ASU Insight
ARIZONA STATE UNIVERSITY
February 16, 2007

Transforming research: Biodesign Institute

Biodesign teamwork leads to measurable results

By Kimberly Ovitt

Less than five years ago, ASU President Michael Crow and a broad coalition of faculty developed a shared vision of an interdisciplinary institute to help vault ASU into the ranks of a world-class research university by 2012. The rapid translation of this vision into a results-producing enterprise – the Biodesign Institute – has been impressive, even to the pioneering faculty who were at the foundational core of the institute.

"We never imagined how quickly we'd see results," says Neal Woodbury, a chemistry professor who has been with ASU since 1987 and directs the Center for Bio-Optical Nanotechnology at the Biodesign Institute. "Collectively, we've secured millions in new funding and are attracting partners who didn't even have ASU on their radar screens five years ago. It's invigorating."

In mapping its strategy to leapfrog to the forefront of 21st century scientific discovery, ASU found that it could turn its relative youth as a research university into its greatest asset. It could take advantage of a major trend in science – the convergence of biology, engineering and computing – with greater agility than universities with more established yet less flexible organizational structures.

"Numerous visitors from other universities have told us they could never have accomplished this level of interdisciplinary cooperation in their organizations," says George Poste, director of the Biodesign Institute. "The collaborative spirit across so many programs at ASU is a distinct strength."

Crow says another key strength of the institute is that its researchers move through multiple phases of discovery and development as a coordinated team.

"Many interdisciplinary programs are simply assemblies of researchers working independently on a shared problem," Crow says. "We've developed an organizational structure and facility that enables researchers to work in a far more integrated manner."

For example, the institute hopes to develop ways to more rapidly detect disease, even before symptoms appear. The team working on this problem includes membership from five of the Biodesign Institute's 15 centers with individuals representing disciplines as diverse as genetics, immunology, engineering, computer programming, chemistry and physics. Another team involving multiple centers is working on renewable energy sources.

Rapid, transformative change requires an investment and carries some risks. But the Biodesign Institute's deputy director, Michael Tracy, says a bold approach was necessary to address dramatic changes in research and development over the past decade.

"Biotech and health care companies have become increasingly hesitant to take the chance on early stage innovation due to the spiraling cost of taking new drugs and diagnostics to market," explains Tracy, who oversees partnership-building for the institute. "Industry and clinical partners now expect us to be able to prove that our innovations will work on a large scale and will be cost-effective to produce."

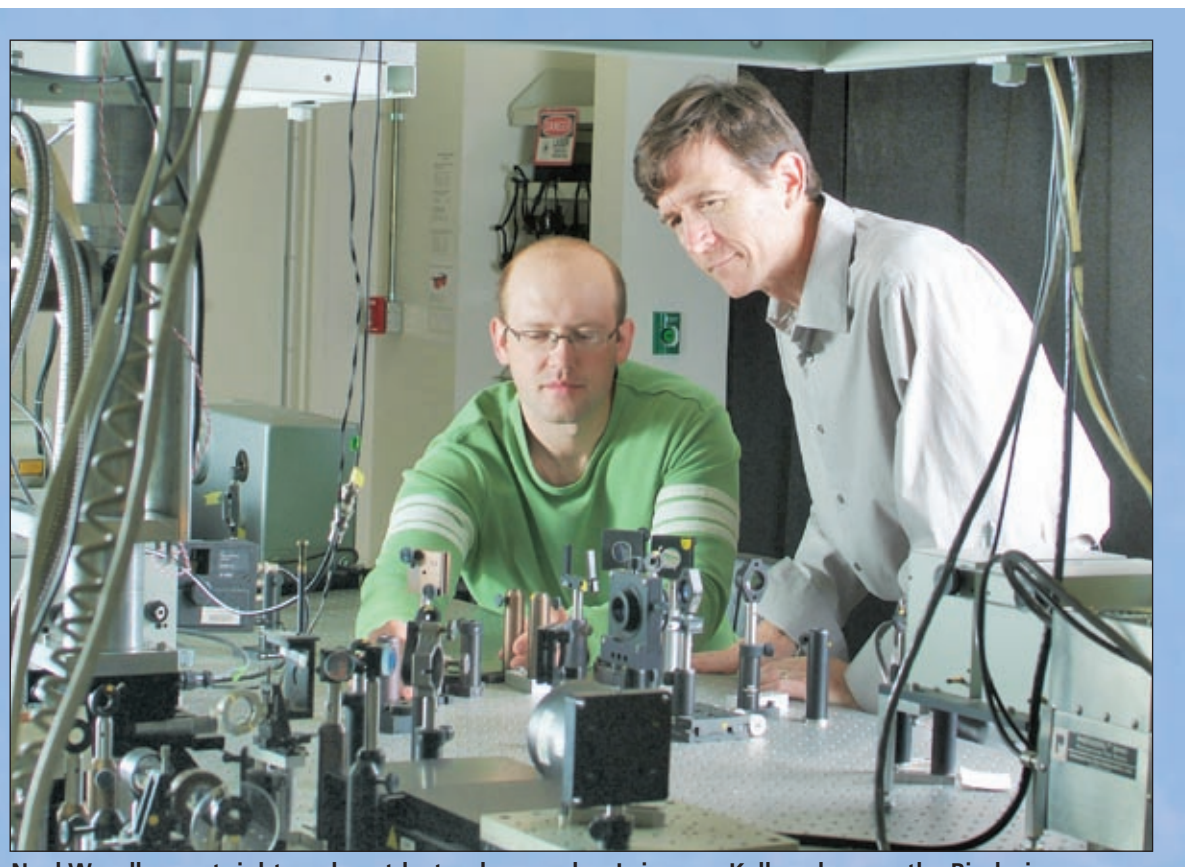
In addition, federal research funding remains flat while competition increases, making it imperative for research institutes to broaden their funding sources. Linkages to clinical and industrial partners are crucial, and collaborations with other academic institutions are often necessary. The Biodesign Institute has more than 200 collaborations and partnerships.

