From lifesaving HIV treatments to energy-saving technology for homes, **UIC research is reshaping industries** from pharmaceuticals and construction to defense and automotive

DISCOVERIES CHANNELED

BY JOHN GREGERSON

Their discoveries have rippled through the fields of medicine and manufacturing, energy and defense, art and science, putting to rest the notion that university research occurs in dim, dusty labs far removed from the world around them.

In so doing, UIC researchers have saved countless lives while teaching many others to see the world in new ways, whether through the lens of night goggles, such as those worn by Navy Seals, or the prism of cyberspace, such as that inhabited by automobile designers.

One recent discovery sprang from a wish to study cyclic forces, another from an interest in thermal conductivity, the results being radically different approaches to the radically different worlds of orthodonture and energy.

UIC is enjoying a golden age of innovation, having joined the ranks of the nation's leading research universities. It didn't happen in a vacuum, nor by accident. In hindsight, or perhaps foresight, the 1982 merger of the University of Illinois at Chicago Circle and the University of Illinois Medical Center created a new paradigm, one facilitating the free flow of research from faculty to physicians, researchers to end users, and back again.

The approach created a model for other UIC initiatives involving art, physics, chemistry and computer science, as well as promoting synergies that attracted some of the world's top talent, along with the funds to house it in top research facilities.

Today, UIC's Office of Technology and Management is charged with facilitating the effective management, transfer and commercialization of UIC technologies and intellectual property—efforts that, in one instance, made the lifesaving drug Prezista, a treatment for HIV infection, affordable in regions where it is needed most, according to Nancy Sullivan, UIC OTM director.

It has been 30 years since the merger of Chicago Circle and the Medical Center, an appropriate time to revisit some of the leading innovations UIC researchers have forged since then.

ACCELERATING ORTHODONTAL CARE

Anyone who has worn dental braces remembers the criss-crossing rubber bands and coils required to promote alignment of upper and lower teeth, or upper and lower jaws, an approach that relied on application of static forces to bone tissue.

While serving as director of UIC's Tissue Engineering Laboratory, **Jeremy Mao, DDS '02** discovered that application of cyclic forces could accelerate bone remodeling and orthodontic tooth movement, an approach commercialized in 2007 when Mao founded Houston-

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Sivalingam Sivananthan, UIC physics professor and director of the Microphysics Laboratory, demonstrates the night vision technology he developed to Illinois Governor Pat Quinn.
Photo: Roberta Dupuis-Devlin

FORTIFYING THE MILITARY

The night Navy Seals executed Operation Neptune Star, the raid on the Osama bin Laden compound, a pair of MH-60 Black Hawk helicopters departed eastern Afghanistan under a moonless sky, its pilots manned with night-vision goggles based on technology developed in the 1980s by Sivalingam Sivananthan, director of UIC's Microphysics Laboratory.

While pursuing his Ph.D. in physics, Sivananthan took an interest in the alloy mercury cadmium telluride, particularly its ability to absorb infrared light and then emit a signal that could be converted to an image.

"Anyone could get access to mercury cadmium telluride," recalls Sivananthan. "We decided the key was to use molecular beam epitaxy, a method of developing single crystals, to synthesize large areas of the alloy and create more sophisticated structures."

The resulting technology cut a wide swath across the U.S. defense industry, which has incorporated it into tanks, drones and fighter planes.

Today, under the auspices of Epir Technologies Inc., a Bolingbrook-based enterprise he founded in 1998, Sivananthan is deploying cadmium telluride on silicon to construct low-cost, high-efficiency solar cells.

"No one believed it was possible to synthesize a base layer of cadmium on silicon," says Sivananthan. "Now, we're developing substrates as large as 6-8 inches in diameter."

based OrthoAccel Technologies Inc.

His product, AcceleDent, a removable device worn 20 minutes per day, generates microvibrational force to modulate the remodeling of bone tissue, chiefly by inducing bone resorption and bone formation, the two phenomena required to promote tooth movement.

According to OrthoAccel, the technology can reduce treatment time by 30 percent, or eight months, for patients prescribed braces for a period of two years.

OrthoAccel currently is marketing the product in Australia and the European Union while awaiting FDA approval.

In April, the company announced an investment of $10 million to fund the U.S. launch of AcceleDent.

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New technology developed by UIC's College of Dentistry may eliminate conventional braces.

