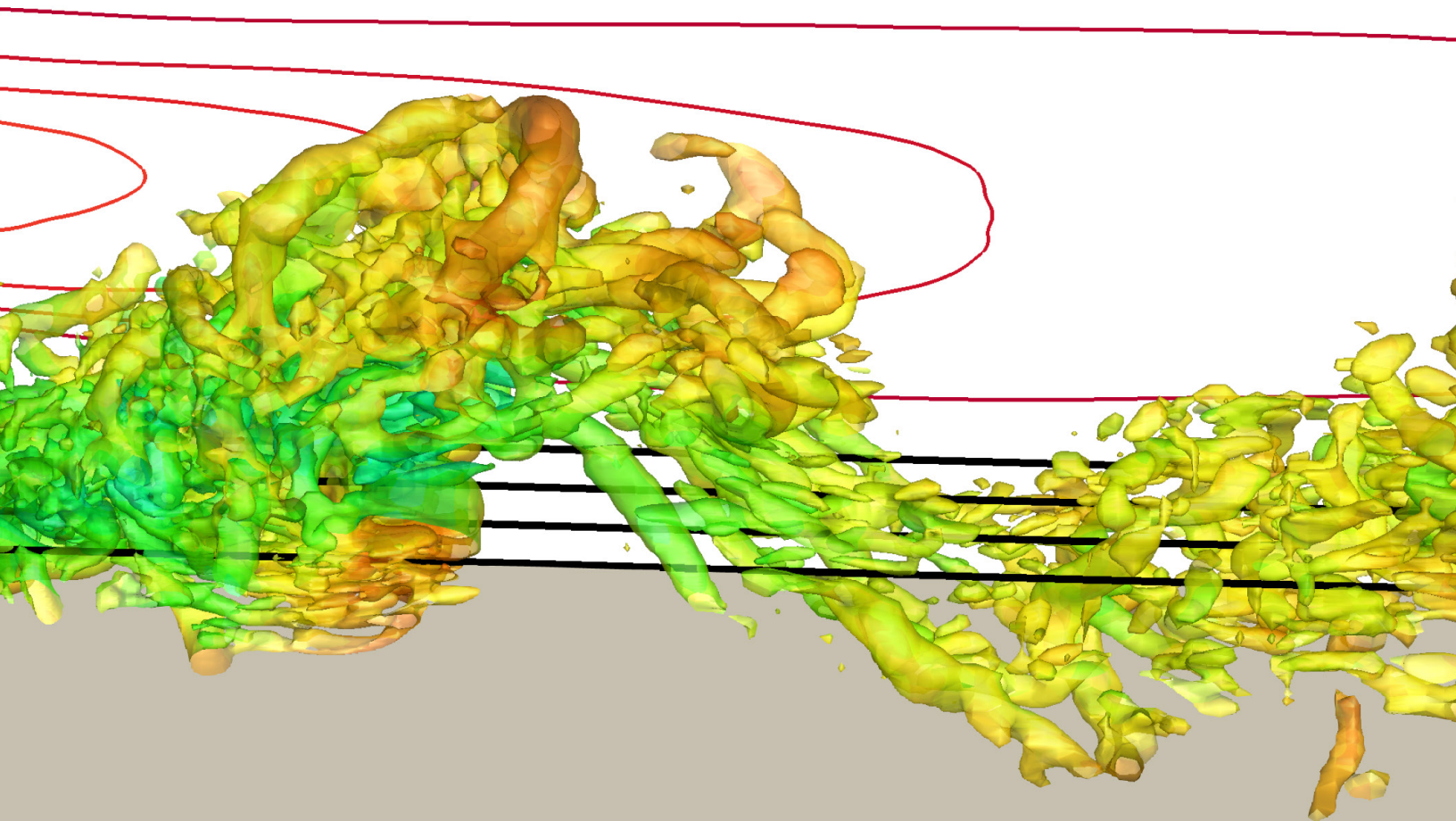


Summer 2017

# Engineering Research

Florida A&M University  
Florida State University



FAMU-FSU  
College of Engineering

# Welcome



We are proud of our research accomplishments at the FAMU-FSU College of Engineering. Located in Tallahassee, Florida, we are unique in the nation as a shared engineering school between two universities – Florida Agricultural and Mechanical University (FAMU) and Florida State University (FSU). Because of the distinct identities of our partners, our students and stakeholders have exposure to one of the most successful producers of African-American engineering graduates and to one of the nation’s Highest Research Activity Universities – a combination that does not exist elsewhere. Our five departments all have a full complement of bachelor’s, master’s and doctoral programs, and students and faculty from both our universities are fully engaged in research, as the book you are reading demonstrates.

When I arrived in Tallahassee just over a year ago, I began a strategic planning exercise to identify the areas where we will expand our research and faculty. The “Focus on the future” pages in this book are each connected to one of our seven initially-selected strategic research directions. In each case, these build on existing strengths, and emerged from an open brainstorming process to create world-leading engineering research. In this process we were keenly aware of the interdisciplinary nature of modern engineering, and the importance of cross-departmental and cross-college collaborations.

In each spread you can read about our successes and about the directions in which we are proposing to go in the future. We hope that you will be excited by this information, and hope you will join us, whether you are a potential student, faculty member, or partner from industry, government, or the military. We are 35 years into an exciting journey at this college, and have a grand vision to deliver a uniquely diverse group of trained engineers, and to simultaneously address engineering problems of national and international importance with a state-of-the-art set of capabilities and talent. We look forward to hearing from you.

A handwritten signature in blue ink that reads 'J. Murray Gibson'.

J. Murray Gibson  
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# Two great universities – one shared college.

Why is that characteristic of the FAMU-FSU College of Engineering such an important and powerful ingredient of our mission? Well, it's certainly unique among colleges of engineering; in fact, perhaps even among colleges of any kind. Our students can study at either of two universities, from which they get their degree, but the curriculum, instruction and standards are identical. Our faculty teach courses together, and follow policies, including promotion and tenure, which are uniform, yet their tenure home is in one or the other university. Faculty have the full rights of joint faculty at both universities. In their first one or two years, our pre-engineering students are immersed in their

home campus. But in their sophomore year and beyond, they study together on our engineering campus located between the two main campuses and have a fully shared experience.

To understand the importance of this, look at the universities. It is not just two universities but two different kinds of universities, with some overlap but also large differences in their mission. Florida A&M University is the top-ranked public Historically Black College/University (HBCU) in the nation. As such they share the mission of HBCUs to provide a nurturing education to underrepresented minorities that has been shown in many studies to be very effective. As an example, consider where



Florida A&M University is ranked by CollegeNet and Pay Scale Social Mobility Index (SMI) as one of the top colleges/universities in the nation for fostering social and economic opportunity.



African American Ph.D.s got their undergraduate degree. The top four universities on that list are all HBCUs including FAMU at #3. Even if the Ph.D.s come from Stanford or Cornell, these are not the institutions graduating most of the incoming doctoral students.

Florida State University is one of the nation's 115 Highest Research Activity Universities, according to the Carnegie classification. The top engineering schools are at the highest research intensive universities because research attracts the faculty expertise, and provides the equipment that students would use in industry, but would not find in a teaching-focused institution.

The partnership at our core bridges a gap that is not bridged anywhere else. No other HBCU is intimately connected to a top research university. Through this partnership, FAMU can offer six Ph.D. engineering programs, more than any other HBCU. And we

offer FSU the ability to have a significant impact on engineering diversity in a way no other top research university can equal. Corporations and government institutions are well aware of the inadequate diversity in our current engineering profession, and its negative impact on talent pools and opportunity.

