



DR. JOHN HARDIN

Executive Director

Office of Science, Technology & Innovation

June 15, 2018

I am pleased to introduce this issue of *Research North Carolina*, a forum for sharing information from North Carolina institutions and companies about their research programs and achievements.

Research-based innovation is a force multiplier – an accelerator that helps create new industries, make existing ones globally competitive, and drive economic growth and well-being. North Carolina's ability to thrive in this increasingly dynamic, global economy depends, fundamentally, on how much it infuses innovation throughout our economic system. Our future success will be determined by what we do now – the quality of our vision, how we invest, how we prioritize, and how we respond to the challenges of an evolving economy.

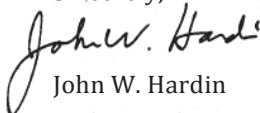
As shown in the North Carolina Board of Science, Technology & Innovation's most recent *Tracking Innovation* report, released last December, one of our state's strongest sources of innovation is its universities. North Carolina's academic R&D expenditures relative to the size of its economy rank the fourth highest in the nation. Compared to the nation overall, North Carolina's academic R&D intensity is 150 percent of the U.S. value, meaning that the amount of academic R&D in the state is 50 percent higher than what we would expect based on the levels of academic R&D in all other states.

North Carolina also has one of the fastest growing populations in the country, and its high-technology sectors are increasing in employment and have wages nearly twice as high as the U.S. average for all industries. The state's companies are also leading the way, with high-tech startups forming in North Carolina at rate nearly 25 percent higher than the national average – and climbing. Moreover, North Carolina manufacturing output as a function of total GDP ranks 4th in the country, performing at 164 percent of the U.S. average. These patterns are driving productivity and job gains in high-technology, high-skill industries.


This special section, *Research North Carolina*, is a great way to learn in more detail about the types of technology based activities that underlie these statistics and are helping to grow our economy in North Carolina. Together, these effects lead to a virtuous cycle of expanding employment, as well as increased wages and lower prices, all of which expand domestic economic activity and create jobs. A high-productivity, high-employment, high-income, growing economy must be a high-technology economy driven by research and innovation.

I invite you to read *Research North Carolina* and to join in these efforts.

Sincerely,


John W. Hardin

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ECU students learn techniques in their laboratory classes, including pH testing and how to properly collect and analyze data, that are valuable to regional businesses.

Cultivating rural prosperity

ECU initiative aims to reshape eastern North Carolina

East Carolina University is leveraging its intellectual capabilities, research facilities, community partnerships and network of alumni to solve the region's disparities in health care, education and economic development. The university's Rural Prosperity Initiative calls for a unique approach to tackling the state's toughest problems. Students, faculty and staff are combining resources and working across multiple disciplines to advance economic development. Additionally, the university continues to work with industry partners to enhance economic growth and prepare community members for a changing technological landscape. The university's motto – *servire* – calls for all Pirates to serve. ECU is answering that call, using innovative strategies to maximize success in eastern North Carolina.

➤ From the lab to the worksite

Student internships with regional businesses are a core element of ECU's goal of preparing its students for the state's increasingly competitive workforce. Rising senior Daysha Ervin, a biology major and member of the TriBeta Biological Honor Society, has put what she's learned in the classroom to good use with Greenville's U.N.X. Incorporated. U.N.X.,

founded in 1958, develops chemical detergents and specialties for consumer industries. Ervin works as an intern at U.N.X., testing the company's products for quality control before they reach consumers.

"My general and organic chemistry labs at ECU have really translated to the work I'm doing at U.N.X.," Ervin said. "A lot of the experiments I've conducted in my lab courses have transferred over to the real world, including pH testing, titrations and collecting and analyzing data."

U.N.X. Laboratory Director Ryan Cotroneo said the company's partnership with ECU has opened U.N.X. up to new ideas and possibilities.

"We're bringing in a variety of students from ECU (who) have learned the latest and greatest teaching tools," Cotroneo said. "Our company is being exposed to new ideas because we're working with students (who) think and work differently than we do. We're becoming healthier as an organization through the exposure we've received from working with ECU and its students."

➤ Faculty and staff reach out

Along with its students, ECU faculty and staff members are



serving the Rural Prosperity Initiative through their work with industry partners.

In 2017, ECU launched seven pan-university research clusters – with an eighth planned this fall – that provide a multi-level framework for fostering interdisciplinary research, outreach and engagement. The clusters bridge the gap between industries and ECU's research projects through advisory boards, which make it easy for strategic partners to capitalize on the benefits of university collaboration as each cluster pursues innovative research that forges new intellectual directions and discoveries.

Additionally, ECU faculty interact with business partners through the university's workforce and extension programs, including the North Carolina Agromedicine Institute, the Small Business and Technology Development Center at ECU, Greenville SEED@ECU and the Center for Innovation in Technology and Engineering.

