UNIVERSITY of DELAWARE

Research

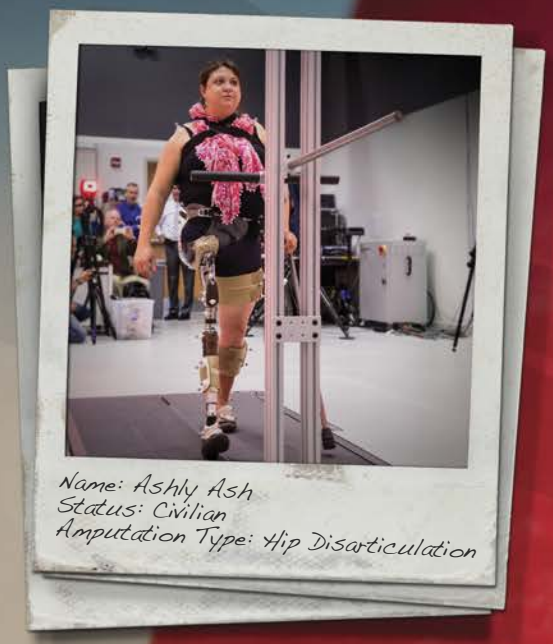
www.udel.edu/researchmagazine

Volume 5 / Number 1 / 2015

★ FROM THE ★

BATTLEFIELD TO THE HOMEFRONT

New Strides in Orthopedic Care



INSIDE

UNIVERSITY of DELAWARE

Research

ISSN 2150-461X

Volume 5 / Number 1 / 2015

University of Delaware
Research Office
209 Hullihen Hall
Newark, DE 19716
Phone: (302) 831-4007
E-mail: udresearch@udel.edu
Web: www.udel.edu/research

University of Delaware Research is published three times a year by Communications and Public Affairs in collaboration with the Research Office. Please address inquiries to Tracey Bryant, Editor, Academy Building, 105 East Main St., Newark, DE 19716-7201, telephone (302) 831-2792; e-mail to ResearchMagazine@udel.edu.

For address changes, please contact ResearchMagazine@udel.edu.

MIX
Paper from responsible sources
FSC® C018743

COVER: BADER Consortium, led by the University of Delaware, is advancing rehabilitation science to help wounded warriors and civilians move forward with their lives. Illustration by David Barczak. 3/15:10K

Features

Visit us at **www.udel.edu/researchmagazine**

22 Fighting Cyberattacks

UD's Cybersecurity Initiative is developing strategic partnerships, needed research and cyberwarriors to battle an ever-present threat to corporate America.

44 World War II Discoveries

UD researchers are using underwater robots to help locate heroes lost in the waters off Palau.

DEPARTMENTS

Follow us on Twitter
@UDResearch

Putting research in motion ... *for you*

As a fellow chemist, I've long admired Richard Heck, UD's Willis F. Harrington Professor Emeritus, who won the Nobel Prize in Chemistry in 2010. He didn't let obstacles that cropped up during his early career in industry become permanent barriers in his quest to discover new chemical reactions.

In Brown Lab at UD in the 1970s, Heck adroitly pursued his passion and ultimately invented the chemical reaction we know as the Heck Reaction. Simply put, it links together carbon atoms that ordinarily wouldn't meet up. The Heck Reaction helps produce many of the world's medicines today. It made DNA sequencing and the Human Genome Project possible, and it is being used to develop new, energy-saving electronics. In short, the Heck Reaction has been a life-changing and life-saving discovery.

Nationally, discussions of university research often echo the title of the latest face-off movie: basic versus applied research, science and engineering versus the humanities, federal funding versus corporate funding, peer-reviewed publication production versus inventions, and so on. These are false dilemmas. The fact is, we the people need all of it. And like the bonding of Heck's divergent atoms, it's clear that great good can come from bringing together different forces, perspectives and fields.

Charles Riordan, Ph.D.
Deputy Provost for Research and Scholarship

As university researchers, we increasingly do our work in collaboration with others and in lots of places. In the lab. In the library. In the field—from the seafloor to outer space. In the marketplace—where new inventions are grown. And most certainly, directly with the public, on local to international levels. UD's recent selection to receive the Community Engagement classification from the Carnegie Foundation for the Advancement of Teaching reflects our commitment to do impactful work far beyond academia's ivy-covered walls.

UD has hundreds of projects underway with community partners. Many of these efforts are research-based, involving our students as problem solvers alongside community residents and agencies. You may have read about these efforts in past issues of this magazine and in the national media—from Professor Mary Dozier's Infant Caregiver Project, focusing on enhancing the development of children who have experienced adversity early in their lives, to Professor Yasser Payne's Participatory Action Research, which involves residents as research assistants in uncovering the underlying causes of crime in Wilmington's Eastside and Southbridge communities.

You'll learn about a number of other efforts in the pages ahead, and in the issues to come. After all, you'll find UD researchers in high-tech labs to busy community centers. But ultimately, our impact comes down to you.

UD receives Carnegie Community Engagement Classification

Led by University of Delaware professor Yasser Payne, 15 residents of the Eastside and Southbridge neighborhoods of Wilmington, Delaware, receive training as research assistants to help determine the underlying causes of violence affecting their communities.

Through the nationally recognized Lori's Hands, founded by Sarah LaFave when she was a UD student, college students provide in-home support to people with chronic illnesses such as cancer and multiple sclerosis.

Thanks to the bridge over the Rio Vibora built by UD's student chapter of Engineers Without Borders, residents of San Jose Petacalapa in Guatemala can now easily reach their farmland even during the rainy season.

These are just a few of the many efforts for which the University of Delaware received the Community Engagement classification from the Carnegie Foundation for the Advancement of Teaching in January 2015.

In order to be selected for the nationally recognized classification, institutions had to provide descriptions and examples of institutionalized practices of community engagement that showed alignment among mission, culture, leadership, resources and practices.

"The University of Delaware is delighted that the Carnegie Foundation has recognized our deep commitment to working with community partners to address societal issues and contribute to the public good," said Patrick T. Harker, UD president. "Community-based experiences are woven into UD's teaching, research and service activities—they are critical to the education of our students as civic-minded, engaged citizens."

Founded by Andrew Carnegie in 1905 and chartered in 1906 by an Act of Congress, the Carnegie Foundation defines community engagement as "the collaboration between institutions of higher education and their larger communities (local, regional/state, national, global) for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity."

More than 300 unique community partners and over 375 examples of community projects were identified during the development of UD's application for the elective classification, which was submitted to the Carnegie Foundation in April 2014.

Under the leadership of Lynnette Young Overby, professor of theatre, a task force encompassing faculty, staff, students and community representatives researched and assembled the successful application, which included major sections focusing on foundational indicators, curricular engagement, and outreach and partnerships.

"Our findings underscored that UD is a dynamic force for good, involved in meaningful work in communities near and far," Overby said. "UD is robustly engaged with communities at the local, regional, national and global levels in efforts that benefit our students, faculty and staff, and the communities with whom we partner."

UD is among 361 institutions that hold the Community Engagement designation. UD's community engagement classification is valid until 2025. The re-application process will begin in 2023. *—Tracey Bryant*

AMBRE ALEXANDER PAYNE

Lynnette Young Overby, *professor of theatre, leads UD's Community Engagement Commission. An internationally known expert in dance and choreography, she is shown with her students who are involved in ArtsBridge, a national network that is bringing the performing arts into K–12 schools.*

Alyssa Hull

Student art detective helps find hidden man in Picasso painting

UD students have made some surprising findings in their senior thesis research, but none like Alyssa Hull's. She worked with the Phillips Collection in Washington, D.C., to unveil a bearded man with a bowtie peering out from under Pablo Picasso's 1901 masterpiece *The Blue Room.* Hull received her Honors Degree with Distinction in Chemistry and a second Honors Degree in Art Conservation last May. She shares her detective work and what she's working on now.

JOHN DELANEY, NATIONAL GALLERY

Q. How did you find him?

We started our analysis by using a non-invasive technique called X-ray fluorescence (XRF) spectroscopy, which gives information about the chemical elements present on a small area of the painting. From this, we were able to get a sense of what pigments Picasso was using on both *The Blue Room* and the hidden painting beneath. We also took microgram-sized samples from the painting so we could look at the layers of paint hidden under the surface and run more analyses to get additional elemental and molecular information on the pigments. These samples are about the size of the period at the end of this sentence.

The next step was to take the painting to the Cornell High Energy Synchrotron Source (CHESS), so we could actually "look" through the upper layers to the painting below. A synchrotron produces intensely powerful X-rays. We used a special detector at CHESS called Maia to map elements present in the painting—data we then used to generate an image of the underlying painting.

Q. What was your reaction when you first saw him?

I had the same question as everyone else: Who is he? It was rewarding when the synchrotron data gave us clues as to what pigments Picasso used for the sitter, because that's going to allow us to better visualize the hidden painting going forward.

Q. How did it feel to work with a priceless masterpiece?

It was truly exhilarating for me. I've always appreciated the vibrancy of Picasso's works. It's special to see a painting like *The Blue Room* up close, because with an image that iconic it's easy to forget that the painting is a real, tangible object as well.

Q. Was it a lengthy process?

I spent several weeks in the summer of 2012 at Winterthur analyzing paint samples that my thesis adviser, Jennifer Mass, removed from the painting. When we took the painting to the synchrotron that October,

Worms may reveal effects of space travel

With apologies to the late Neil Armstrong, whose boots were the first to step onto the surface of the moon, you might describe Chandran Sabanayagam's research at the Delaware Biotechnology Institute (DBI) as one small freefall for a worm, one giant leap for biogenetics.

With support from NASA, Sabanayagam is studying the effect of zero gravity on the worm's genes, work that could produce new insights into the effect of long periods in space on the likes of Capt. Scott Kelly, who will spend a year in space starting this spring—a trip that will help prepare the way for a mission to Mars.

Sabanayagam's worms may go to Mars someday but first they continue their pioneering freefalls at DBI, preparing for a trip to the International Space Station.

Sabanayagam's team employs the tiny worm *Caenorhabdtis elegans*, and while it has none of the credentials of an astronaut, it does have many genetic similarities. More than 70 percent of this roundworm's genes are found within the human genome, he says.

Among its traits, *C. elegans* reproduces rapidly and has a lifespan of only about two weeks—a quick turnaround giving scientists the opportunity to see generational effects.

To put the worms into an environment approaching zero gravity, Sabanayagam's team places them in a small amount of water, encased between two round glass slides. The "worm chip," as he and his colleagues call it, is placed in a new-age version of an instrument called a clinostat, where it rotates at a speed slow enough to protect the worm from colliding with the frame of the device and fast enough to keep the worm suspended in the liquid and free of gravitational pull.

"The orbital motion is like freefalling," he says, "or like a satellite going around the Earth."

A camera mounted to the clinostat produces images that have no blur. With those images and DBI's DNA sequencing capacities, the research team now can collect enormous amounts of data and provide analysis never before possible.

Researchers can look more closely at specific genes, narrowing down 10's of thousands to 100 or 20, Sabanayagam says.

Epigenetics is chemical change that can be passed along to subsequent generations, giving organisms a way to adapt to and survive in conditions that change dramatically or suddenly, he says. A famine this year could affect genetic traits in babies born next year,

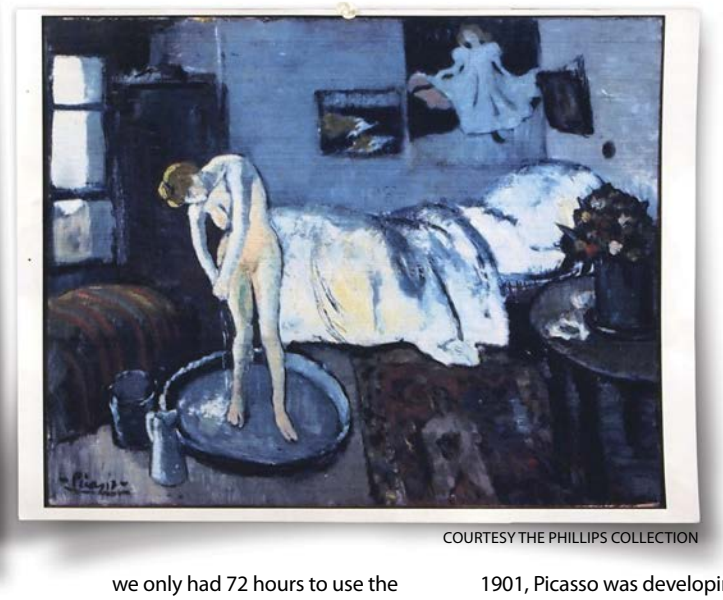
KATHY F. ATKINSON

Chandran Sabanayagam *is studying the effects of zero gravity on a roundworm's genes. The work may shed light on space travel's impact on humans.*

and those changes can be passed along to future generations.

The genetic impact of space travel on astronauts is uncharted territory, he says. They don't return from space with three eyes or other obvious mutations, but more subtle changes may be occurring.

The freefalling worms at DBI might be the first to know.—*Beth Miller*



COURTESY THE PHILLIPS COLLECTION

The hidden man revealed. *Conservators long suspected another painting was hiding under Picasso's The Blue Room due to some strange brushstrokes. Scientific analysis reveals the hidden portrait (far left), which is shown vertically here for ease of viewing. In its hidden state, the portrait is horizontal, as if the mystery man is reclining, head resting on his arm. Experts say Picasso likely painted over the portrait because canvas was expensive.*

we only had 72 hours to use the Maia detector to study it. I then spent my senior year analyzing the data with the help of CHESS staff scientist Arthur Woll.

Q. What do you think this finding tells us about Picasso?

I think the consensus among the conservators, curators and art historians involved with this project is that at the beginning of the Blue Period in 1901, Picasso was developing new styles and new themes in his artwork in response to some tumultuous events in his personal life. Covering up the original painting that was on this canvas with the idealized version of his studio that we see in *The Blue Room* today could have been an attempt on Picasso's part to redefine his direction as an artist.

Q. Do you think other masterpieces hold such mysteries?

This is the case for several Picasso paintings, including such Blue Period works as *The Old Guitarist* (1903–1904, Art Institute of Chicago) and *Le Gourmet* (1901, The National Gallery). The Maia detector was also used to investigate a hidden painting by Rembrandt, so it's not uncommon.

Q. What are you doing now?

This past August, I began 10 months of study at the Munch Museum in Oslo, Norway, where I'm studying pigment changes in the works of Edvard Munch, who painted *The Scream*. I am creating a database of materials that he used in his paintings.

Q. Did you always want to be an art detective?

When I started as a freshman at UD, I was a chemistry major planning to go into patent law. My freshman roommate was an art conservation major and after listening to her talk about what she wanted to do, I felt like I was in the wrong major! I always loved art and history as well as science, so it was amazing to be able to combine art conservation and chemistry coursework.

After I finish my research in Norway, I will start a Ph.D. program in chemistry at Duke. I hope to work as a museum scientist after that.

—Tracey Bryant

Flame Nebula heats up the night

You can see the Flame Nebula with a handheld telescope. It's in the constellation Orion, near the leftmost star in Orion's belt. Photo by Stefan Zimmerman.

It was a clear night on Feb. 3 at Mount Cuba Astronomical Observatory in Greenville, Delaware—and only about 15°F.

But the big chill didn't deter Prof. Judi Provencal's astronomy class from completing their mission, ironically, to photograph the Flame Nebula, where hot new suns are being formed some 8 quadrillion miles away.

Stefan Zimmerman, a senior from Wilmington, Delaware, majoring in computer science with a minor in astronomy, was one of eight students who took part in imaging the nebula, which is a cloud of gas and dust. The outdoor work involved moving around the telescope, which has a 24-inch mirror, using a computer program to point the scope in the right direction, and centering the object in the camera.

Because the camera doesn't produce color images, three sets of images had to be taken, each with a different filter, to let visible light through, then blue light, and finally red light. The students took these raw images, removed the "noise" or grainy areas, and combined them to create a color image.

Provencal says the dark tentacles in Zimmerman's photo, shown here, are clouds of cold hydrogen and dust. Beyond them lies a cluster of young stars only 200,000 years old compared to our sun of 4.5 billion years. These young stars are heating the more distant gas, causing it to glow.

"These young stars may also have rotating protoplanetary disks, which are forming new solar systems. It's pretty neat," Provencal says.

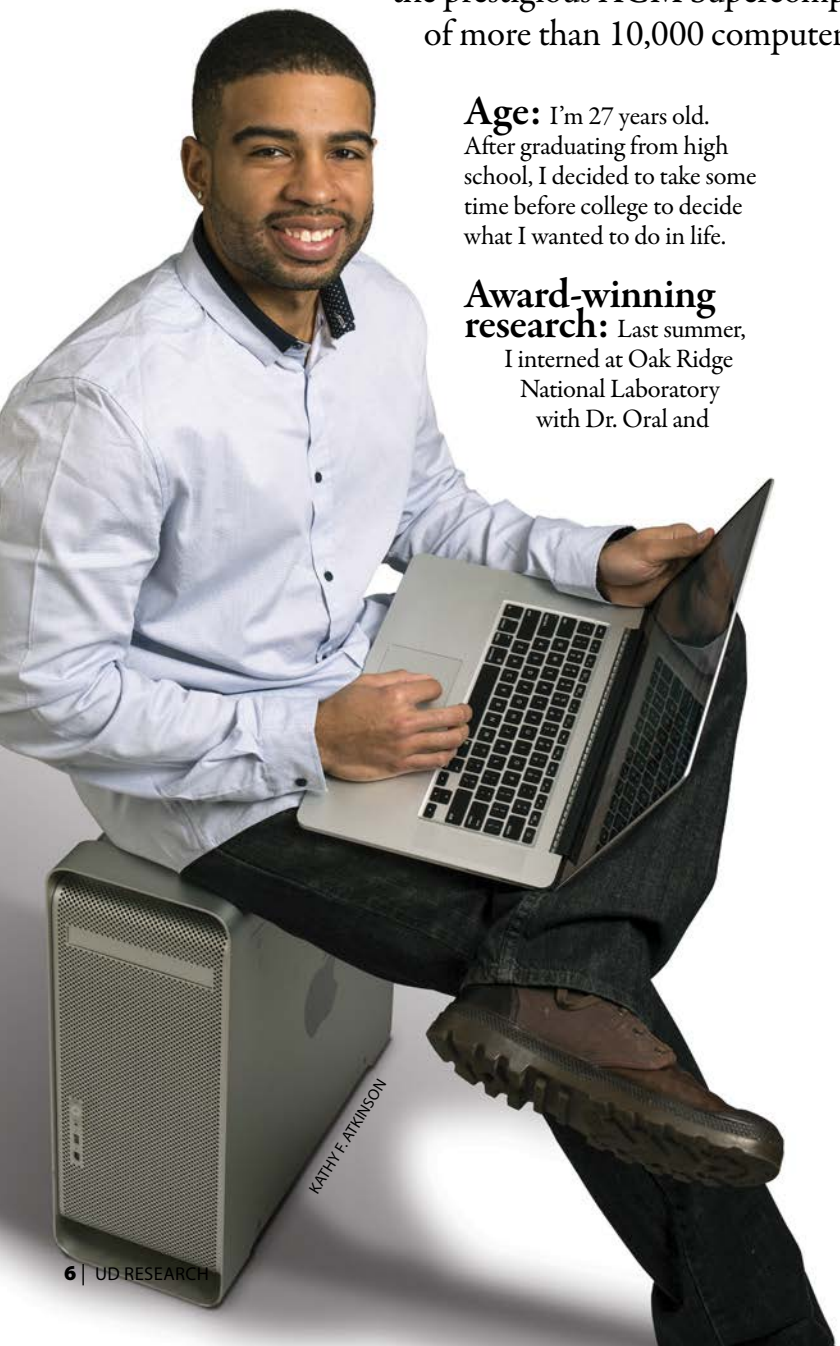
After graduation this spring, Zimmerman plans to head to L.A. to be a game designer. But he says he definitely wants to keep astronomy as a hobby.*—Tracey Bryant*

HONORS

The McDaniel File (that's code for *'computing excellence'*)

Sean McDaniel was but a young tyke when his dad introduced him to computers. McDaniel's fascination with all things code brought him to UD, where he recently received his bachelor of science in computer and information sciences—the first in his family to earn a college degree. Now, he has his sights set on a doctorate in the field.