We offer to our students on our shared engineering campus the most diverse learning environment to be found at a ranked engineering school. Unlike other schools, our students work in teams that are representative of society at large. The experience of crossing cultures provides valuable insight to our students which is a bonus to their future employers.

The partnership works because each institution brings something to the partnership that the other cannot bring – in other words – together they are stronger.

Dean J. Murray Gibson is very

optimistic that we can leverage this unique DNA to grow the college, and to impact the diversity of the engineering profession.

The success of our partnership is only possible through the generous support of the State of Florida, and great cooperation from the administration of both universities — especially the Presidents, the Provosts, Vice Presidents for Research, and other senior leaders.

As you can see, partnership really is in our DNA. We are keen to expand our partnerships further, to add more industries, government and military organizations, and universities to our fold. We recognize that one institution can only do so much, and our strategy must be to build our strength, and partner in other areas. Please contact us if after reading this update on our research activities, you have an interest in partnering with us.



Florida State University has been designated a preeminent research university by the Florida Legislature as a result of having met a set of rigorous benchmarks.

# Electric ships will soon be defending the seas



CAPS' advanced and versatile power systems test bed supports the U.S. Navy, electric utilities, and industry.

The future demands electric ships to support sophisticated new weapons and sensors. But this revolution is very challenging. For more than a decade, naval engineers have been working towards the introduction of an all-electric ship into the U.S. Navy. In the past year, the Navy has ramped up its work in the electric power and energy area. Researchers from the Center for Advanced Power Systems (CAPS) and FAMU-FSU College of Engineering are at the forefront of this effort.

Having been awarded a five-year \$35 million grant by the U.S. Navy's Office of Naval Research and an additional \$13 million four-year contract from the Naval Systems Command, CAPS leads a multi-university team of scientists and engineers to advance the Navy's efforts to build an all-electric ship.

While some electric ships already exist, most of today's ships are powered by steam or gas turbines. Conventional ships wield a tremendous amount of power, however, this power is primarily available only to the propulsion systems; there is not enough power available for new high-energy weapons and sensors.

The Navy wants to create a fully integrated power system that provides electric power to the entire ship, meaning one power source would be controlling propulsion, weapon and sensor systems, and energy storage.

Imagine a vessel that can fire lasers with spot-on accuracy to destroy attacking drones, missiles, small aircraft and other threats.

This is the capability the Navy hopes to develop.

According to Drs. Chris Edrington and Sastry Pamidi, professors of electrical and computer engineering and researchers at CAPS, autonomous control is particularly important to the success of an all-electric ship. Dr. Pamidi adds that they seek a control that is proactive rather than reactive to events. Autonomous control will help synergize all activities on the ship, and can help create a synergistic environment that cuts costs.

Last year, CAPS became the first university test site accredited by the Navy to perform high-powered simulations of the Air and Missile Defense Radar (AMDR) system for “power hardware in the loop” simulation. This process, pioneered by the Power Systems Research Group, allows researchers to test power equipment in real-life conditions with minimal risk or damage to the equipment, while maintaining flexibility.

## Researchers:

- Chris Edrington
- Omar Faruque
- Chul Kim
- Helen Li
- Roger McGinnis
- Juan Ordonez
- Sastry Pamidi
- Karl Schoder
- Mark Stanovich
- Mischa Steurer
- Tuyen Vu

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The method will be critical as CAPS’ researchers conduct extensive research and testing to see how the elements of an all-electric ship will fit together and what technologies the Navy would be able to use.

CAPS Director Roger McGinnis, who worked at the Naval Systems Command for five years, states “I can attest to the incredible work that the CAPS Power Systems Group has put into the simulation validation. It is an extremely important and challenging decision for a government organization to make when they certify a simulation tool for modeling and prototype testing.”

The other institutions working on the all-electric ship with CAPS include The University of Texas at Austin, Virginia Tech, Massachusetts Institute of Technology, Mississippi State University, Purdue University, and the University of South Carolina. They will focus on facets such as energy storage, ship architecture, and a power distribution apparatus.

Situated next to the FAMU-FSU College of Engineering, CAPS’ research areas include Power and Energy Management, Energy Conversion, Power Electronics, Electrical Fault Management, Power Systems Design, Cybersecurity, Thermal Management, and High Temperature Superconductivity.

The work on electric ships is complemented by Department of Energy supported research on renewable energy and the civilian electric grid.

## Future: Secure distributed electric power systems

The rise of “smart” electrical apparatus, devices, sensors, networks, and controls has created systems which efficiently use resources and are more resilient by evolving during catastrophic or dynamic events. But without appropriate design, “smart” systems are vulnerable to malicious intrusion. The National Academy of Engineering lists “Secure Cyberspace” as one of its 14 Grand Challenges. Former President Obama stated in his Cybersecurity Legislative Proposal that the “cyber threat is one of the most serious economic and national security challenges we face as a nation.” Clearly, a secure national energy grid is of paramount importance. At the FAMU-FSU College of Engineering, researchers via the ‘Secure distributed electric power systems’ initiative will be working to address these challenges.

This initiative plans to establish one of the premiere cyber physical programs in the U.S., leveraging FSU and FAMU program strengths, and then building a formidable team of researchers to address challenges in cyber physical systems, particularly in the smart energy sector. The five-year, \$35 million grant from the Office of Naval Research into the advancement of all-electric ships is synergistic with civilian power distribution needs of the future.

# Faster, quieter, greener... [did we mention *faster?*]

Watching the skilled precision of pilots and aircraft in an airshow draws a wide-eyed audience. The ability to perform such feats lies not only in a trained pilot's hands, but also in the aerodynamic capabilities of the aircraft, i.e. how air flows around it in flight and the forces this airflow produces. The aerodynamic characterization of a vehicle takes center stage at the Florida Center for Advanced Aero-Propulsion's (FCAAP) PolySonic Wind Tunnel (PSWT), where research is conducted in association with the faculty of the FAMU-FSU College of Engineering.

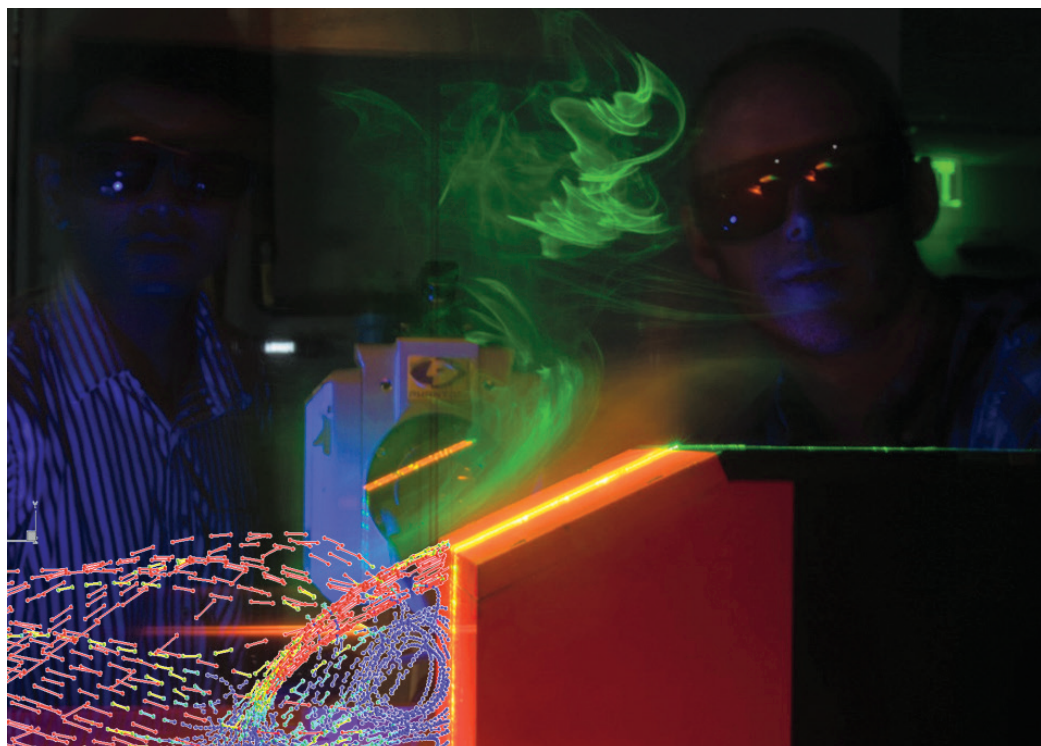
The PSWT boasts the capacity to test air speeds in the range of Mach 0.2 to 5. This translates to the study of subsonic, transonic,