David Harrawood, ECU's director for the Center for Innovation in Technology and Engineering, said his center's mission is to provide regional businesses and industries with university resources.

"One of the biggest benefits I've seen is that it keeps the work local," Harrawood said. "When we do a good job, companies tend to look toward ECU for hires. They don't have to go to Raleigh or Atlanta for a quality worker or trainer. Our faculty members who go out and work with these companies become the face of the university and make valuable connections that benefit ECU and its business partners."

➤ Partnering with industry

In addition to the efforts put forth by ECU students, faculty and staff, the university has committed to serve its local businesses and entrepreneurs.

RFPI, an ECU start-up, has developed technology that generates images from real-time data capture and instant analysis. This data allows surgeons to observe blood flow during surgical procedures. This non-invasive, minimal-risk imaging device provides patient benefits by improving clinical outcomes, physician benefits by enhancing the delivery of patient care, and hospital and third-party benefits by reducing the overall cost of care.

A second ECU invention, Xcomp, is an innovative, competency-based assessment technology that generates cumulative, evaluation data for students, faculty, curricula and programs. This assessment tool goes beyond evaluating academic programs based on grades and course performance. Instead, Xcomp uses factors including demonstrated knowledge, skill growth and values gained to determine a program's worth.

ECU is serving health care, educational and economic development needs in eastern North Carolina, connecting the Rural Prosperity Initiative to its industry partners while cultivating strong industrial roots from the ground up.

➤ ECU Metrics

Among the 17-member University of North Carolina system, ECU is:

- Top 2 in health sciences and clinical trials research expenditures
- Top 3 in funding from businesses, biological and biomedical sciences expenditures, geological and earth sciences expenditures, funding from Health and Human Services and life sciences expenditures

2016 HERD Research Expenditures Survey•

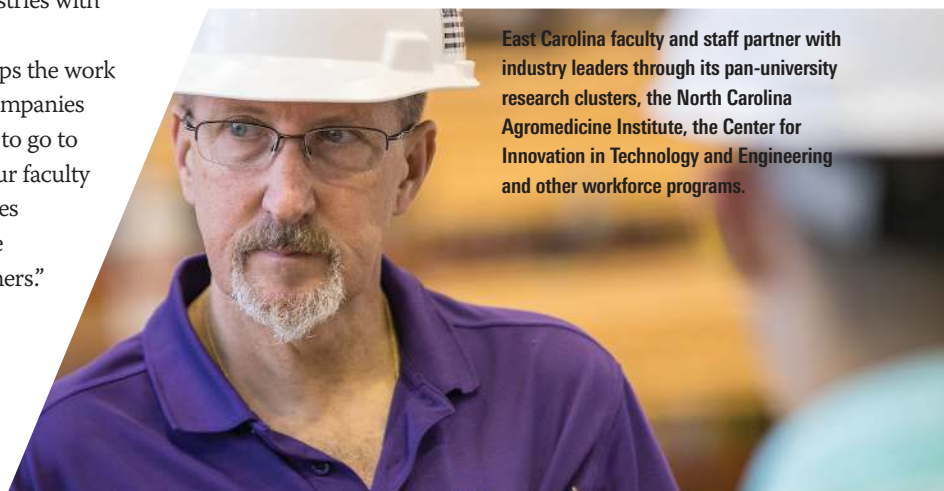
Among 15 sister and peer institutions, ECU is:

- Top 3 in licenses issues
- Top 5 in disclosures received, patents issues and license revenue
- Top 6 in patents field

Association of University Technology Managers, per \$1M research expenditures

ECU's economic impact totals \$2.8 billion in added state income, the equivalent of 42,798 jobs.

Fiscal year 2012-13



East Carolina faculty and staff partner with industry leaders through its pan-university research clusters, the North Carolina Agromedicine Institute, the Center for Innovation in Technology and Engineering and other workforce programs.




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➤ Interested in working with ECU?

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FTCC drone operations are part of the Unmanned Aerial Vehicle courses taught at the College.

FTCC boosts opportunity

Fayetteville Tech's partnerships with Fayetteville Economic Development, NCDOT, and Atlantic Coast Pipeline provide job skills training and result in economic development

Fayetteville Technical Community College (FTCC) has a long history of serving the community and the state of North Carolina. The goal of FTCC's Corporate and Continuing Education division is to not only prepare individuals who want to obtain employability skills and transition out of the military, but also work with the youth of Cumberland County to provide summer camps that will spark interests in employability for years to come.

FTCC's Corporate and Continuing Education division has developed three new programs based on research of programs to offer in which the college and community will see a positive impact. These new programs involve partnerships with Fayetteville Economic Development, the North Carolina Department of Transportation (NCDOT), and Atlantic Coast Pipeline—organi-

zations and entities that serve the local population and improve economic development.