A lot is riding on the institute's success. It not only is a critical linchpin in ASU's strategic plan – it is fundamental to a statewide effort to make Arizona a magnet for bioscience and technology industries.

Such industries cite robust university research programs as an important consideration, since universities ensure a well-trained work force and offer potential for collaboration.

Fortunately, Arizona citizens and government leaders have been enthusiastic supporters. Although many states have made investments in biotech research, the pace of Arizona's efforts is unmatched. The state's bioscience push began in late 2000, when voters approved a sales

(See RESULTS on page B7)



Neal Woodbury, at right, and postdoctoral researcher Laimonas Kelbauskas use the Biodesign Institute's ultrafast laser facility to better understand how plants turn light into energy. Woodbury leads a large team pursuing applications such as alternative fuels.

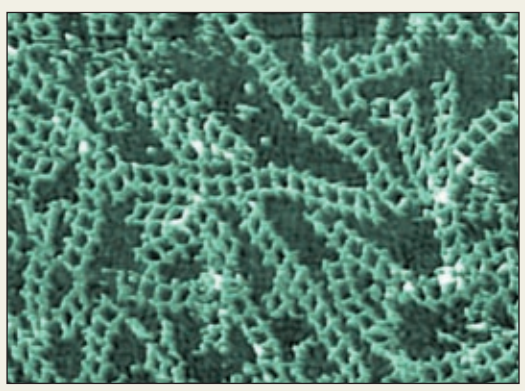
From bold idea to daring reality

Less than five years ago, the Biodesign Institute was just a big, bold idea. Today, the Biodesign Institute is:

- The Valley's single largest generator of federal biomedical research funding.
- An investment that is generating a significant financial return. In 2006, the institute increased its annualized grant funding by 86 percent over the prior year and was awarded more than $31 million in new funding*.
- The largest single investment in research infrastructure in Arizona.
- A 350,000 square-foot facility that was named 2006 Lab of the Year by *R&D Magazine* in an international competition.
- A team of nearly 600 people, working together to tackle big problems in human health and quality of life, specifically in the areas of personalized medicine, public health, environment, energy and national security.
- A major training ground for the next generation of scientists.
- A magnet for scientific talent from around the world. The institute has recruited 55 faculty members since 2002.
- One of the nation's most diverse assemblages of scientific disciplines within a single institute.

*New funding = total nonannualized value of all new awards.

Mother Nature a key partner in scientists' quest for discovery



DNA, shown in an atomic force microscopy image, is being used by Biodesign researchers as a nanoscale scaffold to further advances in improving human health.

By Kimberly Ovitt and Joe Caspermeyer

To understand biologically inspired design, from which the Biodesign Institute derives its name, think of Lego blocks. With those little interlocking pieces, anyone can build a nearly limitless variety of structures.

Similarly, every living system shares a common building set – molecular building blocks that are assembled to produce an infinite array of plants, animals and microbes.

And nature doesn't play favorites. A life-threatening virus is built from the same basic materials as the cells that it attacks and scientists can now use the same genetic coding to devise new medicines to combat disease.

"The essence of biodesign is really about understanding the rules by which nature designs things," says George Poste, director of the Biodesign Institute. "Every life form on the planet has the same genetic code, composed of four letters: A, T, C and G. It's just the way you put those letters together – in the case of human beings, 3 billion of those letters – that gives you every life form on the planet."

While it sounds simple, the complexity of life emerges because living systems are dynamic and constantly in flux. One tiny change can create cascading effects. As the tools to observe these processes have improved, researchers are beginning to see how such adaptations can cause or solve problems.

One example employing these concepts is the Biodesign Institute's work to clean contaminants from drinking water.

Nearly 1.1 billion people do not have access to safe drinking water. Institute researchers have identified bacteria that remove harmful toxins from the water supply.

"We are really just harnessing the

(See NATURE on page B7)

Biodesign tackles big problems with big science

With breakneck speed, the Biodesign Institute has assembled a world-class team to pursue "use-inspired research," which has the goal of solving specific societal problems. Increasingly, today's urgent problems present a complexity that requires large discovery teams.

Today, producing research that gets adopted by society requires a completely new set of skills. It requires "proof-of-concept" that the ideas can work on the scale required at a cost that is economical for industry to commercialize. Conducting research in the 21st century requires a critical mass of intellectual horsepower and closer ties to industry.

This was a driving force behind the development of the Biodesign Institute, and the institute's researchers are applying this horsepower in four broad areas of focus: personalized medicine, global public health, energy and the environment and securing a safer world.

Research to solve these big problems requires big teams. The Biodesign Institute embraces this concept in the largest sense, bringing together partners from all corners of ASU, including expansive efforts with the Fulton School of Engineering, the College of Liberal Arts and Sciences, the Consortium for Science Policy and Outcomes, the Sandra Day O'Connor School of Law, the ASU Polytechnic Campus and the new School of Sustainability, to list a few. Independently, these programs have many bright spots of innovation; collectively, they represent a powerhouse of potential to shape a New American University.

In concert with a rapidly growing network of internal and external partners, the Biodesign Institute is forging new alliances to create a world-class research institute dedicated to seeking solutions to address complex global problems, for the benefits of society and for each of us as individuals.

Energy and the environment

Water. Waste. Energy. This trio of problems is among the greatest challenges to the environmental health of society.

"All of these issues are closely interrelated," says Bruce Rittmann, director of the Center for Environmental Biotechnology. "For example, most of the pollution wastes that we worry about are really just energy put in the wrong place and causing trouble."

Rittmann specializes in developing new ways to use microbial communities for important tasks like detoxifying contaminated water, wastewater, sludge, sediment or soil; capturing renewable energy from biomass; sensing contaminants or pathogens; and protecting the public from dangerous exposure to pathogens.

"We have hardly begun to tap the potential that is already provided by nature," says Rittmann.

Other Biodesign Institute members are engaged in similar challenges on renewable energy products. Neal Woodbury is leading an effort to uncover greener ways of producing hydrogen. Rudy Diaz and Stuart Lindsay – employing nanotechnology inspired by the molecular photosynthetic systems used by plants to convert light to energy – are seeking to overcome the current technological hurdles of solar energy.