supersonic, and hypersonic airflow. Airflow of sub/supersonic Mach numbers are tested in a 12-in by 12-in solid wall test section of the tunnel. Transonic speeds of Mach 0.8-1.2 are tested in the unique slotted wall test section of the tunnel. While the tunnel covers a wide range of operational conditions, the airflow within the tunnel is of the highest quality. Mechanical Engineering Associate Professor Rajan Kumar, a researcher at FCAAP, explains, "This is achieved through a number of strategic design parameters including a large inlet contraction

ratio, multiple flow conditioning screens with increasingly fine mesh, a flow straightener, acoustically treated control valves, a settling chamber and a diffuser."

Although the PSWT was only recently commissioned, it has been busy – engaged in numerous, externally supported research projects supported by \$1 million (and counting.) Among these is the aerodynamic characterization of a hypersonic air vehicle with an integrated inlet – a project sponsored by the Air Force Research Lab at Eglin Air Force Base in Florida. Lockheed Martin is

*Set-up in the FCAAP subsonic wind tunnel to investigate the wake generated by a simplified automobile design using high speed photography and smoke visualization. Experimentally measured 3-D velocity field superimposed.*





supporting research that examines the aero-optical performance of beam director configuration at transonic and supersonic speeds. Another project—sponsored by DARPA and in collaboration with the University of Miami—focuses on characterization of high lift transport aircraft airfoils using co-flow jets at transonic speeds. These are but a few examples of the cutting edge research using the PSWT.

While the above research will advance next-generation air and transport systems, it is the aerodynamic characterization of a hypersonic air vehicle configuration that particularly excites Professor Kumar. The project is an international collaboration between FCAAP, researchers at the FAMU-FSU College of Engineering, the Airforce Research Labs, and the UK Defense Science and Technology Laboratory. According to Kumar, the program addresses “one of the primary challenges in the design of

air-breathing engines for supersonic and hypersonic vehicles.”

The polysonic wind tunnel is key to ensuring future aircraft perform better through improved aerodynamic designs that are tested and refined. These aircraft will transport passengers safely and at a lower cost from point A to B and strengthen military operations, all while reducing the noise and emissions from commercial and military airplanes. (Not to mention providing more exciting airshows!) The PSWT’s Mach 0.2-5 operational range, excellent flow quality, and state of the art diagnostics make it the only one of its kind at a university research laboratory in the U.S. This, combined with the advanced simulation and modeling techniques being pioneered by Professors Taira, Shoele, and others at FCAAP, allows the study of very complex problems in a holistic manner. (See cover).

As a research center intimately connected with the FAMU-FSU College of Engineering, FAMU and FSU faculty, researchers, and students have a unique research opportunity that is not available anywhere else in the nation. The center paves the way for advancements not only in aerodynamics, but in the broader field of engineering and training in high-speed flight.

## Researchers:

- Farrukh S. Alvi
- Lou N. Cattafesta
- Emmanuel Collins
- Rajan Kumar
- William (Billy) Oates
- Chiang Shih
- Kourosh Shoele
- Kunihiko (Sam) Taira
- Neda Yaghoobian

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## Future: Next generation air and space transport systems

The next generation of air and spacecraft will need to meet increasingly stringent noise and environmental regulations. The NextGen air vehicles must address this need leading to airports that handle more traffic with highly efficient aircraft that are quieter, have lower emissions, and avoid negative environmental impacts.

Our initiative will have emphasis on the “faster” and “quieter” needs demanded by the civilian air travel, military, and space industries. The design of supersonic and hypersonic inlets that operate efficiently over the entire flight regime has been one of the primary challenges in the design of air-breathing engines for supersonic/hypersonic aircraft. Keeping the noise pollution from subsonic and supersonic aircraft is another key hurdle that must be addressed.

We will build on existing strengths in advanced testing and diagnostics, coupled with high-fidelity modeling and simulation to address the needs for the next generation of high-speed flight vehicles. This research thrust will benefit from materials innovation in the advanced nano-manufacturing initiative expanding our partnerships with the aerospace industry while serving the needs of military and civilian users.

# Crunching the numbers: making cities smart with big-data

When Hurricane Hermine hit Tallahassee, Florida on Sept. 1, 2016, the inland Florida city was devastated. It was the first hurricane to make landfall in Florida since Hurricane Wilma in 2005 and was the first hurricane to directly hit Apalachee Bay since Hurricane Alma in 1966. Hermine left 100,000 residents without power, knocking out trees, power lines, and shutting down stores and businesses for days. Tallahassee residents wanted answers.

Natural and man-made disasters expose weaknesses as well as strengths in how a city operates. But, how do you quantify efficiency in the regular operation of a city or in the face of a disaster? To answer these questions a multidisciplinary team of researchers in collaboration with the City of Tallahassee is using big data analytics to make Tallahassee smart. A smart city is characterized as an urban development seeking to integrate a multitude of solutions that contribute to the management of the city's assets, especially in the context of infrastructure planning and restoration (i.e. electrical infrastructure and roadway/debris cleaning.) Smart solutions are empowered by big data analysis of individualized responses, from which unexpected vulnerabilities emerge.

Dr. Reza Arghandeh and Dr. Eren Ozguven from the FAMU-FSU College of Engineering

and Dr. Jinghui Hou, from FSU are working with city officials to provide analytics that will be used in making the city efficient and a more sustainable place to live.

Their research is funded in part by the Early-concept Grant for Exploratory Research (EAGER) from the National Science Foundation (NSF). EAGER grants provide funds for the exploration of untested, but potentially transformative research ideas and with the grant of \$233,000, researchers will be able to provide analytics from Tallahassee that will be useful for cities across the nation and abroad.

Arghandeh, an affiliated researcher with the Center for Advanced Power Systems, is focusing on data analysis and electricity distribution networks throughout the city, making the grid more efficient and flexible. Ozguven, a researcher associated with the Center for Accessibility and Safety for an Aging Population, will be examining traffic patterns and other transportation safety and accessibility issues. Hou, a professor in communications, will be focusing more on human interaction like how city residents use digital tools to report outages to authorities.

The research team chose Tallahassee, a diverse mid-sized city, as a site well suited to sample older adults as well as those from underrepresented and underserved populations.