The new Baseball Stadium and Entertainment Venue is bringing real jobs, training, and educational opportunities for residents of Cumberland County. FTCC, in partnership with Barton Malow, the City of Fayetteville, and NC Works Career Center, is developing a construction skilled trade employment opportunity. FTCC will potentially provide a four-week basic construction and safety course to assist with the development of highly trained, work-ready employees. Upon successful completion of this course, individuals will have the opportunity to work for Barton Malow.

The NCDOT and Atlantic Coast Pipeline are partnering with FTCC and surrounding counties to develop a Basic Construction and Pipeline installation course. This course

will be comprised of OSHA, CPR, employability skills, and basic construction content.

After an intensive 40-hour training with FTCC, Atlantic Coast Pipeline will hire individuals to assist with the pipeline installation. This training will not only bring jobs to the county but also provide transferable labor training credentials to individuals after the pipeline installation is complete.

As Unmanned Aerial Vehicle (UAV) usage is intensifying in all industries, FTCC developed UAV courses and will provide an informational session to the county and state. FTCC in partnership with the NCDOT Division of Aviation and Unmanned Aircraft Systems (UAS) Office will host a Regional UAV Workshop. This workshop is intended to educate professionals about current and future industry issues affecting UAS operations in North Carolina. The goal is to inform professionals, such as law enforcement, fire, insurance agencies, and the general population, with information as to how UAVs can enhance the current work environments.

Alongside the development of three new programs, FTCC continues to strengthen training for transitioning service members. Transition Tech is designed to provide transitioning service members portable/industry credential training that will assist them when applying and interviewing for civilian jobs. In addition to industry credentials, the Transition Tech program also incorporates employability skills (resume writing, interviewing techniques, and conflict resolution) into each program. The Transition Tech Coordinator collaborates with other areas throughout the college and the Career Development Center to reach out to the local industry in order for the service members to practice interviewing and potentially secure employment. Since its inception in 2014, Transition Tech has tripled its program offerings. In 2017, Transition Tech served over 1,600 transi-

tioning service members, with a 94% placement rate in four of the eleven programs.

While employability training is extremely viable to our college and community, FTCC is promoting awareness of future employment by increasing Summerscapes and Entrepreneurial camps for school-age children. In 2017, FTCC Summerscapes and Youth Entrepreneurial Camps served over 1,000 Cumberland County youth. The focus of the past two summers has not only sparked personal interest but also enhanced interest in Science, Technology, Engineering, and Math (STEM) fields. Most recent additions to the STEM-related field include Robotics, Computer Programming and Coding, 3-D Printing, Motion Capture, and Space Exploration. Participation in these programs provides exposure to FTCC college programs and encourages secondary education.

FTCC takes pride in servicing the educational needs of students of all ages. Through continuous outreach and community collaboration, FTCC programs are providing instruction that creates skilled residents, which improves employability and the economy.



An FTCC student learns basic masonry skills as part of the construction skilled trade employment opportunity in partnership with Barton Malow, the City of Fayetteville, and NC Works Career Center.

*Fayetteville Technical
Community College*

Fayetteville Technical
Community College

Corporate & Continuing Education
Dr. Jolee Marsh, Associate Vice President
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Unique resources, such as this reactor in the UNC Department of Chemistry's catalysis lab, are available to students, faculty and staff thanks to innovative partnerships and interdisciplinary pursuits.

Big results

Convergent science accelerates research to market at UNC

What if nanotechnology could be used to extract minerals from water so effectively that mining became obsolete? What if it could also offer a low-cost solution to water scarcity all over the world?

Addressing a need that affects over 1.8 billion people worldwide, a team of polymer chemists, computational modelers and engineers at the University of North Carolina at Chapel Hill is developing an innovative membrane-based water purification tool that can safely remove a broad range of water contaminants. This novel technology is more energy-efficient and holds promise for large-scale, affordable production.

The project, led by UNC's Applied Physical Science Professor Theo Dingemans, and joined by scientists from Applied Mathematics and the Gillings School of Public Health, is one example of how Carolina is investing in convergent science — using its research strengths to produce practical new technologies, new businesses, and answers to society's most complex challenges.

> A bold approach

With a reputation for cutting-edge science, Carolina ranks as the nation's 11th largest research university. Much of its science is discovery-driven. From biologists studying how cells repair DNA damage, to marine scientists studying forces behind

hurricanes that impact coastlines, it involves the careful study, within specific disciplines, of how the world works. Over time these discoveries accumulate, yielding new treatments for cancer, or better disaster plans to save lives and property.

Convergent science flips this model on its head. It starts by identifying problems to be solved and relies on transdisciplinary teams with diverse perspectives to engineer tailored solutions. It represents a radical departure from traditional discipline-based science and a foray into problem-focused collaboration. Its focus on practical outcomes and commercially viable solutions is powering breakthroughs in fields like neuroscience, nutrition, precision health and energy.