Don Gervasio is leading a team that has created a tiny hydrogen-gas generator that they hope to develop into a compact fuel cell package. This could then power portable electronic devices three to five times longer than conventional batteries of the same size and weight.

Researcher Jinwook Chung works with membrane biofilm reactors, which use microorganisms to remove toxins from the water supply.

Securing a safer world

Society now lives with the specter of global terrorism. Many researchers at the Biodesign Institute have skills and knowledge that can contribute significantly to enhanced national security. While it is a new arena to some of them, many feel compelled to use their talents to help.

"We are trying to stay ahead of the terrorists who are becoming increasingly sophisticated in their methods," says Joe Wang, director of the Center for Bioelectronics and Biosensors.

Wang has developed a highly sensitive technology to rapidly detect liquid peroxide explosives in as little as 15 seconds. In the wake of the failed London airline bombings that raised the public consciousness about such devices, Wang's team quickly mobilized to develop this solution.

The institute's Center for Applied NanoBioscience, led by director Frederic Zenhausern, is developing large-scale disaster response technologies to safeguard against a bioterrorism and a "dirty bomb," incident.

The institute is also engaged in developing new vaccines against bioterror threats such as plague and smallpox.

The Institute's Center for Applied NanoBioscience, led by Frederic Zenhausern, participated in a regional bioterrorism disaster preparedness exercise included mock bioagent detection and search and rescue missions.

Personalized medicine

Despite knowing that diseases and patients are not uniform, medical science is currently unable to tailor therapies to an individual, leading to treatments that are ineffective in some people or cause serious adverse reactions in others. Annually, more than 2 million people are hospitalized and between 80,000 and 120,000 die from adverse drug reactions.

"This is the most important reason the one-size-fits-all approach to drug treatment cannot continue," says George Poste, director of the Biodesign Institute. "We urgently need the right drug for the right subtype of disease and the right drug for the right patient."

The institute is engaged in several projects that detect 'biosignatures' to improve diagnosis and treatment of disease in a manner that is tuned to variations either to the individual or specific subtypes of disease. The ultimate goal is to detect and treat major diseases even before they cause symptoms.

The Biodesign Institute is working on ways to tailor treatments to individual patients.

Application areas the institute is pursuing include cancer, neurological disorders, metabolic disorders and drug delivery.

The Biodesign Institute has collaborations with several major health care systems in the Valley. Recently, ASU launched the MAC5 cancer collaborative in partnership with the Mayo Clinic Scottsdale.

A major project to emerge from under this relationship is an effort to develop a cancer vaccine led by Stephen A. Johnston, director of the Institute's Center for Innovations in Medicine.

"By combining the expertise from both institutions, our ultimate goal is to create a vaccine that would protect people from multiple forms of cancer," says Johnston. The concept is based on early research Johnston is doing to identify common themes in the proteins causing cancer.

"This idea of identifying signatures unique to cancer suggests the possibility of preventive vaccines," says Laurence Miller, director of research and deputy director of the Mayo Clinic Cancer Center.

Researchers are developing groundbreaking approaches to public health concerns around the globe.

Global public health

Biodesign researchers use three broad technologies to create vaccines: plant, bacteria and viral vectors. In addition to groundbreaking technologies in vaccines, the institute is working on creating new sensor and diagnostic systems to detect current and future health threats such as pandemic flu.

Roy Curtiss offers a straightforward reason for his professional fight against infectious disease over the past half century. "Of the 50 million people who die every year on the planet, more than half die as a consequence of infectious diseases," says Curtiss. "It would be wonderful if we could lessen that number and allow people to live to a ripe old age."

Curtiss, who directs the Center for Infectious Diseases and Vaccinology, leads many research projects aimed at alleviating human suffering. One of these, an effort to develop a new pneumonia vaccine for newborns, received $14.8 million in funding through the prestigious Grand Challenges in Global Health initiative supported by the Bill and Melinda Gates Foundation.

Bertram Jacobs genetically engineers vaccinia virus, a cousin of smallpox, to be a vehicle against a number of infectious agents, bioterrorism threats, cancer and viruses such as HIV. Recently, he received a $900,000 award as part of an international $15.3 million effort funded by the Bill and Melinda Gates Foundation to use vaccinia virus in the creation of a potential AIDS vaccine.

Other research aimed at stemming the HIV/AIDS epidemic includes a project funded by the National Institutes of Health (NIH) to pursue an oral vaccine that stimulates the production of antibodies known to block HIV, the virus which causes AIDS. This funding is in addition to a five-year, $7.4 million NIH grant the Center received to pursue development of topical treatments called microbicides to block HIV/AIDS.

While the two projects are distinct, Tsafrir Mor, a researcher at the Biodesign Institute, says progress in each benefits the other. "It's important to attack the problem from different angles because layers of protection from HIV may be required to effectively stop its advance," says Mor.

ASU duo Lynda Williams and Shelley Haydel are examining the mechanisms that allow two clays mined in France to heal Buruli ulcer, a flesh-eating bacterial disease found primarily in central and western Africa. Buruli ulcer has been declared to be "an emerging public health threat" by the World Health Organization. Related to leprosy and tuberculosis, the Mycobacterium ulcerans produces a toxin, lesions, and destroys the fatty tissues under the skin.

Educational investment in Biodesign enhances state's economy

By Joe Caspermeyer

Arizona, the youngest but fastest-growing state in the contiguous United States, still recalls its frontier roots. Now it's set to conquer new frontiers. ASU, along with the state, will help create a knowledge economy that will look very different as the state celebrates its 100th anniversary in 2012.

To make that leap, ASU and the state are following a tried-and-true strategy.

