S. household electricity use. Schaefer’s work is leading to new understandings in the basic science of fluid dynamics, she says. “The theoretical insights have been really fascinating. We’re learning a lot on how complex fluids behave at a small level. This could have far-reaching impacts for researchers in other fields.”

“TRACKING GLOBAL HEALTH

Computer modeling tools have become increasingly important to understanding and addressing global health problems. By using informatics and computational modeling and simulation, researchers and policymakers can understand more about current public health challenges and determine the best strategies to prevent disease and improve human health.

Modeling also can show how disease spreads through whole populations, as demonstrated by the work of Donald Burke, GSPH dean, UPmc-Jonas Salk Chair of Global Health, and associate vice chancellor for global health at Pitt. Burke is a pioneer in using computer modeling to understand the behavior of pandemic disease.

For decades, Burke tracked infectious diseases like HIV/AIDS and dengue fever throughout the developing world. In the 1990s, he began to think of pandemics as computable processes. “I now think of virus transmission as an algorithmic process, with underlying subprocesses and patterns,” Burke says. “I never would have thought that way before I started to use computer modeling and simulation.” The computer model Burke and his collaborators designed to simulate an outbreak of avian flu in Southeast Asia using transmission statistics from past epidemics, census data, and other social patterns has helped the U.S. Department of Health and Human Services, U.S. Department of Homeland Security, and Centers for Disease Control and Prevention to develop policies on travel restrictions, vaccinations, and school closures in the event of an outbreak. The Bill & Melinda Gates Foundation, which funds projects to help eradicate infectious disease, committed $10 million to Burke’s group to build a model for the use of vaccines to contain epidemic diseases.

“Computer modeling allows us to test in silico our ideas on populations,” says Burke, and not just for epidemics of infectious diseases. Smoking, obesity, and drug use are all examples of public health problems in which social behaviors spread from person to person in a fashion similar to contagious microbes and in which modeling can help people to think through and evaluate public policies designed to limit or reverse the spread of the behaviors, according to Burke. Pitt can be an international leader in this exciting new field, he says: “We’re definitely on the front edge. My intuition is that, soon, virtually every aspect of public health research and policy development will be supported by modeling and simulation, and Pitt is extremely well positioned to lead the field.”

In 2009, the University was designated a MIDAS (Models of Infectious Disease Agent Study) National Center of Excellence, leading a collaborative network of scientists in the development and use of computational models that will prepare the nation to respond to outbreaks of infectious diseases. Recently, SAM consultants have teamed up with Bruce Lee, an assistant professor in GSPH and a core member of the recently founded Public Health Dynamics Laboratory. SAM is developing highly parallel computational modeling tools for studying patient and MRSA (a type of bacterial infection found commonly in hospitals) flow in human institutions such as hospitals and long-term care facilities.
EMBRACING TURBULENCE

Anyone who’s puzzled by an inaccurate weather forecast can appreciate why turbulence is one of the great problems of modern science. “Albert Einstein advised all his associates not to get involved with the problem of turbulence; it’s a very chaotic phenomenon,” says Peyman Givi, William Kepler Whiteford Professor in the Department of Mechanical Engineering and Materials Science and director of the Laboratory for Computational Transport Phenomena at Pitt.

Givi hasn’t stayed away from turbulence—he’s embraced it by developing unique methods of modeling the phenomena of turbulent combustion and high-speed combustion inside engines. He’s gained attention for a novel way to combine two modeling methods—one employing exact calculations engines. He’s gained attention for a novel way to combine two modeling methods—one employing exact calculations with advanced parallelization techniques to enable simulations of ever-larger systems with unprecedented fidelity. His lab is working with SAM consultants to develop a powerful computational software with advanced parallelization techniques to enable simulations of ever-larger systems with unprecedented fidelity.

DESIGNER MATERIALS AND NANOTECHNOLOGY

Just as Givi’s models depict how engines will work before they are built, computer modeling allows researchers to test the properties of new materials and novel chemical compounds prior to their being built. “If you can understand what’s happening at the level of atoms, you can build things from the bottom up and create designer materials,” says Johnson. His lab is using models to probe the physical properties of carbon nanotubes—long, strawlike molecules with very narrow diameters that scientists think may be useful for separating different gases or liquids. For example, a carbon nanotube membrane that selectively separates water from sodium chloride could be used as an easy, low-energy way to desalinate seawater.

Johnson and his group model how specific mixtures of molecules interact with these structures, showing, for instance, how quickly these materials flow through the nanotubes. Unless the flow rate is fast, the membrane will not be useful in practical terms for separating fluids. The model created by Johnson and his collaborators found that gases would pass much more quickly through the nanotubes than expected. Laboratory results published in a 2006 Science article by a separate research team supported some of the predictions Johnson’s team made: The measured flow of gases and liquids was about 1,000 times faster through the nanotubes than through conventional porous membranes.

Jordan is using modeling to study one of the most abundant materials on Earth: water. “Although water is probably the most studied substance on Earth, we still don’t understand all of its properties, many of which are unique,” Jordan says. Jordan’s group simulates the behavior of small clusters of water containing up to 100 molecules. These studies are shedding new light on a wide range of processes, among them chemical reactions in the atmosphere and electrochemistry. One of the most important problems on which Jordan’s group is working is whether charged particles, such as electrons and protons, prefer to be on the surface or in the interior of water clusters. This fundamental science question turns out to have far-reaching consequences, including those of environmental importance in atmospheric chemistry.

One researcher is using computers to model “sticky stuff”—wet or very fine granular material. Joseph McCarthy, a professor and William Kepler Whiteford Faculty Fellow in the Department of Chemical and Petroleum Engineering, studies the science of mixing sticky material. This is an important process in fields like pharmaceuticals, where a thimbleful of active chemicals must be mixed evenly into a roomful of flour-like substance. McCarthy and his collaborators build intricate models to see how best to mix these materials based on their size, density, and ability to be attracted to or repelled by water. They calculate the behavior and mechanics of billions of particles interacting over hundreds of thousands of time segments. This takes months to run across several high-powered processors. The time put into these models saves McCarthy and his colleagues from having to build time-consuming physical experiments.

The McCarthy group simulated a “chute flow” experiment, in which a substance is poured down a surface with a series of zigzags built into it. To construct a physical experiment, the team would have had to build a chute as high as 12-story Benedum Hall, which houses the Swanson School of Engineering. “We can take a lot of measurements you can’t do when you’re working experimentally,” McCarthy says. Computer modeling is allowing Anna Balazs, Distinguished Professor of Chemical Engineering and Robert Von der Luft Professor, to explore the creation of nanomachines that behave in much the same way human cells do.

Balazs uses simulations to study how microcapsules—synthetic bubbles roughly the size of a human blood cell—moving across a surface could form an artificial “skin” on a damaged material. She also has simulated communication between these synthetic bubbles using a route similar to that used in processes occurring in cell signaling. These materials one day could form the basis for chemical sensors that “heal” defective surfaces.

“This artificial skin is essentially a coating that could indicate where a surface has been damaged,” Balazs says. She believes that her simulations will help experimentalists to follow the “recipe” for the nanomachines her team has created using computational modeling.

UNLOCKING THE BODY’S MYSTERIES

Modeling is becoming an invaluable tool for many Pitt researchers in medicine and biology. From studying proteins at the atomic level to focusing on the body’s immune system, models let these University researchers quickly test theories, enabling innovations that could help to save many lives down the road.

Lillian Chong, Pitt associate professor of chemistry, uses computer simulations to study proteins, the body’s workhorses, in order to understand better the roles they play in the biological pathways of the cell. Chong studies natively unfolded protein—proteins that are built but seemingly disordered structure—which include a protein called tumor suppressor p53, thought to play a role in cancer. Proteins initiate important chemical functions in the body by “folding” into target molecules.

The Center for Simulation and Modeling is helping researchers to share their expertise and experience with others at Pitt. “It makes a lot of sense to have a center that supports that kind of faculty collaboration so we can leverage that kind of expertise from so many people in this community.”

LILLIAN CHONG
ASSOCIATE PROFESSOR, CHEMISTRY
and his team model ion channels, one of the body’s least understood but most important protein structures. These nanoscopic channels enable the passage of charged atoms like hydrogen, potassium, and chlorine through the body and are essential for everything from the creation and maintenance of life to the production of such chemicals as insulin. “Malfunctions of ion channels are implicated as the root cause of many serious diseases and neuropsychiatric disorders, including cystic fibrosis, certain types of epilepsy, and migraine headaches,” Coalition says.

According to Coalition, it is difficult to test ion channels in their natural environment within a living organism, but it’s important that they be better understood, as about half of the drugs on the market today target ion channels and their protein cousins. Coalition’s group has developed simulations that calculate the rate of ion flow through channels in cell membranes for various transmembrane voltages and electrolyte concentrations in order to gain insight into the relationship between channel structure and function. Through computational models, Ivet Bahar, John K. Vles Chair and professor of computational and systems biology, and her colleagues in Pitt’s School of Medicine simulate the interactions of proteins with potential inhibitors, small compounds that can limit the undesirable activities of some proteins. In collaboration with the Drug Discovery Institute, Bahar’s lab members screen libraries of hundreds of thousands of chemical compounds for their potential to interact with target proteins in the search to identify promising drugs for further development.

Researchers at Pitt will continue to refine their understanding of the complicated systems they’re modeling. They will collaborate heavily with experimentalists to test their theories against real-world data and explore new ways to make computational modeling even faster.

By doing “virtual screening,” Bahar says, she and her colleagues can not only increase the likelihood of identifying more potent inhibitors but also speed up the process of drug discovery. Other members of the computational biology department also use computational tools to study the role of microRNA, tiny strands of genetic material, in regulating the immune response with respect to cancer and in understanding the complex biophysics of cell signaling.

G. Bard Ermentrout, Distinguished University Professor of Computational Biology and professor of mathematics, uses computational modeling to simulate complex medical phenomena. Ermentrout, who’s used modeling to study everything from the trail-making properties of ants to the pigmentation design of mollusk shells, frequently collaborates with colleagues in the fields of medicine, neuroscience, and biology to study how certain patterns occur.

Ermentrout and his collaborators use models to understand the immune response during sepsis, a potentially fatal condition in which the body’s response to infection inflicts “collateral damage” on internal organs like the lungs. They are trying to model how the immune system response in sepsis reaches a tipping point at which the body’s own immune defenses start causing more harm than good. “At what point does the immune feedback become overwhelming and start to avalanche and cause problems?” Ermentrout asks.

Ermentrout also has used modeling to study phosphenes, the geometric visual patterns that occur when one looks at strobe lights, hallucinates, or enters a pre-epileptic state. He thinks that the patterns represent neural activity transposed directly onto the brain during those instances when the brain’s visual apparatus is knocked off its usual setting.

“There are some problems in science that really lend themselves to modeling,” says Ermentrout. “We’re trying to find the algorithms that generate these patterns.”

FORECASTING THE UNCERTAIN

Predicting how the world economy will react to a laundry list of economic contingencies—wars, resource shortages, or banking meltdowns, to name just a few—is no task for the faint of heart. “The devil is in the details,” explains David N. DeJong, a professor and former chair of the Department of Economics who was recently named vice provost for academic planning and resources management. DeJong is trying to harness the power of computational methods to create economic forecasting models designed in part to chart reactions to such contingencies.

DeJong uses computer simulations to reconcile two branches of the field that don’t always communicate with one another: theory and statistics. Statistics are invaluable in unearthing the details of economic trends, but, DeJong explains, “They don’t really answer the question, ‘How come?’”

DeJong has already begun this task, mapping theoretical models of economic behavior onto statistical models. He understands that because models are simplifications of reality, there are some things that models will have difficulty accounting for: “No matter how rich our understanding of the aggregate economy is, we’re never going to get everything.” For instance, how does a researcher account for the reaction of consumers to unforeseeable changes in their environment not built explicitly into the model, like the recent foreclosure crisis or instabilities in the banking sector?

But as our understanding of the relationship between tax policy, investment, and consumption increases, DeJong and other economists increasingly will use structural models to read the economic tea leaves. “What I’d like to do is to be able to answer questions like ‘Should the Federal Reserve Board be more worried about interest rates or inflation?’ or ‘What are the effects of a tax holiday going to be?’ I’ll fire up the model and give you an answer,” DeJong says.

TRADITIONAL METHODS, NEW TOOLS

Researchers at Pitt will continue to refine their understanding of the complicated systems they’re modeling. They will collaborate heavily with experimentalists to test their theories against real-world data and explore new ways to make computational modeling even faster. In these ways, computational modeling is not so far removed from the most rudimentary rules of scientific inquiry that have been around for centuries: observe, experiment, and analyze.

