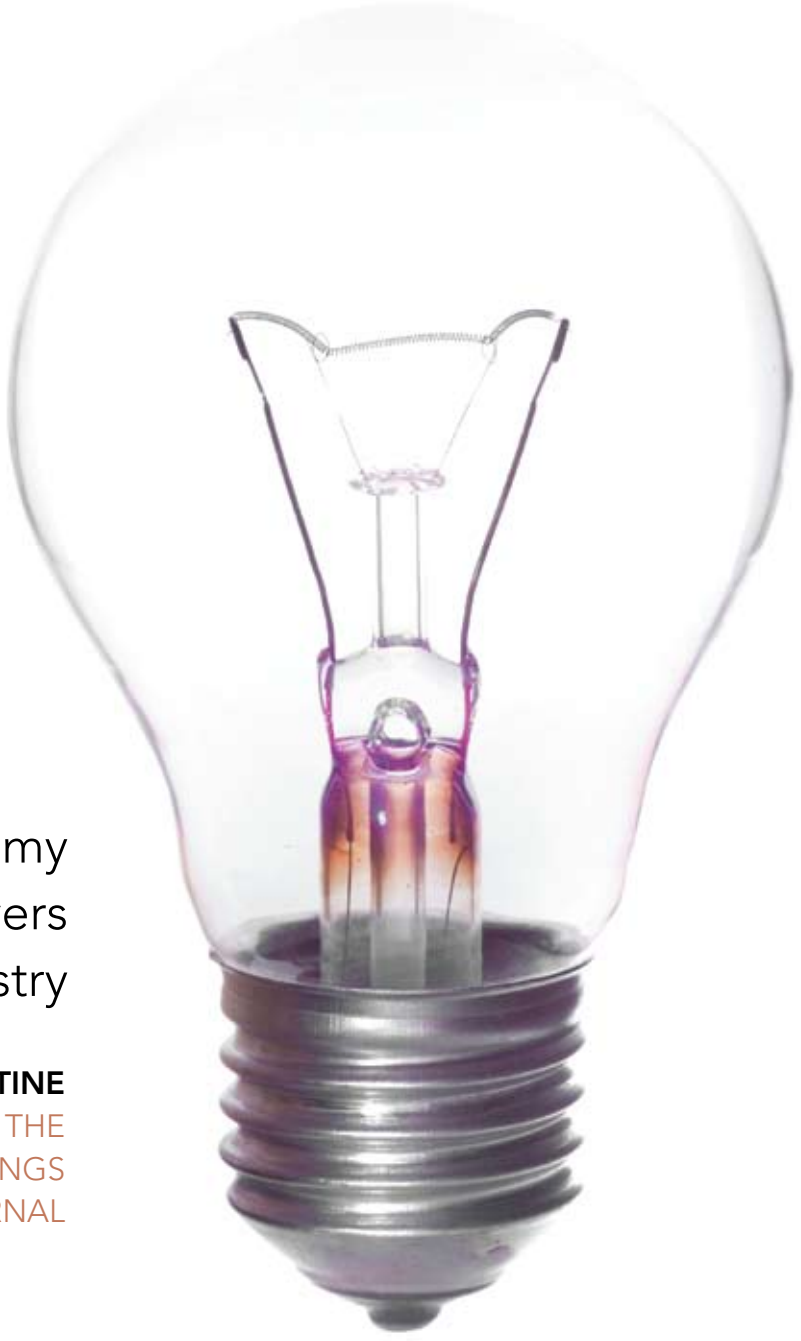

Air Force Academy research delivers boost to industry

BY **AMY GILLENTINE**
COURTESY OF THE COLORADO SPRINGS BUSINESS JOURNAL

Ideas for

the Future

While the Air Force Academy's main goal is training tomorrow's military leaders, it is also engaged in something else that's off most people's radar but is equally important—research that can be transferred to the commercial sector.