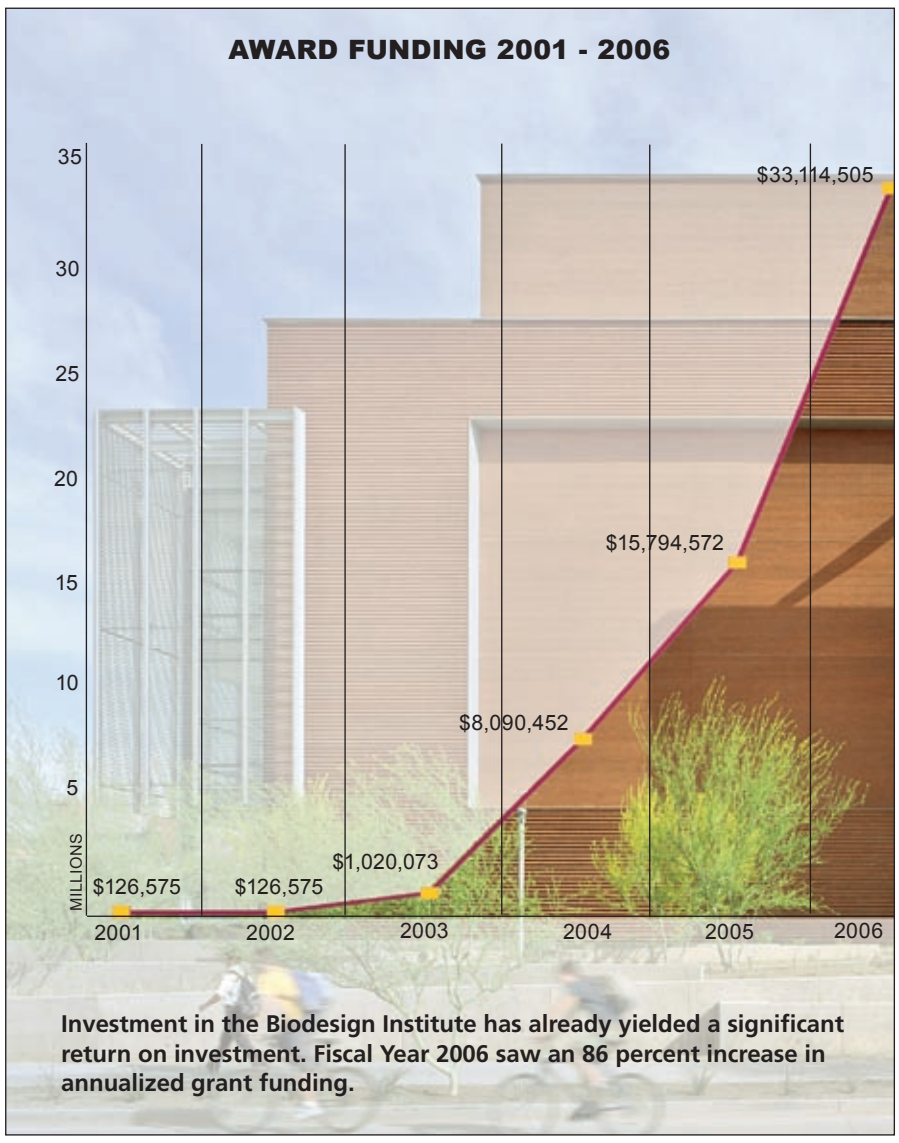
Step One: Invest in research infrastructure

Research capacity in science and technology is the single most critical factor in deciding the fate of regional economies, according to a recent report from the Milken Institute. Thanks to state and citizen support in Arizona, and under ASU President Michael Crow's leadership, ASU has witnessed the most rapid growth of research infrastructure in its entire history, with more than 1 million square feet having been acquired or built since 2002. Public support through a sales tax increase and a significant investment by the legislature in research infrastructure capacity have significantly enhanced ASU's research enterprise.

The investment in laboratory space gives ASU students increased access to training opportunities. The Biodesign Institute provides training to more than 200 students per semester. Thirty-three of these students entered the work force this year armed with advanced science degrees, a key factor in producing a high-wage work force.

The expanded research capacity of the Biodesign Institute pays dividends in drawing new research funding and grants for the institute, which helped boost ASU's total research expenditures past the $200 million mark for the first time in 2006.

"ASU has attained a remarkable level of achievement by doubling the amount of research expenditures in the past six years," says Jonathan Fink, ASU vice president of research and economic affairs. "Now, the bar is set even higher, as we look to the Biodesign Institute and others at ASU to accelerate expenditure growth."



Investment in the Biodesign Institute has already yielded a significant return on investment. Fiscal Year 2006 saw an 86 percent increase in annualized grant funding.

The Biodesign Institute already is generating a significant financial return. In 2006, the institute increased its annualized grant-funding by 86 percent over the prior year and was awarded more than $31 million in new funding.

Step Two: Foster intellectual property

Successful commercialization of innovation requires strong intellectual property. Without the protection of patents, companies are reluctant to spend the hundreds of millions of dollars needed to bring new drugs, diagnostics, devices and vaccines to market. Higher research dollars lead to technology transfer that translates into patents, which in turn, enables universities to secure licensing revenue.

ASU has demonstrated a strong track record of entrepreneurship, and is a top 10 university in the following areas:

- The number of inventions disclosed per $1 million spending on research.
- The number of start-up companies formed per $10 million spending on research.
- The number of U.S. patent applications filed per $1 million spending on research.

Furthermore, ASU has become the top income producer among Arizona universities for licensed technologies, with $2.5 million in revenue in 2005. The Biodesign Institute is turbocharging that record. A 2006 study ranked Biodesign Institute faculty member Stuart Lindsay as a top 10 innovator in NSF-funded nanotechnology research, based on patents issued. Lindsay also was recognized as one of the top 20 highest-funded individual researchers in nanotechnology. The institute's researchers were issued six new patents in 2005 and five in 2006, and have been responsible for more than 200 patent disclosures filed through ASU's technology transfer arm, Arizona Technology Enterprises (AzTE).

Step Three: Commercializing discoveries

By working in tandem with AzTE, the Biodesign Institute is identifying research with high commercial potential and the most effective and efficient options for engaging with industry. These options include licensing intellectual property to industry, creating and expanding industrial, academic and clinical partnerships, and launching new companies.