3 REDEFINING VIRTUAL REALITY

The issue was comfort, or rather, the lack of it. To enter the virtual world of the early 1990s, users first had to don cumbersome helmets.

Along with his colleagues, Thomas A. Defanti, director emeritus of UIC's Electronic Visualization Laboratory, "decided to turn the problem inside out," recalls current EVL Director **Jason Leigh PHD '98 ENG**, then a Ph.D. student in the College of Engineering's Computer Science Department. "Rather than project images through head gear, we decided to project them on walls."

The resulting CAVE automatic virtual environment, essentially a room-sized cube within a larger room, directed projectors at several walls to create an experience akin to "visiting the Grand Canyon rather than looking at a photo of it," says Leigh, adding that CAVE's eyewear not only proved lighter, but more immersive. "Earlier eyewear tended to block peripheral vision," he says. "Ours didn't."

CAVE required only a year to develop. When it debuted in 1992, its impact was immediate. Users could see images that appeared to float on air. They could walk around an image and view it from different vantage points.

Atmospheric scientists were among the first to come calling. They wanted to model molecules with the technology. Then came General Motors, which wanted to design cars with it. "You could simulate the experience of sitting in a car, how it felt with a larger dashboard, then a smaller one, or a more prominent steering wheel, then a less prominent one," says Leigh.

Leigh's own work focused on developing software to link CAVE sites in different locations, a feat that allowed "someone in Chicago to share an experience with someone in California. I went to work for GM, which provided us with funding to link their CAVEs."

In October 2012, EVL launched CAVE2, which combines virtual reality and scalable-resolution display walls at a resolution matching that of human acuity.

"We've constructed the first 100 million-pixel LCD wall," says Leigh. "We'd reached the end of where we could go with projectors."

Lance Long

UIC has played a critical role in virtual reality development. Its CAVE automatic virtual environment is used to analyze everything from molecules to car designs.

4 RE-ENERGIZING THE INSULATION MARKET

Alan Feinerman, UIC associate professor of electrical and computer engineering, calls himself an inventor who "hates to see how much energy we waste."

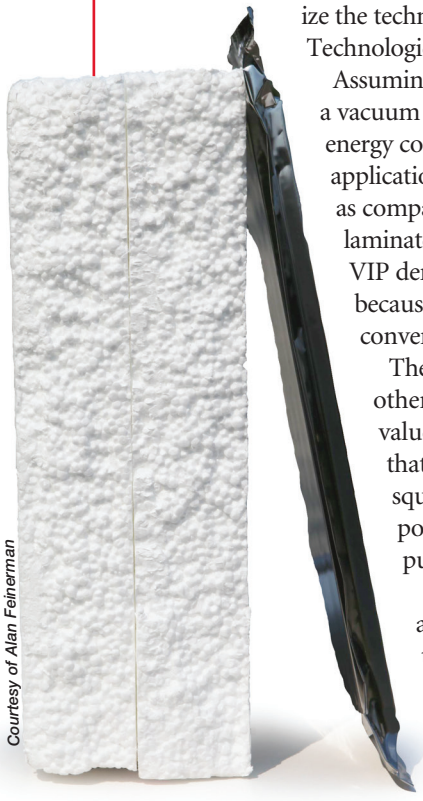
Accordingly, he's devoted much of his energy to reducing the amount of power required to heat or cool homes, in addition to refrigerating vehicles involved in the transport of perishable goods.

Earlier this year, UIC's Office of Technology Management named Feinerman UIC Inventor of the Year, both for his work with ultra-low thermal conductive insulation and his efforts to commercialize the technology via Thermal Conservation Technologies, a company he recently founded.

Assuming it's successful, Feinerman's product, a vacuum insulation panel (VIP), could reduce energy costs by as much as 80 percent in some applications. Wrapped in stainless-steel foil, as compared to the polyester/aluminum foil laminate more common to vacuum barriers, VIP demonstrates superior thermal resistance because its edges don't transmit heat, as more conventional vacuum barriers do.

The material also is ultra-thin, unlike other insulations with equivalent thermal values. "The idea was to create a structure that could support nearly 15 pounds per square inch, or the equivalent of a 100-pound person balancing on a hockey puck," says Feinerman.

The selected VIP structure is akin to a suspension bridge. This configuration also promises less heat loss.



Courtesy of Alan Feinerman

A .05-inch vacuum insulation panel (VIP) has an R20 rating, which is roughly equivalent to a 4-inch-thick layer of white Styrofoam.