## Researchers:

- Reza Arghandeh
- Eren Ozguven
- Jinghui Hou,  
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Communications

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This research will bring measurable mobility benefits and will improve Tallahassee residents' quality of life in terms of:

- lowering energy consumption by vehicles and infrastructure,
- reducing congestion, crashes and traveler frustration,
- improving safety and reliability, and
- providing a more streamlined, efficient and cost-effective system to operate and maintain city service networks.



Hurricane Hermine proved to be a formidable storm for the city of Tallahassee but with the help of big data analytics, the city will have the tools to better handle a large-scale event affecting infrastructure and power. For example, correlations on the micro-level in power and transportation use have not been seriously explored. Our researchers are currently analyzing data received from the city and expect to identify risky locations relating to power systems, fallen trees, and powerlines.

The results are expected to contribute to the team's ongoing effort to meet the goals of the Global City Teams Challenge (GCTC). The program, sponsored by the National Institute of Standards and Technology brings together project teams from universities, government, and industry to work on groundbreaking applications within the smart city environment to lower costs and improve efficiency.

## Future: Augmenting mobility in urban environments

The national transportation network has been slowly degrading since its conception in the 1950s. Traffic congestion is associated with safety issues, air pollution, as well as time and fuel inefficiency. As we work to make cities smart, emerging technologies are expected to significantly transform our transportation system.

FAMU-FSU engineers are exploring promising areas such as connected and automated vehicles, traveler information systems, and ride sharing systems (e.g., Lyft and Uber) for mobility enhancement. They are looking at everything from cyber security, real-time data analysis and wireless communication to mobile/cloud/social computing, sensing technologies, and complex systems engineering in relation to our transportation systems.

In addition to new technology, researchers at the college are looking at how the strain of population growth and aging issues affect the transportation system. Florida has the largest population of senior citizens in the nation, so we are ideally situated to build our research on issues unique to mobility in aging populations.

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## New weapons in the war against neurodegeneration



*John Gamache, a renowned oil painter based in St. Augustine, Florida, continues to produce excellent work and teaches workshops while battling effects from Essential Tremor, a progressive, neurological disorder. Cell therapy has the potential to stave off the onslaught that threatens his productivity. (JohnGamache.com)*

A consequence of longer lifespans is that both individuals and society are dealing with neurodegeneration, a battle that is intensely personal while also having fundamental impacts on healthcare and culture. The enemies in this fight are all too well known: Alzheimer's, Parkinson's, and Lou Gehrig's Disease. Along with acute degeneration in the form of stroke and traumatic injury, these progressive conditions not only place a tremendous burden on the patient and caregivers, but will also continue to challenge national economic priorities for decades to come. The engineers at the FAMU-FSU College of Engineering are attempting to add unique weapons to the arsenal in this fight.

Part of the solution lies in our backyard: the National High

### Researchers:

- Rufina Alamo
- Hoyoung Chung
- Sam Grant
- JingJiao Guan
- Yan Li
- Teng Ma

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Magnetic Field Laboratory (NHMFL) provides high-field Magnetic Resonance Imaging (MRI) and spectroscopy enabling users to uniquely characterize biochemically active agents in tissue.

Sam Grant, Professor in the Department of Chemical and Biomedical Engineering, is an expert in the development of tools for high-field MRI and spectroscopy. Grant - who is also the NHMFL's MRI User Program director - and his colleagues are working to develop unique tools to use the high fields now available at the NHMFL to answer questions of great health care importance.

The application Grant is working on with his colleague, Teng Ma, Professor and Chair of Chemical and Biomedical Engineering, focuses on cell therapy. This new treatment uses bioengineered cells and novel materials as “smart missiles” inside the body. Today’s pharmaceuticals are based on small molecules (e.g. statins), or protein complexes (e.g. monoclonal antibodies). The use of cells with their complexity and specificity offers revolutionary improvement for patients, and some early results have been astounding. The technique, however, is far from ready for widespread use. To make this incredibly promising therapy a reality, we must learn to reliably make the cells, develop advanced imaging techniques to non-invasively track them in the brain, and then assess how they help the recovery of degenerated brain tissues.

“Like a GPS system that allows us to locate objects with pinpoint precision, we hope to discover a way

to precisely deliver therapeutic cells to infected and diseased areas of the human body,” explains Ma.

The particular goal of the new research is to fight disease in an aging population. Cell and tissue engineering is therefore a major focus among the core researchers, with Drs. Ma and Assistant Professor Yan Li taking the lead in cell processing. Building on industrial experience, Li derives therapeutic cells from induced pluripotent stem cells to model and treat neurodegenerative disease. Ma develops innovative systems for the robust production of adult stem cells that can withstand the rigors of pathological conditions.

This expertise in therapeutic cells is complemented by the unique MRI analysis of cellular implants. Grant is building an advanced MRI imaging capability that is the most sensitive method to monitor the progression and treatment of neurodegeneration with cell therapy. He can non-invasively and longitudinally track the transplanted cells and determine their fate in animal brains, laying the foundation to better engineer the therapeutic cells for eventual clinical use in patients.

Moving forward, Grant, Ma, and Li see further collaboration with Drs. Rufina Alamo, Jingjiao Guan, and Hoyoung Chung who work in advanced materials and nanoparticles to support cell expansion and labeling.

## Future: Cell therapy for aging populations

The World Health Organization predicts that by 2040, neurodegenerative diseases such as Alzheimer’s will overtake cancer to become the second leading cause of death after cardiovascular disease in developed countries. In the U.S., neurodegenerative diseases associated with an increasingly aging population are a major driver of healthcare expenditures. Scientific discoveries provide exciting opportunities for early detection and delivery of advanced treatment, but require engineering advancements and new technology to translate findings into clinical treatments.

Our research team is uniquely positioned in this endeavor. First, our growing team combines expertise in three key areas of cell therapy development:

- clinically relevant targeting and detection by high field MR imaging,
- advanced materials for cell tracking and monitoring, and
- cell processing and engineering technology.

This combination disrupts the traditional silos common to therapeutic development by pursuing a continuum approach from “molecule to man.”

Second, these efforts leverage existing strengths at the FAMU-FSU College of Engineering and NHMFL, while broadening the application of state-of-the-art instrumentation to develop novel cellular approaches.

## Simple, low-cost design of bio-covers reduces greenhouse gas emissions

Dr. Tarek Abichou, researcher and professor at the FAMU-FSU College of Engineering, likes to call himself the “garbage guy.” He explains, with a grin, “I spend a lot of time at landfills.”

Abichou’s research team has extensively studied the use of bio-covers to reduce methane dispersion from landfills. Their research has led to an improved bio-cover design that has economic advantages and high functionality. The scientist has used his research results to change standards for waste management, making the world a healthier place along the way.

The decomposition process of waste at landfills is a leading cause of methane gas emission and is a lesser-known contributor to global warming according to Abichou. “When it comes to greenhouse gases, the headlines tend to focus on carbon dioxide (CO<sub>2</sub>),” Abichou continues. “Yet despite methane’s relatively low profile, it plays a crucial role in global warming.”

Gas extraction to control methane emission can be expensive for many smaller communities. Inspired to find economically viable alternatives to control methane emission, Abichou’s research team found that covering the landfill with a bio-cover results in the increase of methane oxidizing bacteria and the decrease of fugitive methane emissions. An added benefit is that the bio-cover used in this study is made from recycled materials, including garden waste and clean recycled glass from discarded fluorescent lights.

His group produced an alternative bio-cover design as a solution to prevent groundwater pollution. This type of cover exploits the water capacity of finely textured soils and the water removal capability of vegetation to reduce infiltration into underlying waste. The use of bio-covers fills a growing need for economical solutions in solid waste management.