> Investments in innovation

Over the past decade, Carolina has steadily increased its emphasis on convergent science. A strategic planning process begun in 2010 gave rise to **Innovate Carolina**, a comprehensive network of programs that translate UNC's research and entrepreneurial spirit into technologies, business ventures and inventions. Led by the Vice Chancellor for Innovation, Entrepreneurship and Economic Development, Innovate Carolina has fostered a campus-wide entrepreneurship culture, with coursework and programs, startup support, business incubator space, seed funding competitions, patent navigation services and access to



venture capital.

UNC's impact in this area has been impressive. Since 1958, over 300 active businesses employing over 8,000 North Carolinians have emerged from Carolina's campus.

Building on the vision of Innovate Carolina, in 2013 UNC launched the **Department of Applied Physical Sciences (APS)** — its first new science department in over 40 years. With the goal of driving convergent science, APS fuses expertise from traditional sciences with principles of engineering to tackle societal and technology challenges around energy, water, material science and device development. The department also manages a network of state-of-the-art campus makerspaces known as **BeAM** (Be a Maker). These new technology-rich studios provide students and faculty access to 3-D printers, electronics, wood and metal working and digital fabrication tools, allowing them to design, develop and test prototypes of their ideas and inventions.

UNC's most recent investment in convergent science comes from the Vice Chancellor for Research. The office's recently launched **Creativity Hubs** awards program is an annual competition that awards up to \$500,000 to successful "Hub teams" — project-specific collaborations of scientists working across disciplines to tackle complex grand challenges. Dingemans' water purification project is one of two teams selected for

awards this year. The Creativity Hubs support will help position it for external funding, investment and industry partnership.

> A new home for convergent science

Until this past year, UNC's emphasis on convergence science has been relatively quiet — known on campus among faculty and students, but less visible to the North Carolina public. But that is rapidly changing.

In October, UNC announced it will use private donor funds to create an **Institute for Convergent Science**. The Institute will be housed in a major new building in the Carolina physical sciences complex, located in the heart of campus. Rather than being the domain of a single scientific discipline, it will provide a home for diverse and fluid teams of faculty, students, industries and entrepreneurs who assemble to tackle and solve grand challenges. It will provide collaborative and entrepreneurial research space, meeting rooms, support services, and offices for visiting entrepreneurs and industry scientists. All of this activity will take place in a physical environment designed to promote the transdisciplinary collisions that lead to creative problem-solving.

The new Institute for Convergent Science will be a highly visible keystone for Carolina's strategic investments in convergent science — another way UNC research is serving North Carolina, and changing the world.



RESEARCH

UNC Chapel Hill
Office of the Vice Chancellor for Research
Chapel Hill, NC
Research.unc.edu

\$1 BILLION+

TOTAL ANNUAL RESEARCH EXPENDITURES AT UNC-CHAPEL HILL

In 2017, UNC-CH surpassed, for the first time, \$1 billion in annual research expenditures, ranking Carolina as one of the world's top research universities.



EPRI researchers in the EPIC High Bay Lab adjusting the base adaptor for the composite insulator.

Good results

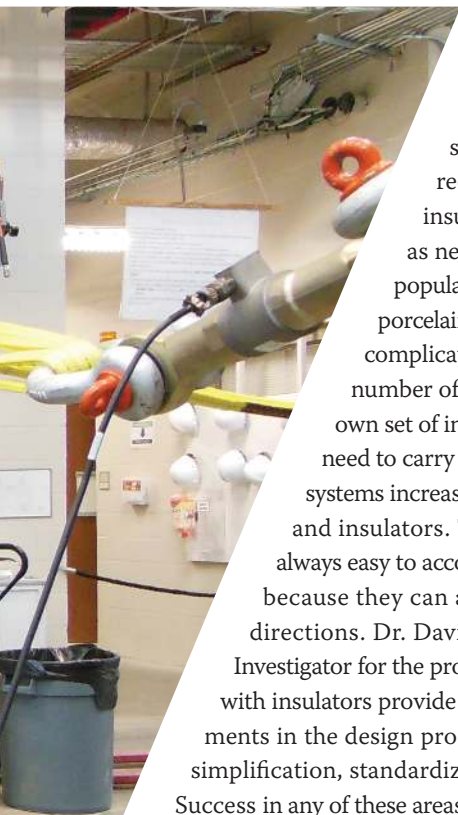
UNC Charlotte Research promises improved energy efficiency

Efficiency affects every aspect of an energy system including production, transmission, distribution, diagnostics, controls, costs, environment, resilience, reliability, and consumer satisfaction. Efficiency efforts often address increasing the flow of energy from the power generation facility or decreasing the use of energy by the customer. Areas receiving increasing attention are the infrastructures that support energy systems. Because they can have significant positive impacts on efficiency.