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The HIV drug Prezista is available in Sub-Saharan Africa at a cost of $2.22 per day.

OUTMANEUVERING HIV

Think of it as the dark side of Darwinism. Because of their ability to mutate, viruses frequently elude treatment, if not initially, then over a period of time. For years, the effects proved deadly for millions infected by the HIV virus, that is until Dr. Arun Ghosh developed the first treatment for multi-drug-resistant HIV while serving as a UIC professor of chemistry and medicinal chemistry in the 1990s.

In collaboration with Hiroaki Mitsuya, a virologist at the Bethesda, Md.-based National Cancer Institute, Ghosh employed structure-based design, an approach that relies on knowledge of the three-dimensional structure of a biomolecular target, to design molecules that concentrated on "near structurally invariant" portions of the virus—meaning portions incapable, or nearly incapable, of mutation.

Approved by the U.S. Food and Drug Administration in 2006, the drug Prezista, an analog of the drug Darunavir, preferentially interacts with HIV's "protease backbone," the principally active-site amino acids that remain nearly structurally invariant, regardless of the strain. By disassembling these enzymes, Prezista inhibits replication of the virus, in some cases reducing viral loads to undetectable levels.

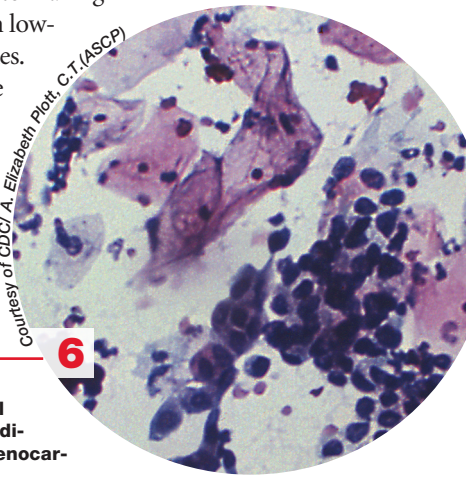
The drug has proven a critical treatment option for patients infected with drug-resistant HIV. It also is highly accessible. While the National Institute of General Medical Sciences provided initial funding for Ghosh's studies, Bridgewater, N.J.-based Tibotec Therapeutics was licensed with bringing Prezista to market.

Rather than market the drug at prices higher than existing drugs in the same class, a common practice among pharmaceutical interests, Tibotec matched the price of Prezista with that of other protease inhibitors, helping to reverse an upward spiral in drug prices.

Prezista currently is marketed by New Brunswick, N.J.-based Johnson and Johnson. Distributed under the J&J Global Access program, the treatment is available in underdeveloped nations at prices well below those in the United States.

In 2010, the White House's Office of Science and Technology lauded co-patent owner UIC and the National Institutes for Health for licensing Prevista to the Medicines Patent Pool, a Swiss foundation dedicated to making HIV treatment affordable in low- and middle-income countries.

Of the 34 million people living with HIV worldwide, a full one-third of them reside in 10 nations in Southern Africa.



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Abnormal vaginal epithelial cells indicate onset of adenocarcinoma.

TARGETING CANCER

The deleterious effects of chemotherapy in the treatment of cancer patients are well documented: anemia, fatigue, diarrhea, hair loss, bleeding, nausea, infection, memory changes. The list goes on and on.

Which is why Tapas K. Das Gupta, who heads UIC's Department of Surgical Oncology, has spent decades seeking alternative methods of targeting cancer, principally with plant- and bacteria-derived peptides that preferentially enter cancer cells and induce cell cycle arrest, resulting in their death.

A recent Phase-1 clinical trial performed by UIC and CDG Therapeutics, a Chicago-based enterprise Das Gupta co-founded in 2001, yielded promising results among 15 Stage-IV cancer patients. As intended, escalating doses of P28, a peptide with potential to inhibit certain cancers, demonstrated preferential entry to cancer cells, results "vital to avoiding the debilitating side effects seen in some patients receiving chemotherapy," Das Gupta indicated last year.

The trial also demonstrated significant regression in a variety of refractory solid tumors, suggesting the peptide may be effective in treating various types of cancer, assuming findings are confirmed in subsequent clinical testing.

CDG currently is investigating the ability of peptides to cross the blood brain barrier, an avenue that could lead to new treatments for primary tumors of the central nervous system. **UIC**