This past November, McDaniel achieved a major national honor: he won the best poster award at the prestigious ACM Supercomputing Conference in New Orleans, a gathering of more than 10,000 computer experts.



KATHY F. ATKINSON

Age: I'm 27 years old. After graduating from high school, I decided to take some time before college to decide what I wanted to do in life.

Award-winning research: Last summer, I interned at Oak Ridge National Laboratory with Dr. Oral and Dr. Nam, collaborators of my UD adviser, Dr. Michela Taufer. We analyzed the performance of an application in cosmology called HACC, created by Argonne National Laboratory. HACC can execute very fast, accurate simulations of galaxies' mass on supercomputers, barring the need to extract large amounts of data generated by these simulations. The problem is that scientists need this big data for visualization and scientific learning. We computer scientists can play a key role in making the process of data extraction efficient. I worked with a simplified version of the HACC code that specifically targets this problem and helped my advisers to understand whether we can trust this simplified (and easier to use) version of the code.

Reaction to the award: As this was my first competition, I did not expect to win first place. I actually let out an audible "What?" when my name was called. I was sure some of the other talented students would win.

Why computer science? It's a long story, but the short version is my father introduced me to computers when I was young. We would have long conversations over the phone about new hardware and software, and I was always eager to learn more to impress him the next time we had a chance to talk.

I find the sheer ubiquity of computers amazing. The fact that in my pocket I have more computing power than what took the first men to the moon is very cool. New discoveries are happening so fast it's head spinning. I look forward to future breakthroughs in computing research and hopefully being able to contribute, too, one day.

Career goal: To work for a company in the industry, preferably one of the big giants such as Google or Microsoft. However, recently I have been interested in learning more about a career in academia. For now, I have a long time to think it over, as I just started graduate school in computer science here at UD.

Two named fellows of American Academy of Nursing

Kathleen Brewer-Smyth and Judith Wheaton Herrman, faculty members in the School of Nursing, were inducted as fellows of the American Academy of Nursing (AAN) during the organization's Transforming Health, Driving Policy Conference this past October in Washington, D.C.

Kathleen Brewer-Smyth

Judith Wheaton Herrman

They were selected for their "leadership in education, management, and policy, and work to improve the health of the nation."

Brewer-Smyth has been a leader in identifying, preventing and managing neurological impairment in high-risk marginalized populations. She was the first to document the prevalence of neurological impairment in female prison inmates during the decade after the closure of facilities for long-term management of neuro-psychiatric conditions. Her award-winning research has had global impact on the science and practice of neuro-rehabilitation.

Herrman is a nurse educator with a passion for adolescents, nursing education and creative teaching strategies across the lifespan. She is involved in research related to adolescent decision making and sexuality, interpersonal violence prevention, and teaching strategies focusing on age-related learning. Her research has examined issues ranging from adolescent parenting to teen pregnancy prevention.

Brewer-Smyth and Herrman join three other UD faculty who are AAN fellows: Barbara Habermann, Nannie Longfellow Professor; Bethany Hall-Long, professor; and Veronica Rempusheski, Jeanne K. Buxbaum Professor.

Academy fellows are nursing's most accomplished leaders in education, management, practice and research. They are recognized for their extraordinary contributions to nursing and health care.

PROFESSORS RECOGNIZED AS HIGHLY CITED RESEARCHERS

Three UD professors—Pamela Green, Blake Meyers and Cathy Wu—rank among the world's top scientists in the 2014 Thomson Reuters Highly Cited Researchers list, which spotlights "standout researchers of the last decade."

The researchers earned the distinction by writing the greatest number of articles ranking among the top one percent most cited for their subject field and year of publication between 2002 and 2012.

Pamela Green

Blake Meyers

Cathy Wu

Green, the Crawford H. Greenewalt Chair in the Department of Plant and Soil Sciences in the College of Agriculture and Natural Resources, is also a professor in the School of Marine Science and Policy in the College of Earth, Ocean, and Environment and holds joint appointments in the departments of Biological Sciences and Chemistry and Biochemistry. She leads a laboratory at the Delaware Biotechnology Institute (DBI) focusing on post-transcriptional mechanisms that regulate the expression of genes, primarily in plants, but also in marine organisms and human cells. Her work investigates the regulatory roles of microRNAs, RNA degradation, ribonucleases and environmental stress responses.

Blake Meyers, the Edward F. and Elizabeth Goodman Rosenberg Professor and chair of the Department of Plant and Soil Sciences, also leads a laboratory at DBI. His focus is plant genomics, in particular, studying and characterizing small RNAs and their regulatory roles using novel approaches and applications of bioinformatics and next-generation sequencing. His emphasis is understanding the biological functions, evolution and genomic impact of small RNAs, plus their interconnected functions in DNA methylation and as modulators of gene expression. These studies take place in rice, *Arabidopsis,* maize, *Medicago,* soybean and other species.

Cathy Wu is the Edward G. Jefferson Chair of Bioinformatics and Computational Biology, director of the Center for Bioinformatics and Computational Biology (CBCB), director of the Protein Information Resource (PIR), and a professor of computer and information sciences and biological sciences. Her research interests include bioinformatics and computational biology, biological text mining, biological ontology, systems biology and bioinformatics cyberinfrastructure. She is the principal or co-principal investigator on a number of big data projects, including the UniProt Consortium, which is funded primarily by the National Institutes of Health to provide the scientific community with a free, high-quality resource of protein sequence and functional information. The website at **uniprot.org** receives over 4 million page views per month.

Revised master plan unveiled

by Andrea Boyle Tippett

It will certainly take decades, maybe even a century, until UD's Science, Technology and Advanced Research (STAR) Campus is complete. But the 272-acre campus—a former Chrysler automotive assembly plant—already is radiating with activity, with a health sciences complex now open and energy research underway.

EVAN KRAPE

Alan Brangman, *UD's vice president for facilities, real estate and auxiliary services, has responsibility for campus design, construction and maintenance and, working with senior leadership, the strategic development of the Science, Technology and Advanced Research (STAR) Campus.*

UD officials shared a draft of the revised master plan for the STAR Campus at two public forums this past November. The plan builds upon the site's original master plan, created in 2011, better illustrating the vision and clearly outlining guidelines for development.

"We have an asset here that is going to be working for us for a very, very, very long time," said Alan Brangman, vice president for facilities, real estate and auxiliary services. "It's important to have the framework established."

Brangman extensively described the framework but could not easily point to a comparable campus elsewhere—and for good reason. The site will not be a typical office park, with individual buildings drifting in a sea of parking lots, he said. Nor will it be a replica of The Green on the UD campus, or duplicate slices of other college campuses.

Buildings will be erected in a pedestrian friendly urban fashion, with doors that open directly onto sidewalks. Parking is initially contained to two parking lots

along one edge of the plot, with future additional parking planned for garages.

"The real key here is mixed use," Brangman said.

While the campus comprises 272 acres, the master plan (shown on the next spread) focuses on just 65 acres in the northeast corner, flanked by train tracks and South College Avenue on the north and east, respectively. These acres represent the initial area of development.

Mockups of the site show streets built on a grid pattern color-coded by use: orange for research, yellow for residential, red for retail and more. A deep purple area marks the intended location of a new train station, to replace the current one serviced by Amtrak and SEPTA.

Green spaces infiltrate the plan for a campus built on land that once housed a Chrysler vehicle manufacturing facility. No spot in the designated area would be more than a five-minute walk from a park space. A long green expanse on the western edge represents the location of Silver

The **Health Sciences Complex** *at STAR Campus opened in January 2014. The building has a University side (right half) for education, research and clinical programs and a tenant side for businesses and organizations that complement UD's mission.*

> "We have an asset here that is going to be working for us for a very, very, very long time." *—Alan Brangman*

Creek, a waterway buried years ago that would be day-lighted, that is, returned to above ground.

Near the southern end of the development area stands the existing Health Sciences Complex.

Health sciences represent one of the site's primary foci, part of a strategy with the moniker "three plus one." The "three" areas are energy and the environment, defense and national security, and health and life sciences. The "plus one" represents the infrastructure, such as roads and water lines, which will enable the site to operate.

Charles G. Riordan, deputy provost for research and scholarship, said the three areas are ones in which UD has strengths and a great potential to impact society.

He invoked the Morrill Land-Grant Act of 1862, which established land-grant colleges, a designation that UD holds. Through that act, universities are compelled to serve the public good through education, practical research and economic development.

"We will not be here when the STAR Campus is fully executed but we have great opportunity and, in fact, responsibility to set the direction," Riordan said.

UD will build out the STAR Campus through collaboration with private businesses and government agencies. The Health Sciences Complex was established through a strategic partnership with Delle Donne and Associates Inc. and Bancroft Construction Company.

The plan emphasizes real-world learning. Potential tenants are expected to offer internships for students and collaborative research opportunities with UD.

"Anytime we talk with potential partners we are very clear and share our strategy and vision," Riordan said.

The master plan is—and will continue to be—in draft form. Members of the community are encouraged to offer feedback by emailing *star@facilities.udel.edu*. Potential research collaborators may email the same address.

It is a living document, Brangman said, for a site that will outlast even the youngest Blue Hens.

STAR™ Campus

A STAR is beginning to shine at the University of Delaware.

The Science, Technology and Advanced Research Campus is taking shape as a center for innovation, and companies are taking notice. . . .

SevOne, a fast-growing software firm that allows businesses to monitor and analyze their networks, is moving its operations to STAR Campus. The company announced in February that it expects to add 200 employees to its rolls this year, many in Delaware, to bring its total workforce to about 600 people.

Founded by two UD alumni—Vess Bakalov, who received his degree in computer science, and Tanya Bakalov, a graduate in management information—SevOne gives clients a comprehensive view of their networks and applications to ensure efficient traffic flow and uninterrupted business operations.

The company draws its name from the term used for the most critical threats to any system—"severity one."

Among its clients are firms with massive telecommunications networks—such as Verizon—and smaller firms that simply want expert eyes reviewing their operations to ensure all systems are "go."

SevOne's applications give companies real-time data on their networks, including traffic and usage. It provides layers of service, from basic monitoring to detailed metrics, depending on the client's need.

Real-time analysis of that data—including cloud-based activity—helps companies identify chokepoints, troubleshoot problems quickly and prevent service interruptions.

From its earliest days, SevOne has hired UD alumni and provided many interns with opportunities to use and develop engineering and software development skills.

It drew $150 million in support, led by Bain Capital, a few years ago and has seen impressive business growth, recently reporting a 61 percent increase in annual revenue—from $39.5 million to $64.5 million.

In addition to its STAR Campus headquarters, SevOne has offices in Philadelphia and Boston and a growing global footprint that now includes London, Hong Kong and Moscow.—*Beth Miller*

ENERGY AND ENVIRONMENT

With home-grown technology, UD researchers showed the world in 2013 that an electric car can plug in and sell battery storage back to the power grid. Studies continue with a test fleet of Mini-Coopers.

A VISION TAKES SHAPE

UD purchased the 272-acre site for the Science, Technology and Advanced Research Campus in late 2009 after Chrysler ceased manufacturing there. Since then, STAR Campus has steadily been taking shape as an innovation center. Through public and private partnerships, UD seeks to develop STAR Campus to provide educational and professional opportunities for students while igniting economic growth.

ECONOMIC DEVELOPMENT

Bloom Energy located its first East Coast manufacturing facility on STAR Campus in 2013.The company makes Bloom Energy Servers, which use solid oxide fuel cell technology to convert fuel to electricity through an electrochemical reaction rather than combustion. The company reportedly plans to hire 900 people by 2016.

INFRASTRUCTURE

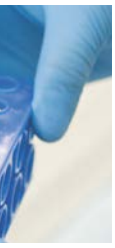
Future improvements to the train station in Newark, Delaware, through a $10 million grant from the U.S. Department of Transportation, will strengthen STAR's connection to cities along the East Coast, creating academic and economic development opportunities.

HEALTH AND LIFE SCIENCES

- The Health Sciences Complex, which opened last year, has a University side, housing the Physical Therapy Clinic, Nurse Managed Health Center, Parkinson's Clinic, research labs, classrooms and other facilities.
- The other half of the building will house businesses and organizations that complement UD's health and wellness mission—perhaps a radiology lab, behavioral health center, or pharmacy, for example. This design creates opportunities for collaborative research, student internships and a "one-stop" center for the public.

NATIONAL SECURITY AND DEFENSE

The recently launched University of Delaware Cybersecurity Initiative (UDCSI) will be located on STAR Campus. UDCSI is a partnership of academia, government and business. From its base in Delaware—America's corporate capital—UDCSI's mission is to develop programs and best practices to strengthen cybersecurity at businesses of all sizes and train a new generation of cyberwarriors to protect corporate America.



INCUBATING COMPANIES

A 10,000-square-foot wet lab, to be built by Delaware Technology Park with a $3 million, 10-year state loan, will serve as an incubator for small research companies in areas ranging from renewable energy to life sciences.

UD's development strategy for STAR Campus is described as "three plus one"—the "three" are the key areas of energy and environment; health and life sciences; and national security and defense. "Plus one" is the enabling infrastructure, from water lines to transportation.

3+1 Strategy

Learn more—visit **www.udel.edu/star**

Health sciences for the community

Since its opening in January 2014, the Health Sciences Complex at STAR Campus is rapidly becoming the center for patient-focused research and community outreach that Kathleen Matt, dean of the College of Health Sciences, envisions. She provides *UD Research* with an update on this new hub for health and wellness activity.

EVAN KRAPE

Kathleen Matt, *dean of UD's College of Health Sciences, views the Health Sciences Complex at STAR Campus as a place of discovery where researchers and students work together with community partners to invent solutions to health and wellness issues.*

Q. Who has moved into the Health Sciences Complex so far?

A. Our Nurse Managed Health Center and our Physical Therapy Clinic were among the first to move in.

The Nurse Managed Health Center delivers "Primary Care Plus" through a team of professionals, creating a signature for interprofessional health care delivery. Services currently include nutrition and exercise counseling, chronic disease management workshops, acupuncture, therapeutic massage, occupational health care and health coaching.

The Nurse Managed Health Center is also home to The Parkinson's Clinic, which offers comprehensive multidisciplinary care for people with Parkinson's and support for their families and caregivers. Using our state-of-the-art telehealth technology, a movement disorder specialist brings advanced, specialized care to the 2,000 people in our state who have PD.

The Delaware Physical Therapy Clinic and our academic doctor of physical therapy [DPT] program provide a model for interconnected clinical, research and academic activities: Community members participate in cutting-edge, patient-centered research conducted by our expert faculty and top-notch graduate students, and the results of that research are fed back into clinical practice as well as into our academic curricula. The STAR Campus has enabled us to double the number of students in our DPT program so that we can become even more responsive to community needs, and the co-location of the clinics facilitates primary and specialized care for our patients.

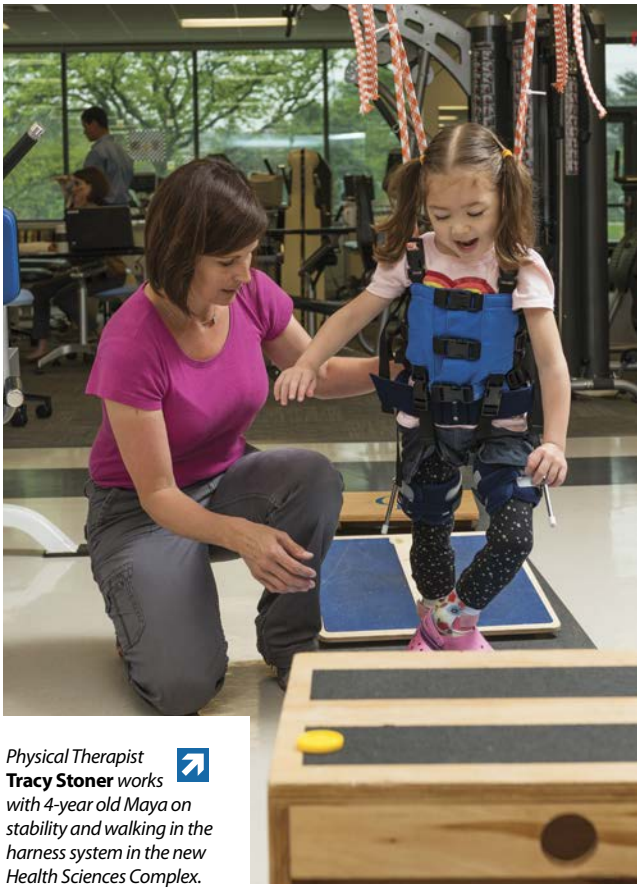
The first building also houses core labs for use by teams of clinical and academic researchers from across campus. These shared spaces encourage basic scientists, clinicians, physician scholars and students to work together conducting interdisciplinary and translational research that changes people's lives.

Other occupants of the first building include the BADER Consortium, which focuses on rehabilitation of wounded warriors; the Delaware Rehabilitation Institute, which brings together clinicians, scientists, engineers and policy-makers to improve the state of the art in rehabilitation medicine; and GoBabyGo!, which is aimed at increasing the cognitive, social and emotional development of infants and young children with disabilities through movement. Within the next year, we'll also be adding our new Communication Sciences and Disorders graduate program and related clinical services.