As Givi says, “In almost anything we do in science, we use what we know and model what we don’t.” The issue is how do you combine these two worlds to come up with a unified methodology? That’s where we are putting our efforts.”

First published in the Pitt Chronicle November 29, 2010
For the most part, the scientists doing the heavy lifting are university-based researchers in physics, chemistry, engineering, biology, and other fields who—given the tools and freedom to explore—are laying the foundation for technologies few thought possible. Prominent among them are the more than 50 University of Pittsburgh researchers who are making significant contributions to the development of nanotechnologies, an endeavor that became a national initiative more than a decade ago.

Pitt's nanoscience clean room

Each year, scientists are making discoveries that advance our understanding of nanoscience, lending substance to the speculation that nanotechnology is a revolutionary force that will profoundly change everything, from the electronics we use to the way doctors practice medicine.

Today, Pitt researchers are:

• developing special coatings with nanoparticles that prevent surfaces from icing;

• investigating materials containing nanosize bits of semiconductor material to solve one of the chief problems standing in the way of making paint convert sunlight into electricity; and

• integrating biology and nanotechnologies to develop highly sensitive, easy-to-use biosensors that push the boundaries of diagnostic medicine.

These researchers' exploration of nanoscience has led to homemade devices with remarkable capabilities, including a microscope capable of capturing on film light trapped within metal particles. They’ve set out to discover never-before-seen nanoparticles with properties that could nudge science closer to realizing true quantum computing with the potential for speeds and computational power that would make today’s computers seem snail-like. And Pitt scientists are among the most proactive in assessing the impact these emerging nanotechnologies may have on human health and the environment as well as in investigating ways to make these technologies safer.
NANOSTUDIES NANNING

A MATTER OF SCALE

The prefix nano means 10^-9 or a billionth. A nanosecond is one-billionth of a second; a nanometer, one-billionth of a meter. At that scale, the head of a pin seems large, measuring about 2 million nanometers. Nanoscience, therefore, is the study of the world around us at the tiniest levels. In this field, atoms and molecules are the building blocks for creating new materials and machines. The federal government defines nanoscience as the understanding and control of matter at dimensions between 1 and 100 nanometers; Pitt directs its research toward the smaller, more challenging end of that range, at 1–20 nanometers.

But size is only part of the intrigue, because materials at nanoscale possess remarkably different properties than their larger counterparts. "Very interesting things happen in that range," says George Klimin, vice provost for research at Pitt. "If you are looking at friction, it's different at the level of 1–20 nanometers than it is in large particles of hundreds or thousands of nanometers. The basic laws are different. Understanding that is very important—and challenging. How are you going to manipulate these things? How are you going to make things if you're not sure how they'll behave? We put a lot of effort into understanding that."

The potential impact of nanotechnology on human health, the economy, and national security led President Bill Clinton to establish in 2000 the National Nanotechnology Initiative (NNI) as a multiagency framework to ensure U.S. leadership in the field by investing in basic research to understand nanoscale phenomena and facilitate technology transfer. Since then, NNI funding has risen approximately fourfold, from $462 million to nearly $1.8 billion in fiscal year 2010.

Pitt’s traditional strength in materials research meant that, even before NNI, University researchers in fields ranging from chemistry to physics were investigating nanoscience with the support of a growing number of federal agencies eager to develop the new technology. In December 2002, under the leadership of then Provost James V. Maher, Pitt created the Institute of NanoScience and Engineering to support and integrate the work of the increasing number of faculty from diverse disciplines embarking on nanoscience research. Within four years, the institute was renamed the Petersen Institute for NanoScience and Engineering (PINSE).

The institute’s Benedum Hall home was renovated to accommodate a state-of-the-art nanoscale fabrication and characterization facility; the range of sophisticated instruments available to researchers expanded significantly; and, with a $35 million gift from the Petersens, an endowment was created to support the work of Pitt’s scientists.

These researchers’ exploration of nanoscience has led to homemade devices with remarkable capabilities, including a microscope capable of capturing on film light trapped within metal particles. They’ve set out to discover never-before-seen nanoparticles with properties that could nudge science closer to realizing true quantum computing with the potential for speeds and computational power that would make today’s computers seem snail-like. And Pitt scientists are among the most proactive in assessing the impact these emerging nanotechnologies may have on human health and the environment as well as in investigating ways to make these technologies safer.

AN UNCOMMON RESOURCE

Today PINSE stands as one of the most up-to-date, comprehensive institutes for nanoscale research on a university campus, offering scientists an uncommon asset for doing science at nanoscale and for securing external support for their work.

Few universities provide facilities and instruments to both characterize and fabricate nanomaterials in one place. From the beginning, Pitt has embraced both aspects, understanding nanomaterials through characterization and doing manipulation, fabrication, and synthesis into a designed structure in a synergistic environment. Many other research facilities focus on one or the other and, thus, may miss important pieces and cannot develop a holistic picture.

The sophistication of the instruments available to scientists has done much to advance their understanding of nanomaterials and structures. PINSE has invested nearly $12 million to stock its characterization and fabrication facility, with more than two dozen of the most advanced instruments required for high-level nanoscience research demands. All are housed in a clean room environment. An example of an instrument available for characterization is the transmission electron microscope, which has a resolution of less than one nanometer. It allows scientists to visualize the atomic arrangement of nanomaterial and reconstruct the way atoms are arranged. On the fabrication side, Pitt scientists have access to instruments such as electron beam and focused ion beam nanolithography systems, which enable the researchers to build almost anything at nanoscale to their precise design specifications.

PINSE employs three technical staff members, a manager, and two research associates and provides resources and support to more than 50 affiliated faculty researchers across several disciplines.

In 2009, PINSE opened its doors to researchers beyond the Pitt campus, including individuals in industry and at other academic institutions. About a half dozen PINSE-affiliated faculty members also are engaged in collaborative research projects with various companies, and the list is expected to grow as the University steps up efforts to form industry partnerships around nanotechnology.

PINSE-affiliated faculty members also are developing undergraduate and graduate-level course work in nanoscience and nanotechnology, including entry-level courses in electrical engineering and a laboratory course that allows undergraduates to experience working with the leading-edge instruments and other amenities in the characterization and fabrication facility. "The philosophy is not only to educate our students in theory but also to give them hands-on experience as well, because we see more and more jobs openings in the emerging nanotechnology industry," says Hong Koo Kim, professor of electrical and computer engineering and codirector of the Petersen Institute of NanoScience and Engineering.

RECOGNITION AT THE HIGHEST LEVELS

Nanotechnology research at Pitt is showing significant potential for helping to develop the kind of longer-term industry relationships the University seeks. That is the result of several factors, including the expertise of faculty members, the breadth of that expertise and their experience, and the expanding list of their accomplishments.

PINSE-affiliated faculty members are involved in more than 100 nanoscience-related research projects during any given year. Their work is supported by an estimated $12 million in grants from federal government agencies, ranging from the National Science Foundation (NSF) and the U.S. Department of Energy to the U.S. Department of Defense and the National Institute of Standards and Technology. Many faculty members have received prestigious awards, including at least 10 PINSE-affiliated scientists who have earned an NSF-Faculty Early Career Development award.

In fact, Pitt is regularly ranked among the top seven universities in both nanoscience and nanotechnology commercialization by Small Times, the leading nanotechnology trade publication. "Its breadth of expertise, resources, and publishing activities," the magazine recently wrote, "puts Pitt near the top for micro and nanotech research."
A QUANTUM CHALLENGE

For decades, quantum computing has been a grand challenge for physicists seeking to realize nanoscience’s potential for surpassing the speeds and computational abilities of today’s best computers. Jeremy Levy’s ambitious experimental research program is directly addressing the many challenges that must be overcome to reach that elusive goal.

Levy, a professor of physics and astronomy in Pitt’s Dietrich School of Arts and Sciences and director of the Center for Oxide-Semiconductor Materials for Quantum Computation, works to understand and create nano-size structures, investigate their properties, and discover new physics in the process. His laboratory specializes in a class of materials known as complex oxides, which act somewhat like semiconductors but have a more robust behavior.

Working with a system consisting of two oxides—a layer of lanthanum aluminate about 1 nanometer thick grown onto strontium titanate—Levy found that the interface between the two materials can be switched between a conducting phase and an insulating phase. His lab also invented a method to control the process, which, he says, is reminiscent of an Etch A Sketch toy. From those oxide nanostructures, his lab was able to make a transistor roughly 1,000 times smaller than those used in today’s computers.

His work with oxide nanostructures has implications for advancing the basic science that underlies quantum computing. Recently, he was awarded a $7.5 million Multidisciplinary University Research Initiative grant from the U.S. Air Force Office of Scientific Research to support his work on quantum preservation, simulation, and transfer in oxide nanostructures. “What we are trying to do is to develop new types of quantum technology that use the properties of superconductors,” says Levy. In one of those projects, researchers in Levy’s lab are trying to discover new particles that have been predicted but never observed before in the universe. These particles possess topological properties that allow them to be “braided” in ways that offer advantages for developing a quantum computer, such as making it more tolerant of errors. “We are dealing with some of the most challenging parts of quantum computing,” Levy says.

ROGER HENDRIX

BACK TO THE FUTURE

When it comes to nanomachines, none has been around longer than a prolific and diverse population of viruses known as bacteriophages. Recent evidence suggests these microorganisms evolved in nature at least 3.5 billion years ago, perhaps near the beginning of life itself—the “original nanomachines,” Roger Hendrix (left) calls them.

One notable attribute of bacteriophages is their ability to infect bacteria. They can penetrate bacterial cells, become one with them, and either kill or alter them. But they are not well understood, despite their advanced age and the fact that some 100 trillion trillion individual bacteriophages are estimated to be roaming the planet at any one time.

A Distinguished Professor of Biological Sciences in Pitt’s Dietrich School of Arts and Sciences, Hendrix studies how bacteriophages, which have been refined by natural selection over billions of years of existence, are assembled from their component parts. Each bacteriophage has a protein shell for a head and a tail that is part of the machinery for injecting DNA into the cell that it infects.

Of particular interest to Hendrix is the introduction of DNA during the head assembly process and the elaborate rearrangement the protein shell then undergoes to make it more stable, sturdy, and resistant. The tail assembly also has its mysteries to solve. One is understanding how the tail is assembled to the same length for all bacteriophages in a population.

“It’s a general question about how you assemble biological structures or nanostructures,” says Hendrix. “How are the dimensions determined? If you’re making a structure out of identical bricks, how do you know when to stop piling up the bricks?”

Answering such questions about bacteriophage assembly could have implications for the development of a range of nanotechnologies. “These nanomachines are more sophisticated than anything anyone can build in the lab these days,” says Hendrix. “So understanding how they work is informative for understanding how we can make nanomachines.”

EXCELLENCE IN RESEARCH

A quantum computer processor with a clock rate of a few gigahertz can operate its transitions at a rate of about once every nanosecond. Most people would likely see that as fast; Hrvoje Petek sees it as an opportunity.

“In principle,” says Petek, a physics and a chemistry professor in Pitt’s Dietrich School of Arts and Sciences, “we should be able to make electronic devices that are much faster and that would consume much less energy if we could combine light with conventional electronics.”

The focus of Petek’s research is ultrafast phenomena in solid-state materials. And by ultrafast, he means phenomena that occur on time scales that are less than 10⁻¹² second. An area of particular interest is ultrafast electron microscopy. One result of this work is the time-resolved photoemission electron microscope his laboratory developed that can image electric fields in a solid-state material or nanostructures with a remarkable 10⁻¹⁴-second time resolution.

“We have speeded up microscopy by many orders of magnitude,” says Petek. “What this allows us to do is to image light on a nanometer scale.”

Using the microscope, Petek is able to make movies of light being trapped inside metal particles and metal films. “The light pulses we can trap in nanofilms on nanometer scale may be combined with conventional electronic devices to speed them up and to reduce their energy consumption. To achieve that, the first thing that is necessary is to take movies of these trapped light pulses inside a metal film on both a femtosecond (one-quadrillionth of a second) temporal scale and a nanometer spatial scale.”

Petek also is exploring single-molecule machines. Using a scanning tunneling microscope, for example, he can shoot single electrons into a molecule and learn how its internal structure can be manipulated. It’s a step into the next frontier in electronics. “There is going to be a limit on how far conventional electronic devices can be shrunk,” Petek says. “At some point, rather than using silicon, there may be advantages to using molecular materials. Such single-molecule devices represent the smallest miniaturization of a device one can imagine.”