In fiscal year 2006, two institute spin-off enterprises were acquired by multinational bioscience companies, propelling Biodesign technologies toward commercialization.

"This is an example of how the research growth strategies put in place by President Michael Crow benefit the Valley's biotech sector development as well as ASU," says Lindsay, director of the Institute's Center for Single Molecule Biophysics, when his joint spin-off was acquired by Agilent Technologies, Inc.

Since its inception, the Biodesign Institute has spawned three spin-off companies: NanoBiomics, which was acquired by the Molecular Profiling Institute; Arizona Engineered Therapeutics, which was acquired by OrthoLogic Corp.; and AdveNsys.

Caspermeyer, with the Biodesign Institute, can be reached at (480) 727-0369 or (joseph.caspermeyer@asu.edu).

Scholars gain through institute's pioneering approach

By Joseph Caspermeyer

The Biodesign Institute at ASU has a three-pronged approach to benefiting the community it serves: research impact, economic impact and educational impact.

Its educational initiatives take many forms, but among the most critical is training the next generation of scientists through forward-thinking graduate programs. For this reason, the institute has launched a highly competitive, $30,000-per-year scholarship program to prepare future Ph.D. research scientists.

"This premier program will provide new vistas for ASU interdisciplinary graduate student training. It realizes an essential element of our core educational mission," says George Poste, director of the Biodesign Institute.

Traditional graduate science education has focused on a 'one-lab, one-discipline and one-mentor' experience in producing the next generation of research scholars.

The Biodesign Institute's broad educational vision, from high school internships to undergraduate education to doctoral education and post-doctoral research, aims to break down these traditional boundaries between disciplines and provide individuals with a dynamic, interdisciplinary research experience that will better enable them to engage with real- world problems irrespective of where their future careers in science take them.

Central to this success is engaging students with a team-oriented research experience, and working alongside interdisciplinary faculty in labs devoted to addressing some of society's most pressing problems.

Stephen A. Johnston, director of the Center for Innovations in Medicine and the Biodesign Institute's graduate program, adds, "In addition to receiving training in a world-class research environment, these individuals will be well-prepared to enter the work force and perform research that ultimately benefits the community and region."

From left, Kausar Nadim Samli, John Schloendorn, Gabriel Bodeen, Lijing Jiang, Sarah Kessans and Rebecca Halperin are the first participants in the Biodesign Institute Graduate Scholar program.

As well as training the next generation of pioneering research scholars, the Biodesign Institute's graduate scholar program will provide doctoral degree candidates with exposure to a wealth of opportunities: 350,000 square feet of advanced research infrastructure space with state-of-the-art instrumentation and technologies; dynamic, collaborative science through lab rotations in multiple research centers; and a creative culture of entrepreneurial research that translates research discoveries into improved personal health, public health, environment and national security.

All Biodesign Institute research scholars, through the course of their graduate experience, will also participate in special seminars, meetings and social activities to encourage broad research interactions. In addition, the group will gain valuable lecturing experience in a one-semester Teaching Assistantship.

For the 2006-2007 academic year, six students were selected for the program. The institute hopes to continue to expand the number of available scholarships.

Caspermeyer, with the Biodesign Institute, can be reached at (480) 727-0369 or (joseph.caspermeyer@asu.edu).

THE BIODESIGN INSTITUTE IN REVIEW — SELECTED HIGHLIGHTS

Accelerating Discovery for a New American University

2000-2001

FUNDING

$ NOVEMBER 2000
Taxpayers approve sales tax increase which creates Technology & Research Initiative Fund (Proposition 301)

PEOPLE

★ JANUARY 2001
Charles Arntzen appointed Institute founding director

★ FEBRUARY 2001
Jiping He, Sudhir Kumar, Stuart Lindsay and Neal Woodbury are named to direct centers in the newly-emerging Institute

2002-2003

PEOPLE

★ JULY 2002
Michael Crow announced as President of ASU

★ AUGUST 2002
James Abbas and Ranu Jung recruited to co-direct the Center for Adaptive Neural Systems

★ DECEMBER 2002
Frederic Zenhausern recruited to direct the Center for Applied NanoBioscience

★ APRIL 2003
George Poste named Institute Director

INFRASTRUCTURE

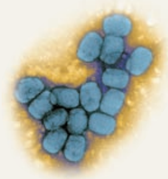
▬ JULY 2002
Facility master plan developed

▬ JUNE 2003
Funding for Building B provided by the Arizona Legislature

2004

FUNDING

$ FEBRUARY 2004
$5.5 million for safer smallpox vaccine



$ AUGUST 2004
$7.4 million for plant-based HIV research

PEOPLE

★ AUGUST 2004
Roy Curtiss, National Academy of Sciences member, recruited as co-director of the Center for Infectious Diseases and Vaccinology

★ OCTOBER 2004
George Poste named Scientist of the Year by *R&D Magazine*

★ NOVEMBER 2004
Joseph Wang recruited as director of the Center for Bioelectronics and Biosensors

★ NOVEMBER 2004
Bruce Rittmann, National Academy of Engineering member, is recruited as director of the Center for Environmental Biotechnology

INFRASTRUCTURE

▬ MARCH 2004
Groundbreaking for Building B

▬ DECEMBER 2004
Grand Opening of Building A

2005

FUNDING

$ JUNE 2005
$14.8 million Gates Foundation Grand Challenges Award to develop pneumonia vaccine for newborns

$ JUNE 2005
A Biodesign spin-out company, Nanobiomics, is acquired by Molecular Profiling Institute

$ SEPTEMBER 2005
$3.9 million in four grants to help individuals with spinal cord injuries

$ SEPTEMBER 2005
$5.9 million for Biodesign to lessen dirty bomb threat

$ DECEMBER 2005
$3.2 million for vaccine against Tuleremia, a possible biothreat

PEOPLE

★ FEBRUARY 2005
Stephen Johnston recruited as director of the Center for Innovations in Medicine

★ JULY 2005
Lokesh Joshi appointed director of the Center for Glycosciences and Technology

★ OCTOBER 2005
Sudhir Kumar named sixth most-cited computer scientist in the world