Q. How will the STAR Campus affect health sciences education?

A. When I talked about the Nurse Managed Health Center earlier, I said it would deliver care through a team of health professionals. If that's how we're going to provide care, it's critical that we train students in the same way. Effective health care can be delivered only if team members work together to treat disease and injury—and, more importantly, to promote health and wellness—and there is no more effective way to achieve this goal than to educate students in an interprofessional environment.

Our goal is to provide our students with as many rich opportunities for learning as



KATHY F. ATKINSON

Physical Therapist **Tracy Stoner** *works with 4-year old Maya on stability and walking in the harness system in the new Health Sciences Complex.*

possible, so that as they exit our programs, they're equipped to "hit the ground running" when they move into the workforce.

Q. What does the future of health care look like to you?

A. We face tremendous challenges in this arena, challenges that will require bringing the right people to the table to identify problems, design solutions and implement solutions. The ultimate goal has to be better health outcomes at lower cost. We have to find ways to keep the people of Delaware healthier and safer, so that we spend less on chronic illness and catastrophic injury. This means putting people in control of their own health and creating communities to foster a healthy lifestyle. No sector or discipline will have all the answers to this problem, but I think the environment we create at STAR will foster the kind of collaboration that will move us in the right direction.

Also, in the past few years, we've put tremendous resources into determining how to pay for health care and who should pay for it—to the point where the term "health care" has become almost synonymous with "health insurance." When we talk about health care, we should really be talking about the kinds of care that will keep people healthy, not about the kinds of funding that will pay for treatment of lifestyle-induced chronic illnesses.

Q. How will the STAR Campus facilitate partnerships?

A. One of the clear advantages on the STAR Campus is the way this building is structured, with a University side for our education, research and clinical programs, and a tenant side for businesses and organizations that will complement our mission—for example, a radiology lab, a behavioral health center, or a pharmacy. This set-up will create opportunities for collaborative research, offer a convenient "one-stop shopping" experience for clients, and allow our students to learn under the tutelage of not only our faculty but also our partners in the private sector.

We also hope to expand our outreach into the community by inviting medically related nonprofits, student clubs and organizations, and support groups to locate on the STAR Campus.

Finally, our core research facilities will promote collaborative research with our clinical partners, which I think is critical. If our research is to have maximum impact, we can't work in isolation and we can't live in silos. As health sciences research and training become increasingly complex, the need for costly high-tech research equipment grows. Core research labs on the STAR Campus will not only help to contain costs through resource sharing but also foster collaboration.

Q. Can you sum up in one sentence what most excites you about this new facility on STAR Campus?

A. The new health sciences building is unique in the way it integrates the community and our partners with our learning environment—it's about creating a place of discovery where we co-invent with our partners the solutions to real-world problems.

Check out the many public programs offered at UD's Health Sciences Complex. Visit **www.udel.edu/chs/star**.

STAR Campus

KATHY F. ATKINSON

The Nurse Managed Health Center *delivers a wide range of services for adults, from immunizations, to occupational health, exercise and nutrition counseling, and chronic illness management.*

★ FROM THE ★

BATTLEFIELD TO THE HOMEFRONT

New Strides in Orthopedic Care

by Kelly Bothum

The BADER Consortium may be officially housed in the Health Sciences Complex on the University of Delaware's STAR Campus, but much of its work takes place at military treatment facilities and academic institutions across the country.

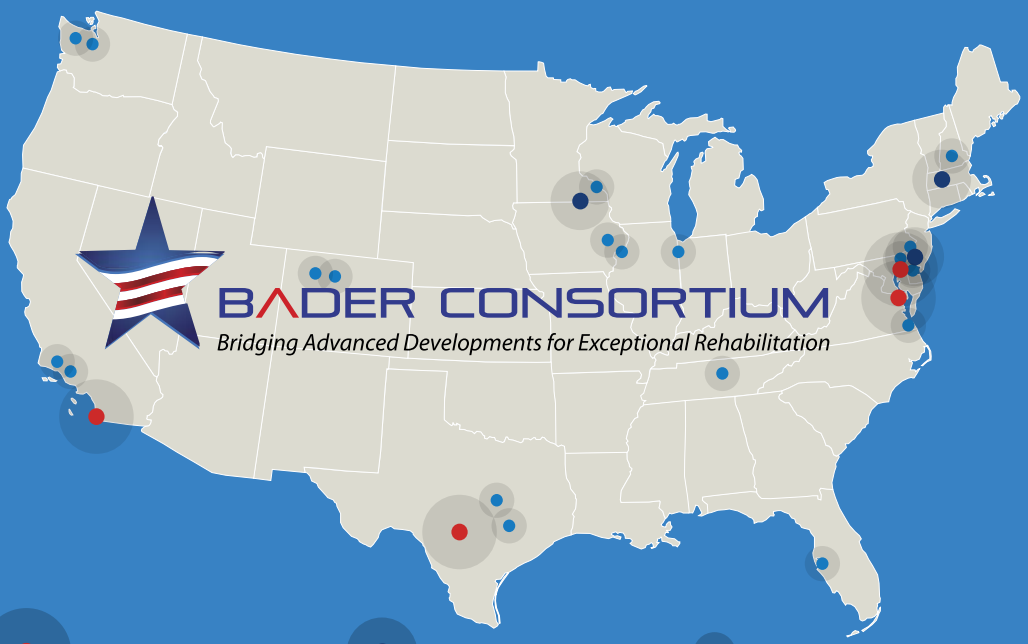
Its role—funded through a nearly $20 million grant from the Department of Defense (DOD)—is to support orthopedic research that helps service members with limb loss or limb difference return to optimal function.

Far from being housed in one place, BADER's geographic blueprint stretches from the First State to California, with stops along the way in Maryland, New York, Massachusetts, Rhode Island, Minnesota, Colorado and Texas.

★ THE CONSORTIUM ★

MORE THAN 100

BADER is a collaboration of core civilian trauma centers, four Military Treatment Facilities, and more than 100 affiliates throughout the U.S., unified to identify and address critical issues challenging the recovery of combat and civilian trauma patients.



SUCHAT PEDERSON

Among the eight studies BADER is funding are a virtual-reality training program to increase stability when walking; biofeedback strategies for improving walking and running; and identifying the optimal stiffness and height of a running prosthesis.

But BADER also is having an impact here in Delaware, the result of a new partnership with a local prosthetics company to help civilian patients who want to optimize the fit and function of their prosthetic devices.

The BADER Clinic, operated in conjunction with the UD Physical Therapy Department and Independence Prosthetics-Orthotics, has seen a handful of patients in its first weeks. The clinic operates with a multidisciplinary approach that involves clinicians, researchers and patients working together to determine the best approach when it comes to prosthesis design and fit.

Already, it shows the potential for improving patient outcomes through collaboration and innovation, said BADER Consortium Director Steven J. Stanhope.

"We're trying to rewrite how we look at functional outcomes in prosthetics and orthotics by involving students, faculty, industry and other experts," Stanhope said. "We want to take advanced technologies and see how they are best suited for which level of functioning. We want to be that bridge to see the highest level of functioning from patients."

Bridging advanced developments for exceptional rehabilitation

Stanhope's bridge analogy is a good one to describe BADER, which stands for Bridging Advanced Developments for Exceptional Rehabilitation. It began in 2011 when BADER was awarded a five-year, $19.7 million grant from DOD to strengthen evidence-based orthopedic rehabilitation care for soldiers with musculoskeletal injuries to help them return to optimal function in their daily lives.

Steven Stanhope, *director of the BADER Consortium, and his UD team are building a national network of researchers, physicians and health professionals to further strengthen evidence-based orthopedic rehabilitation for wounded warriors so that each patient can reach his or her optimal level of function. Their findings are also helping civilian patients.*

The award was made through DOD's Office of Congressionally Directed Medical Research Programs, and the idea was to bring together military treatment facilities, academic researchers and rehabilitation centers for the benefit of the nation's wounded service members.

Over the past 13 years, more than 1,500 members of the U.S. Armed Forces have suffered a traumatic injury requiring a limb amputation as a result of the conflicts in Iraq and Afghanistan. Only about 17 percent of soldiers with amputations return to active duty—an improvement from about 2 percent in the 1980s.

★ ★ ★

A STORY FROM THE HOMEFRONT

Ashly Ash lost her right leg to cancer more than 20 years ago, but even now she was still looking for a durable prosthesis to accommodate her higher-level amputation and active lifestyle.

Among her goals: to be able to walk more than two miles and handle the yard work on her Nottingham, Pennsylvania, property without having to rely on an arm crutch. And to have a prosthesis that could withstand her lugging firewood and going up and down the stairs without breaking—something that happened more than once.

She sought out Prof. Steven J. Stanhope after hearing about the BADER Consortium from her aunt who works at UD. BADER supports orthopedic research to help service members who have lost all or part of a limb to return to optimal function.

Stanhope put her in contact with John Horne, owner of Independence Prosthetics-Orthotics, who is teaming up with BADER to develop a clinic to help civilian patients who want to reach their highest level of mobility.

The clinic, which has seen a handful of patients so far, offers a collaboration point between clinicians, patients and researchers, with the goal of translating research and directly impacting patient care.

"We want to help patients who demand the highest level of function," said Stanhope, director of the BADER Consortium. "We have a broad range of people helping us to reach that goal."

Wow! – Ashly Ash

For Ash, the BADER Clinic arranged for Oklahoma City prosthetist Jay Martin to visit and demonstrate the casting and fabrication of his so-called "bikini hip," the lightweight hip socket device he created to give higher-level amputees more control and comfort.

Ash had her right leg amputated when she was 4 years old after being diagnosed with osteosarcoma, a type of bone cancer. She has a hip disarticulation amputation, which means she doesn't have a hip, knee or ankle joints. Only about 1 to 2 percent of all patients with a prosthesis have a higher-level amputation like her. These patients typically face additional challenges related to balance, walking and other activities.

Martin spent two days in Delaware working with Ash. He casted her at Horne's lab in Newark, and it didn't take long for the 29-year-old to notice the process was faster, easier and less messy than in the past.

"That's our socket," Martin told Ash while drawing on the wet plaster cast wrapped around her pelvis. "That's all it's going to encapsulate."

"That's the entire socket right there?" she said.

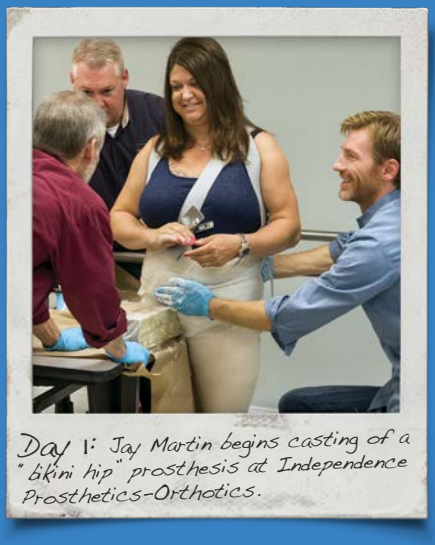
"That's all you're going to need," he said.

"Wow!" Ash said.

The next day, Ash took her first steps in her new prosthesis. Although she still used the crutch while walking on the split-belt instrumented treadmill in the BADER lab, she could already tell a difference.

"Just being in the bikini leg, I can move. I can sit. When I would

Day 1: Ashly Ash listens and waits for a chance at a more mobile life. EVAN KRAPE



Day 1: Jay Martin begins casting of a "bikini hip" prosthesis at Independence Prosthetics-Orthotics. EVAN KRAPE

Day 2: Adjustments of new prosthesis. EVAN KRAPE

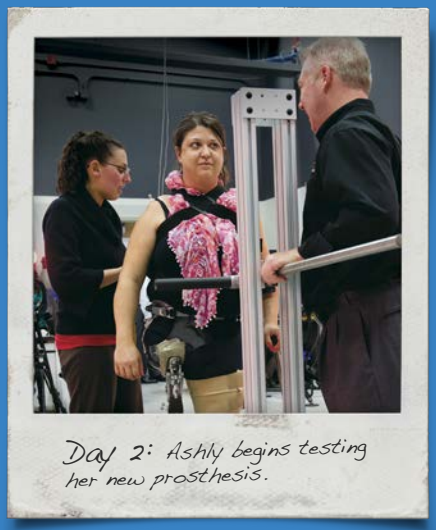
Check out our **Research & Discovery** playlist on **UD YouTube** to see how our students are working with John Horne to assist amputees.

sit with the bucket leg, because there is so much of the rigid plastic around you, it would hurt your back," she said. "This is wonderful—and so much lighter."

Horne expects the BADER clinic will become another local resource for patients with limb loss who want to improve their mobility outcomes. He already works with UD's Department of Physical Therapy, which has a monthly amputee clinic to help patients who need an objective measure of their prosthetic function.

"This is a paradigm shift," Horne said. "It just changes your thought process to see something dramatically shift that much."

A new **"bikini hip"** *prosthesis is made for Ashly Ash with the help of Oklahoma City prosthetist Jay Martin and Independence Prosthetics-Orthotics in Newark, Delaware. The company is collaborating with the BADER Consortium to develop the new BADER Clinic. The clinic's goal is to help civilian patients with limb loss to reach their highest level of mobility.*



LANE MCLAUGHLIN

Ashly Ash *prepares to test her new bikini hip prosthesis at UD's Health Sciences Complex. Comparing the device to her old prosthesis, she said, "This is wonderful—and so much lighter."*

DAVID BARCZAK

★ BY THE NUMBERS ★

COST PROJECTIONS

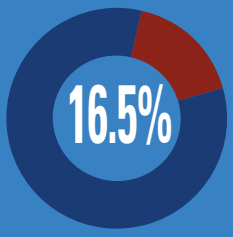
$45,563 The average cost projection for a veteran with an above-the-knee amputation.

— The Journal of Rehabilitation Research and Development

$8.3 BILLION

Annual hospital costs associated with amputation.

— Amputee Coalition of America



Of soldiers with amputations return to active duty.

— The Journal of Trauma

2 MILLION

People are living with limb loss in the United States.

— Amputee Coalition of America

In many ways, their needs are different than the typical civilian population, in part because of their younger ages, severity of injury and their activity levels prior to getting hurt.

Marilynn Wyatt, a BADER-funded researcher and director of the Gait Analysis Laboratory at the Naval Medical Center in San Diego, Calif., said many of these patients have high expectations of what they'll be able to do once they've been fitted with a prosthesis. But returning to an active lifestyle is not always that easy.

"They were in great shape and athletes when they were injured," said Wyatt. "Once they're put back together orthopedically, they want to do high-functioning activities. They accomplish walking early on in their rehabilitation. They want to do more."

These kinds of projects are asking questions that haven't previously been considered in prosthetics research, Stanhope said. Rather than assuming a patient will be happy reaching some kind of basic function with their prosthetic device, these researchers are looking at how this technology can be used to improve athletic ability—perhaps in helping someone reach even higher functional levels than expected—or reduce their risk of future injury.

Research also is needed to learn more about the long-term impact of a prosthesis on the rest of the body, particularly as these devices become more advanced, said Alena Grabowski, a BADER-funded researcher at the University of Colorado who is looking at the stiffness and height of running prostheses.

"There's a lot more going on in an intact limb than a prosthesis. It's very challenging comparing apples and oranges," she said. "As scientists, we're trying to understand both."

Assisting military treatment facilities in transforming care

Stanhope said the BADER Consortium builds on UD's solid foundation in biomechanics and rehabilitation while leveraging relationships with other national experts to create a framework supporting orthopedic research with the potential to transform care for patients with limb differences.

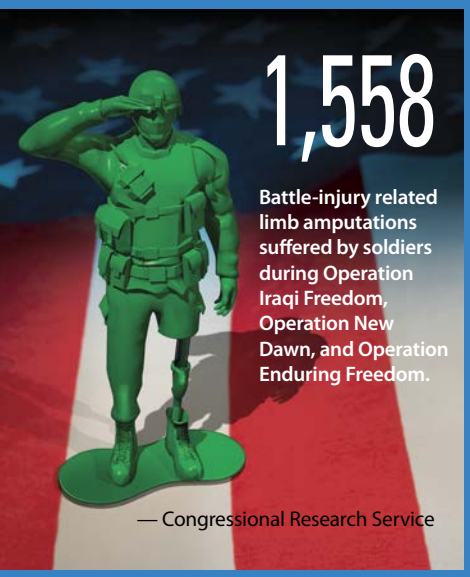
Housed within BADER are several cores that provide administrative, clinical research and scientific assistance to military treatment centers and affiliates. The administrative core is similar to the one found in the Delaware INBRE program, which is funded by the National Institutes of Health (NIH) to enhance the region's biomedical research capability.

It's a program Stanhope knows well—he worked at NIH for 22 years and now directs the Delaware INBRE program, which recently received a $23.2 million renewal.

"It was a matter of marrying that NIH model system with the world-class status of the UD biomechanics and movement science program," he said. "We wanted to create something like that for the DOD."

In addition, BADER also includes a clinical research core with UD employees who are located on-site to support and assist with the research going on at the participating military treatment facilities—Naval Medical Center San Diego in California, San Antonio Military Medical Center in Texas, Naval Medical Center Portsmouth in Virginia and Walter Reed National Military Medical Center in Maryland.

The consortium was the first in the nation to partner with the National Institute for Child Health and Human Development to use its clinical trials database outside the confines of the federal agency. The BADER Clinical Trials Database, or CTDB, mirrors the NIH database—though it operates externally—and offers affiliates an opportunity to access a controlled central repository of data. It can be used for multi-site protocols or individual research teams and is protected by a secure firewall.



Working in conjunction with the CTDB are the biomechanics, biostatistics and outcomes measurement cores, which further bolster research capabilities at the sites.

Mayo Clinic researcher Kenton Kaufman, who oversees BADER's scientific cores, said the consortium brings together the work being done by the military treatment centers on a larger scale. Although each facility has a method for collecting data, BADER helps pool that data, in part thanks to the CTDB.

"We're bringing together groups of people that can look at improving the outcomes of people who have had military injuries," said Kaufman, director of the Biomechanics-Motion Analysis Laboratory at the Mayo Clinic. "One of the strengths of BADER is the infrastructure it has developed. We make it possible to do clinical studies on combat-relevant patients."

At Naval Medical Center San Diego, BADER has embedded two positions into the core staff, Wyatt said. One is a funding protocol coordinator and another is a limited-term researcher, both of whom are on-site and working on the projects.

"BADER is unique in that its purpose is to support us—to facilitate and help the research," Wyatt said. "That has been a huge help."

★ ★ ★

Boosting a research-intensive culture at military treatment facilities

One of the goals of the BADER Consortium is to develop a research-intensive culture among the participating military treatment facilities.