BREAKING SPEED LIMITS

Faculty members are involved in more than 100 nanoscience-related research projects during any given year. Their work is supported by an estimated $1.2 million in grants from federal government agencies, ranging from NSF and the U.S. Department of Energy to the U.S. Department of Defense and the National Institute of Standards and Technology.
In his laboratory, Di Gao is investigating ways of modifying surfaces with nanoparticles that some day might lead to ice-proof roads while also exploring the use of nanowire arrays to solve a stubborn problem confounding the development of a promising new technology for harnessing the power of the sun.

Gao is applying his study of superhydrophobic surfaces to develop coatings that prevent the conditions necessary for icing to begin. Particle size, in particular, is critical. And if making an anti-icing material is the goal, smaller is better. Gao’s laboratory exploits that scientific fact by developing coatings that are a blend of polymers and nanoparticles small enough to deny supercooled water the nucleation center necessary for ice to form.

"Water basically gets bounced away," says Gao, an assistant professor of chemical and petroleum engineering and a William Kepler Whiteford Faculty Fellow at Pitt. "Eventually, this can be applied to power lines and the wings of airplanes to prevent icing."

Road surfaces present another challenge. The coating when applied to a road surface won’t endure the abuse of traffic and other factors. So Gao is collaborating with other Pitt scientists to make an anti-icing concrete containing nanoparticles.

Gao’s laboratory also is focusing its expertise on improving the efficiency of dye-sensitized solar cells, an emerging technology with the potential to harvest energy at a significantly lower cost than silicon-based cells; this research is attracting considerable attention throughout the world. The emerging technology’s potential won’t be realized, however, until these new solar cells can be made to do a better job converting infrared light into electricity. One problem with current dye-sensitive solar cells is their disordered nanoparticle network, which requires electrons to hop between particles. Gao is trying to solve that problem by using ordered, or vertically aligned, titanium oxide nanowire arrays, which, he says, "give the electrons a freeway to get out of the cell and improve the electron transport efficiency of the anode."

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UNCONVENTIONAL OPTICS

A basic premise of conventional optics is that light bends in a certain way when it enters a different medium. The basic premise of conventional optics is that light bends in a certain way when it enters a different medium. The basic premise of conventional optics is that light bends in a certain way when it enters a different medium. The basic premise of conventional optics is that light bends in a certain way when it enters a different medium. The basic premise of conventional optics is that light bends in a certain way when it enters a different medium. The basic premise of conventional optics is that light bends in a certain way when it enters a different medium.

For instance, the new nano-optic structure, when used for imaging, could make it possible to produce smaller transistor patterns. The structure also has promise as an advanced lens capable of observing extremely small objects, achieving higher-resolution imaging than is currently available. It also could lead to enhancing efficiencies of photovoltaic devices. "By bending light, this approach, this structure, allows the light to interact with thin-film solar cell material at longer distances," says Kim. "That means better absorption and better use of that solar energy, which produces higher efficiencies in electricity generation."

Among the potential benefits of nanoparticles are the possibilities of solving such problems as developing a viable photovoltaic paint able to convert sunlight into electricity ... or highly sensitive biodegradable sensors for early detection of diseases.

One of his interests in particular is making light bend the opposite way from its natural way of bending — and developing new nanomaterials that will allow that to be exploited as a platform for new applications ranging from extremely high-resolution imaging to advanced photovoltaic devices.

While the potential for so-called negative-index metamaterials has been recognized and pursued for several years, moving the technology from the laboratory to real-world applications has been problematic. In most approaches, for example, light is lost as it travels through the metamaterials. And these materials work only for a narrow spectral range. Both drawbacks limit the materials’ practical usefulness.

Kim, however, is taking a different approach, developing a nano-optic structure that can bend light in a negative direction in a way that is amenable to a wide range of wavelengths; is relatively easy to fabricate; and is almost lossless, meaning that light passes through it with minimal loss of energy. Such properties open the door to a host of possible advanced uses.

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PHOTOVOLTAIC PAINT

Among the potential benefits of nanoparticles is the possibility of finally solving one of the major problems standing in the way of realizing a commercially viable photovoltaic paint able to convert sunlight into electricity. Although the world is moving closer to such a solar-powered paint, available technologies fall short of reaching the needed conversion efficiencies because too few of the solar photons they absorb are converted into electrons. One scientist working on that problem is David Waldeck, a professor of chemistry and chair of Pitt’s Department of Chemistry in the Dietrich School of Arts and Sciences, whose research interests include understanding and controlling electron motion on nanometer scales.

Waldeck’s laboratory is making composite materials of nanoscale bits of semiconductor that are mixed with a conducting polymer material. These semiconductor nanoparticles have several advantages. "We are able to tune the color of light they absorb and where their energy levels lie by changing their size," says Waldeck. "By changing the surface coating on the nanoparticles, we can place them at the interface of two different polymers and absorb most of the light at the boundary of the polymers. Because we can make one of the polymers be a cathode and the other polymer an anode—like the poles of a battery—absorbing the light at that boundary allows us to very efficiently drive the electron from one phase to another."

Such a development would offer a more efficient and less expensive process for converting light into electricity. "If it all works, you will be able to ‘paint’ your roof one day, plug it in, and save on your electricity bill. That’s the basic idea."

Another research interest of Waldeck’s is understanding how to manipulate light on nanometer-length scales. This work has led to a collaborative project with Joanne Yeh, a professor in the Pitt School of Medicine’s Department of Structural Biology, to develop enhanced biosensors that have drawn support from the National Institutes of Health and the National Aeronautics and Space Administration (NASA).

Waldeck’s laboratory is creating thin metal films approximately 200 nanometers thick that are structured with holes, rings, or slits that enable them to direct the path along which light travels. Yeh’s laboratory integrates biological materials onto these nanoplasticom devices. The idea is to create new nanoplatforms for performing chemical and biological analysis using the same concepts of miniaturization and integration that have been so successfully applied to electronics.

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Clinic is currently the most common method of measuring.

She has also shown that nanobiosensors are capable of detecting prostate-specific antigen (PSA) with unprecedented sensitivities. Her approach enables the precise spatial incorporation of each sensor component to maximize the functionality and sensitivity of the biosensor. In addition to being highly sensitive, these biosensors are platform-independent and easily miniaturized.

**SUPERSENSITIVE DETECTORS**

Turning carbon nanotubes into chemical and biological sensors is one of Alexander Star's research interests. His research group recently used tubes with diameters 100,000 times smaller than a human hair to develop a sensor that can warn asthma sufferers of an impending attack.

The sensor detects concentrations of nitric oxide in human breath. Nitric oxide is a marker of inflammation. Rising levels of the gas suggest a buildup of inflammation in the airways, which can predict an asthma attack.

A nanotube's advantage in detection is its extremely small size. When gas molecules like nitric oxide bind to the surface, they significantly impede the flow of electrical current—an event that can be detected. "Ideally, such sensors could be sold in pharmacies, like glucose sensors that test glucose levels in blood," says Star, an assistant professor of chemistry at Pitt. "People would be able to detect the nitric oxide levels in their breath and take their asthma medication as a preventive treatment."

Star's lab also found that cup-like nanomaterials can be built in small quantities, says Star. For that to happen, nanomaterials must be made to safely degrade in the human body. Star's research includes investigating the impact such materials have on the environment and on human cells. His lab, for example, was the first to discover that enzymes derived from horseradish could be used as a catalyst for degrading nanotubes.

Recently, the first human enzyme capable of biodegrading carbon nanotubes was identified by an international team of researchers led by Vaterian Kagan, a professor and vice chair in the Department of Environmental and Occupational Health in Pitt's Graduate School of Public Health. Tests on mice have suggested that inhaling carbon nanotubes can result in severe inflammation in the lungs and early onset of fibrosis. The researchers found that nanotubes degraded with the human enzyme myeloperoxidase did not cause lung inflammation.

The findings suggest that carbon nanotubes might someday be developed as a safe method of delivering drugs and that a natural treatment for people exposed to carbon nanotubes is possible.

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It could be said that nothing shook the nation to its core—and catalyzed a transformation in the way the nation thinks about the complexities of national security and disaster preparedness—like the tragedies of September 11, 2001, and Hurricane Katrina in 2005.

Certainly, preparedness discussions already were occurring at places like the University of Pittsburgh long before those infamous events. But amidst those disasters, the nation’s lawmakers, law enforcers, policy analysts, constitutional rights advocates, public health officials, first responders, the military, and academia suddenly found themselves front and center in national and regional debates. With a new sense of urgency, they grappled with the future what-ifs of disasters—how to better prepare for them, anticipate them, manage them, and mitigate their consequences.

An intellectual “Code Orange” thus ensued over the coming years as thoughtful leaders around the country theorized, planned, and simulated possible future disasters—and worked to solve technological problems at a level of intensity not seen before.

Among them, of course, was a diverse group of University of Pittsburgh researchers and policy experts who joined forces to build their own academic discussions; conduct intensive research; and, ultimately, develop science-driven big-picture frameworks to harness the complexities of large-scale disasters. That collective initiative culminated in 2004 with the launch of the University of Pittsburgh Center for National Preparedness.

Since then, the multidisciplinary center has helped to drive the national agenda. Its leaders hail from Pitt’s Schools of Medicine, Information Sciences, Law, Nursing, and Swanson School of Engineering as well as, among others, the Dietrich School of Arts and Sciences and the Graduate Schools of Public and International Affairs (GSPIA) and Public Health (GSPH). The center’s researchers have developed new innovations in such areas as disaster management, robotic search and rescue, information analysis, and public health monitoring.

But that’s only the beginning.

By taking the issue of national preparedness to a new level, these collaborative experts have created a whole new academic discipline at Pitt.

“It’s a cycle.”

“National preparedness is about having leaders who expect or anticipate things that previously were unimaginable,” says Carey Babakin, a professor in the School of Medicine’s Departments of Otolaryngology and Neurobiology and a seemingly unlikely codirector of the Center for National Preparedness. “These leaders know the possibilities, try to mitigate them beforehand, respond quickly when they occur, and build to prevent them from recurring. It’s a cycle.”
National Preparedness

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CAREY BALABAN
CONNECTOR CENTER FOR NATIONAL PREPAREDNESS
PROFESSOR OF OTOLARYNGOLOGY, SCHOOL OF MEDICINE

And now it's a science, too, according to Balaban and Kenneth Sochats, an information systems engineer who also is a founding codirector of the center.

"We're making a science of national preparedness," Balaban declares. "We have taken an evidence-based, systems-of-systems analytic approach to issues of national preparedness. We are bringing the full rigor of the academic environment to practical problems that improve outcomes for the good of society."

A BRIEF HISTORY

While Pitt researchers had been studying national preparedness issues substantively prior to September 11, 2001, the fall of the World Trade Center towers quickly prompted the University's Office of the Provost to evaluate its own potential for creating a national preparedness-focused research program, which included an inventory of any current related research.

A consulting firm's conclusion at the time, according to George Klinzing, was, "You already have one. The Scharpenburg Report (as the consulting firm's report came to be known) confirmed that we have great strength in the areas of health and information science."

"We're finding that the different aspects of a national preparedness, We're finding that the different aspects of health and information science."

Balaban and Sochats say, "They really work great together."

"I think that, after a broader focus earlier in its evolution, we've found some solid niches on which to build. I'm happy with them; we have the right talent."

Sochats, who has spent more than 30 years working in both academia and the telecommunications industry, says the center has matured in its focus since "the early days, when everybody was scurrying around exploring a number of competing theoretical approaches to managing disasters." He adds, "It's still a new field, but now we're actually developing tools and producing educational programs."

And the center's doing so in partnership with, among others, the Potomac Institute; Harris Corp.; Lockheed; the military; federal agencies such as the North American Aerospace Defense Command (NORAD); the Federal Emergency Management Agency (FEMA); the National Institute of Standards and Technology (NIST); and the Pennsylvania legislature for a statewide public health preparedness and disaster response.

"Traffic congestion resulting from an explosion in the West End of Pittsburgh"

On the ethics front, the Matthew B. Ridgway Center for International Security Studies within Pitt's Graduate School of Public and International Affairs began to study the ethical dilemma presented by effectively gathering security intelligence on potential terror threats while still respecting the constitutional privacy rights of U.S. citizens.

Another initiative that brought Pitt to the forefront of national preparedness shortly after the 9/11 tragedy included the Regional Biocontainment Laboratory, Pitt's $17.5 million grant in 2003 to establish this laboratory—one of nine centers nationwide that were funded by the Centers for Disease Control and Prevention.

"Traffic congestion resulting from an explosion in the West End of Pittsburgh"

At the same time, Margaret Potter, a Pitt professor of health policy and management and director of Pitt's Center for Public Health Practice, was advocating with the Pennsylvania legislature for a statewide public health communications network that would improve the response to local emergencies. Potter also served as principal investigator with the Graduate School of Public Health's Center for Public Health Preparedness, one of 22 such centers nationwide that were funded by the Centers for Disease Control and Prevention.