Years of slogging through landfills, or solid waste management facilities, as they are more formally known, produced a data set of measurements that generated models that accurately predict methane





## Researcher:

- Tarek Abichou

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oxidation. This extensive data-base provided solid evidence that bio-covers work and as a result, the U.S. Environmental Protection Agency (EPA) proposed a change to the rule attributing only 10% of methane oxidation to landfill covers. Abichou's work proved that higher methane oxidation is achievable by improving cover designs.

"The proposed new rule was a direct outcome of the work we have been doing at the college," says the researcher. "We measured methane oxidation in landfill covers by studying over 37 seasonal sampling events at 20 different landfills across the USA."

In Colorado, the EPA and the state used the researchers' work on alternative landfill covers to develop statewide guidance for landfill cover design. Similarly, the EPA engaged his multi-disciplinary team to assess uncontrolled waste dumps in Puerto Rico and develop remedial solutions for the island to prevent groundwater contamination. Abichou's cost-effective biological solutions have been published as a "Best Management Practices Manual" to be used by landfill operators to reduce their greenhouse gas emissions.

Dr. Abichou's research focuses on Geo-Environmental engineering in general and sustainable solid waste management. Along with being ranked fourth in the United States in terms of publications in solid waste management journals, the group has built a national and international reputation in the solid waste research, consulting, and regulatory communities.

## Future: Resilient and sustainable infrastructure

Infrastructure is the basic framework of a modern society; yet, the American Society of Civil Engineers has given America's infrastructure systems a grade of D+. Researchers at the FAMU-FSU College of Engineering are seeking to improve the functionality and longevity of existing infrastructure systems, while developing a new generation of sustainable and resilient infrastructure technologies that are environmentally responsible, can withstand disruptions, adapt to changing conditions, perform effectively, and recover rapidly. We have a strong track record in bioremediation of soil and groundwater, drinking water treatment, waste management and sewage treatment, sustainable building design, efficient goods distribution, and analysis of wind damage to infrastructure.

According to Dr. Yassir AbdelRazig, a civil and environmental engineering professor, "The new initiative will cover five primary areas, including energy, emergency planning, and social impact, as well as hazard vulnerability and mitigation, and environmental impact."

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# Going where no nanomaterial has gone before

As evidenced by the Hollywood blockbuster “Hidden Figures,” space exploration has been dominated by white men; but with the engagement and investment made by industry partners in minority education for STEM, the field is changing. As the only joint partnership between a Historically Black College/University (HBCU) and a Carnegie I Research Institution, the Florida A&M University-Florida State University College of Engineering has become one of the prime recipients of these investments.

Recently, Lockheed Martin and NASA invested nearly \$10 million combined in research and educational opportunities at the College of Engineering. While these are two separate contracts, both will focus on enabling nanomaterials manufacturing for deep space applications. Working in conjunction with the FSU High Performance Materials Institute (HPMI), FAMU-FSU College of Engineering faculty will serve as principal investigators (PI).

## Researchers:

- Petru Andrei
- Tarik Dickens
- Jingjiao Guan
- Ayou Hao
- Richard Liang
- Okenwa Okoli
- Chiwoo Park
- Jin-Gyu Park
- Subramanian Ramakrishnan
- Arda Vanli
- Mark Weatherspoon
- Cheryl Xu
- Mei Zhang
- Chad Zheng
- Jim Zheng

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During the five-year collaboration, Lockheed Martin will provide up to \$5 million in funding to FAMU through a series of task orders commissioning work related to space exploration. Students and faculty at the College of Engineering will work on NASA's Orion Multi-Purpose Crew Vehicle Program and other Lockheed Martin space exploration projects. For Lockheed, this represents the first such partnership with an HBCU. Nearly one hundred students will be able to work on different projects during the contract, with the potential for additional students to contribute in smaller ways. Participating students are expected to be from underrepresented populations.

Dr. Okenwa Okoli, chair of the Industrial and Manufacturing Engineering (IME) department and associate director of HPMI, serves as the lead PI for the Lockheed Martin initiative. His team's objective is to address a new range of challenges, including cutting costs on manufacturing parts for Orion using additive manufacturing, a key goal for Lockheed Martin and NASA. Okoli's research will focus mainly on identifying methods to manufacture cost-effective high-performance composite materials and systems.

The College of Engineering and HPMI will also play a major role in an overall initiative by NASA to create the first Space Technology Research Institute (STRI) that will work on the next-generation of materials for missions to Mars and beyond. Both FAMU and FSU are expected to receive more than \$4 million combined in funding from the Institute over the next five years. The money will help fund graduate students and researchers at the College of Engineering.

IME faculty members, Dr. Tarik Dickens and Dr. Richard Liang, director of HPMI, serve as lead PIs for this project. The College of Engineering joins a consortium, which brings together 11 prominent universities and two industrial partners, to achieve NASA's and STRI's goals.

Bridging the gap between industry and academia has never been more important than it is today. The investments that industry makes in the future of STEM education at the FAMU-FSU College of Engineering support changing the workforce to create minority and gender equality in space exploration. The College is proud to partner with Lockheed Martin, the Orion program, NASA and STRI in these research enterprises.

## Future: Advanced nanomanufacturing

Additive manufacturing will revolutionize the world by making parts with lower cost and superior performance. The Advanced Nanomanufacturing Initiative (ANI) will explore and develop transformative technologies of multifunctional nanomaterials, advanced 3D printing and scale-up nanomanufacturing, as well as training the next generation of skilled engineers, researchers, and workers. The High-Performance Materials Institute and other research centers making up the ANI team will focus on developing:

- strong interdisciplinary teams crossing engineering departments and universities;
- leading resources to seek center funding opportunities;
- strong industry/university collaborations and joint force research; and
- hands-on and interactive learning approaches for leading workforce training.