To that end, BADER—through a $1.2 million award from the UD College of Health Sciences—is covering the cost of tuition for eight full-time Ph.D. students in the biomechanics and movement science program.

John Collins is the first BADER-supported doctoral student to go through the program. He is on hiatus from the Naval Medical Center San Diego, where he worked in the gait lab with patients who had lost all or part of a limb.

He works in the BADER treadmill lab, collecting data for the lab's human movement database under the direction of BADER director Steven Stanhope. Collins enjoys the opportunity to get data from patients that can be helpful to both clinicians and researchers.

"With prosthetics, there are still a lot of unknowns. A lot of it is based on reiterations of old technology. A lot of it is done by feel," said Collins, who was part of the team that started the first Naval gait lab on the West Coast. "We can provide objective data to the prosthetists, so they know there is a reason that a change should be made, instead of doing it just to do it."

Marilynn Wyatt, director of the Gait Analysis Laboratory at the Naval Medical Center San Diego, said the expertise Collins is getting while working at BADER will have a positive impact on the services her treatment facility provides to patients.

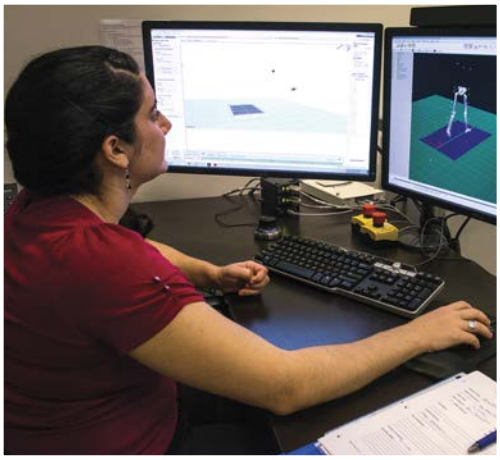
"It is a super-neat step for his career," she said. "I'm really proud of him."

Collins plans to take three semesters of coursework before he returns to San Diego, armed with an idea for his doctoral dissertation project.

"My goal is whatever research I do benefits the hospital," said Collins, who already has a master's degree in biomechanics. "I've wanted to eventually move into a leadership role, and I think a Ph.D. prepares me for that."

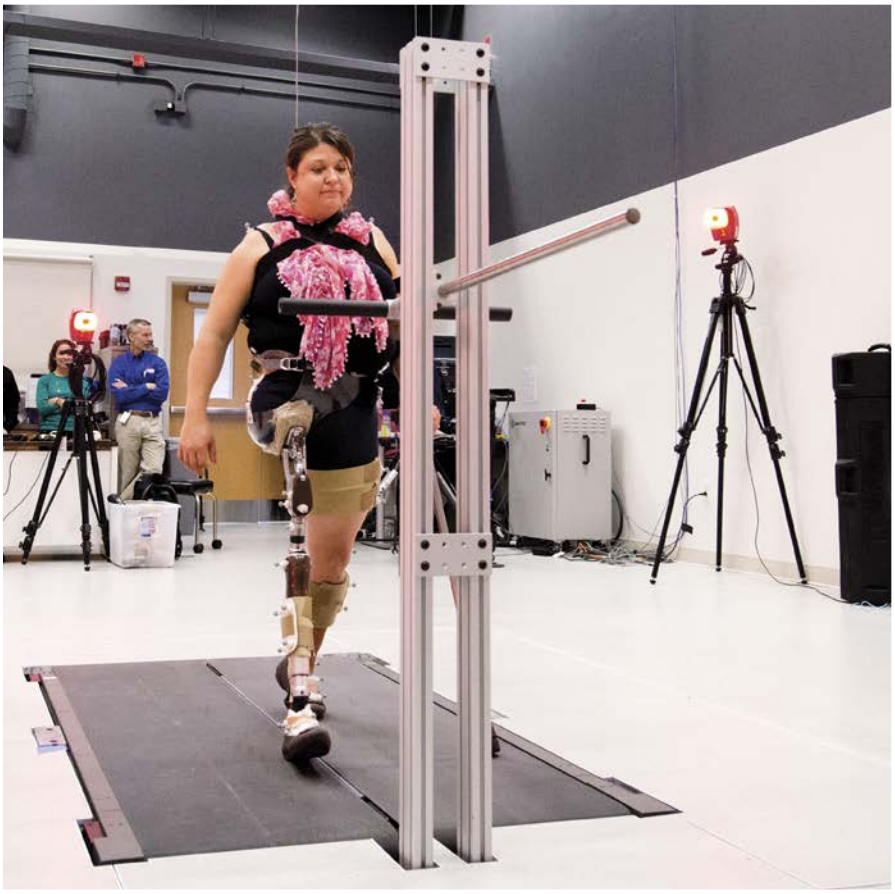
KATHY F. ATKINSON

John Collins, *from the Naval Medical Center San Diego, is now working on his doctorate in biomechanics and movement science at UD.*



★ ★ ★

As Ashly Ash walks on an embedded treadmill in the BADER lab, her movements are recorded by surrounding high-speed cameras. This motion capture analysis will help prosthetists and clinicians to assess her gait and alignment and make any needed changes to improve her function and comfort.



LANE MCLAUGHLIN

"It's really a one-stop shop. I think it will really make a precedent for the way health care is handled for amputees."—*Ashly Ash*

The need for ways to treat new war injuries

Despite the national reach of BADER, there have been some recent additions in Delaware that offer the potential to strengthen an already robust program.

One is the recent hire of David Tulsky in UD's College of Health Sciences. Tulsky, an expert in outcomes assessment research, joined UD's Department of Physical Therapy and is working with the Center for Translational Research ACCEL program.

Tulsky already serves as director of the Rehabilitation Outcomes Measurement (ROM) Core for BADER. He works with principal investigators to recommend outcome measures for their projects, provide training in the use of these measures and develop new measurement platforms for research.

Among the BADER-funded projects Tulsky is currently working on is an outcomes toolbox to identify common data elements at multiple military treatment facilities.

"There are new injuries with these wars that have surprised the medical community. One thing we have to do is develop ways to treat these signature injuries, which include traumatic brain injuries and amputations," Tulsky said.

A collaborative approach can help drill down on some of these challenges, said Wyatt, who is working with Tulsky on the toolbox project. In many cases, though, it's a guessing game, particularly when it comes to the long-term effects of using these prostheses.

"We're all concerned about and don't know the secondary effects," Wyatt said. "For the opposite limb, we know there's increased forces. Is there also osteoarthritis and back pain? These new prosthetics are allowing our patients to be more active and is that increased activity leading to secondary effects or, in fact, preventing them? We don't know the answer."

A clinic for civilian patients

The opening of the BADER Clinic at STAR Campus also offers an opportunity for civilian patients to access interventions and collaborations that can help them reach individual goals, whether it's to be faster, feel more secure or get around more easily with their prosthetic device.

"Patients enter the clinic by expressing a goal. The goal is to get a higher level of function," Stanhope said. "The ticket to this specialty clinic is that they have to express and demand this. The want to be better."

Patients so far have been referred to the clinic through Independence Prosthetics-Orthotics, which has a lab location outside Newark. Owner John Horne works with BADER staff, UD physical therapy clinicians and other researchers to learn more about patient needs and challenges they may be facing.

Information captured through motion analysis inside BADER's treadmill lab—where cameras capture the movements of patients walking or running on the split-belt instrumented treadmill—helps Horne and his staff make changes to improve patient function and comfort.

So far, the approach seems to be working for Ashly Ash, who was recently fitted with a new prosthesis specially designed to be more functional for her type of higher-level amputation. She is the fourth patient to visit the BADER Clinic, and she credits the streamlined approach with changing her own expectations of what's possible.

"Before this, you're going to this doctor and that doctor and they don't necessarily talk to each other. It's all on the patient to handle everything," said Ash, who is missing three joints as a result of her amputation.

Horne, with funding assistance from BADER, arranged for a national expert on Ash's type of amputation—known as hip disarticulation—to visit Newark and demonstrate a new model for making a prosthesis. After it was made, Ash walked on the treadmill at the BADER Lab and underwent further tweaking by staff.

She said the experience was unlike any she had before. Stanhope said it highlights what's possible to help patients reach their optimal level of function.

"It's really a one-stop shop. I think it will really make a precedent for the way health care is handled for amputees," she said. "It's so much easier going here and having everyone connect."

For more information, visit the BADER Consortium at **bader-c.org**.

LANE MCLAUGHLIN

A beaming Ashly Ash *with her team at UD's BADER Clinic. From left, Jay Martin, prosthetist; Elisa Schrank, UD doctoral student in mechanical engineering; John Horne, owner of Independence Prosthetics- Orthotics; and Pete Seaman, a certified prosthetist at the company.*

FIGHTING CYBERATTACKS

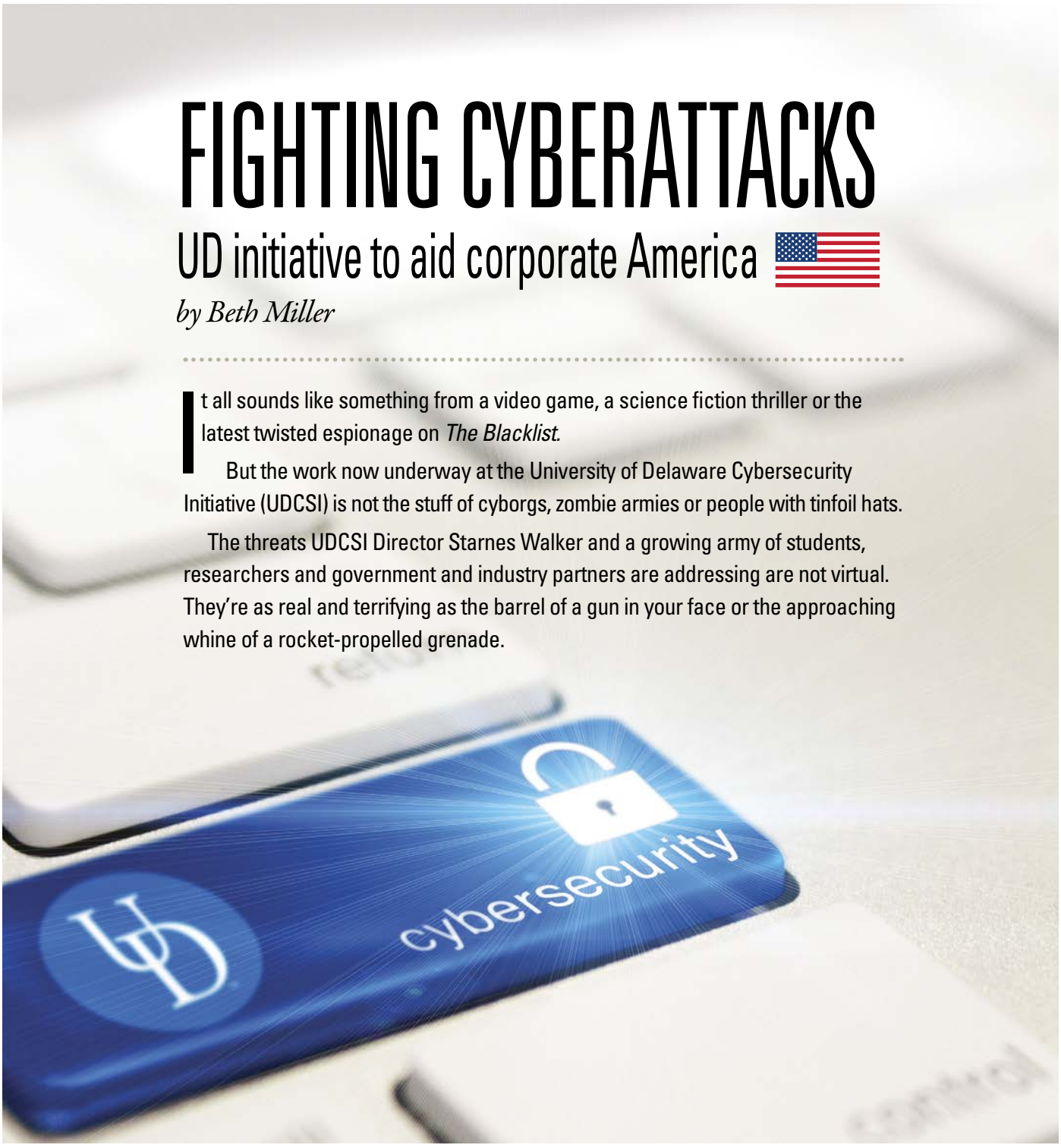
UD initiative to aid corporate America

by Beth Miller

It all sounds like something from a video game, a science fiction thriller or the latest twisted espionage on *The Blacklist*.

But the work now underway at the University of Delaware Cybersecurity Initiative (UDCSI) is not the stuff of cyborgs, zombie armies or people with tinfoil hats.

The threats UDCSI Director Starnes Walker and a growing army of students, researchers and government and industry partners are addressing are not virtual. They're as real and terrifying as the barrel of a gun in your face or the approaching whine of a rocket-propelled grenade.

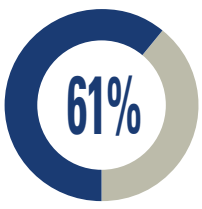


DAVID BARCZAK

Costs of Cyberespionage

The theft of intellectual property is estimated to cost the U.S. economy over $300 billion a year, which translates into roughly 2.1 million lost jobs.

—The Commission on the Theft of American Intellectual Property



The Future of Cyberattacks

Sixty-one percent of industry experts believe there will be a major cyberattack causing widespread harm by 2025.

—Pew Research Center

As headlines and an endless crawl of news bulletins attest, cyberattacks are increasing—and increasingly productive.

Ignore them and they will make you a believer, experts say. Get used to locking down your online life—at home, at work, wherever—and you can escape many potentially destructive intrusions.

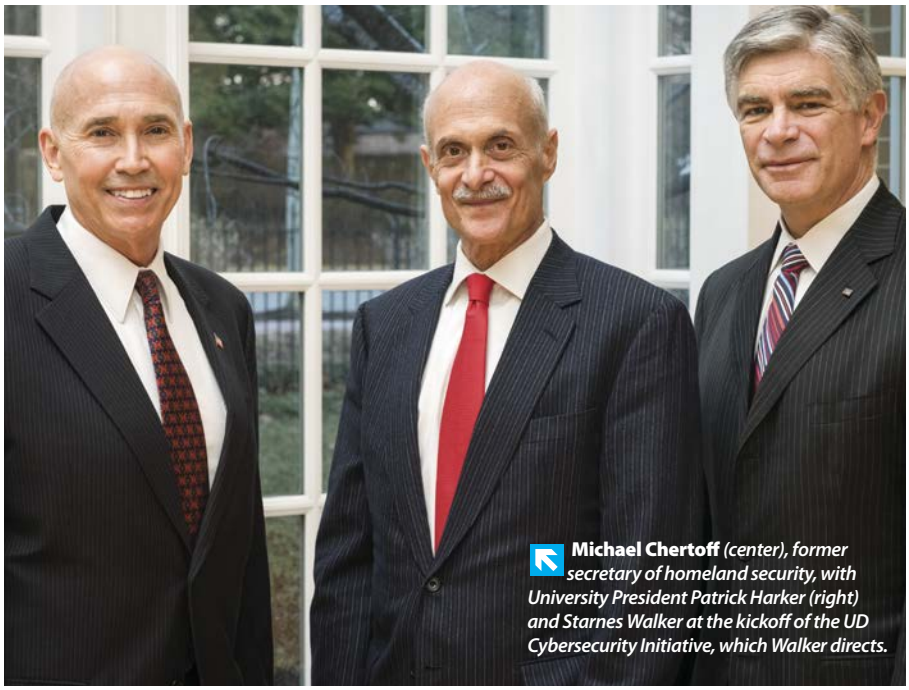
But you'll never have 100 percent online security unless you get off the grid, unplugging your life from the Internet, Walker says.

That comes at a higher cost than most probably realize—losing email, texting, streaming video, cell phone service, online flight and hotel reservations, quick Internet searches to find clues about the daughter's new date, tweets from developing situations around the world, pop-up alerts warning of an approaching tornado, real-time traffic reports from GPS devices and countless other connections we already take for granted.

It's even tougher for government, business and industry networks, so working together is an essential piece of national security.

"It's more than just a network of emails and passing information and documents," said Walker, a nuclear physicist who spent more than three decades researching, developing and engineering strategies to protect national security. "It's also how the nation's critical infrastructure runs today. In years past, you opened a valve, shut a valve. Everything is done by computers now—whether refineries, petrochemical plants, transportation nodes."

As a nexus of corporate life, Delaware is an ideal place to develop, refine and standardize cybersecurity training and protocols for business, Walker said. The state's Chancery Court is a nationally recognized authority in business law, more than half of all publicly traded companies in the U.S. are incorporated here, and the state's financial services sector includes many of the nation's major banks and their credit operations.



Michael Chertoff *(center), former secretary of homeland security, with University President Patrick Harker (right) and Starnes Walker at the kickoff of the UD Cybersecurity Initiative, which Walker directs.*

EVAN KRAPE

It's a tall challenge, though, and in the inaugural presentation for UDCSI's Distinguished Lecture series on Feb. 10, Michael Chertoff, former secretary of the U.S. Department of Homeland Security, left no one with a false sense of security.

"One hundred percent protection is not possible," Chertoff said. "Chasing that leads to unproductive pathways."

A better pursuit is finding ways to minimize the risk and mitigate the damage, he said.

The UDCSI, for which Walker was hired last year, is meant to connect many problem solvers with backgrounds in defense, business and research. The University will contribute much to the effort—including unbiased research, proven protocols, a skilled workforce, standards for training and expertise in legal and business practices, according to University President Patrick Harker.

The work emerges as the nation tightens its cyberdefenses, with President Obama's announcement of the new Cyber Threat Intelligence Integration Center, designed to collect and share intelligence, much as the nation did with its counterterrorism initiative.

Chertoff placed cyberthreats among the greatest dangers to the United States' national security, with consequences as paralyzing, destructive and deadly as the violence perpetrated by ISIS, Boko Haram, and other terrorist networks.

He noted several recent attacks by other nations—the Russians' attack on the White House and a major bank, a "persistent effort" by Chinese hackers to gain intellectual property including blueprints, manufacturing processes and clinical trials of emerging drugs, and North Korea's attack on Sony, done in protest of its movie *The Interview*.

"How do we not feel overwhelmed and throw our hands up?" Chertoff asked.

You beat one network by building another, he said—in this case, a network of trusted partners who work together to identify and address the dangers.

Industry Losses

The hack of Sony Pictures Entertainment, with costs estimated to reach $100 million, is believed to be the worst of its type on a company on U.S. soil.