Today, that center (www.prepare.pitt.edu) continues to thrive, educating and training public health workers and school personnel in preparedness issues such as emerging infectious diseases, disasters, preparedness law and policy, and crisis leadership. The center also oversees a graduate certificate program in public health preparedness and disaster response.

"Traffic congestion resulting from an explosion in the West End of Pittsburgh"

PREPAREDNESS TODAY: AN EVOLVING DISCIPLINE

Today's Center for National Preparedness continues to pave new paths in helping to drive the nation's preparedness agenda.

"Traffic congestion resulting from an explosion in the West End of Pittsburgh"

"It has morphed in a lot of ways," Klinzing says of the center. "We're finding that, after a broader focus earlier in its evolution, we've found some solid niches on which to build. I'm happy with them; we have the right talent."

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Once together, though, this emerging team not only agreed to lead the new center, but they also began to explore—over lots of Starbucks coffee—the need for new decision-making tools in managing disasters that account for the many “actors” responding to or affected by a disaster and the fast-changing dynamics of the disaster scenario. Eventually, their collaboration led to the development of what they call their Dynamic Discrete Disaster Decision Simulation System, or D4SS.

The patent-pending system, which continues to evolve, integrates a geographic information system, discrete event simulation, a custom-built decision-making system, and a control interface that resembles an emergency operations center. It allows users to overlay all actors in a given disaster and informs each group continuously as situations change and decisions are made.

“It’s all about situational awareness,” Balaban says, as he compares the system to the human body’s neural system. “It’s all about prediction and dealing with complex interactive networks and how they operate together. I think it’s actually a very powerful platform for other applications. ... We expect this to become a premier tool in emergency response.”

Balaban and Sochats are working with the University’s Office of Technology Management to commercialize their innovation.

AVOIDING THE “CASCADE OF FAILURE”

When Louise Comfort, a professor in GSPIA since 1984, looks at a disaster, she sees multiple actors and situations and a sequence of decision points that can, in cases like the Hurricane Katrina disaster, lead to a “cascade of failure.”

“I’m very interested in the decision making,” says Comfort, an organizational design theorist and policy analyst. “I believe that the decisions made in the initial response to a disaster will set the trajectory of the rest of the situation and determine whether it will escalate or not.”

Her biggest complaint: “The information was there, but it was very complex, and nobody put the pieces together. Nobody saw the whole. That’s exactly what we’re trying to facilitate with computational decision support for human managers.”

Comfort, who also spent time recently in Japan studying the response to the March 2011 earthquake, tsunami, and subsequent nuclear disaster there, has turned her analysis into what she calls the Interactive Intelligent Spacial Information System (IISIS). She describes her innovation as a computer-based decision support tool that tracks and monitors the interactions between critical conditions, actors, and agencies in real time, providing decision support for emergency managers in a rapidly changing, urgent environment.

“I study ways that computers can extend human capacity for decision making in urgent situations, when human decision-making cognitive capacity drops under stress,” Comfort says of her innovation and research. “The one constraint is that human minds are much faster than machines, but human beings also make more mistakes.”

Comfort says she continues to update her computer system, recently adding modules for an engineering dashboard for hospitals and collaborative decision support for airport fire-rescue teams. Meanwhile, she also is studying the concept of regional risk assessment and is working on helping others “to look at the whole set of hazards that could happen in a region” and helping them to develop “complexity profiles,” among other tools, she says.

Is she obsessed with studying disaster response? Maybe a little bit. “I am thinking about disasters all the time,” Comfort deadpans. “But given my teaching schedule, I can probably manage [researching] one disaster a year.”

MAKING OPINIONS MATTER

While some researchers work on ways to prevent or manage disasters and possible security threats, one Pitt professor and her research team are trying to harness the potential intelligence that could be extracted and interpreted from vast amounts of printed text.

Janyce Wiebe, a professor in the Dietrich School’s Department of Computer Science and co-director of a multiuniversity intelligent Systems Program initiative, is collaborating with Rebecca Hwa, a professor of computer science at Pitt. They, along with researchers from several other universities, are working to develop what Wiebe describes as machine learning-based statistical models that can rapidly process large volumes of unstructured text in search of opinions, general sentiments, motivations, and tensions.

“Making decisions, policymakers have to be aware of what people are writing and saying,” Wiebe says. “What are all of the opinions being expressed, and how do they travel over time and forums? There are vast amounts of texts, and humans can’t possibly read it all, so we want to develop systems that can bring the relevant data to analysts’ attention.”

And what are these systems looking for in those texts? “I’m looking for subjectivity—the linguistic expression of somebody’s opinions, sentiments, emotions, evaluations, beliefs, speculations,” Wiebe says. “You can’t just look for points like ‘good’ and ‘bad.’”

MULTIPLE-ROBOT SEARCH AND RESCUE SIMULATION

Also building on Pitt’s strength in information sciences is Michael Lewis, a professor of intelligent systems programs in the University’s School of Information Sciences. He started working on human-robot interaction research in the area of search and rescue beginning in 2002, supported by a National Science Foundation Information Technology Research grant.
Lewis, in collaboration with Carnegie Mellon University researchers, began to develop robots, design interfaces, and equipment, all aimed at search and rescue with multiple robots in extreme environments. Ultimately, the researchers developed an urban search-and-rescue simulation that eventually was used in a national Virtual Robots RoboCupRescue Competition. The simulator also has been used by many researchers across the country to support and test their own robotic development efforts in search and rescue.

Among the challenges that Lewis and his collaborators tackled with the simulation platform were organization and command and control using multiple platforms. Lewis says, “When you have four or five robots in one area, you get lots and lots of redundancy, and it gets very confusing,” Lewis says. “They may be good for search and rescue of static targets, but it’s more difficult with dynamic targets.”

More recently, Lewis and researchers from Carnegie Mellon, Lockheed Martin, and the Eglin and Wright-Patterson Air Force bases have been developing prototype interfaces and intelligent-agent coordination algorithms for interacting with small teams of unmanned aerial vehicles and unmanned ground vehicles. The challenge is to find ways to elaborate communications systems capable of managing large numbers of robots.

Williams, the Wesley W. Posvar Chair in International Security Studies and director of GSPSA’s Matthew B. Ridgway Center for International Security Studies, has redirected the center’s research focus to target this threat category and develop an academic program around it in collaboration with the likes of the Carlyss, Pa.-based U.S. Army War College’s Strategic Studies Institute. He has found plenty to observe.

“If you look around the world, there has been a phenomenal rise of violent nonstate actors,” says Williams, who singles out Mexico and the Middle East to make his point. “Around the world, something is going on with states where we have more weak states, unstable states, and even failed states. And because of globalization, the instability is spilling over to developed countries. So we have a much less stable world where things are much less predictable.”

Williams says the Ridgway Center has been developing an academic effort “to get a handle on the new threat.” The new endeavor also has led to the addition of several new security studies faculty members in GSPSA, who have increased the Ridgway Center’s depth. “We’re building a niche within that subject,” he adds.

Among Williams’ own academic interests, which focus largely on the “pernicious” interconnectedness of these armed groups, are the relationship between terrorists, criminals, and drug-trafficking organizations; the question of whether drug organizations in Central and South America are willing to help fund terrorists; links between those drug-trafficking organizations and terrorist groups in West Africa; and, more academically, the question of whether these threats represent disparate threats that seem to be converging to create fewer but bigger threats or threats that are diverging, creating more threats about which to worry.

THE ACADEMICS OF NONSTATE VIOLENCE

One doesn’t need to look much beyond the so-called Arab Spring uprisings throughout North Africa and the Middle East, the chaos of Somalia, the insurgent Taliban, or Mexico’s drug culture to realize that national preparedness and security in the future will depend largely on a new and better understanding of the world’s fast-emerging threats. That is what GSPSA Professor Phil Williams (right) calls such violent nonstate actors as terrorists, criminals, insurgents, pirates, militias, warlords, and drug traffickers, among other armed groups.

As Williams, in defining the future academic challenges of the Ridgway Center, told an audience during his inaugural lecture, “The rise of violent, nonstate actors is one of many developments that have made the security agenda in the 21st century both more crowded and more complex.” His contention, which drives his research and teaching, is, “The issue is not simply that governance is inadequate to meet security challenges; rather, it is that poor governance itself is a major source of insecurity and disorder.”

THE EMERGENCE OF AN ACADEMIC DISCIPLINE

Recognizing a need to turn all of this collective research into a big-picture academic discipline with substance, Balaban and Sochats have spearheaded a Center for National Preparedness-based initiative to develop an entire University curriculum around national preparedness. As such, the team, in partnership with Pitt’s College of General Studies, launched in fall 2010 an 18-credit Certificate in National Preparedness and Homeland Security program.

The program focuses on the analytical and managerial aspects of preparedness at the international, national, state, and local levels. It describes itself as evidence-based, analytical, systems-of-systems oriented, and visual.

“We’re trying to develop scholars in this area,” Balaban says of the certificate program. “We now have the vision of what a Pitt graduate in this area should look like: one who adept an analytic, often innovative approach to managing issues of national preparedness.”
Despite these achievements, there are significant gaps in our understanding. But, day by day, University of Pittsburgh neuroscience faculty work to unlock the brain’s remaining secrets, attracting considerable research support to the University, primarily from the National Institutes of Health (NIH).

Throughout the past two decades or more, Pitt has built itself into a leader in brain research, focusing on its strengths in basic and clinical science. A spirit of collaboration is engendered in this work through the Center for Neuroscience, a University-wide center encompassing neuroscience on campus. The center’s diverse and multidisciplinary nature is reflected by the more than 30 different academic departments and centers in which more than 100 faculty conduct neuroscience research. Doctoral and postdoctoral trainees also play a major role in the center’s research activities, as do students in the highly successful undergraduate neuroscience major in the School of Arts and Sciences’ Department of Neuroscience.

Neuroscience research at the University runs from conducting basic cellular science to developing medications to building prostheses to replace damaged limbs. It includes work done through the Department of Psychiatry in the School of Medicine (and its clinical affiliate, Western Psychiatric Institute and Clinic [WPIC] of UPMC), for decades a national leader among NIH-funded psychiatry departments, which received about $90 million in total research funding in 2010. It also includes work through the Center for the Neural Basis of Cognition (CNBC), a joint venture of the University of Pittsburgh and Carnegie Mellon University that leverages the strengths of each to support a coordinated research and education program of international stature.

The following profiles in neuroscience research by prominent members of our faculty are just a sampling of the exceptional neuroscience enterprise here at the University of Pittsburgh.

Although it is a three-pound lightweight, the brain is the human body’s uncontested heavy hitter. Its 100 billion neurons control the seat of all knowledge, power the central nervous system, and cradle the soul of our individuality. We have mapped its lobes, nerves, and blood vessels. We have labeled its cells; divided its activities into motor, cognitive, and sensory; and sorted its matters according to color—gray, white, and substantia nigra (Latin for black stuff).
Developmental neuroscience to his behavioral research. “We have spent more than 20 years probing the foundations of antisocial behavior in children, looking for ways to successfully intervene before it’s too late. “We have funding from the National Institute on Drug Abuse to look at the effects of genetics on brain function, the effects of environment, and the interactions between genetics and environment,” he says.

“We have more than 100 brain scans so far—unusual for this literature—but we have an incredible cohort,” says Shaw. “We hope to have a breakthrough paper when it’s all ready [in late 2011].”

YOUR BRAIN ON ADOLESCENCE

For Beatriz (Bea) Luna, a professor of psychiatry in the School of Medicine and of psychology in the Dietrich School of Arts and Sciences, there is no question that maturity modifies brain function. Winner of a 2005 Presidential Early Career Award for Scientists and Engineers, Luna uses functional magnetic resonance and diffusion tensor neuroimaging technologies to study how brain mechanisms underlying cognitive skills develop during adolescence—a period often marked by a spontaneous combustion of risk taking, misjudgments, crisis-level mood swings, and impulsivity.

“As a teenager, I remember thinking that something extremely special was going on and at the same time knowing it was temporary,” says Luna, who also is founding director of the Laboratory for Neurocognitive Development at WPI. “I looked at my parents, and I knew they didn’t think in the same way that I did.”

Connections between neurons—called synapses—multiply rapidly during the first two years of life, followed by a process to cull superficial connections and strengthen those used most frequently. Scientists believe this process allows the brain to adapt to an individual’s particular environmental needs. “Adolescence is not a disease,” she says with a smile. “It’s an extremely special time that everybody should be encouraged to explore, gain experience and independence, and sculpt their future selves.”