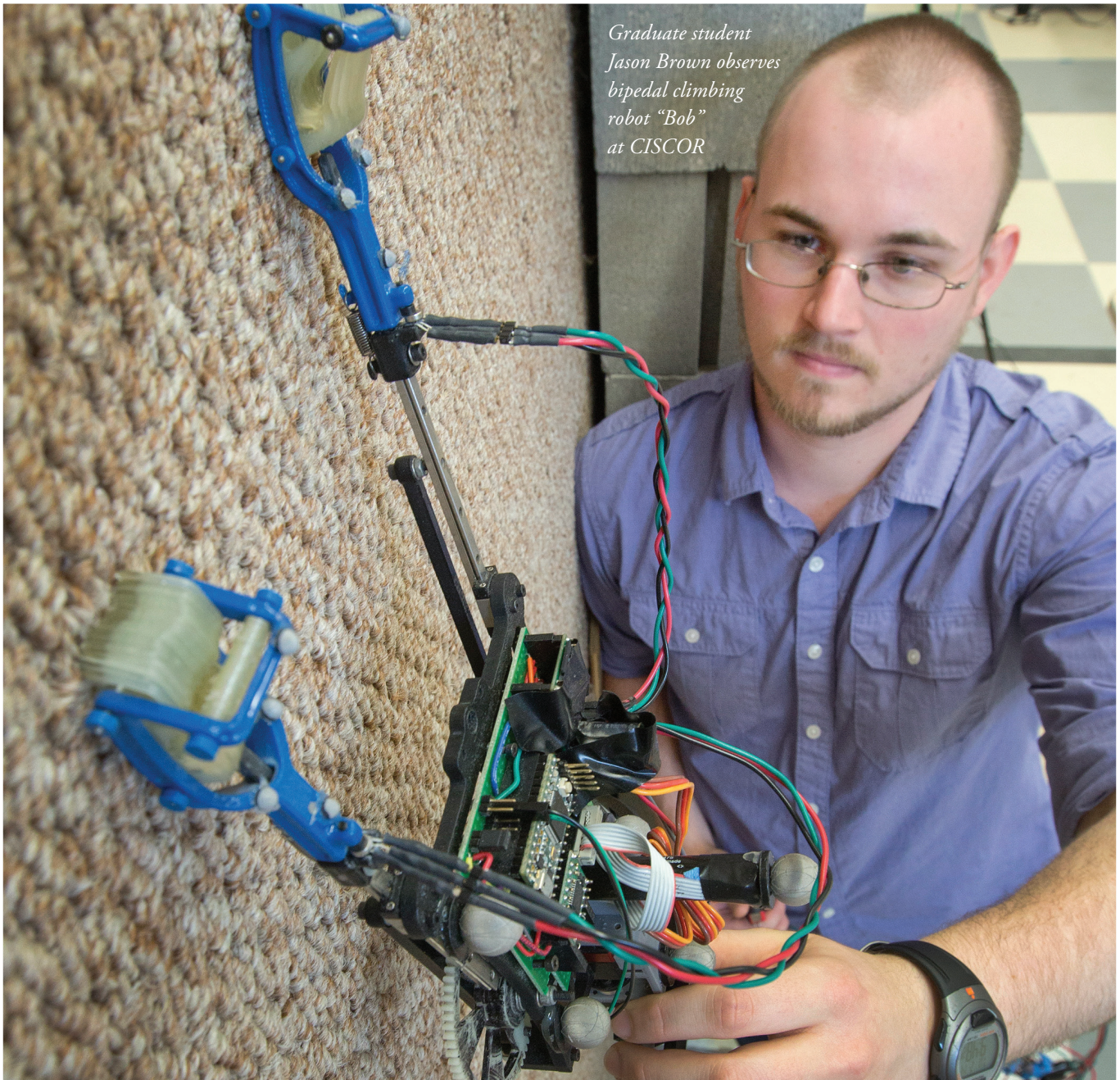
Building upon successful experiences with an NSF Industry/University Cooperative Research Center, Florida Board of Governor's Center of Excellence, NASA Space Technology Research Institute in Ultra-high Strength Composites and a NASA/Lockheed Martin HBCU Center for Composites, ANI will work with governmental agencies, industrial partners and local communities to generate high impact research, accelerate commercialization and economic development, and create jobs. The targeted research and development areas include:

- high-strength structural materials;
- scaled-up and printable large scale sensing and LED technologies;
- internet and robotics-based hybrid 3D printing;
- advanced manufacturing for aerospace, medical devices, energy storage, and environmental protection applications; and
- conducting nanocomposites for smart sensors.

## Focus: Helping the impaired musculoskeletal system

# Lizard locomotion leads to legged robots

You're taking in the warm, moist air as the sun gleams overhead on a crystal clear day. The sound of the waves gently lapping the sand sends you into a sleepy trance. Suddenly, you feel something fleetingly touch your foot. Curious, you sit up from your trance only to see a robotic critter making its way around your



*Graduate student  
Jason Brown observes  
bipedal climbing  
robot "Bob"  
at CISCOR*

feet to continue on a path through the golden beach sand. You see a pile of rocks in its path, but does it go around the pile? No, instead it climbs over the rocks to casually stroll on its merry way.

Your new beach friend is one of the various robots created by researchers at CISCOR, the Center for Intelligent Systems, Control, and Robotics. A FAMU-FSU College of Engineering associated center, CISCOR is a hub for producing robots that mimic animal movement, speed, and agility. Researchers at the center focus on creating legged robots with the ability to move through various environments—like the robot making its way through beach sand—and use artificial intelligence to change their gaits and trajectories based on the demands of the environment.

“Legs give humans and animals a biological structure that is able to effectively handle complex terrains,” explains Emmanuel Collins, CISCOR Director and John H. Seely Professor of Mechanical Engineering. Collins, who was named “Black Engineer of the Year” in 2015 continues, “It is even more difficult to endow a robot with the ability to move through these environments.”

Jonathan Clark, Associate Director of CISCOR and

Associate Professor of Mechanical Engineering at FAMU-FSU College of Engineering, takes up the challenge. Clark designs the physical structure of a robot by using simplified models of robot dynamics in order to guide the design process.

“Taking cues from how geckos and insects rapidly scale vertical surfaces, CISCOR has developed the world’s fastest legged climbing robots. Our current work includes adjusting climbing gaits for various surfaces and developing machines that can both run and climb,” Clark explains.

Clark was awarded an NSF Early Career Development Grant of \$402,804 for his research in 2014. The funding has allowed for the expansion of novel research which has led to publications in top robotics journals, including a paper on the first robot that can both run across the ground and up a vertical wall.

Whereas Clark focuses on designing and modeling the mechanics of biologically inspired robots, Collins’ research answers questions of how a given robot can intelligently move through a complex environment. In discussing the collaborative nature of their work Collins notes, “If the robot is legged, its mobility intelligence must take into account the gaits developed by Clark’s research.”

The interplay of research teams headed by Clark and Collins produces robots that move effectively in complex environments. The research endeavors at CISCOR have earned a ranking of 11th place among robotics graduate programs in the nation according to GradSchoolHub.com.

## Focus: Helping the impaired musculoskeletal system

CISCOR’s research has opened doors toward the study of the human musculoskeletal system and the potential for robotic devices to be used to aid people with compromised systems

“The creation of bipedal dynamic climbing robots has led to exciting advances in, and new tools for, quantifying disturbance rejection for walking and running systems. CISCOR now plans to hire bio-mechanics faculty and collaborate with the medical school to use these technologies to help guide and inform studies of humans with mobility challenges,” explains Dr. Jonathan Clark.

Associate Professor of Chemical and Biomedical Engineering Jingjiao Guan, a collaborator, explains that the goals of this research include “developing devices for enhancing the ability of older people to perform physical exercise, innovative workout equipment designed for the elderly, and new instruments able to provide the benefits of physical exercise to older people.”

FSU Colleges of Medicine, Arts and Sciences, and Human Sciences, and the FAMU College of Pharmacy will collaborate with engineering faculty on the initiative.

### Researchers:

- Jonathan Clark
- Emmanuel Collins
- Rodney Roberts

contact: [clarkj@eng.famu.fsu.edu](mailto:clarkj@eng.famu.fsu.edu)

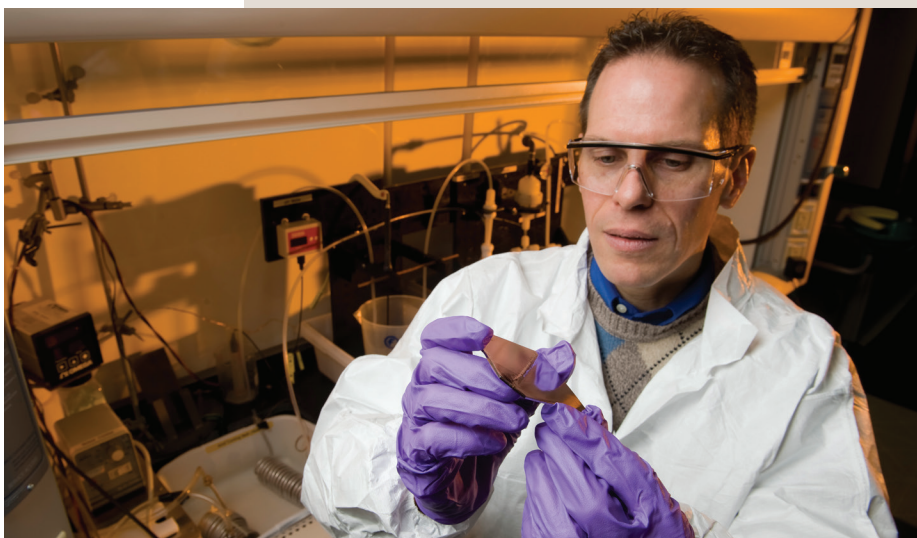
### Fermilab scientist joins research effort in Applied Superconductivity

FAMU-FSU College of Engineering is adding another eminent scientist to its ranks by hiring an accomplished expert in the field of applied superconductivity.