—Center for Strategic and International Studies

Cyberworkforce Shortage

The U.S. has a serious cyberworkforce shortage, with only 1,000 skilled specialists in the field when the nation needs as many as 30,000.

—Clandestine Information Technology Office

Because the private sector is the most active online, Chertoff said, business leaders are essential to that effort. They must identify and share the attacks and threats they encounter.

That can be testy territory, with global reputations and proprietary information often at stake. No one—no industry, no university, no bank, no government agency, no nonprofit or small business—wants to be named in headlines as the victims of such an attack, lest readers conclude they are unworthy of trust or the unwitting disseminator of sensitive personal and financial information.

But even the Pentagon has been hacked. UD has been hacked, major banks and corporations have been hacked, those with enormous security budgets and protective protocols have been hacked. Human error is a factor, software problems are a factor and, Chertoff said, no institution is immune.

So it's essential to share "indicators of compromise," said Chase Cotton, professor of electrical and computer engineering and director of UD's Center for Information and Communications Sciences. "The IP address, the email, the file name it leaves behind in your machine—so you know that if you get attacked, you will see these."

Breaches sometimes aren't discovered for months, though, and not all are quickly disclosed. Some corporate victims went "radio silent," he said, and some choose not to make problems known until they file SEC reports.

"But we've seen a sea change in the way industry is behaving this year, especially after the Target breach," Cotton said.

UD's program, which will help to develop effective corporate strategies, is drawing significant interest, Walker said. UD students can pursue a minor in cybersecurity, and Walker hopes to expand course offerings to include research in human behavior, ethics and public policy.

Ralph Begleiter, former CNN world correspondent who directs UD's Center for Political Communication, raised the issue of human behavior in a question to Chertoff, who agreed it was an underconsidered element of cybersecurity.

Chertoff pointed to a recent situation that emerged when a mid-level employee in the Department of Defense inserted a thumb drive into his computer, unleashing a major intrusion into the network.

Those portable memory sticks apparently are hard to resist. Chertoff cited a study that showed the majority of people who find a thumb drive lying in a parking lot will put it into their laptop or computer to check it out, unaware or unconcerned that it may be delivering a payload of malware and viral code. If that same thumb drive has a logo on it—an Eagles logo, perhaps—studies show 95 percent of people will insert it into their computers, he said.

Chertoff said he sees good news in the increasing amount of cooperation and urgency around cybersecurity.

But difficult decisions must be made—where to strike the balance between civil liberties and public safety, protecting the values that define the nation.

UD launches cybersecurity initiative for business world

Starnes Walker has held leadership positions in the U.S. departments of Defense, Energy and Homeland Security, overseeing cyberwarfare programs and thousands of cybersecurity specialists. Now, as founding director of UD's Cybersecurity initiative (UDCSI),he is forming partnerships across the corporate world, government and academia to develop practices and programs to strengthen cybersecurity at businesses of all sizes and grow a new generation of cyberwarriors to protect corporate America.

What do you want UD's new Cybersecurity Initiative to be known for?

I want UD to become a go-to place for corporate America—a center for best practices and for strategic partnerships, offering the finest curriculum, research, and training in this field.

What are the industries most at risk in America?

There are risks to businesses of every size. There are critical nodes in 17 different areas, from the banking industry, to transportation, and reaching all the way into the energy infrastructure, where there are vulnerabilities in the power grid.

"Cybersecurity is serious business, and UD needs to be at the forefront of workforce development in this area."
—Starnes Walker

What efforts does the UDCSI already have underway?

UD has been selected to participate in the Federally Funded Research and Development Center (FFRDC) that is supporting the National Cybersecurity Center of Excellence in Montgomery County, Maryland. UD is among a small consortium of universities that will be called upon to assist with research and training tasks.

We also are pursuing grant opportunities to support the training of master's degree students, developing a cross-college response to training opportunities, and exploring wireless testbeds for big data, increasing the bandwidth of the data we can transmit. We're learning how to do this more efficiently and effectively.

What other disciplines does cybersecurity work require?

Just as no one business has all the capabilities in this cyberconnected world, academia can't help develop programs to counter future attacks without being informed by many disciplines. Understanding human behavior requires cyberanalytical tools that allow you to visualize data, enabling you to begin to see patterns. But you also need the benefit of the social sciences, as well.

What experiences will you draw on for this initiative?

I was privileged to be asked to stand up the U.S. Fleet Cyber Command and the U.S. 10th Fleet for the Department of Navy/Department of Defense and create a workforce aligned to delivering technology to customers. I served as technology director and chief scientist of the Office of Naval Research and as the chief scientist at Argonne National Laboratory. In industry, I was involved in creating a very competitive nuclear fusion program with Phillips Petroleum. I've always taken chances—I've never been afraid to try something new.

EVAN KRAPE

UD is one of nine universities chosen by The MITRE Corporation to serve on the Academic Affiliates Council, supporting the company's operation of the nation's first federally funded research and development center on cybersecurity. Pictured are students who participated in the United States Cyber Challenge camp hosted at UD in July.

Asked about efforts to force software developers to include anti-encryption access points in data encryption programs, Chertoff said he's reached the conclusion that government should not make such requirements. He said that would just make U.S. products less attractive around the world, where they would be seen as vulnerable, and would mean only "bad guys" would have impenetrable software.

Managing responses to cyberattacks probably should be left to the federal government, though, Chertoff said. Corporations should not try to retaliate.

Walker said security analysts focus instead on what happened, how it happened, and what needs to change to prevent a recurrence.

Michael Vaughan, associate dean of the College of Engineering, said he is excited about the educational and research opportunities UD's Cybersecurity Initiative brings to campus.

Walker has established an advisory council to help guide the initiative that includes representatives from business and government, as well as key academic partners including Purdue, Carnegie Mellon and the University of Texas, whose cyber-strengths will complement UD's.

The work will include local academic partners, too—including Delaware Technical Community College and Delaware State University. Students at those schools will be part of the cybersecurity training "pipeline," said Delaware Tech President Mark Brainard.

This past fall, UD began offering an 18-credit minor in cybersecurity, allowing students to incorporate computer and network security fundamentals into their current degree program. A major is in development and a proposed master's degree is under review by the Faculty Senate, Walker said.

It's a challenge that appeals to many students, including Dylan Ross, an engineer and first-year Ph.D. candidate doing research in electromagnetics and photonics.

"What drives me is solving problems," Ross said, "and no one's ever cracked this one. No system is perfect, every design is going to have some kind of flaw.... But solving a specific problem—for a lot of students in science and engineering, that is what drives them."

Did you know from an early age that you wanted to go into cyberscience?

Well, growing up in Independence, Missouri, I built an oscilloscope when I was 12, and I got a vacuum meter to build TVs and radios to learn signal processing. I also loved my chemistry set and launching rockets. My dad was a Navy fighter pilot during WWII. My Mom got her master's at the Sorbonne and taught French and Spanish. They both influenced me greatly.

What keeps you up at night?

Without question, cybersecurity is serious business, and UD needs to be at the forefront of workforce development in this area. I'm excited about the opportunity to establish a world-class program, working with domestic and international partners, that will make this a win both for our university and for corporate America, and also add value to small business, as an engine for the future.

Starnes Walker, *director of the UD Cybersecurity Initiative, formerly was chief technology officer and technical director for the U.S. Fleet Cyber Command and U.S. 10th Fleet for the Department of Navy/Department of Defense. His previous senior executive positions include director of research for the Department of Homeland Security, technical director and chief scientist at the Office of Naval Research, associate laboratory director at Argonne National Laboratory, and senior adviser for science and technology at the Defense Threat Reduction Agency.*

Teaching number sense

by Alison Burris

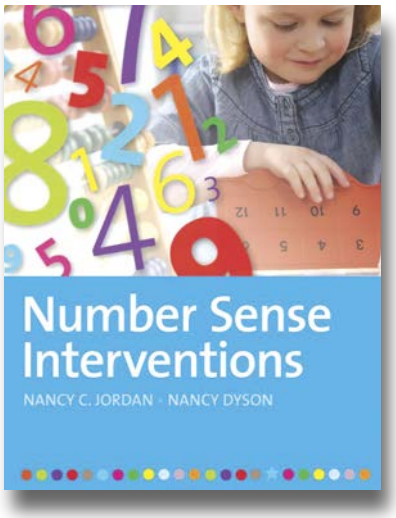
Think how difficult math would be for a kindergartner who can't tell you that three pennies represent the number three, or that a set with five cookies has two more than a set with three cookies.

While the tasks seem simple, many children, particularly those from low-income families, come to school without such basic number competencies.

"Even students with ample intellectual capacity may experience weaknesses in developing number sense, leading to serious academic consequences," says Nancy C. Jordan, professor in the University of Delaware's School of Education. "If students do not develop foundational math in elementary and middle school, they are less likely to develop essential skills to master concepts such as algebra, which will hinder their success in high school and college."

Jordan recently completed a five-year grant from the Eunice Kennedy Shriver National Institute of Child Health and Human Development at the National Institutes of Health to study students at risk for math difficulties and to develop interventions to help kindergartners develop number sense.

"In earlier studies, we found that mathematical difficulties, such as core deficiencies in number sense, were evident even as a child entered kindergarten," says



Jordan, who has been working in this area since 1998. "This had a direct impact on growth in formal math between first and third grades—and consequently on their level of proficiency on the Delaware state tests at the end of third grade."

While the education community has embraced early interventions to improve reading, fewer efforts have been made to explore the potential benefits of early interventions in mathematics.

A guide to better math skills

Thus, Jordan, along with her colleague Nancy Dyson, a researcher and doctoral graduate in the School of Education, set out to develop a new curriculum for preschoolers called *Number Sense Interventions.* This user-friendly guide is designed to help teachers strengthen young students' foundational math skills.

Teachers get 24 scripted lessons, each 30 minutes long with interventions that are fun, simple and highly effective at boosting key math skills related to number concepts, number relations and number operations.

Proven to improve young children's number sense, these engaging lessons help resolve early math difficulties before first grade and start students on the path to long-term success in elementary school and beyond.

The guide is based on research published in 2012 in the *Journal of Educational Psychology* that Jordan conducted with UD colleagues Dyson, Prof. Joseph Glutting and education doctoral graduates Brenna Hassinger-Das and Casey Irwin. The team evaluated children from five Delaware elementary schools that serve primarily low-income students.

Tips for boosting your child's math skills

What can parents and teachers do to help pre-schoolers become math thinkers? Try these tried-and-true approaches from *Number Sense Interventions:*

1. Make numbers and counting fun and part of your child's everyday world.
2. Count everyday objects. "How many books do we have in the pile?"
3. Recognize quantities of 5 or less instantly without counting.
4. Think about number partners. For example, 5 is made up of 3 and 2, or 4 and 1.
5. Count on from a cardinal value (one, two, etc.) to emphasize that the next number in the sequence is always one more than the previous number (n + 1 rule).
6. Play board games, such as Chutes and Ladders, that move along a number list.

If you believe your child has a math disability, you should request that he or she be screened with a measure of early number competencies.

For more ideas, be sure to check out the "What Works Clearinghouse" at the Institute for Education Sciences: **www.ies.ed.gov/ncee/wwc**.

Using random assignment, 132 students were divided into three groups—a number sense intervention, a contrasting language intervention, and a business-as-usual control group. The results showed that the number sense intervention group performed better on number competencies and general math achievement than the comparison groups.

And eight weeks later, when the children were tested again, many of the effects remained, suggesting they had internalized what they learned.

Early math intervention a key to long-term success

Jordan and Glutting also have developed a number sense screener to help teachers determine who needs help and to monitor progress. Her research team plans to scale up this intervention to serve more kindergartners and to develop follow-up programs for subsequent grades.

"Our study shows that early number sense is malleable and can be successfully taught to most children," says Jordan. "Our work has already had an impact. For example, it influenced the widely used Common Core State Standards in mathematics for kindergarten."

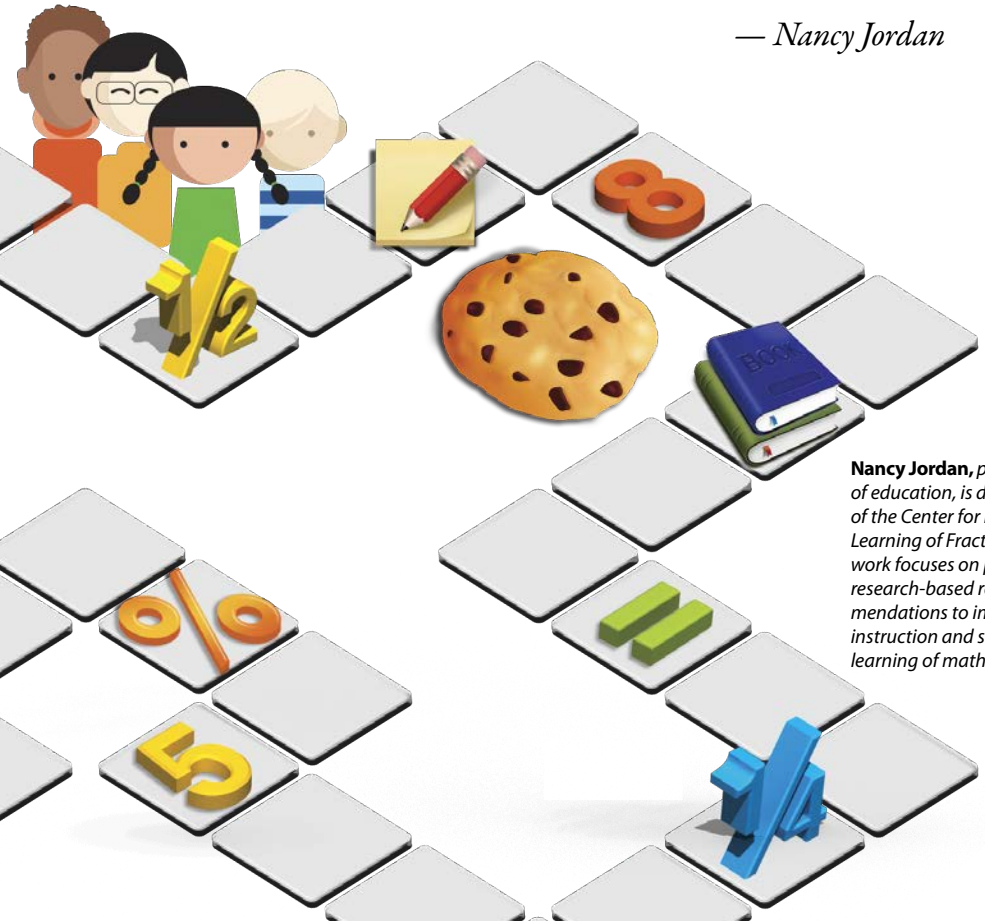
Jordan also has noticed a positive trend. "In the past, math intervention wasn't typically provided until third grade or later. Fortunately, Delaware public schools are now addressing their students' needs at a much earlier age."

In addition to her work with number sense, Jordan is director for the Center for Improving Learning of Fractions, funded by the Institute for Education Sciences (IES). The center incorporates longitudinal research methods to identify how to improve math instruction for elementary and middle schoolchildren who have problems with fractions.

As a result of her work, Jordan was selected to serve on a panel of experts to create *Teaching Math to Young Children,* an educator's practice guide published in late 2013 by the What Works Clearinghouse of the IES. This report offers educators evidence-based recommendations that address the challenge of teaching early math to children ages three to six.

"Delaware public schools are now addressing their students' needs at a much earlier age."

— Nancy Jordan



Nancy Jordan, *professor of education, is director of the Center for Improving Learning of Fractions. Her work focuses on providing research-based recommendations to improve the instruction and student learning of mathematics.*

EVAN KRAPE

UNIVERSITY of DELAWARE

Research at a Glance

The University of Delaware is classified by the Carnegie Foundation for the Advancement of Teaching as a research university with very high research activity, a designation held by **less than three percent** of U.S. institutions. Here's a quick look at UD's research enterprise and the excellence of our scholars.

UD ranks in the top 100 in federal science/engineering obligations and 71st in total R&D expenditures among U.S. institutions without a medical school.

World-class Scholarship

Among our faculty and alumni, you'll find Nobel Laureates, pioneers of the Internet, innovators of touch-screen technology, leaders in art conservation to early childhood education. Our faculty includes members of the National Academy of Sciences, National Academy of Engineering, and Guggenheim and Fulbright Fellows, to name only a few.

Richard Heck, 2010 Nobel Laureate in Chemistry, invented the Heck Reaction, which uses the metal palladium as a catalyst to bring carbon atoms together. The Heck Reaction is used to produce many of the world's pharmaceuticals and is spurring the development of new, energy-saving electronics.

FY2014 **Research Expenditures by Sponsor**

Research support received by University of Delaware faculty and research staff from federal sources is awarded competitively, based on the scientific and technical merit of proposals.

$138 MILLION

Other
19.5%

State of Delaware
10.9%

U.S. Department of Defense
11.9%

U.S. Department of Health and Human Services
15.3%

Delaware has been regularly ranked as **one of the top three states** in the U.S. for the number of academic papers published per dollar of academic R&D expenditures, and for academic patents per academic doctorate holder.

RANKED 5th

UD ranks fifth in the nation in U.S. Department of Energy ARPA-E awards, which support research on new ways to generate, store and use energy.

John Elias and **Wayne Westerman** invented the touchpad technology used in smartphones and tablets.

Maria Telkes, the "Sun Queen," was inducted into the National Academy of Inventors for her pioneering solar energy research.

Over **1,000 undergraduate students** engage in hands-on research each year, and more than **3,000 graduate students** are involved in research and scholarship activities across UD's seven colleges and more than 70 research centers and institutes.


AROUND THE WORLD

A team of UD faculty and students *is helping the Ese'Eja Nation of southwestern Peru to document their history and fleeting way of life as hunting, gathering and fishing people in the forests of the Amazon basin.*

MAPPING a CULTURE

ANCESTRAL LANDS OF THE ESE'EJA

THE TRUE PEOPLE

Photos by Andy Bale, Jon Cox, Lindsay Yeager

by Ann Manser | *Additional reporting by Alison Burris*

With a double major in environmental engineering and plant science, University of Delaware student Brian Griffiths was already an interdisciplinary kind of guy when he set off for the Amazon rain forest last spring.

In documenting the Ese'Eja way of life, **Brian Griffiths**, *a UD senior double-majoring in environmental engineering and plant science, got to be something of an anthropologist, cartographer, botanist, Spanish language interpreter, oral historian and materiaculture specialist, not to mention a hunter-gatherer himself.*

The UD team stayed in a traditional Ese'Eja dwelling, camping in tents brought from home. Although the Ese'Eja live in remote areas, their communities do have satellite dishes.