Selected by NIH to serve as a member of its Advisory Committee to the Director, Luna also has advised the U.S. Supreme Court on sentencing guidelines for adolescent offenders. “As we understand more and more about how the brain works,” she says, “we can try to understand breakdowns that may lead to conditions like ADHD, autism, and mental illnesses like depression and schizophrenia.”

A MATTER OF MENTAL HEALTH

Molecular neurotransmitter pathways also intrigue David A. Lewis, UPMC Professor of Translational Neuroscience and chair of the Department of Psychiatry, who investigates pathways’ relevance to the devastation of mental illness. “Brain circuitry abnormalities appear to underlie schizophrenia,” says Lewis, who also is director of Pitt’s National Institute of Mental Health-funded Conte Center for the Neuroscience of Mental Disorders. “These abnormalities change with development and may generate different symptoms yet are interconnected.”

A complex disorder, schizophrenia affects more than 1 percent of the population. Clinical symptoms typically become apparent in teenagers and young adults, and the disorder frequently results in a lifelong struggle against severe cognitive and social challenges. Symptoms range from disordered thoughts, delusions, and hallucinations to motivational and an emotional “absence” called flatness. There also can be difficulties in thinking, attention, and memory.

“While schizophrenia is a disturbing illness, it’s a disease of the brain,” she says. “If we understand more and more about how the brain works, we can try to understand breakdowns that may lead to conditions like ADHD, autism, and mental illnesses like depression and schizophrenia.”

EXCELLENCE | IN RESEARCH

A complex disorder, schizophrenia frequently results in a lifelong struggle against severe cognitive and social challenges. Current medications primarily target delusions and hallucinations; there are few treatments available that help patients to manage disordered thinking, motivation, or memory. A troubling susceptibility among many with schizophrenia to fail prey to addictions—perhaps as a form of self-medication—also presents challenges.

Among Lewis’ recent publications are studies of the biochemical relationship between the neurotransmitter gamma-aminobutyric acid (GABA) and a key ingredient in marijuana that suggest a biological basis for population studies that connect marijuana use during adolescence with an increased risk of developing schizophrenia. In addition, the course of illness is worse for people with schizophrenia who use marijuana, he says.

Because GABA is known to be reduced in schizophrenia, these findings suggest possible new drug targets that could improve brain function in individuals with schizophrenia. One of the most studied brain areas is the dorsolateral prefrontal cortex, which houses executive processes and working memory, says Lewis, defining working memory as the ability to remember information transiently and use it to guide behavior or thought. “Now we are working to decipher the specific components—the molecules, cells, and synapses—and the larger circuit present in the dorsolateral prefrontal cortex that are behind this disturbance,” he adds.

Among these components, morphological evidence reveals that some neurons may even be smaller and have fewer dendritic protrusions called spines, which help to transmit electrical signals to the neuron. Other neurons exhibit variations in gene product expression. “There may not be a classic neuropathology of schizophrenia similar to the tangles and plaques characteristic of Alzheimer’s disease,” says Lewis. “But that doesn’t mean there aren’t changes in the brain that are, in fact, the basis of the illness.”

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NEUROTRANSMITTERS GONE WILD

Brain regions associated with schizophrenia include the hippocampus and prefrontal cortex. Drug use and environmental toxins are implicated in its development; there also are several candidate genes and possible roles for the neurotransmitters dopamine, glutamate, and serotonin. Rodent models of schizophrenia developed at Pitt point strongly to the hippocampus.

“The question is, ‘What’s wrong?’” says Anthony A. Grace, Distinguished Professor of Neuroscience in the Dietrich School of Arts and Sciences, who helped to develop this study. Among his observations is that there is hyperactivity in the hippocampus because of altered GABA transmission that ultimately results in dopamine system overdrive.

David Lewis, Anthony Grace

NEUROSCIENCE

We’re working with a chemist at the University of Wisconsin to design drugs specific to the alpha 5 GABA receptor in the hippocampus. These drugs are like Valium and other benzodiazepines in that they amplify GABA. These seem to reverse this physiological and behavioral response and could turn out to be a new antipsychotic,” says Grace.

PITTSBURGH INSTITUTE FOR NEURODEGENERATIVE DISEASES

Located in Pitt’s state-of-the-art Biomedical Science Tower 3, the Pittsburgh Institute for Neurodegenerative Diseases (PIND) brings together scientists who are working on degeneration from a number of perspectives. But investigators have one collaborative goal: to conduct successful translational research toward potential therapies for neurodegenerative diseases.

J. Timothy Greenamyre, UPC Professor of Movement Disorders, vice chair of the Department of Neurology, and PIND director, studies the mechanisms that cause nerve cell death in disorders like Parkinson’s, Huntington’s, and Alzheimer’s diseases.

“What is it in Parkinson’s that makes dopamine neurons so vulnerable?” Greenamyre asks, listing mitochondrial abnormalities and systemic exposure to environmental toxins among likely suspects. “Odds are that genetics loads the gun, and something in the environment sets it off.”

Considered a world expert on mitochondria, the “power plants” of living cells, Greenamyre becomes particularly passionate about rotenone. A commonly used pesticide, rotenone until recently had support even among organic food producers and home gardeners because it is found naturally in a number of tropical plants. “We used to sprinkle it on our tomato plants,” Greenamyre says, grimacing.

“Normal GABA activity is essential for proper cortical structure functioning,” Grace notes. GABA loss, in turn, disrupts other key brain cell communications involving stimulus recognition and higher cognitive function, he adds. Grace believes similar neuron and GABA losses in the prefrontal cortex also contribute to cognitive deficits associated with schizophrenia. In addition, other characteristics are exhibited that are consistent with human schizophrenia patients, including amplified startle reflex, altered executive function, and hyperresponsiveness to drugs of abuse like phencyclidine and amphetamine.

Perhaps the most significant diagnostic advance in Alzheimer’s research today is Pittsburgh Compound-B (PiB). PiB allows clinicians to see amyloid plaques in the living brain of individuals with Alzheimer’s and also in those who do not yet exhibit signs of the disease. This finding could lead to earlier diagnosis, illuminate disease progression, and uncover prevention strategies.

Classified as moderately hazardous by the World Health Organization, rotenone targets mitochondria. In studies of a model of Parkinson’s disease, researchers found that rotenone “acts systemically, yet is specifically neurodegenerative,” says Greenamyre. Based on Greenamyre’s work in the laboratory, a recent epidemiological study has confirmed that human exposure to rotenone is a risk factor for the disease.

Other Greenamyre investigations involve reactive oxygen species and alpha-synuclein. “We know that alpha-synuclein is a major player,” Greenamyre says of the protein, which is a significant component of Lewy bodies—clumps of proteins that are a clinical hallmark of Parkinson’s. Alpha-synuclein is found throughout the central nervous system, but its function in the healthy brain is currently unknown.

Edward A. Burton, assistant professor of neurology and of microbiology and molecular genetics, is developing zebrafish models of progressive supranuclear palsy, a rare brain disorder that causes Parkinson’s-like disabilities yet does not respond to Parkinson’s medications. Developed through genetic modification, these fish overexpress a form of human neuronal tau, a protein also associated with Alzheimer’s disease and dementia secondary to traumatic brain injury.

“We see age-related progressive neuropathology and motor difficulties in adult animals,” says Burton, who also has engineered tau transgenic for screening. Using these models, Burton and colleagues hope to identify therapeutic targets for the development of new candidate drugs. Already, he has been able to establish noninvasive evaluation methods that are sensitive to neural dysfunction and could be used to detect repair mechanisms.

PITTSBURGH COMPOUND B

Perhaps the most significant diagnostic advance in Alzheimer’s research today is Pittsburgh Compound B (PiB). Developed and tested by William E. Klunk, Distinguished Professor of Psychiatry and Neurology, and Chester A. Mathis, professor of radiology and director of Pitt’s Positron-emission Tomography (PET) Facility, PiB allows clinicians to see amyloid plaques in the living brain of individuals with Alzheimer’s and also in those who do not yet exhibit signs of the disease.

This finding could lead to earlier diagnosis, illuminate disease progression, and uncover prevention strategies.

PiB imaging also can be used to differentiate Alzheimer’s from other forms of dementia and to directly measure the effects of anti-amyloid therapies currently in development. For their work, Klunk and Mathis have earned major honors, including the Ronald and Nancy Reagan Research Institute Award for outstanding contributions to research, care, and advocacy for Alzheimer’s disease and the Potamkin Prize, often called the “Nobel Prize” for neurology.

VIRAL VECTORS BLAZE THE TRAIL

Peter Strick, Distinguished Professor and chair of the Department of Neurobiology, uses rabies and herpes simplex viruses to “envision” neural pathways related to movement.

Peter Strick
Strick investigates the essential connections between function and physiology, cognition and behavior. Using viral markers, Strick can work neuron to neuron, linking neurons like individual cars that together give purpose to a speeding train.

With the viruses revealing chains of synaptically connected neurons, Strick has uncovered new evidence that the brain’s basal ganglia and cerebellum are linked to form an integrated functional network. The findings provide a neural basis for a cerebellar contribution to some of the disabling symptoms of basal ganglia disorders like Parkinson’s and dystonia.

“Have always been interested in the nature of volition,” says Strick, also codirector of the Center for the Neural Basis of Cognition. “How is it that when I want to move my finger, it moves? What regions of the brain are involved in that?” Strick investigates the essential connections between function and physiology, cognition and behavior. Using viral markers, Strick can work neuron to neuron, linking neurons like individual cars that together give purpose to a speeding train.

“We can work out the circuitry,” Strick says, listing potential investigations to further elucidate the connection between the basal ganglia and cerebellum. “There’s growing evidence, for example, of cerebellar involvement in addiction and fear response,” he continues, adding that knowing how such connections work could lead to new treatments not only for addictions but also for post-traumatic stress disorder.

In previous work, Strick mapped a new area of the cerebral cortex that has evolved to enable humans and other higher primates to perform fine motor tasks. His findings show that the brain’s primary motor cortex has adjacent “old” and “new” regions. But unlike the older, less direct region more active in lower animals, this newer region directly controls spinal motor neurons to activate shoulder, elbow, and finger muscles, refining movements required for complex tasks like playing a musical instrument. In recognition of his seminal findings in neural tracing studies, Strick was elected a fellow of the American Academy of Arts and Sciences in 2004.

TRANSLATIONAL SCIENCE AND STROKE

“There are so many diseases where neurons die—degenerative diseases like Huntington’s, traumatic brain injury, stroke,” Robert M. Friedlander, professor and chair of the Department of Neurological Surgery, says with a sigh. “Causes may differ, but many of the pathways mediating cell suicide are shared. As we better understand these pathways, we can be better prepared to develop novel therapies for these often devastating and untreatable diseases.”

Friedlander’s lab works with models of stroke, spinal cord injury, Huntington’s disease, multiple sclerosis, and amyotrophic lateral sclerosis (ALS, or Lou Gehrig’s disease), testing drug libraries for potential new uses. Experiments have shown that the antibiotic minocycline appears to delay disease progression, along with the hormone melatonin and the antiangioma drug methotrexamide. Clinical trials with minocycline are now under way.

The third-most common cause of death, stroke is the leading cause of disability in the United States. Triggered by blockage of a blood vessel by a blood clot or by a small burst blood vessel, which leads to a lack of oxygen to the brain, the most common cause of inpatient hospital care. Unchecked, it can lead to death.

Andrew Schwartz

Throughout the past two decades or more, Pitt has built itself into a leader in brain research, focusing on its strengths in basic and clinical science. A spirit of collaboration is engendered in this work through the Center for Neuroscience, a University-wide center encompassing neuroscience on campus.

Andrew Schwartz

“Want the patient to use the robotic arm to reach out, grab objects, and interact,” says Schwartz, explaining that the sensory cortex of one patient’s brain also will be stimulated by an implanted electrode array, allowing him or her to “feel what the robot hand is doing.”

These examples only hint at an intensity of neuroscience expertise that the University of Pittsburgh shares with few institutions. Arthur S. Levine, senior vice chancellor for the health sciences and dean of the School of Medicine, says he can envision the future development of a neuroscience research institute similar to the current University of Pittsburgh Cancer Institute. Such a center could support, recruit, and focus the collaborative brain power of talented faculty to further reveal the organ that Luna calls “this wonderful machinery that holds the secret of who we are.”
It should come as no surprise, then, that in 1956, when Edward Litchfield was appointed chancellor, he had a mandate to effect that transformative change, and he, in turn, appointed Charles H. Peake vice chancellor for the academic disciplines. By the end of the decade, Peake had articulated a strategy to improve Pitt's status within the humanities by attracting to the university a coterie of young scholars who were just beginning to make waves in the world of philosophy. This marked the beginning of a dramatic shift in purpose and scholarship at Pitt.