Lance Cooley, who worked as a scientist at the Fermi National Accelerator

“We are very excited to have Lance join the faculty here and add to the already stellar lineup of scientists who are working at the Applied Superconductivity Center at the NHMFL,” said FSU Vice President for Research Gary K. Ostrander. “He will be an

“Our students . . . will no doubt benefit from his expertise and scientific ingenuity in the area of superconducting magnets.”



Laboratory (Fermilab), recently joined the Applied Superconductivity Center (ASC) at the FSU-based National High Magnetic Field Laboratory. He also holds a faculty appointment in the Department of Mechanical Engineering at the Florida A&M University-Florida State University College of Engineering.

asset to our students who will no doubt benefit from his expertise and scientific ingenuity in the area of superconducting magnets.”

Cooley began working in superconducting materials as a graduate student at University of Wisconsin (UW) under the direction of David Larbalestier, who is now director of the NHMFL’s

Applied Superconductivity Center. He received his doctoral degree from UW in 1993 and has held positions at the National Institute of Standards and Technology, the University of Wisconsin and Brookhaven National Lab.

At Fermilab, Cooley headed a leading national program on superconducting radio frequency accelerators. His interests extend to the application of superconductivity in rotating machinery.

“I’ve been working with David and many other researchers at the NHMFL for much of my career,” Cooley said, “and I am looking forward to continuing our collaboration.”

### \$1.8 million Army grant earned for capacitor development

FAMU-FSU College of Engineering professor Jim Zheng landed a \$1.8 million grant from the U.S. Army to develop an internal hybrid battery/capacitor power system — a safer, easier and lighter power source for soldiers.

It's the next big step in an invention the army is already using. Soldiers had been troubled by lithium batteries in their radios that overheated, so Zheng invented a lithium ion capacitor that was a safer option.

"After they switched to our capacitor, it worked very well," Zheng continues, "We are helping reduce the weight soldiers carry so that they can be more mobile."

Zheng has 18 patents, five of which are licensed for commercial use, and is the Sprint Eminent Scholar Chair and Professor in the FAMU-FSU Department of Electrical and Computer Engineering.

The hybrid idea is more than 20 years in the making. Zheng joined the army's research lab in Fort Monmouth, New Jersey, in 1993. He came to FSU four years later with the hopes of creating a less expensive version of the capacitors he made for missiles.

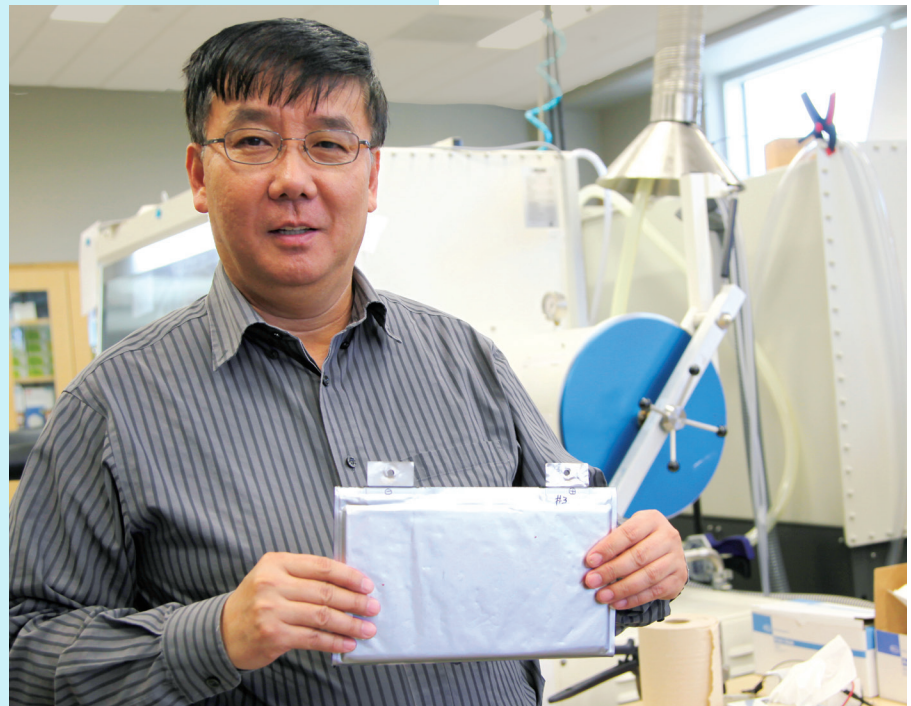
General Capacitors, located on Hamilton Park Drive across from Tallahassee Community College, was created as a result

of Zheng's invention. With 15 employees, the company has more than doubled in size in the last two and half years.

"Companies like General Capacitor are leading the way to rewriting our economic story here in Tallahassee," said Jay Revell, vice president for the Tallahassee Chamber of Commerce.

"We believe that research grants and similar opportunities that invest in the technology being developed here are a huge step in the right direction for diversifying our local economy."

Jim Zheng has 18 patents, five of which are licensed for commercial use. He's the Sprint Eminent Scholar Chair and Professor in the FAMU-FSU Department of Electrical and Computer Engineering.



### No-insulation technique leads to magnetic field record of 40.2 tesla

In 2016 the National High Magnetic Field Laboratory reported a new record for the creation of a magnetic field, a

provided Hahn and his team an advantage due to the absence of insulation which frees a magnet's electrical current to find a path with the least electrical resistance. In turn, the current avoids "quench," — a part of the path where superconductivity is lost. Insulated magnets lack this benefit because of a current's defined spiral path. Therefore, the absence of insulation provides a way for the current to protect itself and avoid quench.