The Energy Production and Infrastructure Center (EPIC) was created on the UNC Charlotte campus by the State of NC with strong encouragement and support from the energy industry. This backing has remained strong throughout EPIC's six year history. Energy industry partners are heavily engaged in EPIC's activities, which focus on workforce development, research, technology development, and technical problem solving. The Electric Power Research Institute (EPRI) is a world-wide, 40+ year old, independent, nonprofit, member-supported organization conducting

research on behalf of its members and the public on energy and the environment. Benefitting from facilities practically across the street from one another, EPRI and EPIC have formed a strong collaboration to tackle complex energy issues.

Engineering faculty and research staff at EPIC are working closely with engineers and scientists at EPRI to improve the efficiency of components in electricity transmission and distribution systems. One example includes their work on improving design procedures for the insulators suspended from transmission towers and distribution poles. Insulators carry the heavy power lines (conductors) that span from tower to tower. Over the last three years, EPIC's High Bay Lab Manager, Dr. Youngjin Park, has worked closely with EPRI scientists and engineers on several projects to improve the design and evaluation process for insulators. Early projects evaluated numerical models for analysis and design and more recent projects involved mechanical tests to evaluate insulator behavior under required loading conditions. This work is funded by EPRI with the support of its members.



Before transmission towers and distribution poles can be installed, details of the insulators must be specified by a designer or vendor. In recent years, the design process for insulators has become more complex as new insulator materials have become popular (composite materials instead of porcelain, for example). Design has been complicated further by an increase in the number of vendors, each of whom has its own set of insulator details. Furthermore, the need to carry more electricity through existing systems increases the physical loads on towers and insulators. These increased loads are not always easy to accommodate in the design process because they can act simultaneously in three directions. Dr. David Young, EPIC's Principal Investigator for the project states, "The complexities with insulators provide opportunities for improvements in the design process in three broad areas: simplification, standardization, and optimization. Success in any of these areas will result in more efficient designs, meaning less material, greater capacities, greater resilience/reliability, and/or lower costs."




Dr. Youngjin Park, EPIC High Bay Lab manager, prepares for insulator testing

The inherently large number of parameters and variables in the design process requires many assumptions. Early results of the investigation revealed disparities across analysts, designers, and vendors as they made differing assumptions. To standardize or eliminate assumptions, more recent phases of the EPIC-EPRI research focused on gaining a better understanding of the material and structural behavior of insulators through full-scale experimental testing. To date, work has included experimental studies of common insulators, including unbraced and braced insulators, subjected to a variety of load combinations.

Results of the work are encouraging and provide a better understanding of the behavior of insulators under required, complex loading conditions. This improved understanding will provide a more refined design with fewer customized assumptions, thereby leading to a more standardized and streamlined process across all designers and vendors. Additionally, increased confidence in analysis and design procedures has led to the development of new and innovative types of insulators. Already research work has begun through the EPIC-EPRI team on unique vendor-specific designs, which ideally will lead to greater efficiency through the optimum use of materials and components.



At failure the base of the composite insulator showed significant separation of fiber glass material



Dr. Rueppell and two undergraduates assess a queen's egg-laying pattern, for a project comparing virus resistance in different bee strains.

Buzzworthy

Social Insect Lab zeroes in on honey bee health

Dozens of young honey bees buzzed through the air on the warm June day. The two undergraduates, though, weren't sure how to proceed. Collecting bees for research isn't covered in most classes.

The students, visiting UNC Greensboro for a National Science Foundation research experience program, asked Dr. Olav Rueppell for help. The Social Insect Lab director was happy to demonstrate.

He eschewed the beekeeper's hood and seemed oblivious to bees swirling around him. Young bees, it turns out, rarely sting.

As the students observed from several feet away, Rueppell briskly collected bees for them to take to the lab.

The bees were headed inside to be sedated and studied — all part of the Social Insect Lab's research to better understand how honey bee genetics, behavior and health fit together.

➤ A sticky problem

Rueppell believes research on how genetics and the environment interact in honey bees will help beekeepers keep hives healthier, and therefore help us all.

In the last few decades, bee populations have declined. Colony collapse disorder, where most worker bees disappear from a hive, is just one well known but poorly understood cause.

"Colony collapse is the tip of the iceberg," Rueppell says. He ticks off a range of problems: less diverse food sources, pesticides, diseases, mites and lifestyle-related stress.

Researchers aren't the only ones concerned. Beekeepers are losing 20 to 40 percent of their bees yearly — millions of bees per commercial beekeeper.

These losses threaten businesses and our food supply. That's because bees do much more than make honey: they pollinate billions of dollars of produce each year.

"Most wild pollinators can't survive in our modified agricultural landscape," Rueppell explains. "We rely on honey bees for a lot."