"Until about 50 years ago," says Distinguished Service Professor of Philosophy Robert Brandom, "there were a handful of elite universities maintaining uniformly excellent academic departments across the board, and the vast majority of world-class scholars, researchers, and experts in their fields were to be found in them. But now any serious American research university can be expected to have some world-class departments, and most of the departments will have at least some world-class faculty members. Because of Charlie Peake's early commitment to philosophy, Pittsburgh was in the vanguard of this sea change."

With the help of Pitt's Andrew W. Mellon Professor of Philosophy of Science Adolf Grünbaum, the results soon exceeded Peake's most optimistic ambitions, as the University of Pittsburgh Department of Philosophy quickly earned a nearly unparalleled reputation as a preeminent new center for research within the field.
In time, some of the most distinguished names within the realm of 20th-century scholarship joined the department, including the late professors Wilfrid Sellars, Carl Hempel, Kurt Baier, and Wesley Salmon. The many doctoral students they educated now occupy important positions across the contemporary philosophical scene, while their successors at Pitt carry on their tradition of excellence in scholarship and teaching. The University expanded its philosophical offerings by establishing the world-renowned Center for Philosophy of Science in 1960 and the independent Department of History and Philosophy of Science in 1971. Along with the philosophy department, these academic sites enhance and develop philosophical inquiry at the University of Pittsburgh and in the larger academic community.

DEPARTMENT OF PHILOSOPHY

Since 1960, Pitt's philosophy department has consistently been ranked in the top five philosophy departments nationally (National Research Council, The Letter Report). The department is currently the intellectual home of 19 primary faculty members and more than 50 graduate students. Fifteen secondary and affiliated faculty members also contribute to the life and scholarship of the program. Among the top U.S. departments, Pitt's has most consistently strived to maintain a broad coverage of key research interests, ranging from technical studies in logic and science to ethics and aesthetics.

Logic

Research in philosophical logic has been a mainstay of the philosophy department since its founding days, and many of the pioneering discoveries that later proved important in computer science were developed at Pitt by the late professor Alan Ross Anderson and by Nuel D. Belnap, Jr., Alan Ross Anderson Distinguished Professor of Philosophy, professor of history and philosophy of science, and fellow of the Center for Philosophy of Science. Today, allied investigations relating to the concept of "truth" are being pursued by a number of faculty members, including Assistant Professor James Siew, Brandon (who also is a fellow of the Center for Philosophy of Science), and Department of Philosophy Chair Anil Gupta. Distinguished Professor of Philosophy, professor of history and philosophy of science, and a fellow of the Center for Philosophy of Science. In recent years, Gupta (who now occupies the Alan Ross Anderson Chair in Logic) has applied some of the tools that he and Belnap developed with respect to truth to the behaviors of epistemological terms such as "experience" and "content."

Anil Gupta

Gupta's new work can be viewed as continuing the epistemological objectives that underpinned the research of the late Wilfrid Sellars, one of the department's important early members, who is now widely regarded as a great thinker within 20th-century American philosophy.

Both Distinguished University Professor of Philosophy John McDowell and Brandom also have attempted to combine Sellars' insights with other vital sources of philosophical traditions. In particular, McDowell and Brandom (sometimes referred to, as in the subtitle of a recent book, as "the Pittsburgh neo-Hegelians") have been at the forefront of a recent revival of interest in Hegel that, in conjunction with a parallel rediscovery of Kant, has stood behind some of the most stimulating developments within English-language philosophy over the last 40 years. McDowell also is one of the most important interpreters of the thought of Ludwig Wittgenstein. His synthesis of these concerns with a reading of Aristotle has sparked a contemporary neo-Aristotelian movement (in which Pitt Professor of Philosophy Michael Thompson is a principal player), which began in ethics and has spread to metaphysics.

Normative Study

Another grand Pittsburgh tradition is the field of normative study. Several of the central figures within late-20th-century ethics—the late professors Kurt Baier, Professor Emeritus David Gauthier, and Alan Gibbard (now at the University of Michigan)—taught at Pitt, and their work is continued today by McDowell, Thompson, Professor of Philosophy Kieran Setiya, and Assistant Professor of Philosophy Karl Schaf.

The interests of these scholars range widely, but their proposals tend to be strongly informed by a rich appreciation of the field's history. In these endeavors, the moral theorists have profited greatly from the presence of several specialists who have concentrated upon the history of ethics, including Professor of Philosophy Stephen Engstrom and recently hired Assistant Professor of Philosophy Kristen Ingles. Engstrom's recent book, The Form of Practical Knowledge, already has gained a reputation as a vital contribution to our understanding of Kant's moral thought.

Philosophy of Science

Although Pitt's philosophy of science core offerings now reside within the sister Department of History and Philosophy of Science, the philosophy department has continued to maintain its own stable of specialists in the subject, especially those who focus on scientific issues related to metaphysics and philosophy of mathematics. Professor Kenneth Manders, who is a fellow of the Center for Philosophy of Science and has a secondary appointment in the Department of History and Philosophy of Science, specializes in the history of geometry and algebra. Assistant Professor of Philosophy Giovanni Valente (also a fellow of the Center for Philosophy of Science) explores the baffling mysteries of quantum physics and statistical mechanics. Mark Wilson and Professor of Philosophy Robert Batterman (an associate director of the Center for Philosophy of Science) have recently become interested in the philosophical salience of recent work within materials science. They feel that such studies open fresh avenues of approach with respect to many standard philosophical concerns within metaphysics and philosophy of mind.
Whatever its specific interests, the department’s philosophy of science faculty contingent strongly feels that its investigations need to be continually tempered by an appreciation of how allied proposals have unfolded within the history of ideas. Here they rely, just as its ethicists do, upon the strong group of local historians, both within the department proper and elsewhere in the University (many of whom serve as valued adjuncts to the philosophy department). Engstrom, Brandon, Associate Professor of Philosophy Anja Jauernig (also a fellow of the Center for Philosophy of Science), and Distinguished University Professor of Philosophy and Center for Philosophy of Science Cochair Nicholas Rescher are the linchpins of the department’s early modern coverage, while James Allen—a professor of philosophy and fellow of the Center for Philosophy of Science—and Inglis handle the ancients (with help from their colleagues in Pitt’s interdisciplinary Classics, Philosophy, and Ancient Science Program).

McDowell, Wilson, and Professor of Philosophy Thomas Ricketts concentrate upon more recent historical developments within the analytic tradition. Pitt’s University Library System Archives of Scientific Philosophy are world renowned for their extensive historical holdings in 20th-century analytic philosophy, and Ricketts, in particular, consults these materials in his trailblazing research into the thought of Rudolf Carnap and Ludwig Wittgenstein.

In reflecting on the scope of philosophical inquiry, Rescher observes that “philosophy in the modern period pursues how they were practiced, how they developed, and how theories explain and are confirmed and whether they should be read literally, and the moral dilemmas raised by the sciences. Scholars also investigate the conceptual content of individual sciences and how this bears on the following ancient philosophical questions: What is the nature of space, time, and matter? What is life? What is thought? The history and philosophy of science discipline is distinctive in integrating these areas of study.

Since 2004, Pitt has been consistently the top-ranked program in general philosophy of science, according to a respected academic survey of experts.

Many history and philosophy of science graduate students come to the program with graduate degrees or undergraduate majors in the sciences, and those who don’t are encouraged to do master’s-level work in a scientific field while working toward their history and philosophy of science doctorate.

“We tend to get two kinds of graduate students,” says Professor and department Chair Sandra Mitchell, who specializes in the philosophy of biology and is a secondary faculty member in the Department of Philosophy. “Many come from backgrounds in the sciences, and they find that what really excites them are questions that are conceptual or methodological. The other kind comes from the study of philosophy, and they have found during their studies that the epistemological questions—how do we know what we know?—can be studied by investigating the history and current practice of science.”

The topics that department scholars explore exhibit a range of interests in philosophy of science, from significant historical discoveries to the cutting edge of contemporary science. The department has several areas of concentration that highlight scholars’ expertise, though all history and philosophy of science faculty travel among these categories and engage with general questions in philosophy of science.

The Department of History and Philosophy of Science comprises nine primary faculty members, six research or emeritus faculty members, and about 30 graduate students who hail from around the globe. The department offers an undergraduate major in the history and philosophy of science, often taken as a second major with one in the sciences; an undergraduate Certificate Program in Conceptual Foundations of Medicine; and an internationally esteemed PhD program.

The department’s scholars believe that the study of the history and philosophy of science affords a broad appreciation of science; its nature and fundamentals; its origins; and its place in politics, culture, and society. In the history of science, historical methods—including archival research, interview, and experiment reenactments—are used to develop an understanding of how the sciences originated, how they were practiced, how they developed, and how they related to their intellectual and social contexts. In philosophy of science, the sciences themselves are brought under philosophical scrutiny. Scholars investigate the nature of science in general, what distinguishes scientific activity, how theories explain and are confirmed and whether they should be read literally, and the moral dilemmas raised by the sciences. Scholars also investigate the conceptual content of individual sciences and how this bears on the following ancient philosophical questions: What is the nature of space, time, and matter? What is life? What is thought? The history and philosophy of science discipline is distinctive in integrating these areas of study.

The Department of History and Philosophy of Science's excellence is known across the globe, evident in the many lectures given by its faculty in China, Australia, Germany, England, Italy, Estonia, France, Turkey, and elsewhere. Its graduate students are drawn from the very best in the world; they complete a rigorous program and go on to help shape the field. Its undergraduates have received many of the most prestigious awards given to students, including Rhodes, Marshall, Mellon Humanities, Fulbright, Udall, Truman, and Goldwater scholarships. Science is increasingly important in daily life. The study of its history, its foundations, its logic, and its development offers rich territory to explore—which is at the heart of the Department of History and Philosophy of Science.

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James Woodward, a Distinguished Professor of History and Philosophy of Science and an associate director of the Center for Philosophy of Science, is a generalist in philosophy of science. He is the department’s most recent senior appointment and current president of the Philosophy of Science Association. He works on causal reasoning, explanation, and theory testing as well as neurobiology and economics. Much of his recent work has focused on causation. His 2003 book, Making Things Happen, winner of the 2005 Lakatos Prize for the best book in philosophy of science, describes a general framework for understanding causes in terms of idealized experimental manipulations or “interventions.” Woodward has been working on extending this framework and in applying it to understand causal reasoning in sciences like biology, psychology, and economics. A closely related interest concerns the empirical psychology of causal learning and causal judgment: “How do human beings (both infants and adults) learn about causal relationships?”

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Professor of History and Philosophy of Science Peter K. Machamer’s expertise on “the mechanical philosophy” of Descartes and Galileo helped inspire a new version of mechanism that is one of the most influential contemporary accounts of scientific explanation and discovery. In fact, his 2000 *Philosophy of Science* article “Thinking about Mechanisms” (written with Lindsey Darden and Carl F. Craver) is the most-cited article for the past three years in the premier journal in the field. Machamer is an associate director of the Center for Philosophy of Science and an adjunct faculty member in the Department of Philosophy.

**History and Philosophy of Biology**

Biology takes center stage in much of the public’s interest in science, from its practical roles in medicine and agriculture to its conceptual role in our understanding of what it means to be a human being. The department’s concentration in this growing area of history and philosophy of science includes faculty experts Professor of History and Philosophy of Science James G. Lennox, Kenneth F. Schaffner, and Mitchell. Schaffner is Distinguished University Professor in the History and Philosophy of Science, University Professor of Philosophy, and a professor of psychology (secondary). He is a member of the World Psychiatric Association-World Health Organization Workgroup on Classification and on International Diagnostic Systems. As such, he put his widely recognized expertise in the philosophy of psychiatry to work to help structure the reference tool used as the international standard by health care providers, researchers, and policymakers. His seminal account of reduction in biology continues to influence contemporary discussions. His research on behavioral genetics combines philosophical analysis of core concepts with capturing historically significant developments in the field by interviewing key scientists.

Mitchell’s research explores contemporary scientific studies of complexity in the life sciences, investigating how new developments in science reshape some of our basic philosophical views. Her 2009 book *Unsimple Truths: Science, Complexity and Policy* lays out her research results on topics including emergent structures, knock-out experiments, and genetically modified foods. She examines our vision of the world, how it is constituted, what kind of knowledge we can have, how to investigate it, and how to act in light of the results of those investigations that reflect nature’s complexity and contingency. Her current research is focused on the multiple scientific perspectives directed toward explaining protein folding. How do the physics of the atomic interactions, the chemistry of the bonds, and the biological function in the cell all contribute to our understanding of this essential ingredient of life? How does the use of “citizen scientists” in the form of Internet game players, for example, change the shape of scientific practice in this domain?