The Academy receives more research funds than any other undergraduate university in the nation, and its cadets are involved in projects often seen at the graduate and post-doctoral level. More than 100 staffers at the Academy—all with Ph.D.s—are involved solely in research. The Academy's research program is funded at $60 million a year, and houses 13 areas of research ranging from social sciences to aerospace to biology and chemistry. Some of the projects are years away from the commercial market, while others are closer to production. But a few Academy professors over the years have created start-up companies and some have seen their work commercialized with great success.

UP, UP IN THE AIR

Learn space by doing space—that's the goal of the aerospace program at the Air Force Academy, one of the more visible areas of research at the institution. Cadets in the program are responsible for building, launching and tracking their own multi-million-dollar satellite. Known as FalconSat and FalconLaunch, they are the only undergraduate programs in the nation that allow cadets this sort of hands-on experience.

Teams of cadets are responsible for everything from building rockets that get the satellite into orbit to the final launch and data-collection on their projects. The programs have so far launched four satellites, each carrying research projects about near-Earth space, where most of Air Force satellites operate, gathering information that will assist military satellites operating in space.

Not surprisingly, most of the research in the Academy's aerospace program has military or government applications. Cadets and professors in the department are working to aid customers in the active-duty Air Force, the Department of Defense, NASA and the Naval Research Laboratory. Research projects from the Academy have been launched by NASA and are operating at the International Space Station. NASA, among others, has benefited from research conducted via the Academy's aerospace program. Recently, for example, the government agency started using a gas sensor developed through cadet research for its rockets.

WATER, WATER EVERYWHERE

Dr. Stefan Siegal heads one of the Academy's research projects that seems destined for the commercial sector: He's developing new ways to capture energy from ocean waves. While the project isn't new—for the past 30 years, various projects have attempted to harness the ocean's energy to create electricity—Siegal's approach is different, and apparently very promising. "In the other projects," he explained, "they have the device residing on top of the water. But nothing lasts more than six months in the open sea. I take a different approach."

Siegal's device is placed about 100 feet under the water, where it is safe from high winds and rough seas, but can still capture about 95 percent of a wave's energy. The device is designed to capture the energy of a wave and translate that energy into power for U.S. cities and military bases. Once the device is proven to work, the rest of it is easy: underwater cables will deliver electricity to port cities—and beyond.

It works in the lab, and Siegal is ready for the next step: testing a larger version of the device in the Gulf of Mexico. He has a partnership with the Offshore Technology Research Center Wave Basin at Texas A&M University to create the bigger device and then to test it in the open ocean. Not only does Siegal believe he's conquered the violent storms of the ocean, he also thinks his machine is more efficient.

The project has received funding from the National Science Foundation for the past two years and, this year, the U.S. Department of Energy has kicked in some dollars, too. Siegal believes wave energy will soon prove to be more efficient than either solar or wind energy. "Waves are more consistent than either solar or wind," he said. "When you go to the ocean, there are always waves; they're constant. It's not a new idea, on the scientific end, but no one has really seen this kind of device before."

He'll be building the larger-scale model this year. The one in the Air Force Academy lab is built to 1/250th scale. The new

Cadets maintain satellite operations from the lab at USAFA.

Dr. John Wilkes in the USAFA chemistry lab.

one will be 1/10 scale, or 25 times larger. Siegal has created a company, called Atargis Energy, to seek venture capital or angel investment for his project. "We're really trying to start the transition to bring this project into the world," he said. "There's a focus on finding specific hydro-kinetic energy, and ocean wave energy does that."

THE RIGHT CHEMISTRY

Shunts to ease ocular pressure in glaucoma patients, a miniscule video camera that reacts as quickly as an insect, storage cells for hydrogen fuel and research into ionic gases—all are part of the research and development going on in the Academy's biology and chemistry departments.

Biochemist Dr. John Wilkes has been a researcher and teacher at the Academy for decades. And, during those years, he's partnered with defense companies like Ball Aerospace to bring his inventions to market. His latest project could clear the hurdle in bringing hydrogen-powered cars to market. It's a hydrogen fuel storage cell—sort of a battery. It stores hydrogen as a near-solid because doing so takes up less volume and more can be packed into the fuel storage cell, he said.