★ OCTOBER 2005
Michael Tracy recruited as deputy director for the Institute

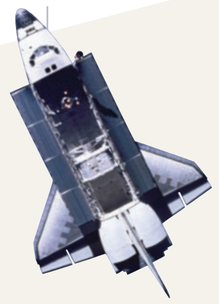
★ NOVEMBER 2005
Tsafrir Mor wins Governor's Award for Innovation for work to generate an immune response to HIV/AIDS

INFRASTRUCTURE

▬ SEPTEMBER 2005
Facility design earns top award for environmental excellence

2006

$ JANUARY 2006
National Science Foundation awards ASU $6.2 million for Center for Nanotechnology in Society



$ JUNE 2006
$1.2 million in NASA funding to study impact of space flight on human health

$ JULY 2006
$1.9 million in three grants to create new bioinformatics tools

$ AUGUST 2006
$18 million for Microscale Life Sciences Center research aimed at cancer, stroke and heart disease

$ OCTOBER 2006
$1.1 million to pursue nanotechnology improvements to solar energy

$ NOVEMBER 2006
$2.7 million for plant-based production of nerve agent antidotes

PEOPLE

★ APRIL 2006
Joseph Wang named Electrochemist of the Year by American Chemistry Society

★ MAY 2006
Hao Yan earns National Science Foundation's Career Award for young investigators

★ JULY 2006
George Poste awarded Albert Einstein Award by the Global Business Leadership Council

★ AUGUST 2006
Ranu Jung elected president of the Organization for Computational Neuroscience

★ AUGUST 2006
Marc Porter is recruited to direct Center for Combinatorial Sciences

★ SEPTEMBER 2006
Center for BioEnergetics is launched with newly-recruited co-directors Sidney Hecht and Guy Miller

★ DECEMBER 2006
Deirdre Meldrum, recruited as Dean of the Fulton School of Engineering, also is appointed to direct Center for Ecogenomics

★ DECEMBER 2006
Bertram Jacobs wins Governor's Award for Innovation for work on vaccines against smallpox, AIDS and other diseases

INFRASTRUCTURE

▬ FEBRUARY 2006
Biodesign facility named "Lab of the Year" in international competition by *R&D Magazine*

▬ MARCH 2006
Grand Opening of Building B

Key figures enhance efforts, research at institute

The Biodesign Institute has recently completed another recruiting cycle and is now at almost full-staff capacity for its first two buildings. As part of this strategic planning, each major scientific recruit expands on the core competencies of the institute. By expanding the number of disciplines under one roof, drawing talented researchers who are experts at developing the science from idea to the market, and assembling large teams to solve big problems affecting science and humanity, the Biodesign Institute is blazing the path to success.

Some recent major recruits include:

Biodesign Institute Director George Poste, right, and deputy director Mike Tracy lead a talented team of researchers exploring the boundaries of scientific disciplines.

Sidney Hecht
Co-director, Center for BioEnergetics

Sidney M. Hecht researches diseases caused by defects in the body's energy production processes. In a career spanning more than three decades, Hecht has held both academic and industrial research positions. He joins ASU from the University of Virginia, where he was a professor of both chemistry and biology. From 1981 to 1987, he concurrently held leadership positions in research and development for Smith Kline and French Laboratories. Prior to his 28 years at the University of Virginia, he was a faculty member at MIT. Hecht is the co-founder of Edison Pharmaceuticals, a pharmaceutical company focusing on inherited mitochondrial disorders.

Sidney Hecht

Guy Miller
Co-director, Center for BioEnergetics

Guy Miller is a chemist and physician with uncommon insights into metabolism and its linkage to disease. Metabolic disorders, caused by mitochondrial defects, are responsible for more than 40 different diseases that independently are classified as rare. Collectively, however, these diseases have significant impact.

In the United States, about one in 4,000 children will develop a mitochondrial disease before age 10. Mitochondrial impairment also is implicated as a factor in aging. Miller became a protégé of Sidney Hecht during his doctoral studies in chemistry. The pair has collaborated frequently in the past and co-founded Edison Pharmaceuticals, a pharmaceutical company focusing on inherited mitochondrial disorders. Miller is also founder and chairman of the Human Energy Project Foundation and chairman and CEO of Galileo Pharmaceuticals.

Guy Miller

Deirdre Meldrum
Director, Center for Ecogenomics

Deirdre Meldrum develops technologies that enable the study of live organisms in harsh environments from the human body to the oceans. She develops tools, sensors and automated systems to detect and analyze differences between healthy and diseased cells. In addition to her responsibilities at the Biodesign Institute, Meldrum is dean of ASU's Ira A. Fulton School of Engineering. The Center for Ecogenomics is the headquarters for the Microscale Life Sciences Center (MLSC), which Meldrum directs, as well as the facility for Meldrum's part in an oceanography project called NEPTUNE.

Deirdre Meldrum

The MLSC is a National Institutes of Health Center of Excellence in Genomic Science. As its director, Meldrum leads research into the fundamental mechanisms governing the birth, growth and decline of human cells with the aim of better understanding and seeking ways to combat the most widespread diseases and threats to human health.

Marc D. Porter
Director, Center for Combinatorial Sciences

The history of combinatorial sciences is rooted in the pharmaceutical industry, with the idea of optimizing drug discovery. Marc Porter focuses on the design of new materials. Materials have many properties to aid fundamental bioresearch and create applications of high commercial potential. Prior to joining the Biodesign Institute, Porter was on the chemistry faculty at the Ames Laboratory-USDOE at Iowa State University from 1986 to 2006.

Marc Porter

He was instrumental in the creation of ISU's Microanalytical Instrumentation Center, now known as the Institute for Combinatorial Discovery, where he served as director. Porter was also co-founder of two Ames-based companies: Advanced Analytical Technologies and CombiSep, and he has technologies licensed to BioNanoforce Laboratories, now publicly traded, and Concurrent Analytical.