### Ancient and Early Modern Science and Philosophy

Lennox and Machamer contribute to the history and philosophy of science component of this interdepartmental area of research, joined by faculty in philosophy and classics. Lennox explores the ways in which different philosophical views about the nature of life and about science influence the way in which living things are investigated. He starts with Aristotle. The source of the other set of puzzles that directs his investigations is, appropriately, Charles Darwin.

Lennox investigates the ways in which various philosophical influences on Darwin, and his own methodological innovations, shaped his modes of explaining living things. As a committed historian, Lennox naturally asked, what happened in between? In the last decade, he began to focus more intensely on the 18th and 17th centuries, especially on William Harvey, an English physician who studied the circulatory system.

The early modern period stretches roughly from the 15th through the mid-18th centuries. This period includes the scientific revolution (think Copernicus, Galileo, and Newton) and the birth of modern philosophy (think Descartes, Hobbes, and Rousseau) as well as significant transformations in mathematics, mechanics, optics, astronomy, chemistry, biology, and medicine. It also sees the rise of probabilistic reasoning, the emergence of new views of objectivity, metaphysics and epistemology, and deep changes in the wider culture of Western civilization. This is ripe territory for the integrated history and philosophy of science exploration led by Machamer, Lennox, and Professor Paolo Palmieri.

It is a long way from being a control engineer in Italy’s Ferrari plant, charged with the mathematical modeling of the automobile’s dynamics, to poring over dusty archives in Florence. But that is one direction Palmieri’s research has taken. In order to read the manuscripts and fully interpret what the Renaissance scholars added, Palmieri has had to call on his knowledge of Latin, Greek, French, and German as well as his native Italian. What fascinates Palmieri is the creative processes at the crossroads of art, science, and technology.

### History and Philosophy of Psychology, Neuroscience, and Psychiatry

The sciences that study “us” provide a special fascination to historians and philosophers as well as to the curious bystander. The history and philosophy of science is rich in resources that reflect on the sciences that study human behavior. Machamer, Schaffner, and three recently added faculty members—Woodward, Eduoard Machery, and Maznita Chirimuuta—focus their research in this area.

Like many past and contemporary philosophers, Professor of History and Philosophy of Science Eduoard Machery is fascinated by the mind and wants to understand the nature of mental states, the relation between the mind and the brain, the human capacity to make rational judgments and decisions, the function of consciousness, and the origins of morality, among other subjects of study. But, in contrast to many philosophers, Machery doubts that this understanding can be gained through pure philosophical reasoning. Rather, answers to the puzzling questions about the mind are likely to be found at the intersection of philosophy with cognitive science and cognitive neuroscience, and his work is deeply rooted in these scientific disciplines. For example, understanding morality involves its evolutionary origins and the empirical work of moral psychology.
Philosophy of Physics

From Aristotle to Newton to Albert Einstein to today, physics has occupied a foundational place in science. History and philosophy of physics continues to be a core domain of research in the Department of History and Philosophy of Science. Its faculty expertise has always been accorded significant international acclaim. Several members of the faculty delve into the technical details to explore questions about space, time, and matter, including Professor John D. Norton (who also directs the Center for Philosophy of Science and is an adjunct professor in the Department of Philosophy) and Distinguished University Professor Emeritus John Earman, as well as faculty from the Department of Philosophy (Giovanni Valente, Robert Batterman, and Mark Wilson).

What Norton had found connected with Einstein’s greatest discovery, his general theory of relativity. That is the theory that relates gravity to a curvature of space-time and leads to the big bang theory and black holes. The general theory of relativity did not spring fully formed from Einstein’s brow. He had first missed, publishing a misshapen version of the theory in 1913. Just how Einstein had gone wrong was one of the outstanding puzzles of the history of science.

Norton’s work on Einstein shows how the history of science and philosophy of science can be synthesized. While Einstein was struggling with his misshapen theory, he hit upon an ingenious argument, “the hole argument.” Working with his Pitt colleague Earman, Norton found that Einstein’s argument could be recreated in modern debates in the philosophy of space and time. It has now become a modern staple in that literature, providing a strong argument against the thesis that space and space-time are substances.

THE CENTER FOR PHILOSOPHY OF SCIENCE

The Department of Philosophy and the Department of History and Philosophy of Science are teaching departments. A third unit completes the unique philosophical strength of the University of Pittsburgh in philosophy: the Center for Philosophy of Science.

The center is the leading research institute of its type in the world. It hosts visiting fellows, postdoctoral fellows, and senior fellows, eight of whom are in residence at any one time. In the three decades since the visiting programs were initiated, the center has hosted nearly 300 visiting professors from more than 30 countries.

The center supports a busy program of formal events. Its signature series, the Annual Lecture Series, brings leading philosophers of science and scientists of interest to philosophers. It has been in unbroken operation since 1960. There are many lunchtime talks given by fellows, by local faculty from various University departments, or by philosophers of science who happen to be passing through Pittsburgh. The center organizes four or five workshops and conferences annually.

“Subjects of the conferences and workshops range over the full span of sciences,” says Norton. “One workshop might plumb the depths of quantum field theory. Another conference looks at the peculiar status of experiments in science. A third conference might look at modeling.”

Perhaps the most important thing about the center is intangible: It is designed to be a site of intellectual ferment. The best scholars in the field go there when they are ready to free themselves from obligations, to recharge their intellectual batteries by engaging with their colleagues, or to sit down to write their next work.

“It is a busy place, with chance encounters in the hallways leading to collaborations that may extend across the years,” says Norton. “Everyone is just preparing for a talk about to be given, pondering one just heard, preparing to discuss their own work in a small reading group, or eagerly capturing the latest inspiration.”

In conjunction with the University Library System, the Center for Philosophy of Science created and operates philsci-archive, pitt.edu, a preprint server for professional work in philosophy of science. It is the leading repository of its type in the world.

With its unique position in scholarship in philosophy of science, the center is internationally recognized and commonly cited as the center other fledgling organizations seek to emulate.

First published in the Pitt Chronicle October 29, 2012
Translational medicine is an old idea with a new urgency and a new level of support, both of which stem from the realization that modern medicine is on the cusp of great things, but only if we can figure out how to translate good ideas from the lab to the clinic. Pitt has created a support structure and a culture that together demonstrate that translational medicine is simply the way we do science.

“THE UNIVERSITY HAS ALWAYS BEEN STRONG IN TRANSLATIONAL MEDICINE. WHAT IS EXCITING NOW IS THAT WE HAVE A VERY PROMISING SUBSTRATE OF INVESTIGATORS WORKING IN THE CUTTING-EDGE AREAS OF SCIENCE THAT ARE CRITICAL TO THE ADVANCEMENT OF MEDICINE IN THE 21ST CENTURY. AND WE HAVE THEM HERE IN PITTSBURGH, WHERE WE HAVE THOUGHTFULLY AND PURPOSEFULLY CULTIVATED A CULTURE OF COLLABORATION AND INTERDISCIPLINARY TEAM SCIENCE THAT IS RARER IN ACADEMIA THAN ONE MIGHT THINK.”

ARTHUR S. LENINE
SENIOR VICE CHANCELLOR, HEALTH SCIENCES
DEAN, SCHOOL OF MEDICINE

“Unfortunately, the moment we become patients, we want results. We read the newspapers and we know that we are living in a golden age of scientific investigation. So we want our futuristic, life-changing medical care, and we want it now.”

At Pitt, discoveries in the lab get fast-tracked for the clinic.

Here, in a nutshell, is a fundamental challenge facing modern medicine: How can we best translate scientific discoveries made in the laboratory into cures, therapies, and guidelines for the treatment of patients in the clinic?

Outside the medical and scientific fields, most people don’t think about this question. All we know is that the moment we become patients, we want results. We read the newspapers and we know that we are living in a golden age of scientific investigation. So we want our futuristic, life-changing medical care, and we want it now.
the general public in 1965, leading to a dramatic drop in the incidence of this previously unpreventable, devastating disease.

Younger, Pitt Distinguished Service Professor Emeritus of Microbiology and Molecular Genetics, notes that the speed and scope of the clinical trial of the polio vaccine—involving 1.8 million children in 12 states—could never be replicated in today’s regulatory environment. One estimate suggests that it now takes 17 years on average to incorporate new research findings into widespread practice. Translational medicine is the art of improving public health by increasing the rate at which this happens and reducing the time it takes.

“...The University has always been strong in translational medicine,” says Arthur S. Levine, senior vice chancellor for the health sciences and dean of the School of Medicine. “What is exciting now is that we have a very promising substrate of investigators working in the cutting-edge areas of science that are critical to the advancement of medicine in the 21st century. And we have them here in Pittsburgh, where we have thoughtfully and purposefully cultivated a culture of collaboration and interdisciplinary team science that is rarer in academia than one might think.”

WHY TRANSLATIONAL MEDICINE? WHY NOW?

In 2003, the National Institutes of Health (NIH) released a landmark report—the NIH Roadmap—that laid out three themes for the future of biomedical research. The intention was to advance scientific understanding and to ensure that scientific discovery translates to better health. The three themes read like a how-to manual for translational medicine:

- Deepen our understanding of biology by investing heavily in basic sciences like structural biology, molecular biology, and computational biology
- Stimulate interdisciplinary research teams so that scientists routinely move beyond the confines of their own disciplines and explore new organizational models for team science
- Accelerate medical discovery and bring those discoveries to bear on improving people’s health

PITT PRESCIENCE

When the NIH Roadmap was released, researchers and officials on campus might have thought the University of Pittsburgh had helped to draft it. Pitt was already hard at work in these three thematic areas.

Basic sciences research: Since the day he arrived in Pittsburgh in 1968 (after a long career at NIH, significantly), Levine has invested heavily in basic research in biomedical sciences. Building on immunological expertise already in place owing to strong programs in organ transplantation and infectious diseases research, the School of Medicine established the Department of Immunology in 2002. With a handful of high-profile recruits to complement the University’s existing expertise in molecular genetics, Levine jump-started a program in the fast-growing field of DNA repair. Soon after came new departments in structural biology, computational biology, developmental biology, and biomedical informatics.

Interdisciplinary research: Levine’s predecessor, the late Thomas Detre, said decades ago that the research programs that would really take off in the future would be multidisciplinary centers of excellence, where common problems would be approached collaboratively from many different perspectives. In later years, Detre would display an alphabetical list of 60 multidisciplinary centers started at Pitt under his tenure—from AIDS to genetics to tissue engineering—indicating his belief that these centers were key to Pitt’s rapid climb in the ranks of institutions receiving NIH research support. (Pitt entered NIH’s top 10 in 1997 and has been there ever since.)

Clinical research: To better nurture translational medicine, the University created the Office of Clinical Research (OCR) in 2001. Operating across all six health sciences schools—medicine, public health, pharmacy, nursing, dental medicine, and health and rehabilitation sciences—OCR set out to help researchers collaborate across institutional and professional boundaries and to navigate the administrative complexities and nuances of the research process, allowing them to put their focus on research instead of red tape.

To facilitate the translation of discoveries to the real world, the University of Pittsburgh created the Office of Technology Management (OTM) in 1996. Led by Marc Mairadro, associate vice chancellor for technology management, OTM addresses the fact that universities are very good at making discoveries and gathering evidence to answer scientific questions, but the details of commercialization are typically the purview of private industry. OTM ensures that the University interacts with industry to drive research and the translation of research results for the benefit of patients. One very significant stumbling block in this translation is the early stages of a new technology. Traditional NIH funding mechanisms only provide funding for the development of technology to a certain point.

FROM DISCOVERY TO BUSINESS PLAN

The classic translational medicine story begins in a laboratory when a basic scientist takes up the microscope or the latest experimental data and remarks, “Well, that’s odd.” In 1990, one such scientist with a puzzled expression was biochemist Bruce Freeman. He was interested in free radicals, those highly reactive oxygen compounds that can weaken havoc on our cells. It had been shown in the lab that nitric oxide (NO) combined with free radicals spins off even more toxic, inflammatory byproducts. But that’s not what Freeman found in his experiments.

“When I tried to replicate those test-tube, chemistry-based observations in cell or animal models, we observed that nitric oxide, rather than being pro-inflammatory, had anti-inflammatory properties,” says Freeman, who is now the University of Pittsburgh Professor and chair of the Department of Pharmacology and Chemical Biology in Pitt’s School of Medicine. And this wasn’t the only laboratory observation to make Freeman sit up and take notice. As he continued to investigate these surprising anti-inflammatory properties of NO, his experiments turned up a new and unusual molecule—a fatty acid with a nitrogen compound branching off from a carbon bond. He’d never seen nor heard of anything like it. These nitro-fatty acids, as they came to be called, are an important element of the anti-inflammatory properties of NO.