Without them, many fruits and vegetables you see in the grocery store simply wouldn't be there. By some estimates, honey bees pollinate \$15 billion in crops annually — crops accounting for one-third of the American diet.

Commercial beekeepers transport hives across the country to pollinate crops like broccoli, peppers and almond groves.

This brings us to bee lifestyle. "Commercial bees get shipped everywhere," Rueppell says. "Usually in high density conditions, with 20 or 30 colonies right next to each other."

Imagine growing up in a rural town and being relocated to a crowded, noisy high-rise. You'd be stressed, too.



In addition, agriculture use means many hives get nutrition from one or a few crops, rather than the diversity of plants they'd encounter in the wild. And they can be exposed to pesticides. It's tough to be a honey bee.

"Beekeepers are trying to split colonies and manage as best as they can," Rueppell says. "But they're running out of tools."

As colonies struggle, pollination costs increase for food and forage crops, raising prices in the fruit, vegetable, nut, beef and dairy industries in turn.

"We need long-term, sustainable solutions for improving honey bee health."

➤ Cleaning up mites

Work by Social Insect Lab postdoc Kaira Wagoner may turn into one of those tools. To understand Wagoner's research, you must understand one of the biggest threats honey bees face: varroa mites.

These tiny, rust-colored arachnids prey on bee larvae, sucking their blood when larvae are defenseless in the cells of honeycombs. Not only do varroa harm and sometimes kill bees, they also transmit deadly viruses.

Treatments protect bees from the mites, but some, like pesticides, can hurt bees. Wagoner discovered something that may be better.

She studies bee hygienic behavior. Worker bees sometimes open honeycomb cells containing larvae and, if they find mites, remove the parasitized larvae, leaving healthy ones to continue growing. This behavior allows bees to police their own hives against varroa.

But how do bees know when to do this?

Wagoner is identifying biochemical alarms that trigger bees to start hygienic behavior. Her discoveries may give beekeepers a new weapon against varroa: Spray those natural chemicals in infested hives, and bees could ramp up hygienic behaviors, eliminating mites themselves.

Researchers might also breed bees more responsive to those biochemical alarms.

The USDA recently awarded the Social Insect Lab \$999k to continue its varroa research, previously funded by NC Biotechnology Center and Project Apis m. The lab is collaborating with three other universities, extension specialists and beekeepers to test and share innovations.

➤ To breed better bees

The idea of breeding healthier bees is an important one Rueppell approaches from multiple angles.

His lab is studying the impact of stress on honey bee gene expression with U.S. Department of Defense funding. It's examining the effect of major viruses on different bee strains from across the country. And it's planning a collaboration with Israeli researchers to develop a new line of hygienic bees.

"There's a lot of talk about breeding disease-resistant bees," Rueppell says. "But you have to understand the genetic architecture and system constraints. There's a lot to know to be successful."

His lab, part of UNC Greensboro's newly established Plant and Pollinator Center, is here to help.

See the full version of this article in the Fall 2017 issue of UNCG Research Magazine.



Social Insect Lab graduate student Taylor Reams examines a worker bee, as part of her research on varroa mites.



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UNCW's Center for Marine Science supports coastal and marine sciences through research.

UNCW has global impact

Top-ranked university's research leads to more sustainable relationship with oceans

Scholars at the University of North Carolina Wilmington are conducting research of regional and global significance, including the effects of rising ocean waters and the continuous movement of shorelines; the causes of marine mammal stranding; the creation of sustainable fisheries and more.

> Oyster research

Building a sustainable shellfish aquaculture industry is a paramount objective for UNCW's Shellfish Hatchery. Research conducted at the hatchery contributes to the state's efforts to restore declining populations of ecological and commercial shellfish. Current research focuses on issues constraining the development of shellfish aquaculture industry, including the selective breeding of oysters for superior growth and survival; the investigation of best practices for the cultivation of sunray venus clams and bay scallops; and the evaluation of the effects of triploidy on performance.

> North Carolina shellfish siting tool


UNCW researchers developed an interactive tool for the N.C. coastline that aids in site selection for new or expanding

shellfish operations. The tool is designed to help potential shellfish growers determine site feasibility and identify potential risks and long-term suitability. It provides data related to salinity, bottom type, depth soundings, shellfish growing area classifications, boat access areas, surrounding land cover and current shellfish growing operations.

> From the coastline to the stars

Physics and physical oceanography Associate Professor Dylan McNamara is leading an interdisciplinary team of researchers from seven universities – from geomorphologists to economists – to investigate ways public policies will affect both economic decisions and the coastal environment. The results of the team's research will provide insight into how real estate markets respond to complex changes in environmental conditions, public policies, scientific knowledge, and individual attitudes and values.