As hunter-gatherers, the Ese'Eja are always in search of their next meal. While hunting for white-lipped peccaries, which resemble hogs, **Jose Ekiney** *spied a small pond filled with fish. In minutes, his pockets were full.*

The Amazonian region of Peru: *The Ese'Eja are the indigenous people of the Amazonian region of Peru. More than 60% of Peru is covered by the Amazon rain forest, more than in any other country. It is one of the most biologically diverse areas on Earth.*

But during the three-week expedition with a UD team focused on documenting the culture of the indigenous Ese'Eja people of Peru, Griffiths also was something of an anthropologist, cartographer, medicinal botanist, Spanish language interpreter, oral historian and material culture specialist. And that's not to mention the day he became a traditional hunter—learning how to find the precise type of tree that provides raw materials for bows, bowstrings and arrows; fashioning those items by hand; and finally shooting with them.

"This whole project was incredible, and I learned so much," Griffiths says of the team's work. "I'm an engineer, and I got interested at first because I wanted to learn about the polluted rivers in the area. I never thought I'd be going into people's houses and interviewing them about their lives and their possessions and their histories. It was amazing to develop such new skills."

His experience was far from unusual in the University's "cultural mapping" pilot project designed to explore the Ese'Eja, a hunting, gathering and fishing community whose numbers have plummeted in recent years and whose traditional culture is threatened by development, industry and restricted access to ancestral lands.

When Jon Cox, a photographer and assistant professor of art at UD, began planning the project, he says he knew the team would need to conduct fieldwork in numerous areas of study. While photographers and a videographer were documenting the lives of the Ese'Eja, others would be collecting data about the community members' lives, histories and traditions in a variety of ways, from mapping GPS coordinates to recording stories told by elders.

"WE ALL HAD TO GET OUT OF OUR COMFORT ZONES."—*Jon Cox*

UD anthropologist **Carla Guerrón Montero** *is documenting the Ese'Eja's subsistence strategies, as she interviews them about daily life and accompanies them on foraging expeditions. The information gathered, from drawings to oral history recordings, is being incorporated into educational materials for the Ese'Eja children.*

"I was challenged to be a patient listener. Going on community walks with both Ese'Eja children and adults, I found that it was not always the questions I had planned that yielded learning for me. Learning came more from patiently waiting for community members to share information.... There are layers of trust. The leaders were generally on board, but many others in the community were not so aware of our purpose."

—**Rosalie Rolón Dow,** *Associate Professor of Education*

Rosalie Rolon Dow, *UD associate professor of education, helps prepare shaka vines, which release a milky poison that is used to stun fish.*

More than just assembling a team from a variety of academic backgrounds, Cox said, each of those people would need to help with many different tasks. The team would be interdisciplinary, and so would each individual member.

"We all had to get out of our comfort zones," says Cox, a UD alumnus who previously contributed the photos for a book about another endangered group, the Hadzabe people of Tanzania in East

"We brought tents, camping toilets and a foot-powered shower; we could use it in one of the villages, which had a well. The biggest challenges in our living conditions were the insects—mosquitoes and chiggers—and the day we had a huge drop in temperature that nobody was prepared for. We were all dressed for the 95-degree heat when the winds suddenly blew in from the Antarctic, and we all nearly froze."

—Jon Cox, ***Assistant Professor of Art and Project Manager***

Africa. "You need to put together all these different pieces to try to get a full picture of the Ese'Eja. We had small groups doing different things every day, and each group always included a member of the community working with us."

For Rosalie Rolón Dow, associate professor of education at UD, the multidisciplinary nature of the project was so distinctive that she studied that aspect of the work, as well as observing children and schools in the three Ese'Eja villages the team visited.

"Part of what I did is talk to the team members about how the interdisciplinary nature of what we were doing affected their communication and the way they worked," Rolón Dow says. "I found that learning and using such new skills really stretches us all in positive ways."

She and undergraduate Morgan Lehr used educational anthropology as an approach to their work, visiting schools in the villages and documenting practices related to the Ese'Eja language and culture.

Examining educational issues for the Ese'Eja was an important component of the overall project, Rolón Dow notes. Every task was performed in collaboration with the community, whose members set the agenda based on what they wanted for themselves and future generations, and schooling was a major issue.

Lindsay Yeager *admires the book José Mishaja developed to teach Ese'Eja children their native language. Yeager, a visual communications major from Suffern, New York, served as a photographer and videographer on the expedition.*

"This trip truly helped me understand that education is more than just the time that a child is sitting in a classroom. The [Ese'Eja] traditional form of education is completely informal. Each generation learns about traditions, how to cook and gather food and other practices by watching their parents and participating. Now they are being formally educated in a classroom supported by the government. There is clearly a mismatch between school and home."

—**Morgan Lehr,** *Senior Majoring in Elementary Teacher Education*

"A big concern of the elders is that their children and grandchildren are losing the knowledge of their culture and how to use the rain forest," Rolón Dow says. "So we observed the everyday ways the children were learning outside of school—how to fish in the traditional way, for example—as well as in school."

Along with their observations and interviews, she and Lehr provided 40 children and teenagers with simple digital cameras and asked them to photograph important aspects of their lives.

The result of that social science technique, known as PhotoVoice, was a treasure trove of images—taken by many

"It was not too long until our boats pulled up to a sloping beach with butterflies fluttering around.... As I sat there watching the Tambopata River flow by, entrenched by the green jungle canopy, hovering blue sky and howler monkey calls in the distance, I felt blessed.... Every time I walk through the jungle, I feel connected to the beautiful ecosystem around us. It's so vital and vulnerable, integral to the lives of the Ese'Eja."

—From anthropology student **Chelsea Rozanski's** *journal*

more than the original 40 youngsters, as the cameras were shared among friends—of elders, families, plants, animals and daily life. In addition, children who had never before held a camera quickly discovered the "selfie" genre and produced many photos of themselves.

The cultural mapping team spent three weeks in Peru, visiting three villages inhabited by the Ese'Eja: Infierno, Palma Real and Sonene, all in the Madre de Dios Amazonian region.

One community was accessible by dirt road, and the other two only by water. The group traveled in local boats known as peki pekis, a kind of large canoe powered by an outboard motor, with one village a five-hour trip along the river and the other a 10-hour journey.

When they arrived at each stop, the first order of business was to ensure that everyone in the community understood why they were there and that their goal was to help the residents accomplish what they wanted for themselves, not what outsiders thought they should want.

Cox and Andrew Bale, a photography professor at Dickinson College who earned his master's degree in fine arts at UD, had traveled to the region a couple of months earlier to lay the groundwork with community elders.

"I thought we had everything set up from that visit," Cox says. "But in May, every time we went into a new village, we had to sit down for a meeting to explain what we were doing. And these were meetings that might last for an entire day."

The team came to realize, says Rolón Dow, that "there are layers of trust." Even when elders understood and approved of the project, some community members might still have been unaware or skeptical of the purpose.

She says a useful tool was Cox's book from Tanzania, which the team showed to the Ese'Eja as an example of the kind of documentation they had in mind. And the village children, always curious and eager to approach the group, were good icebreakers, Rolón Dow says.

Mateo Viaeja, *an Ese' Eja elder, wears traditional cloth made out of the bark of the yanchama tree. "We are the ancient owners of this land because we were the first to come down from the sky," Viaeja told the UD team. According to their beliefs, the Ese' Eja climbed down to Earth from a cotton thread in the sky. "Without the forest, there is no life… and no Ese'Eja," he said.*

In addition to the photo and video documentation and the work of the education team, others on the expedition focused on tasks involving anthropology, ethnobotany and creating a physical map of the community's ancestral lands.

Carla Guerrón Montero, associate professor of anthropology at UD, and student Chelsea Rozanski focused on understanding the subsistence strategies of the Ese'Eja, accompanying them on foraging expeditions and interviewing them about their daily activities. They also recorded stories told by the elders and assisted them in creating maps that showed their traditional lands—many of which the government has now prohibited them from accessing—and sacred sites, including burial grounds.

The anthropology team was assisted by the other members of the group, who all spent some time talking with community residents to learn about their traditions, activities and hopes for the future.

Griffiths, who says he initially expected to spend all his time in the forest, ended up also visiting homes, asking questions and recording the answers. He says he realized that people, understandably, don't necessarily consider their common objects and everyday chores to be of any interest to outsiders, so he learned to ask, "What's the oldest thing in your house? Where did you get it? Can you show me how you use it?"

1

Amazonian Peru: The main lookout over the Madre de Dios River at Palma Real, an Ese'Eja community of more than 300 people.

2

The Threat of Loss: Carlos Dejaviso Poje, president of the Ese'Eja Nation, said, "It would be a cultural genocide if we lost our customs and we didn't know how to value what our ancestors valued."

3

Indigenous Ways: The Ese'Eja use a vine called tamshi to weave baskets for use at home and for sale. The vines are stripped of their bark and then split into long, flexible pieces for weaving.

4

Origin of the Ese'Eja: As this drawing by Fermin Yojaje shows, the Ese'Eja believe their people climbed down to Earth from a cotton thread in the sky. Elders can pinpoint the exact spot in the forest.

5

Pinpointing Locations: Anthropologist Carla Guerrón Montero (right) and student Chelsea Rozanski use GPS to record culturally important sites.

6

A Culture Captured: UD's Rosalie Rolón Dow works with the Ese'Eja to create a 10-foot-long map of traditional hunting and fishing sites.

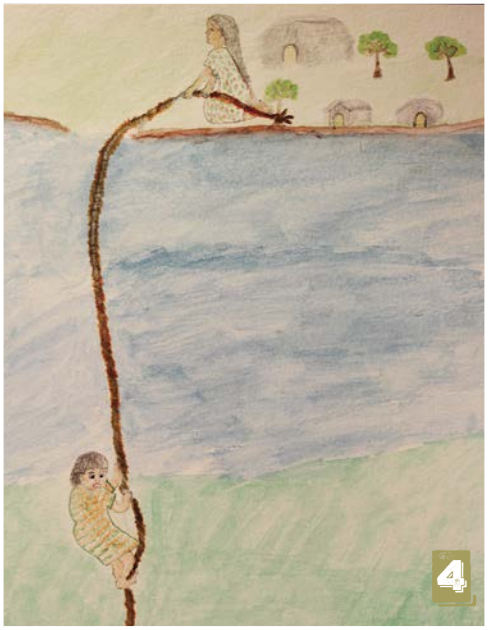
7

Mapping Ancestral Lands: During the 2014 expedition, the UD team worked with Ese'Eja elders to draw maps of their ancestral lands from memory.


1

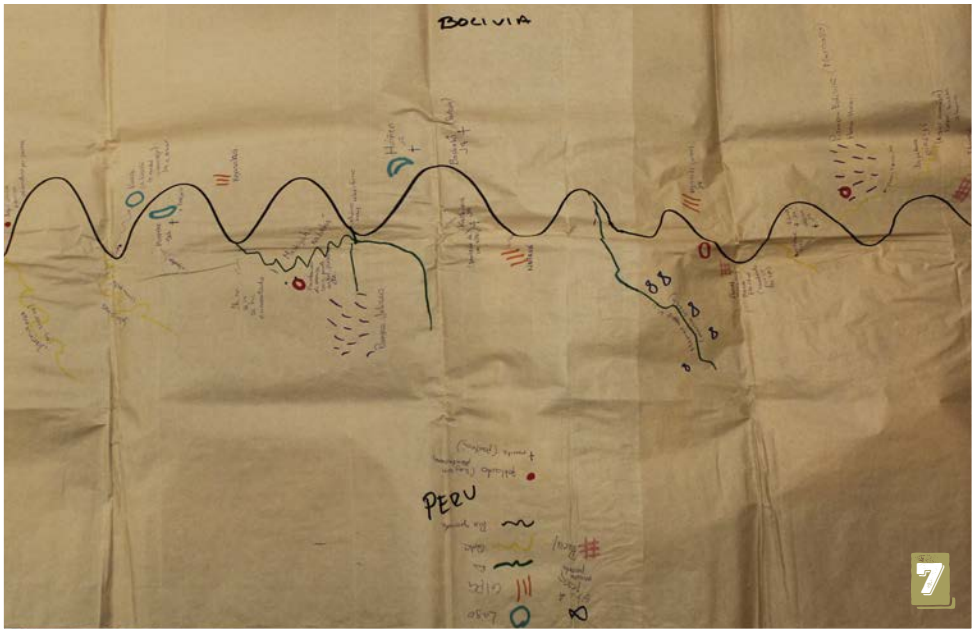

2


3


4


5


6


BOLIVIA
PERU
7

—THE— PARTICIPANTS

The participants who spent three weeks with the Ese'Eja in May 2014 worked in small teams focusing on a particular aspect of the project:

PROJECT MANAGERS:
Jon Cox, assistant professor of art at the University of Delaware, and Rocio Martinez, of Rainforest Expeditions in Peru

ESE'EJA REPRESENTATIVES:
Carlos Dejaviso Poje, president of the board of the Ese'Eja Nation in Peru, and Victor Pesha, an Ese'Eja elder

UD ANTHROPOLOGY TEAM:
Carla Guerrón Montero, associate professor, and student Chelsea Rozanski

ETHNOBOTANY TEAM:
Katherine Koumoutseas, a consultant whose daughter is a UD student, and UD engineering and plant science student Brian Griffiths

UD EDUCATION TEAM:
Rosalie Rolón Dow, associate professor, and student Morgan Lehr

PHOTOGRAPHY/VIDEO TEAM:
Jon Cox; Andrew Bale, Dickinson College photography professor and a 2005 UD alumnus; Steven Zeigler, a New York City Apple employee and a 2007 UD graduate; and UD visual communications student Lindsay Yeager.

OTHERS THAT HAVE BECOME INVOLVED:
Vicki Cassman, UD associate professor of art conservation, and two groups of students who are working with the objects that will make up a planned exhibition

Monica Dominguez Torres, associate professor of art history at UD, and some of her students, who will work on developing the exhibition

Priscila Rodriguez, an indigenous-rights lawyer in Washington, D.C., who is working to help the Ese'Eja gain legal access to their homeland

THE SUPPORTERS

Support for the project has come from the Amazon Center for Environmental Education and Research, Dickinson College, the Greater Philadelphia Latin American Studies Consortium, National Geographic's Genographic Legacy Fund, and Rainforest Expeditions in Peru.

University of Delaware units supporting the work include the Department of Anthropology, Department of Art, a General University Research Grant, the Institute for Global Studies, the College of Arts and Sciences' Interdisciplinary Humanities Research Center, the Office of Undergraduate Research and Experiential Learning, and the School of Education.

The team eventually purchased about 70 items, from traditional hand-woven baskets and cloth made of tree bark to a bag woven from used plastic bottles that would likely be sold to tourists. Plans are to document the objects and their uses and to create a traveling exhibition to further share the Ese'Eja culture with others before returning the collection to Peru.

Griffiths did, however, spend a lot of time in the forest, working with an educational field ethnobotanist who served as a consultant to the team. They documented a variety of plants—through field notes and sketches—and interviewed members of the Ese'Eja about each plant's use as food, raw material or traditional medicine.

Because all the plant material the group studied was to be left with the community, the botanists documented everything in photos and labeled specimens with scientific names, as well as the common Spanish and Ese'Eja names.

The eventual goal is to include the results of the research in an international ethnobotanical database.

Another result of the three-week project is a map showing the Ese'Eja's ancestral lands. Using a 10-foot sheet of brown paper, elders from the community worked with the team to draw a map showing such key locations as traditional hunting, fishing and burial sites.

Team members used GPS on the ground to visit as many of those sites as possible and overlay the hand-drawn map with specific coordinates.

"I was never working alone on the map," Griffiths says. "It took a lot of people and several weeks to figure it all out."

For the Ese'Eja, whose population once numbered as many as 20,000 but is now reduced to about 600, all forms of documentation are essential. The community members realize that they must preserve the memories their elders have, while those elders remain physically able to walk through the forest and to recall their traditional knowledge.

That's what two members of the community told an audience in Delaware when they visited the University in October to talk more about the project and to see what had been accomplished since the team left Peru last May.

"We want to share our unique culture, and we want to preserve our culture," Carlos Dejaviso Poje, president of the board of the Ese'Eja Nation in Peru, said at the time, speaking through a translator. "We don't know how long we will have our elders. We need them for the link they provide to our knowledge and traditions."

Professor **Vicki Cassman** *and her art conservation team are caring for some 70 Ese'Eja objects.*

WHAT HAPPENS NEXT?

by Ann Manser

When two representatives of the Ese'Eja came to the University of Delaware campus for follow-up discussions about the project that had brought a UD team to Peru earlier in the year, one of their stops was in an art conservation workroom in the campus building known as Old College.

There, some 70 objects the community provided for further study are housed. The collection includes baskets and bark

MORE ABOUT THE PROJECT

See the team and the Ese'Eja at work

As participants in the project continue their work, one tangible result of the expedition can already be seen, a seven-minute video titled *The Ese'Eja: From a Cotton Thread in the Sky to Protectors of the Amazon*. The title refers to the traditional belief that the Ese'Eja people traveled down to Earth on a cotton thread.

The video, hosted on the National Geographic website, can also be viewed via a link on the overall project website, "The Ancestral Lands of the Ese'Eja—The True People," at www.eseeja.org.

The video shows such practices as traditional hunting and fishing, preparing and cooking food, harvesting bark and fashioning it into cloth and then into clothing, gathering vines to make baskets and carving a bow for hunting. The cultural mapping team can be seen recording oral histories, and drawings are shown that elders made to illustrate some of their stories.

"Facing a range of challenges, the Ese'Eja community is taking steps to protect their history and preserve their natural resources," according to a description of the video by the Genographic Project Legacy Fund. The description quotes Carlos Dejaviso Poje, president of the Ese'Eja Nation:

"I worry most about losing the indigenous knowledge of our people. It would be a cultural genocide if we lost our customs and we didn't know how to value what our ancestors valued."

UD's **Jon Cox** *is leading the team in the development of a book about the Ese'Eja. He previously contributed the photos for a book about another endangered group, the Hadzabe people of Tanzania.*

The Ancestral Lands of the Ese'Eja—The True People www.eseeja.org

cloth—and samples of the raw materials that went into their creation—along with carved wooden bows, a necklace made of wild-pig teeth, items dyed from red berries and other natural materials, arrows with elaborate feather arrangements on their shafts, bags used to carry Brazil nuts and drawings by elders illustrating the Ese'Eja creation stories.

"They came to see what we were doing with the artifacts," says Vicki Cassman, associate professor of art conservation, whose students are preparing condition reports on the objects. "I think they were surprised at how interested we were in all the items and the effort we were putting into caring for them."

Plans call for the objects to become the basis of an exhibition highlighting the Ese'Eja culture, traditions and challenges they are facing from development, industry and government restrictions on access to their ancestral lands.