Wilkes explains, "It's then released at the rate needed for the device to run properly. The idea of a fuel cell isn't new; it's been around since 1840. But storing hydrogen—that's been the problem. This type of device is combined with the fuel cell in order to use it in a device."

What device? Well, essentially anything that needs power, including automobiles. Wilkes' fuel battery is about half the weight of previous batteries, and he believes his device gets past the stumbling block of how to store hydrogen fuel. But it won't solve all the problems associated with hydrogen, he said. "Hydrogen is very flammable. It's one of the negatives—there's a lot of energy in hydrogen, so you have to be very careful."

Wilkes is leaving the tech-transfer possibilities to his partners at Ball Aerospace, which is headquartered in Boulder, Colorado. It may be years before any of his work on the storage cell goes to market, but one of Wilkes' earlier projects took just a month to go from lab to marketplace. He managed—with a corporate partner—to create a new battery pack and re-charger for the nation's unmanned aerial vehicles. That was back in 2003, and Wilkes has continued to work on batteries and storage cells for vehicles.

But he is best known as the "father of ionic liquids," a way of taking liquids and ionizing them so they absorb dangerous chemicals—things like methamphetamines and mustard gas. Some of Wilkes' research has been shown to clean meth out of walls, making it possible to renovate and reuse former meth labs without making new tenants ill. His research could also prove to be the solution to cleaning up the Pueblo Chemical Depot, where the Army has stored mustard gas since World War II, but has yet to find a safe, effective way of destroying the cache.

Another Academy professor, Dr. Mike Wilcox, has produced research that has led to the establishment of several new companies. Wilcox's interests span a number of disciplines. At the moment, he has at least three projects in various stages of development including one that is starting human trials and could gain Food and Drug Administration approval as early as 2012.

The concept of using a shunt to displace fluids from the eye isn't new. But Wilcox's design addresses many of the complications associated with surgery to correct glaucoma, a disease of the eye in which pressure from ocular fluid builds up, causing blind-

Dr. Mike Wilcox from the Biology Department looks into a microscope.

Marcus Roemer (left) and Dr. Stefan Siegel stand near a water tank containing a 1:300 scale model of a wave energy converter they designed in the fall of 2008.

ness in some cases. His shunt is a 28-millimeter long cylinder with two prongs at the end. When embedded, it occupies only 10 millimeters of space in the eye.

His research shows, he said, that the device is able to drain fluids 16 times more efficiently than other shunts that are thicker. The device is now being marketed by Aqueous Biomedical, a company set up by Wilcox. He also has developed a tiny camera that reacts like an insect's eye. After months of studying the complexities of a fly's eye, Wilcox began to try to apply what he learned to a tiny camera that would be used in robots and unmanned aerial vehicles. "Imagine if a robot or plane could respond to a threat as quickly as a fly," Wilcox said. "That's what we're trying to do here."

The "fly camera," as its known, isn't ready for commercial production, nor is Wilcox's other project—a glove that will help stroke victims regain their grip—a glove so sensitive that patients can pick up an egg or a coffee cup. "Right now, we've just proven we can do one finger," he said. "So now this semester we're going to spend it on the entire hand."

The glove creates a sort of "exoskeleton" and is like an extension of the skin, he said. "It's pretty exciting," Wilcox recounted. "This will allow people to change their grip and get more control. It's really an assistive therapy."

Of course, a lot of the research under way in the labs and classrooms at the Academy is, in a way, assistive, too.

BY THE NUMBERS

The Air Force Academy's research lab at a glance:

- $60 million — value of research grants received annually
- 90 — cooperative research and development agreements with private industry
- 550 — scientific journal articles published annually by its professors.
- 13 — research centers and two institutes at the Academy
- 100 — Academy doctoral staff engaged solely in research projects

Source: Air Force Academy.

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