Professor John Morrison, also in the Department of Physics and Physical Oceanography, and a team of international scientists have developed a one-of-a-kind ocean color nanosatellite, or CubeSat, that can enhance scientists' ability to observe the ocean. The CubeSat, the size of a loaf of bread, provides a unique



vantage point to observe the ocean's surface, alerting researchers to expansion of harmful algal blooms and potential fishing zones, among other things. The project will enhance scientists' ability to observe ocean color while increasing worldwide accessibility to the data. The group is working with representatives from NASA's Goddard Space Flight Center, Cloudland Instruments and Clyde Space.

➤ Coastal Ocean Research and Monitoring Program

The Coastal Ocean Research and Monitoring Program (www.cormp.org) operates nine oceanographic and marine weather platforms in the coastal waters off North and South Carolina. Through partnerships, CORMP helps diverse stakeholders prepare for and respond to both natural and man-made risks to economic growth, prosperity and survivability, and ensure a safe, productive, resilient ocean and coastal zone. Lynn Leonard, professor in the Department of Earth and Ocean Sciences, leads the program.

➤ Research facilities

Many of these compelling discoveries take place at UNCW's MARBIONC, the Center for Marine Science, the Finfish Aquaculture Facility and the Shellfish Research Hatchery, North Carolina's only shellfish research hatchery.

MARBIONC develops and markets new products and technologies derived from living organisms found in the sea. The facility also provides commercial research laboratories for companies focusing on biotechnology, analytical services, environmental sciences, translational science, and early-stage pharmaceutical research and development. The accelerator is currently affiliated with 11 partners, including SeaTox Research Inc., a company that developed toxin tests for seafood.

The Center for Marine Science supports and promotes coastal and marine science through research, outreach and service, and teaching. The CMS's outreach involves the Cape Fear River Program, N.C. SeaGrant, the National Estuarine Research Reserve, regional aquaculture growers, local governments, industries and nonprofits.

Interested in working with MARBIONC?
Visit www.uncw.edu/marbionc.


➤ Global collaboration

UNCW, the state's coastal university, is internationally recognized for excellence in coastal and marine sciences. Its location, with convenient access to the Atlantic Ocean, Intracoastal Waterway and coastal habitats, is ideally suited to experiential learning and field research.

To leverage UNCW's expertise and broaden collaborative research, the university convened its first Global Marine Summit in fall 2017. International scientists, policymakers and industry leaders focused on developing progressive solutions for global marine science issues and improving the economic climate of coastal regions around the world. Information from the summit will be used to improve and sustain coastal economies and to partner with local, state and federal agencies tasked with setting policies.

UNCW has been at the forefront of coastal and marine science research and education for more than 30 years, continuously improving coastal resilience and economic sustainability.

"North Carolina's 'blue economy' is largely dependent on the responsible management and stewardship of its marine resources," said College of Arts and Sciences Dean Aswani Volety. "Scientists and researchers from UNCW's marine science programs are working to develop solutions to the very complex environmental and economic issues facing our region and other coastal communities around the world."



Marine biology graduate students tend the shellfish along the Intracoastal Waterway where UNCW's Shellfish Hatchery grows its research specimens.



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SBTDC's Technology Commercialization Team
(left to right) - Chris Veal, David Walker, Dr.
Nicole Schwerbrock (Director), John Ujvari,
Mike Carnes.

Helping tech firms fly

SBTDC provides specialized technology commercialization services

Lucinda Camras comes from a long line of inventors. Her father, Carl Camras, discovered a new class of drugs (prostaglandin analogues) to treat glaucoma that remain the first-line treatment in the field. By the time she was 19, she and her father had created a new glaucoma device and surgical approach.

They worked together on the design and towards pursuing licensing agreements and funding. In 2009, Lucinda's father passed away, but she obtained a PhD and continued their work to make their idea into a viable product.

According to Lucinda, "Our first attempt at funding failed so we were looking for a funding strategy and a colleague of mine recommended the Small Business and Technology Development Center (SBTDC). They helped us tailor our Small Business Innovation Research (SBIR) application for our firm Camras Vision to the granting agency and knew how to package it. We wouldn't have been able to get off the ground without the SBTDC."

Founded in 1984, the North Carolina SBTDC was the first Small Business Development Center in the nation to be officially

recognized as providing specialized technology commercialization services. The SBTDC is a business advisory service of The University of North Carolina System administered statewide by NC State University. Its 10 regional centers and 16 offices across the state are hosted by UNC System campuses and provide business counseling and educational services for thousands of small to midsize businesses each year.

The SBTDC's Technology Development and Commercialization Program's primary goals are providing counseling services to clients with technology-based businesses throughout North Carolina, and engaging with UNC System campuses to bring promising technologies to market. Counselors work closely with tech transfer offices, and sit on patent committees at several campuses.