The exhibition is planned for public view at UD at University Museums' Old College West Gallery in fall 2016. It will travel after that, ultimately returning to Peru. The Ese'Eja want the exhibit, and related projects, to help preserve their traditional culture while also sharing knowledge of it with others.

In addition to the exhibition, participants expect the cultural mapping project to produce such results as:

- A documentary book;
- Comic books or other educational materials geared to young Ese'Eja children, teaching them about their culture;
- Legal action to protect territorial rights; and
- Plan de Vida, a sustainable plan to support the Ese'Eja's future survival.

Students Michele Marino, Julianna Ly and Rebecca Selig (left to right) have written condition reports on the Ese'Eja objects in their art conservation classes.

Academia, ability and people *'like me'*

by Karl Booksh

Have you ever wondered why there are so few people with disabilities in academia, and especially in science, technology, engineering and math—the so-called STEM fields? I became very interested in this phenomenon a few years back. I slowly realized that I rarely saw people *'like me'* at national conferences, when giving seminars at other universities or even in the applicant pools for new faculty hires.

EVAN KRAPE

ABOUT THE AUTHOR:
Karl Booksh, *UD professor of chemistry and biochemistry, is a member of the National Recruiting and Retaining Students with Disabilities in Engineering and Science Board, the American Chemical Society Committee on Chemists with Disabilities, and the congressionally mandated Committee on Equal Opportunities in Science and Engineering.*

I realized that I was in a unique situation. To my knowledge, I am the only tenure-track faculty member in chemistry at a Carnegie-classified research university who went through college identifying as having a disability. I broke my neck when I was a freshman, but continued on to earn a B.S. in chemistry with honors from the University of Alaska and a Ph.D. in chemistry from the University of Washington. I also received a National Science Foundation Postdoctoral Fellowship prior to my first faculty position in 1998.

Those of us who have a disability and have earned tenure in STEM are exceptions. Surveys estimate that 7 percent of the population between 16 and 20 years old identifies as having a disability. The proportion increases to 13 percent of people between 18 and 44 years. Based solely on proportional representation, I would expect that every STEM department should have an assistant or associate professor with a disability or at least should have interviewed such a candidate. But that is far from the case.

Amazingly, there has been no improvement in STEM doctoral degree attainment for people with disabilities since the passage of the Americans with Disabilities Act (ADA) in 1991. Less than 2 percent of STEM doctorates conferred in the United States are earned by students with disabilities.

While there is still a long way to go before proportional equity is realized, we have seen advances in degree attainment by women, blacks and Hispanics over this same period. Women are now the majority of doctoral recipients in some STEM fields, and the percentage of STEM doctorates earned by black and Hispanic students has doubled from 1990 to 2010.

However, a vicious cycle has been observed for people with disabilities in STEM—the lack of role models, under-employment and suppressed degree attainment lead to decreased participation for people with disabilities, as well as reticence by mentors to encourage them into STEM.

Why was I successful while so many other people with disabilities become under-employed or drop STEM altogether? A significant component was luck. I found excellent mentors at all levels who saw what I could accomplish in research. I might not be efficient in the lab performing 'bench chemistry,' but I was good at data analysis, experimental design and problem-solving—skills that become more important with advanced degrees and leadership positions. Therefore, I was offered opportunities to hone these skill sets and encouraged to pursue a doctorate and become a professor.

Karl Booksh *teaches chemistry to 55 freshmen during the spring 2015 semester.*

EVAN KRAPE

Also, I acquired my disability later in life, so my career expectancies were set higher. Hence, it was easier for me to deny the socially assumed limitations of my capabilities. For example, after applying to one research university after graduate school, I was told by a faculty member that someone like me could never succeed as a professor.

With these experiences in mind and with funding from the National Science Foundation, a UD colleague, Prof. Sharon Rozovsky, and I started a Research Experiences for Undergraduates (REU) program in chemistry for students with disabilities. This unique program offers research, mentoring and community-building opportunities to outstanding scholars who happen to have a recognized disability that impacts one or more aspects of their lives.

The core of the program is an eight-week residency laboratory experience, culminating with a presentation at UD's Undergraduate Research Symposium. During the two-month program, we discuss the intersection between disability and career. Topics include navigating graduate school, research expectancies, strategies for disclosure of disabilities and requesting accommodations, and countermeasures for overcoming the biases that can sidetrack plans to become a scientist or engineer.

There is still much to do in promoting the inclusion of people with disabilities in all levels of STEM. I am particularly interested in the transition between high school and college. This transition confronts students with their first need to anticipate, locate and negotiate accommodations on their own.

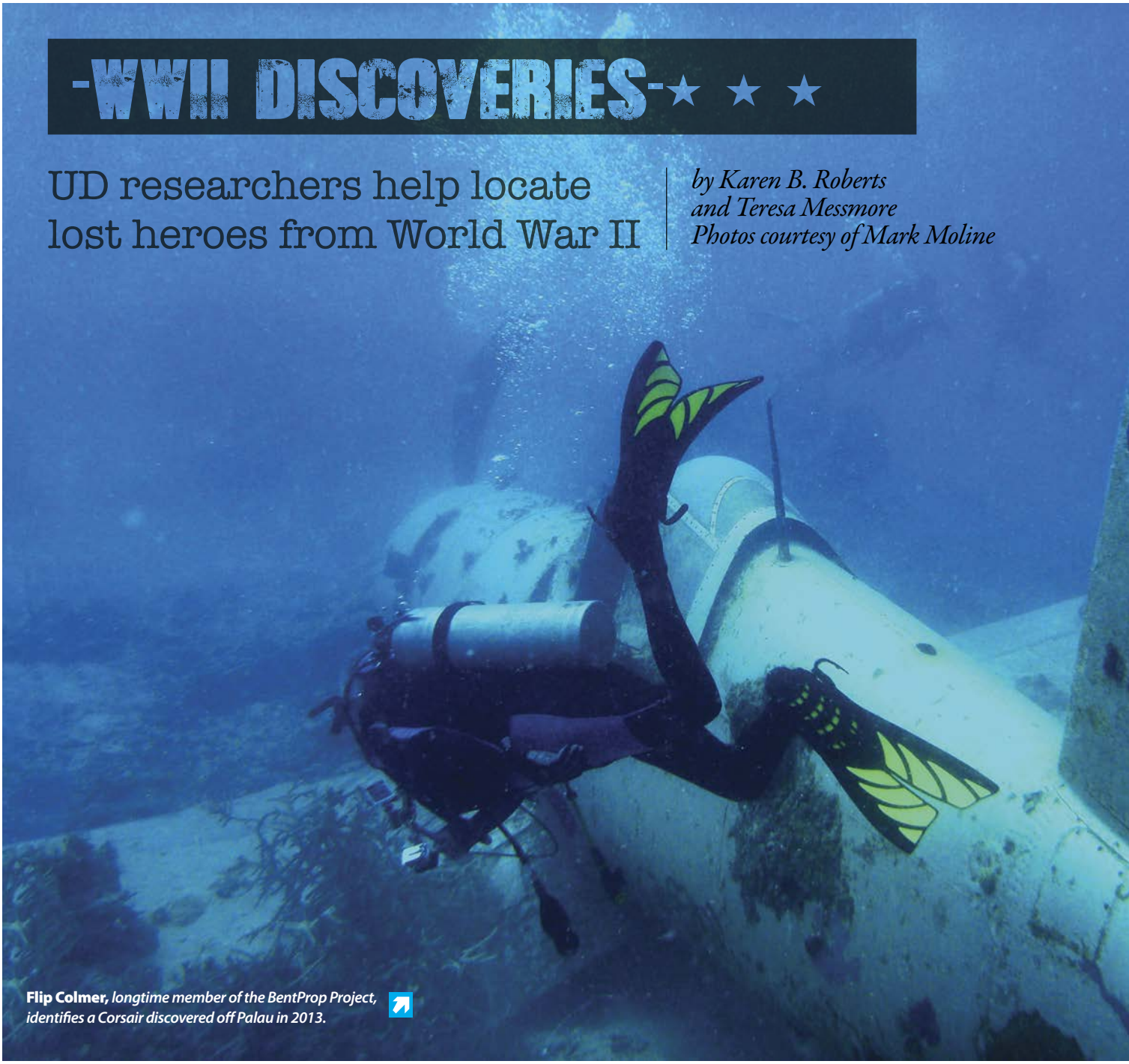
I also see significant holes in psychological and sociological literature proposing effective interventions that promote improved participation and performance of people with disabilities in STEM. Factors influencing the persistence and performance of ethnic minorities and women in STEM have been extensively studied. Yet, very few comparable studies have focused on students with disabilities.

Currently, success is measured in cardinal numbers, as efforts like our REU program affect one student at a time through individual mentoring. However, I have faith that, in time, students with disabilities will be recognized for their unique abilities, not for their assumed limitations. And then I will be able to stop wondering why there are so few people with disabilities at national conferences.

-WWII DISCOVERIES-★ ★ ★

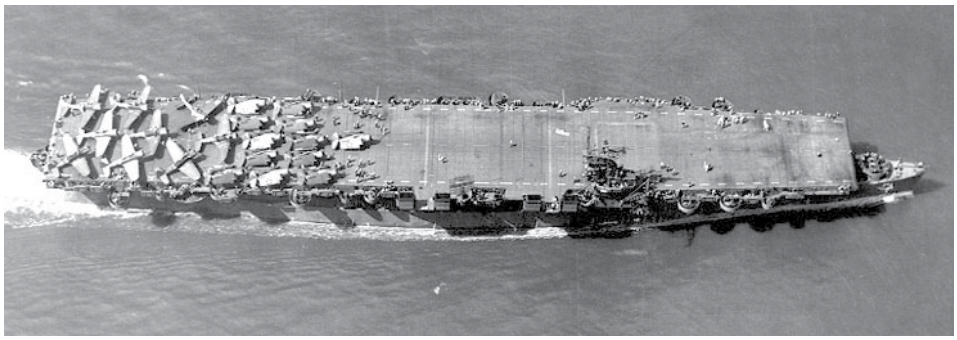
UD researchers help locate lost heroes from World War II

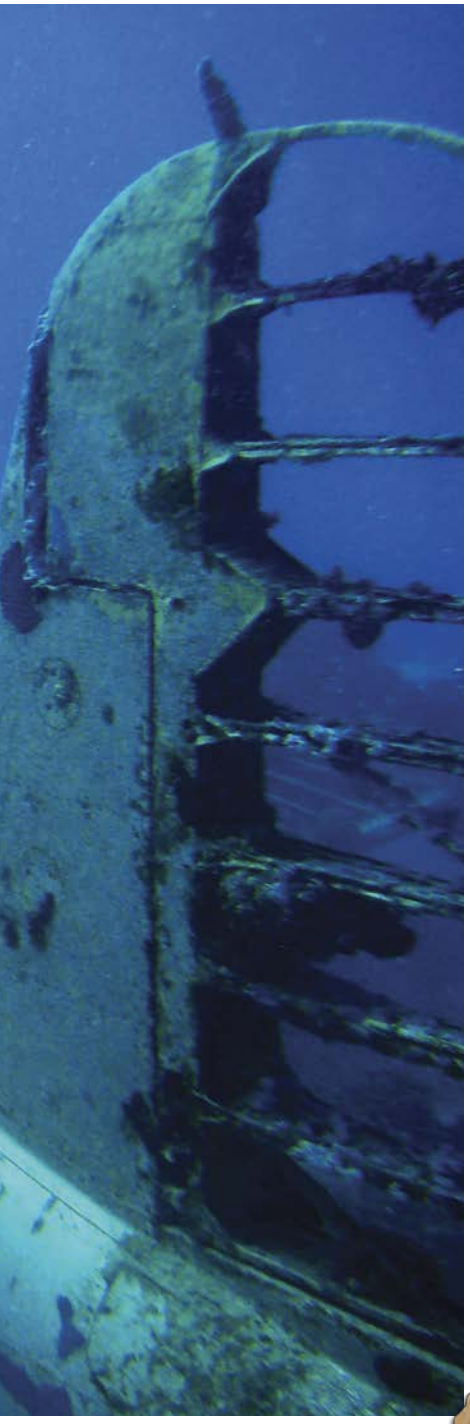
by Karen B. Roberts and Teresa Messmore
Photos courtesy of Mark Moline



Flip Colmer, *longtime member of the BentProp Project, identifies a Corsair discovered off Palau in 2013.*

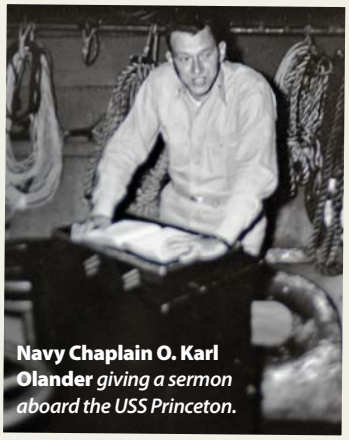
The grandfather of UD's Mark Moline—*O. Karl Olander—was a Navy chaplain aboard the aircraft carrier USS Princeton, which attacked Palau in 1944. The vessel is shown during its shakedown cruise in the Atlantic on May 31, 1943, carrying nine SBD scout bombers and 12 F4F fighters. Moline and a colleague at Scripps Institution of Oceanography began collaborating with the BentProp Project in 2013 and helped locate a U.S. TBM Avenger and an F6F Hellcat in 2014. Official U.S. Navy Photograph.*





The University of Delaware's Mark Moline knew that his grandfather, O. Karl Olander, was a Navy chaplain in the Pacific during World War II. But it wasn't until his mother shared his grandfather's journal and scrapbook that Moline realized his grandfather had been on the USS Princeton, one of the aircraft carriers that attacked Palau in March 1944.

During World War II, the western Pacific islands of Palau were a hotbed for combat. The Japanese wanted to use the islands for battle preparation and refueling grounds—and so did the Allies. Numerous aircraft were lost in the waters off Palau, submerged for decades with little closure for the families of fallen airmen.



Navy Chaplain O. Karl Olander *giving a sermon aboard the USS Princeton.*

Moline, director of the School of Marine Science and Policy within UD's College of Earth, Ocean, and Environment, and a colleague at Scripps Institution of Oceanography began working with the non-profit BentProp Project in 2013 to apply underwater robotics technologies in search of lost U.S. airmen.

"About the time that we realized we were at the limit of our capabilities, we met the folks from Scripps and University of Delaware. Their technology changed everything," said BentProp founder Patrick Scannon.

The collaboration led to the discovery of two long-lost planes in 2014. The work was profiled on the CBS news magazine *60 Minutes* and featured in a video by the mounted camera company Go Pro.

Underwater discovery

Since 2010, Moline and Scripps colleague Eric Terrill have used sophisticated technology to study and model the complex flow of water around the coral reefs, lagoons and islands of Palau, funded by the U.S. Office of Naval Research (ONR). The researchers make annual field expeditions to examine currents, large-scale eddies and tides' impact on water movement. The hydrodynamic research also focuses on the impact of super-typhoons on beaches and coral reef environments.

O. Karl Olander's scrapbook and journal *provided Mark Moline a personal connection to the scientific work of searching for downed American aircraft in Palau. Pictures, holiday menus and details about how many servicemen attended services and received communion gave a glimpse into life aboard the USS Princeton.*

LISA TOSSEY

During fieldwork, the researchers crossed paths with BentProp, a group of individuals dedicated to returning World War II servicemen missing in action back to the United States. BentProp has spent the last 20 years conducting historical research, documenting firsthand accounts and launching annual land and water expeditions to search for missing aircraft.

"I felt connected to BentProp's mission, but having the journal made the connection that much stronger," explained Moline.

As they compared projects, Moline and Terrill realized that the underwater robotics technology used for their scientific work could significantly improve BentProp's search efforts, and established Project Recover, with support from ONR.

Underwater robots known as autonomous underwater vehicles, or AUVs, can be programmed to independently survey large swaths of the seafloor to determine depth, water conditions and other oceanographic variables. With sonar and cameras on board, AUVs can capture images of sand ripples, coral reefs—and objects like airplanes.

Using historical documentation to guide their search, the UD and Scripps teams began systematically scanning the ocean bottom in 2013, zeroing in on promising search areas.

The data collected provided scientifically valuable information, and even captured footage of a Japanese Kawanishi airplane, one of only a handful produced. While the sighting demonstrated the AUV's capabilities, it was not the aircraft they were looking for.

Moline and his BentProp colleagues returned to the case files on particular airmen and incidents of missing aircraft, combing the documents in search of clues. Moline stumbled upon a document that named a small bay where, coincidentally, BentProp previously had discovered the wing of a U.S. TBM Avenger.

The group narrowed their search area and in March 2014, the AUVs found the remainder of the Avenger bomber, which had been missing in action for 70 years. A few days later, sonar images helped reveal a second aircraft, an F6F Hellcat, in a second location.

"It was an exciting time, but also a solemn time because you know there are potentially servicemen still in the plane," said Moline, who attributes the discovery to the combination of BentProp's historical knowledge of the area and archival records, and the advanced robotics technology provided by UD and Scripps.

Repatriating MIAs

The discoveries start the process of repatriating the MIAs through proper government channels. Information about the wrecks' locations has been shared with the U.S. military, which will review the cases and determine whether servicemen's remains can be returned to the United States—which is outside of the scope of the researchers' and BentProp's roles.

"We don't disturb the wrecks at all," said Hunter Brown, who manages UD's fleet of underwater robots.

Brown and Megan Cimino, a UD oceanography graduate student, ran many of the AUV missions in Palau and scoured through hours of footage at the end of long days of fieldwork.

"You put so much time into doing these operations every day, and to actually find something ... it was really rewarding," Cimino said.

UD ROBOTIC DISCOVERY LABORATORY FLEET ★ ★ ★

REMUS 100

The Kongsberg Hydroid REMUS 100 is a semi-modular autonomous underwater vehicle (AUV) used for coral reef studies, benthic habitat mapping, aircraft and shipwreck searches and surveys. Equipped with sidescan sonar, the REMUS 100 can detect the difference between aircraft metal and organic matter, which proved useful in helping to locate downed aircraft in the waters off Palau. An acoustic modem provides researchers with status and position updates while the vehicle is deployed on a mission, while a spectral radiometer helps researchers measure light levels of different frequencies in the vehicle's location.

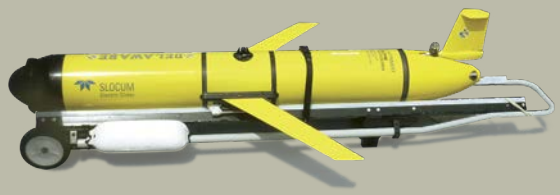
DIMENSIONS: Length: 1.6 m; Diameter: 19 cm
MISSION DURATION: 5–8 hours
TRAVEL DISTANCE: 1–6 km
MAXIMUM DEPTH: 100 m
RECENT MISSION: Studying marine organisms in the Arctic Ocean.