Since then, Freeman and many colleagues have painstakingly probed the biochemistry of these compounds. The picture that is emerging suggests they may be a safe, stable, easily produced drug with applications for diabetes and metabolic and inflammatory diseases. Freeman has launched a pharmaceutical start-up company through the Pittsburgh Life Sciences Greenhouse to license the University’s intellectual property. Experimenting with several versions of nitro-fatty acids, the company has settled on a few that show evidence of being both powerful and safe. They are currently preparing to produce U.S. Food and Drug Administration-approved versions of the compounds for human trials.

An intriguing hint of the potential these compounds have for addressing health problems: In Nature Structural & Molecular Biology, Freeman and colleagues showed that their nitro-fatty acid fits a particular receptor in the cell membrane like a key in a lock. The same receptor is the target of the diabetes drug Avandia, but it “had been previously unknown what naturally occurring compound might fit this receptor. Avandia’s annual global sales have totaled in the billions, but it has recently been associated with negative side effects, including heart attack.
**TRANSLATIONAL MEDICINE**

**BEYOND MEDICINE**

Translational medicine is not limited to the University’s six schools of the health sciences. Pitt’s Dietrich School of Arts and Sciences houses numerous hot spots for translational biological and chemical research. Long-standing, productive collaborations with researchers in the health sciences help to ensure that research projects address the entire translational spectrum, from laboratory to clinic and back again.

**Peter Wipf, Jeffrey Brodsky**

Jeffrey Brodsky, the Asstrow Professor of Biological Sciences, studies species of yeast, one of the most important organisms for laboratory research. Even those who are particularly fond of bread and fermented drinks probably do not think of yeast as a close relative. Many millions of years of evolution separate us from yeast. However, yeast species not think of yeast as a close relative.

Brodsky’s numerous publications and active projects include collaborations from Pitt’s Schools of Medicine, Pharmacy, Dietrich School of Arts and Sciences, and more. With Peter Wipf, Distinguished University Professor, whose home base is the Department of Chemistry, Brodsky has developed a series of selective regulators of chaperone activity to search for candidate drugs that might fix defects in cellular protein-folding processes.

In some areas of public health research, the future is now—or, at least a few researchers are already using the tools of translational medicine to address public health concerns of the future. A 2010 paper in Nature Nanotechnology was the result of a collaborative effort by a slew of Pitt researchers plus colleagues from other institutions. It explored the biological mechanisms by which carbon nanotubes could be safely degraded before they become a danger to human health.

Carbon nanotubes, which are one-atom thick rolls of graphite 100,000 times smaller than a human hair yet stronger than steel, have a long list of industrial applications. They are used to reinforce plastics, ceramics, and concrete. They are excellent conductors of electricity and heat. But laboratory tests suggest that inhaling carbon nanotubes could result in severe lung inflammation and fibrosis.

Valerian Kagan, a professor of environmental and occupational health in the Graduate School of Public Health, has a long track record of research on nanotubes and health. For this nanotubes study, his collaborators included faculty from the Departments of Structural Biology and Cell Biology and Physiology in the School of Medicine. Another, Alexander Star, from the Department of Chemistry, received one of eight 2010 Outstanding New Scientist awards from the National Institute of Environmental Health Sciences. The Pitt researchers partnered with clinicians and basic scientists from as close as West Virginia and as far away as Ireland and Sweden to conduct the study, which revealed a new route by which carbon nanotubes could be enzymatically biodegraded in the body. Their findings can be used to develop methods for mitigating the inflammation caused by the inadvertent inhalation of nanotubes. Even more intriguing, the researchers raised the possibility that nanotubes can be safely biodegraded after inhalation, suggesting there could be a way to pack them with drugs and turn them into a biodegradable drug delivery system.

The CTSA program is an enormous initiative aimed at transforming the research and training environment in this country to enhance the efficiency and quality of clinical and translational research. It calls for a nationwide consortium of academic medical institutions eventually numbering 60. The first cohort included Pitt and 11 other institutions deemed advanced enough to set the standard. In 2010, the CTSA consortium reached 55 member institutions.

Translational Technologies and Resources Core promotes the use of a wide range of research core laboratory facilities available at the University that facilitate translational and clinical research, provides support to and augments the capabilities of those core labs, and helps investigators to gain access to core facilities that will enable important scientific explorations.
The Participant and Clinical Interactions Resources Core supports both ‘bench-to-bedside’ and ‘bedside-to-bench’ investigators by providing facilities, staff, equipment, and resources to conduct studies according to research protocols in a variety of specialized inpatient, outpatient, and community-based health care settings.

Researchers with an idea can apply for pilot funding through CTSI, but there’s a hitch: Almost all of the pilot funding programs require investigators from different disciplines to work together.

Sometimes the connections seem obvious, but institutional boundaries had previously worked against collaboration.

“As an example, we had a call for pediatrics research where we required a researcher investigating a disease in children to pair with a colleague who works on the same disease in adults,” says Reis.

This simple approach is paying off in creating multidisciplinary teams, he says. CTSI has provided more than $2.5 million in pilot funding to researchers, many of whom say they never had an opportunity to work with their research partners before.

CASE STUDY: IS CALCIUM REPLACEMENT HELPING?

While training as a molecular biologist, Matthew Rosengart tracked the influence of calcium and some related proteins on cell function. Then, as a Pitt assistant professor of surgery, he made a bedside observation that calcium levels frequently fall in intensive care unit (ICU) patients, prompting physicians to order routine calcium replacement. Curious about calcium, Rosengart conducted a comprehensive review of the scientific literature and was somewhat surprised to find evidence that calcium could provoke a deluge of inflammatory cytokines.

Following where the evidence led, he designed a lab-based study to probe the effects of calcium administration in septic mice. The striking result was that it was associated with a two-to-three-fold increase in mortality, likely related to the disruptive consequences of calcium-dependent proteins on inflammation.

CTSI helped Rosengart to recognize the potential intellectual property value of several of his concepts now under patent disclosure based on preliminary data and is working on a second.

“I’m driven by clinical problems,” says Faraji, whose ultimate goal is to unite his passions for neurosurgery, oncology, and chemistry into what he recognizes will be a demanding career as a physician-scientist. “Now we want to do proof of principle in vivo.”

There have been significant examples of exactly this type of translational cancer research in Pittsburgh, starting with one that predates UPCI itself. (Founded in 1985, UPCI became an NCI-designated Comprehensive Cancer Center in only five years.) In 1985, Bernard Fisher, a Pitt professor of surgery and 1943 graduate of the University of Pittsburgh School of Medicine, and a team of researchers demonstrated in clinical trials that lumpectomy combined with radiation therapy is as effective as radical mastectomy in treating breast cancer. The news that many women with breast cancer, who might otherwise undergo a disfiguring radical mastectomy, could opt for lumpectomy was a dramatic advance in the treatment of breast cancer. Fisher’s group would go on to show the effectiveness of chemotherapy and hormonal therapy (tamoxifen) in preventing recurrence.

By creating an institutional culture that places a high value on translational medicine, Pitt strives to contribute to the future of medicine, whether those contributions are giant leaps forward or small steps along the path to better outcomes and better quality of life for patients.

Fisher’s work was a tour de force of translational medicine, particularly with respect to clinical trial design and execution. Like the best translational medicine, it began with a fundamental insight into cancer biology—that cancer was a systemic disease more often than a localized disease—made by Fisher in the surgical research laboratory that he founded at the University of Pittsburgh, then proceeded through rigorous clinical testing, and ended with improved clinical practices that led to better health for the public.

UPCi looks back on extraordinary growth in its translational research program, with some of the most exciting and promising work in the area of cancer vaccines and immunotherapy. Most of us know vaccines as agents that turn the immune system against a foreign invader, such as a virus. But cancer isn’t a foreign invader. It’s your own cells gone bad. To teach the immune system to target cancer, scientists must first identify molecules that distinguish cancer cells from normal cells. The first clinical trial in the world of a synthetic peptide cancer vaccine—at Pitt in 1990—enrolled patients with very advanced cancer and poor prognoses. Regulators deemed the risk of a vaccine unacceptably high, but the response was too great to include patients with better odds. “The first patient died of her advanced cancer within a month of us starting the trial, not even giving the vaccine time to generate an immune response,” says Olivia Finn, Distinguished Professor in and chair of the Department of Immunology and coleader of UPCI’s cancer immunology program.

The concept is so novel and the laboratory work so promising that Faraji, a four-year student, has filed one patent disclosure based on preliminary data and is working on a second.

Cancer cell and surrounding antibodies
A lot has happened since then, and cancer immunotherapy is now more realistically expected to prevent cancer, prevent recurrence, or cure cancer in its early stages. A new version of Finn’s 1993 vaccine is currently being tested in patients diagnosed with premalignant colonic adenomas, precursors to colon cancer, to prevent adenoma recurrence and progression to cancer. In another example, Theresa Whiteside, professor of pathology, otolaryngology, and immunology, along with Professor of Immunology, Soldano Ferrone, has developed a vaccine able to target a unique molecule that appears on head and neck tumor cells as well as on the normal cells building blood vessels to sustain it.

Pitt’s John Kirkwood, professor and vice chair for clinical research in the Department of Medicine, developed the first adjuvant therapy for patients recovering from melanoma, a disease with a high rate of recurrence. Kirkwood’s interferon therapy stimulates the immune system’s natural killer cells against melanoma. Kirkwood leads a large multidisciplinary and multilaboratory melanoma program at UPC, funded by a prestigious Specialized Program of Research Excellence (SPORE) grant from NIH. Two other SPORE grants at UPC support the lung cancer and the head and neck cancer programs.

Finn is currently working on laboratory experiments that define other cancer-promoting conditions that could be controllable with vaccines. People with chronic inflammatory disorders such as inflammatory bowel disease (IBD), for example, are at greater risk for developing cancer at the inflamed site, says Finn. Her group has reported that a vaccine directed against an abnormal variant of a self-made cell protein called MUC1, which is altered and produced in excess in both IBD and colon cancer, has the potential to delay the onset of IBD and, in turn, prevent progression to colon cancer. Their findings, reported in Cancer Prevention Research in 2010, suggest that early stages of chronic inflammation might be considered a premalignant condition.

Dr. Olivera Finn

THE EVOLUTION AND REVOLUTION OF TRANSLATIONAL MEDICINE

By creating an institutional culture that places a high value on translational medicine, the University of Pittsburgh strives to contribute to the future of medicine, whether those contributions are giant leaps forward or small steps along the path to better outcomes and better quality of life for patients. One of those giant leaps forward—and a seminal moment in the University’s history—came in 1984, when Pitt Distinguished Service Professor of Surgery Thomas E. Starzl performed the world’s first double transplant operation (simultaneous heart and liver transplantation) on a 6-year-old girl from Texas. In the early days of organ transplantation, no person worked harder than Starzl to develop new surgical techniques and advance experimental immunosuppressive drugs like cyclosporine—all of which were necessary to make these lifesaving procedures available to deadly ill patients. Practically overnight, Pittsburgh became the organ transplantation capital of the world.

Dr. Thomas E. Starzl

Dramatic and revolutionary events such as this may be rare, but they owe their provenance to the hard work that yields steady progress over long periods of time. The steady growth of the scientific and clinical enterprise in Pittsburgh over several decades has many observers wondering what dramatic new milestones are on the horizon.

“There has been an evolution—if not a revolution—in the way we conduct research at the University of Pittsburgh,” says Levine. “And my own sense is that this process is just beginning to hit its stride.”

George E. Klinzing
Vice Provost for Research from 1995–2012

EXCELLENCE IN RESEARCH

A CLOSING WORD

BY GEORGE E. KLINZING

This book is the second edition in the Excellence in Research series. The first edition, which was published nine years ago, featured cutting-edge research and scholarship at the University. It highlighted multidisciplinary inquiry in areas ranging from the humanities and social sciences to engineering and the natural sciences. This updated edition echoes this theme, but it incorporates many new ideas and discoveries. Our progress has been remarkable. The University remains a very special place where innovation and breakthroughs are commonplace.

This edition of Excellence in Research reflects the combined effort of faculty members from the University’s many departments, centers, and institutes. My valued colleague Sheila Rathke worked with me and many others to bring the reader up-to-date information on the advances we have seen over the past six years. The University of Pittsburgh continues to be ranked as one of the premier research universities in the world. It gives us great pleasure to provide you with a snapshot of this exciting research.