Randall W. Nelson
Leader, Molecular Biosignatures Analysis Unit

Randall Nelson recently joined the Biodesign Institute as Leader of the Molecular Biosignatures Analysis Unit (MBAU) in the new Center for Systems and Computational Biology.

Randall Nelson

This unit will focus on improving human health and contributing to the vision of personalized medicine by understanding protein differences involved in healthy or ill individuals. The MBAU will initially strive for advances in a number of different illnesses including cancer, cardiovascular disease and diabetes.

This new unit allows easy communication and collaboration with other investigators throughout the Biodesign Institute and ASU, as well as with clinical partners such as Banner Health, TGen and the Mayo Clinic. For the last 10 years, Nelson founded and served as President and CEO of Intrinsic Bioprobes, Inc. (IBI), a local company in Tempe that provides protein analysis services.

Centers, directors offer broad expertise, experience

The new recruits for the Biodesign Institute add to the list of rapidly-expanding centers at the Institute, each with a broadly-defined area of expertise. The centers house multiple research teams working collaboratively to solve complex problems. This structure allows increased agility in adapting and responding to new information and challenges.

In addition to the above, the institute's centers include:

• Center for **Adaptive Neural Systems** - Enhancing independence for people with neurological disorders or impaired limb function by designing adaptive, intelligent devices and systems. **James Abbas**, co-director; **Ranu Jung**, co-director.

• Center for **Applied NanoBioscience** - Developing ways to diagnose disease, monitor health, and create flexible electronics by merging new technology with genomics and molecular biology. **Frederic Zenhausern**, director.

• Center for **BioOptical Nanotechnology**- Using biological systems as models for producing energy and sensors, and advancing personalized medicine by creating molecules merged with modern optics and electronics. **Neal Woodbury**, director.

• Center for **Bioelectronics and Biosensors** - Developing specialized sensor technology to manage diabetes and other diseases, improve food safety and detect chemicals or other hazards in the environment. **Joseph Wang**, director.

• Center for **Environmental Biotechnology**- Minimizing pollution and depletion of natural resources using microbiological systems and renewable energy resources. **Bruce Rittmann,** director.

• Center for **Evolutionary Functional Genomics** - Understanding how the genes and genomes of humans and other organisms change over time to help pinpoint the origins of disease. **Sudhir Kumar**, director.

• Center for **Glycosciences and Technology** - Developing novel treatments for a broad spectrum of diseases including cancer and immune disorders and utilizing plants as green-manufacturing units to produce life-saving drugs. **Lokesh Joshi**, director.

• Center for **Infectious Diseases and Vaccinology** - Combating infectious diseases through innovative and effective vaccine development using plant, bacterial and viral delivery methods. **Roy Curtiss**, director.

• Center for **Innovations in Medicine** – Exploring ways to detect illness before symptoms appear and developing systems for detecting, treating and preventing cancer. **Stephen Johnston**, director.

• Center for **Neural Interface Design** - Developing technology, such as intelligent prosthetics and therapeutic devices, for people with central nervous system disease or injury. **Jiping He,** director.

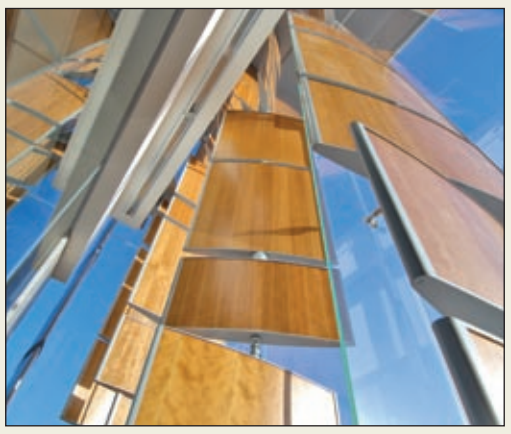
• Center for **Single Molecule Biophysics** - Using nanotechnology to study the physical processes on which life is based so that diseases can be accurately diagnosed and better treatments can be developed. **Stuart Lindsay**, director.

• Center for **Systems and Computational Biology** – This new collaborative center between Biodesign and TGen leverages the fast-growing field of computational biology to speed research and directly impact patients. Director to be announced.

The design of Biodesign

RIGHT: At night, the Biodesign Institute becomes a beacon of light to the community, and serves as the eastern gateway onto ASU's Tempe campus. The facility was named *R&D Magazine's* 2006 Lab of the Year.

BELOW: The open labs of the institute help break down the traditional walls between disciplines, provide extensive flexibility and rapid adaptability, and foster a collaborative research environment.



ABOVE: Suspended wood louvers on the north façade of the institute help the building design maintain a connection to natural light and mimic a gene array pattern.

BELOW: The extensive use of glass is a physical representation of the transparency that connects the researchers to one another and beyond the facility to the outside community. The open walkways and atrium encourage interaction among the institute's researchers and visitors.

ABOVE: The interior of the institute was designed with the idea of collaboration in mind. With the labs visible throughout the complex, the extensive white board space and seating foster impromptu discussions and easy exchange of ideas. The building features a broad range of green design features and references nature by elements such as the lower level terrazzo floor that uses native river rock, paying tribute to the Salt River that flowed though the site long ago.

Results, teamwork trumpet Biodesign Institute's rapid success

(Continued from page B1)

tax increase that funded research initiatives at each of the state's universities. The Technology and Research Initiative Fund (TRIF) has generated more than $110 million for ASU since its inception and has been used to support a variety of programs at ASU.

In 2003, the Arizona Legislature passed a farsighted infrastructure appropriation to help the state's universities construct new lab space. This funding paid for the second phase of the Biodesign Institute facility. Local foundations and private citizens also have stepped up to the plate to fund elements that contribute to Arizona's competitiveness in science and technology.

Poste says success will take different forms as the Biodesign Institute matures. Economic and educational benefits already are being realized, he says, but the most important success measures will be those that impact human health and quality of life.

"While breakthrough discoveries may seem unpredictable, there are steps you can take to encourage innovation," Poste says.

He says the institute has taken these steps by assembling researchers with impressive track records, developing a solid framework for addressing large problems, placing a purposeful emphasis on team approaches, and providing top-tier laboratory facilities.