Similar to Camras Vision, SBTDC technology commercialization clients typically have the following characteristics: (1) an innovative technology-based concept, product, service or process; (2) intellectual property that serves as a foundation for a competitive advantage; (3) high potential for growth; (4) a high level of uncertainty/risk; and (5) don't qualify for traditional



financing. Many of the clients benefit from the Tech Team's expert counsel on the national SBIR/STTR Program, a non-dilutive federal funding mechanism to help small businesses develop and commercialize innovative solutions to existing problems that the federal government is interested in and have significant market potential. Federal agencies with research budgets over \$100 million are required to set-aside a certain percentage of their budget for SBIR awards.

SBIR is a three-phase program covering concept development (Phase I with awards from \$150-225K), prototype development (Phase II with awards from \$1.0 – 1.5 million), and commercialization (Phase III with no SBIR funding). The SBTDC's technology counselors help client companies effectively incorporate SBIR/STTR into their funding strategies, identify appropriate agencies and topics, and provide comprehensive proposal reviews. The SBTDC also offers periodic SBIR/STTR workshops across the state, as well as online training. In 2001, the SBTDC created a statewide SBIR Specialist position, which helped to increase the state's award rate. From 2005-2015, North Carolina firms have received \$551 million in SBIR/STTR awards, and the Tech Team assisted with 76% of the winning proposals.

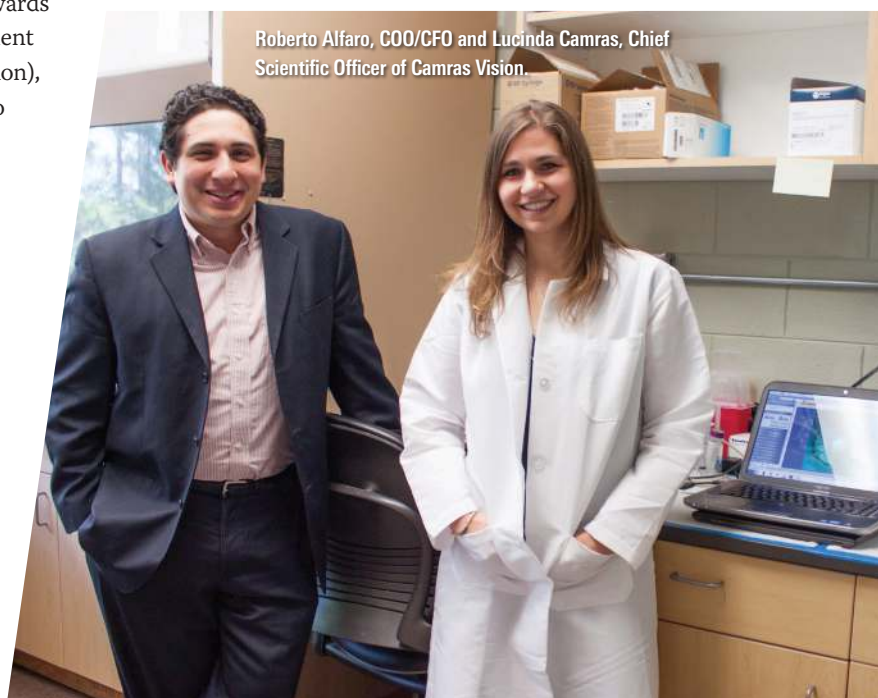
Access to capital, particularly equity capital, is often a challenge for technology-based firms. To address this issue, Tech Team counselors help clients better understand the equity investment landscape and options as they prepare to seek funding. The SBTDC also offers a well-regarded "Becoming an Investor-Ready Entrepreneur" workshop that is designed to educate and prepare growth-oriented entrepreneurs to successfully engage private equity investors.

Another highly valued Tech Team initiative is the Graduate Summer Internship Program that links both business and engineering graduate students with technology-based companies

to assist with a variety of business development projects, including customer analysis, primary and secondary market research and financial modeling. This summer over 20 companies are participating, many of which are SBIR/STTR awardees in the process of developing and executing on commercialization strategies. Since this competitive program began in 2002, the SBTDC's Graduate Summer Internship Program has placed 150 summer consultants with over 200 technology companies, and provided over 60,000 hours of service. Many of those companies have gone on to achieve significant success, like Camras Vision.

The SBTDC continues to assist Camras Vision with SBIR/STTR proposal reviews, research and commercialization plans, and investor pitch presentations. In November 2017, Camras won the Emerging Company Award at SEBIO's 19th Annual Investor and Partnering Forum. In early 2018, Camras closed on \$5.7 million in equity funding that it plans to use to support clinical trials, including a pilot study in the US.

Last year (2017), the Tech Team worked with 338 client companies, and helped them obtain \$30.9 million in funding, including SBIR/STTR funding, angel investment and venture capital. Given these results, the SBTDC's Technology Commercialization Team is recognized as an important part of North Carolina's innovation ecosystem for technology companies.



Roberto Alfaro, COO/CFO and Lucinda Camras, Chief Scientific Officer of Camras Vision

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