REMUS 600

The Kongsberg Hydroid REMUS 600 is a modular AUV used for deep research. The vehicle extends both the depth and duration of the Robotic Discovery Laboratory fleet by carrying larger sonar equipment deeper into the ocean. Dual frequency down-looking sonar, built specifically for the UD vehicle and used for biological research, extends the range of the sonar to approximately 4,000 feet. Applications for the work include hydrographic surveys, environmental monitoring, search and salvage operations, coral reef studies, and sampling and mapping.

DIMENSIONS: Length: 6.096 m; Diameter: 32.4 cm
MISSION DURATION: 8–60 hours
TRAVEL DISTANCE: 8–60 km
MAXIMUM DEPTH: 600 m
RECENT MISSION: Studying the distribution of food sources for whales off the California coast.

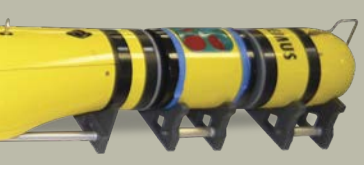
UD's Mark Moline *(pictured second from the left) participates in a flag ceremony over the site of a U.S. Navy MIA airman and his Hellcat fighter aircraft discovered in Palau in March 2014 by BentProp and researchers from the University of Delaware and Scripps Institution of Oceanography.*



Slocum Gliders

The Teledyne Webb Research Slocum Gliders are AUVs used for long-term deployments. The gliders can measure water quality parameters over great distances where other AUVs are limited by battery-powered propellers. The vehicle periodically surfaces and uses its iridium satellite communications to report its position and status, providing the research team an opportunity to change its mission. Gliders are typically used for environmental monitoring, habitat extent monitoring and large area oceanographic studies.

DIMENSIONS: Length: 1.5 m; Diameter: 22 cm
MISSION DURATION: 1–90 days
TRAVEL DISTANCE: 100's of km
MAXIMUM DEPTH: 200 m(1 km)
RECENT MISSION: Tracking and studying penguins in Antarctica.



Teledyne Gavia

The Teledyne Gavia is a modular AUV used for research. The vehicle has surveyed more than 3,500 kilometers (over 2,175 miles) in over 180 missions, including surveying scallops to track how dredging affects their populations, coral reef studies and seafloor mapping.

Phase-measuring Bathy sonar technology enables the Gavia to create 3-D sonar plots, while optical cameras capture video and images. An acoustic modem, not too dissimilar from a Wi-Fi modem, provides researchers status updates of the Gavia's progress and helps them find the vehicle if it gets lost. Text messages via satellite communications when the vehicle surfaces inform scientists about the AUV's position and mission status.

DIMENSIONS: Length: 1.8 m; Diameter: 20 cm
MISSION DURATION: 3–4 hours
TRAVEL DISTANCE: 15–20 km
MAXIMUM DEPTH: 500 m
RECENT MISSION: Used to map an 1889 shipwreck off the coast of Cape Henlopen.

Full circle

For Moline, the work in Palau that started—and continues—with a scientific focus, also has become personal. His grandfather's scrapbook includes notes about an airman who went missing from the ship. BentProp is aware of the serviceman, and collectively they have been trying to find him over the last 20 years.

While the "Hollywood ending" to the story would be to aid in the recovery of the airman mentioned in his grandfather's journal, Moline is firm that this is not the mission.

"BentProp believes there are about 70 MIAs that are recoverable from nearly two dozen aircraft downed in Palau. We look forward to continuing the work to bring these servicemen home," he said.

LISA TOSSEY

Mark Moline *leafs through his grandfather's scrapbook.*

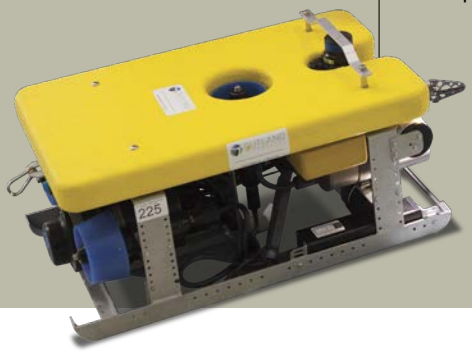
UD ROBOTIC DISCOVERY LABORATORY FLEET CONTINUED ★ ★ ★

ROV

The Outland 1000 is a remote operated vehicle (ROV) that is controlled by an operator over a tether cable. Equipped with many add-ons, this ROV is versatile for many types of research, including low-visibility sonar mapping, real-time video surveying and data collection. A manipulator component enables grab sampling and vehicle retrieval, among other things.

This type of unmanned underwater vehicle (UUV) provides real-time video and real-time scanning sonar to investigate subsurface environments. The sonar works by looking forward and using sound, or acoustics, to sweep from left to right to create a picture. In murky water, imaging sonar helps researchers acquire a visual representation of what they would see if the water were clear.

DIMENSIONS: Length: 66 cm; Width: 38 cm; Height: 26.67 cm
MISSION DURATION: Indefinite
TRAVEL DISTANCE: 300 m
MAXIMUM DEPTH: 300 m
RECENT MISSION: Assessing artificial reefs and associated biological communities off the Delaware coast and rescuing an AUV in the Cayman Islands.



Aerial Vehicles

The DJI Phantom and Phantom 2 Quadcopter unmanned aerial vehicles (UAVs) are the latest addition to the Robotic Discovery Laboratory fleet.

Equipped with sensors, a high-definition camera and GPS technology, the UAVs provide a unique perspective for data collection. They are transported and deployed by a single operator, and can soar above and capture high-resolution imagery and video.

The UAVs will be used for coastal and marsh research on the Delmarva Peninsula. The top-down view of coastal areas will provide new insights into habitat growth and decay as well as offer new territory for image analysis research.

DIMENSIONS: Diagonal length: 35 cm
MISSION DURATION: 20 minutes
TRAVEL DISTANCE: 300 m
MAXIMUM DEPTH: 300 m
FUTURE MISSIONS: Studying the effects of sea level rise and severe storms in the mid-Atlantic.

ADDRESS REPLY TO
BUREAU OF ORDNANCE, NAVY DEPARTMENT
AND REFER TO

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON 25, D. C.

MEMORANDUM

Q&A with Mark Moline

The College of Earth, Ocean, and Environment (CEOE) opened the Robotic Discovery Laboratory (RDL) at the Hugh R. Sharp Campus in Lewes last August, consolidating the college's environmental robotics capabilities and bringing together a variety of research technologies.

UD RESEARCH recently talked with Mark Moline, director of the School of Marine Science and Policy, about the capabilities and uses of the robotic fleet.

Q: How do CEOE researchers choose vehicles for different jobs?

MOLINE: Which vehicle is used for a specific mission is ultimately driven by the mission's scientific goal. First, we consider our needs, including how long the robot needs to be at sea, how deep it needs to dive and what type of data we are trying to capture. Then we decide what system works best and customize the vehicle for the mission.

For example, if we are interested in visual data, we will choose a vehicle with optical cameras. If we are interested in gathering light data (irradiance), we might use a vehicle equipped with multispectral optical sensors. Several of the RDL vehicles have similar sensors (sidescan-sonar, cameras, etc.) but overall, it is the combination of sensors, vehicle logistics and performance that dictate which vehicle is best suited for the scientific mission.

One configuration of a vehicle can be used for many different missions. Wherever possible, the vehicles are preconfigured in the RDL before being deployed, but, if this is problematic, the equipment is transported and assembled on location. In all cases, researchers carry spare equipment because it's difficult to acquire additional parts or devices while at sea.

Q: Tell us about the CEOE environmental robotics fleet.

MOLINE: The RDL fleet includes more than a dozen robotic systems, including unmanned underwater vehicles (UUVs) and unmanned aerial vehicles (UAVs).

LEAH DODD

Pictured with the Remus 600 are, from left, Mark Moline, Art Trembanis and Matthew Oliver.

UUVs can be split into two groups: autonomous underwater vehicles (AUVs) and tethered underwater vehicles known as remote operated vehicles or ROVs.

The UUVs can map and measure, record video, and capture photos and sidescan sonar images. The UAVs, or flying drones, can survey coastlines, marshes, beaches and more.

Q: Where are the UD robots being used?

MOLINE: Our robots have been deployed on aquatic research missions all over the world, including the Arctic, Antarctica, the Caribbean, Canada, New Zealand, Turkey and Brazil. In the United States, they've helped researchers collect data in California, the Gulf of Mexico and up and down the East Coast.

I'm currently using UUVs to aid in the search for downed American aircraft from World War II in the Pacific Ocean and to understand how marine organisms in the Arctic Ocean cope with continuous winter darkness.

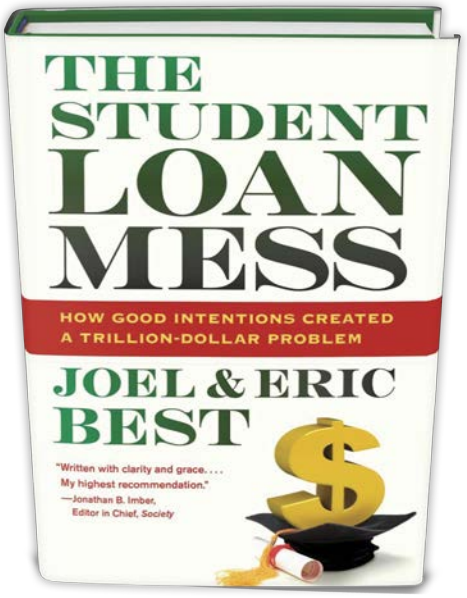
Other projects in the college include assessing the impact of physical processes on penguins in Antarctica, quantifying dredge impacts on scallop harvesting in the mid-Atlantic and managing environmental resources at Assateague Island National Seashore.

Q: What is sonar and how does it work?

MOLINE: Sonar, short for Sound Navigation and Ranging, is a technique used to navigate or detect objects underwater or at the water's surface. Sonar works like a speaker and a microphone together. The research vehicle sends out a sound pulse from a speaker and when the sound hits an object it is reflected back to the UUV in a return signal. By timing the difference in transmission and reception times, researchers can infer how far away things are and the kind of material off which the signal is reflecting.

Student Loan: Handle with Care

WARNING Use of this product may be harmful to your financial health | *by Beth Miller*



If the United States were to put a warning label on student loans, it might say something like this:

"WARNING: Use of this product may be harmful to your financial health. Student loans may be addictive, produce distorted perceptions of the cost of education, offer no guarantee of future employment and cannot be erased in bankruptcy court."

Such warnings haven't put an end to tobacco use, of course. And it will take far more than red caution flags to arrest the mushroom cloud of student loan debt that continues to grow over the U.S. economy—a heavy burden of more than $1 trillion.

It is a problem University of Delaware sociologist Joel Best has been thinking about for decades, with special interest in the changing social dynamics, public conversations and government policies that were developed to address various needs.

His son, Eric, a social scientist with experience in investment banking, introduced him to the financial dynamics in play, suggesting the student loan crisis may be kin to the housing bubble that left millions in foreclosure. Eric, who earned his bachelor's, master's and doctorate at UD, is an assistant professor of emergency management at Jacksonville State University.

Now, in a new book they call *The Student Loan Mess,* Best & Son share several years of collaborative research, showing how well-intentioned public policy produced one student loan mess after another and suggesting ways to address the problem in the future.

The book, published by the University of California Press, traces federal student loans from their genesis in the late 1950's, when the Cold War with Russia prompted U.S. officials to see higher education as valuable to national interests, to the 1970's, when tighter repayment terms emerged to address student default, to 2012, when student loan debt topped $1 trillion.

The rapid growth in the popularity of the loans is demonstrated throughout the book with a series of milestones—$100 million borrowed in 1962, $1 billion in 1971, and $100 billion in 2011, so that total debt reached $1 trillion in 2012.

The surge reflects continuing change in society's view of debt and the value of education. Where families of the 50's were loath to borrow, education was promoted as an investment in the future, a stepping-stone to a more profitable career, well worth a temporary loan. As credit became a larger part of families' financial profiles, student loans carried less stigma. Better jobs were promised to graduates—until, quite abruptly, they weren't.

The Great Recession reshaped many students' prospects, including laid-off workers who hoped a new degree might help them find new work. But students who made it to graduation didn't necessarily find eager employers waiting. And those who didn't graduate still had loans to repay but no degree with which to find better-paying jobs.

The expansion of guaranteed federal loans also sparked growth in an unexpected sector—for-profit schools. These schools used readily available federal loan money to recruit students with little concern for their ability to succeed, the authors say, let alone their financial welfare. Many had to drop out, taking only their debts with them.

At the same time, tuition and other costs also rose at public and more traditional private schools as they competed for students by building bigger and more luxurious facilities and programs.

The next mess is emerging now, Eric Best says, as marginal schools close, leaving the taxpayers on the hook for forgiven loans.

The loans meant to expand access to higher education for middle-class and low-income families have instead become a burden too great for students and society.

So is a college education still worth it?

"College absolutely pays off," Joel Best says—and not only for the graduate, who typically makes a higher salary and enjoys other advantages, but also for society, which benefits from a more productive worker.

Education is not a one-size-fits-all proposition, though, they say. They would not point every student to a four-year school, for example. Less-expensive options—community colleges and technical schools—may deliver a much better return on investment for some.

The authors promise no easy fixes, but they do offer several recommendations (with more detail than could be included in this space), including:

- Control the growth of administrative costs in higher education.
- Reduce non-instruction costs, perhaps by cutting athletic programs.
- Reduce instruction costs, perhaps by requiring less time on campus for students.
- Find ways to encourage more family savings.
- Increase state support for higher education.
- Adopt realistic accounting methods that don't mask the truth.
- Restrict support for schools that perform poorly.
- Improve grants for more vulnerable students.
- Make payment terms more workable.
- Restrict lending to high-risk borrowers.

Joel Best *is a professor of sociology and criminal justice at the University of Delaware. His writing focuses on understanding how and why we become concerned with particular issues at particular moments in time—why we find ourselves worried about road rage one year, and identity theft a year or so later. His co-author, oldest son* **Eric**, *is an assistant professor of emergency management at Jacksonville State University. Eric received his bachelor's, master's and doctoral degrees from the University of Delaware.*

STUDENT LOAN DEBT

Now exceeding $1 trillion and predicted to reach $2 trillion by 2020.

INCREASING DEBT

Student loan debt is rising by more than $100 billion every year.

LOAN REPAYMENT

Among recent college students who are supposed to be repaying their loans, more than a third are delinquent.

BANKRUPTCY

Because student loans cannot be discharged through bankruptcy, the federal government assumes virtually all loans will be repaid in full.

LOAN POLICIES

Higher default rates and college costs, and proposals for more generous terms for student borrowers make it likely student loan policies will cost taxpayers hundreds of billions of dollars.

For the latest updates, visit **studentloanmess.com**

TEST YOUR KNOWLEDGE

Spring has sprung

As spring rolls in to the Northern Hemisphere, life emerges from winter hiding places. From this magnified glimpse, can you identify who is springing forth? Our thanks to ***Shannon Modla*** at UD's Bioimaging Center for the cool view.

A. Butterfly
B. Zinnia
C. Rainbow trout

Answer: A—BUTTERFLY

UNIVERSITY of DELAWARE
Research
ISSN 2150-461X
Volume 5 / Number 1 / 2015


EVAN KRAPE

Colleges

- College of Agriculture and Natural Resources
- College of Arts and Sciences
- Alfred Lerner College of Business and Economics
- College of Earth, Ocean, and Environment
- College of Education and Human Development
- College of Engineering
- College of Health Sciences

Research Centers & Institutes

Agricultural Experimental Station
Applied Science & Engineering Laboratories
Art Conservation Laboratories at Winterthur
Avian Biosciences Center
Bartol Research Institute
Catalysis Center for Energy Innovation
Center for Applied Business & Economic Research
Center for Applied Coastal Research
Center for Applied Demography & Survey Research
Center for Archaeological Research
Center for Bioinformatics & Computational Biology
Center for Biomedical Engineering Research
Center for Carbon-free Power Integration
Center for Catalytic Science & Technology
Center for Climate & Land-Surface Change
Center for Community Research & Service
Center for Composite Materials
Center for Disabilities Studies
Center for Drug & Health Studies
Center for Economic Education & Entrepreneurship
Center for Energy & Environmental Policy
Center for Environmental Genomics
Center for Fuel Cell Research
Center for Historic Architecture & Design
Center for Improving Learning of Fractions
Center for Information & Communications Sciences
Center for Innovative Bridge Engineering
Center for Managed Ecosystems
Center for Material Culture Studies
Center for Molecular & Engineering Thermodynamics
Center for Neutron Science
Center for Political Communication
Center for Remote Sensing
Center for Research in Education & Social Policy
Center for Science, Ethics & Public Policy
Center for Spintronics and Biodetection
Center for the Study of Diversity
Center for the Study of Metals in the Environment
Center for Translational Cancer Research
Christina River Basin Critical Zone Observatory
Computer Architecture & Parallel Systems Lab
Delaware Asteroseismic Research Center
Delaware Biotechnology Institute
Delaware Cardiovascular Research Center
Delaware Center for Transportation
Delaware Design Institute
Delaware Education Research & Development Center
Delaware Environmental Institute
Delaware Geological Survey
Delaware Rehabilitation Institute
Delaware Sea Grant College Program
Delaware Space Grant Program
Delaware Water Resources Center
Disaster Research Center
Early Learning Center
Elbert N. and Ann V. Carvel Research & Education Center
Exelon Trading Center
Gerard J. Mangone Center for Marine Policy
Halophyte Biotechnology Center
Institute for Global Studies
Institute for Public Administration
Institute for Transforming Undergraduate Education
Institute of Energy Conversion
Institute of Soil and Environmental Quality
Interdisciplinary Humanities Research Center
John L. Weinberg Center for Corporate Governance
JPMorgan Chase Innovation Center
Laboratory Preschool
Nurse Managed Health Center
OCEANIC—The Ocean Information Center
Small Business & Technology Development Center
UD Nanofabrication Facility
UD Professional Development Center for Educators
University of Delaware Botanic Gardens
University of Delaware Energy Institute
Water Resources Agency

Dare to be first.
UNIVERSITY OF DELAWARE

Postmaster:
Send address changes to:

University of Delaware Research
Communications and Public Affairs
Academy Building
105 East Main St.
Newark, DE 19716-7201

UNIVERSITY of DELAWARE
Research

Communications and Public Affairs
University of Delaware
The Academy Building
Newark, DE 19716-7201

Nonprofit Org.
U.S. Postage
PAID
Permit No. 26
Newark, DE