"I'm confident in the potential of the Biodesign Institute to make transformative discoveries that will benefit all of us, as well as future generations," Poste says.

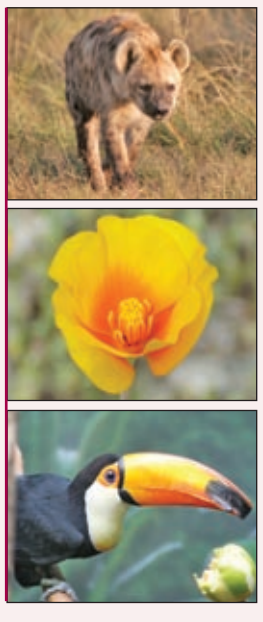
Ovitt, with the Biodesign Institute, can be reached at (480) 727-8688 or (kimberly.ovitt@asu.edu).

Natural Inspiration

Almost 170 years ago, Charles Darwin set sail on a voyage of discovery that would transform not only science, but man's worldview of life.

"There is a grandeur in this view of life," Darwin said, adding that it's a life in which "endless forms most beautiful and most wonderful have been, and are being, evolved."

Now, Arizona, the youngest state in the continental United States, is embarking on its own vigorous journey of discovery in the evolution of the modern research university as part of ASU President Michael Crow's vision of the New American University. And it is in these extravagantly diverse biological structures and functions that one of the primary vessels of Crow's vision, the Biodesign Institute at ASU, draws its inspiration.



Nature offers multitude of solutions

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natural capabilities of microorganisms," says Bruce Rittmann, director of the institute's Center for Environmental Biotechnology. "What we consider contaminants, they consider food."

Rittmann is expanding on these capabilities to use microorganisms to harness waste and turn it into a renewable alternative form of energy.

"Microorganisms, as part of their normal lives, do all kinds of things that we constitute as a service to society," he says.

Another project, led by Roy Curtiss, transforms a bacterial pest to make a new vaccine against bacterial pneumonia.

"We are using what is normally a bacterial pathogen, salmonella, and genetically modify it to deliver information that induces immunity to pneumonia," says Curtiss, director of the Center for Infectious Diseases and Vaccinology. "So it's an engineering feat of harnessing one bacterial pathogen and turning it into a friend that will do some good."

Science has, at its heart, always been about the quest to understand the world around us. While the tools available to do this have improved dramatically, each era of revelation inevitably also discloses new layers of complexity.

For this reason, scientists will continue to marvel at the elegance of living systems with the same intensity that caused Charles Darwin in 1839 to proclaim, "There is a grandeur in this view of life."

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Biodesign engages community to assess social impact

By Kimberly Ovitt

Because science must venture continuously into the unknown to expand the boundaries of understanding, it carries a weighty responsibility.

Many discoveries have the dual potential to cause benefit and harm. Careful analysis of the benefits and risks of scientific advances – and their social and ethical implications – is a priority for the Biodesign Institute.

ASU is engaged in developing rational policies for responsibly advancing human discovery by drawing on diverse scientific, cultural, religious, ethics and public policy expertise across the university.

"When we talk about the Institute as an interdisciplinary program, this extends beyond the walls of the hard sciences," says Jonathan Fink, ASU vice president of research and economic affairs. "The Institute also engages with social scientists, such as those in ASU's Consortium for Science, Policy and Outcomes (CSPO)."

One of the most talked about new frontiers is nanotechnology. Together, the Biodesign Institute and CSPO launched the Center for Nanotech in Society, funded by the National Science Foundation. Center director David Guston explains that this is an unprecedented effort to expand knowledge of how emerging technologies like nanotechnology interact with society.

"We want to learn how to train students to understand connections between their work in the lab and the larger world," he says. "We want to involve the general public in helping to make decisions, along with scientists and engineers and policy-makers, about the role of nanotechnology."

People in developed nations such as the United States expect science and technology to provide a rapid solution to virtually any challenge. At the same time, there is a growing intolerance of risk and, historically, new scientific frontiers often are met with fear. The Biodesign Institute is committed to devising rational, evidence-based approaches to assess the risks and benefits posed by new technologies.

"Our objective is to build a sophisticated resource in science policy expertise that lawmakers and regulators can tap when shaping oversight policies and regulations that are based on rigorous standards of scientific evidence," Fink says.

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Imagine a world with...

- Safer, more cost-effective vaccines.
- Alternative fuels that mimic natural photosynthetic processes.
- Implantable devices that enable people living with spinal cord injuries and stroke to regain mobility.
- Nanoscale devices that deliver lab results to patients in seconds rather than hours.
- A vaccine to prevent virtually any type of cancer.
- Methods to detect illness before symptoms appear.
- Systems to remove chemicals from drinking water using natural microorganisms.
- Food-packaging technology that warns if food is unsafe to eat.
- Vaccines and other systems to prevent the spread of HIV.
- Early warning systems to detect infectious diseases and bioterrorism threats.
- Processes to generate energy from waste.

Geri Wentz, center, uses partial-weight bearing therapy to help in her rehabilitation from spinal cord injury. Assisting Wentz are, from left, bioengineering graduate student Manoshi (Mo) Bhomik, Russ Brandt, research coordinator at Banner Good Samaritan Medical Center, and Jimmy Abbas, co-director of the Institute's Center for Adaptive Neural Systems.

THE biodesign INSTITUTE
ARIZONA STATE UNIVERSITY

A Regional Force, Globally Engaged

The Biodesign Institute has rapidly become a regional force, remaining the Valley's single largest generator of federal biomedical research funding while its interdisciplinary research space rivals the best found on any campus in the nation. But funding and facilities are only part of the equation. A strategic effort is underway to assemble the most talented teams within ASU and engage with partners throughout the world to advance scientific research and discovery. The Biodesign Institute's academic, industrial and educational partnerships parallel the geographic U.S. biotech/high-tech corridor, and span several continents and time zones. Solving the needs of a global community requires global engagement, and the institute's reach will extend as far as necessary to address shared problems.