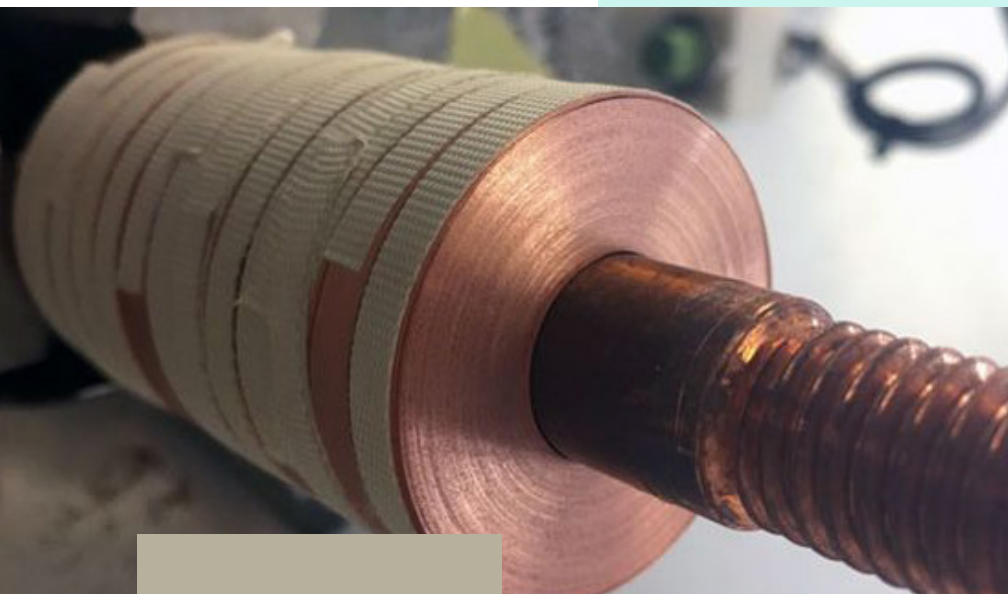
The origin of the no-insulation technology hails from Dr. Hahn's 2010 research at MIT. On finding the method that allows an increase in current, he explains, "When I invented this at MIT, the primary goal was to enhance the mechanical robustness of an HTS insert coil which was to be installed in a background magnet to complete a 30.5 tesla NMR [Nuclear Magnetic Resonance] magnet. Then, we identified the important 'self-protecting' feature from which we realized that we could build a really compact magnet."

Given the protective ability of the no-insulation REBCO magnet, the path was paved for much more electrical current when powered together with the NHMFL's resistive magnet, and thus resulted in the new record for magnetic field power.

record of 40.2 tesla. Leading the effort that set the new record was Seungyong Hahn, an associate professor in the FAMU-FSU Department of Mechanical Engineering. Hahn and fellow researchers combined the powers of a new HTS (high temperature superconductor) magnet wound with rare earth barium copper oxide (REBCO) conductors manufactured by SuperPower Inc., and a resistive magnet of 31 teslas to achieve the new 40.2 tesla record.

The NHMFL's No-Insulation HTS magnet technology

Leading the effort that set the new record was Seungyong Hahn, an associate professor in the FAMU-FSU Department of Mechanical Engineering.



### Discovery of new crystal structure holds promise for optoelectronic devices

A research team at the FAMU-FSU College of Engineering has discovered a new crystal structure of organic-inorganic hybrid materials that could open the door to new applications for optoelectronic devices like light-emitting diodes and lasers.

Associate Professor Biwu Ma, in the Department of Chemical and Biomedical Engineering, has been working with a class of crystalline materials called organometal halide perovskites for the past few years as a way to build highly functioning optoelectronic devices. In this most recent work, his team assembled organic and inorganic components to make a one-dimensional structure.

“The basic building block of this class of materials is the same, like a Lego® piece, with which you can assemble different structures,” Ma said.

These Lego®-like pieces, scientifically called metal

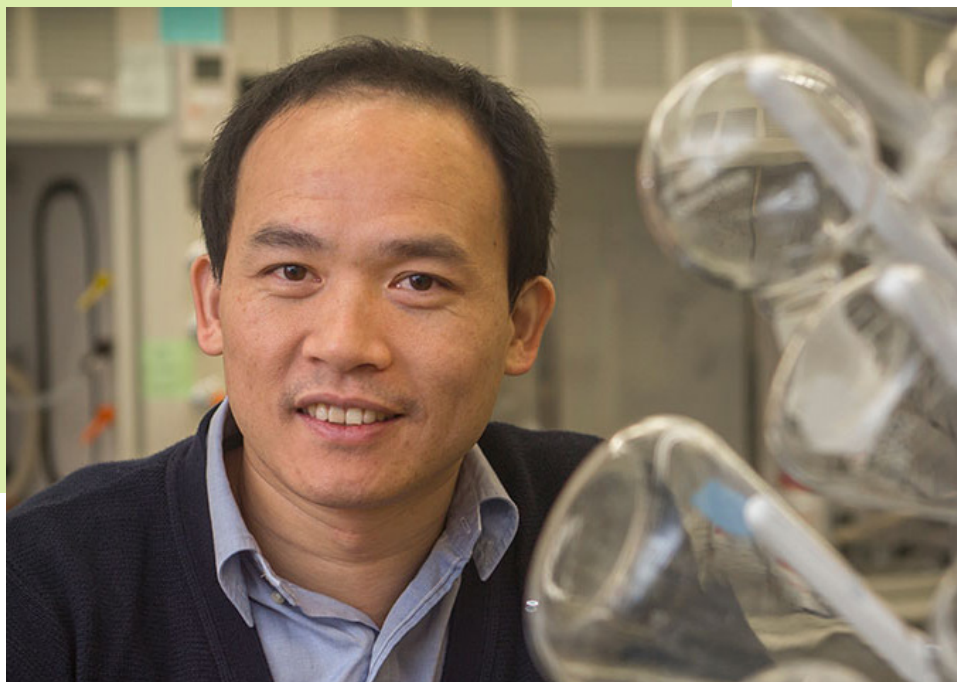
halide octahedra, can form 3D networks, 2D layers, or even 1D chains. While 3D and 2D structures have been extensively explored, 1D structures are rare. Ma’s team found a way to put these pieces together in a chain, which is surrounded by organic pieces to form a core-shell type wire. Millions of the organic-coated wires then stack together to form a crystalline bundle. From a distance these structures look like crystal needles.

It is the first time scientists have observed these hybrid materials forming a crystal structure like this.

This crystal displays very interesting optical properties, Ma said. For example, it is highly photo luminescent, which scientists can manipulate moving forward as they use it for different technologies.

“They are good light emitters,” Ma said. “This research tells us we have the capabilities to develop new structures and these materials have great opportunities for practical applications in devices like LEDs or lasers.”

The research was published in the journal *Nature Communications*.



### Students in FAMU-FSU College of Engineering win statewide Hackathon competition



Two students in the FAMU-FSU College of Engineering, Tucker Russ and Maxwell Brecher, are on a roll with their innovative business Safebriight.

Russ and Brecher won their second business competition this year - and another grand prize of \$10,000 - in Orlando at the MuniMod Hackathon hosted by the Florida League of Cities and business incubator

Domi Station.

FAMU-FSU College of Engineering Dean J. Murray Gibson praised the students for embracing and pursuing entrepreneurship. "We love to see our engineers learning how to design solutions to problems and as entrepreneurs, they learn how to bring these solutions to market," Gibson said. "It's a great synergy between business and STEM, which the Jim Moran School of Entrepreneurship and FSU's entrepreneur-in-residence program fosters. We're proud of Tucker and his team."

### RISEing opportunity for engineering students

A \$1M NSF grant awarded to FAMU-FSU College of Engineering faculty Tarik Dickens and Hui Wang (Department of Industrial and Manufacturing Engineering) and Carl Moore (Department of Mechanical Engineering) will provide new research opportunities for students in advanced manufacturing utilizing biomimetic robotics. The HBCU- Research Infrastructure for Science and Engineering (RISE) award is the first awarded to

FAMU, and one of only two ever awarded in Florida.

The program involves high performance additive manufacturing ("3-D printing on steroids") of composite structures via reconfigurable cyber-physical robotic systems. "The question we are trying to answer is what will 21st century manufacturing look like? Our cutting-edge research will help our students gain the skills needed for commercial and defense careers of the future,"

remarked Dickens. The High Performance Materials Institute will host the new capabilities.

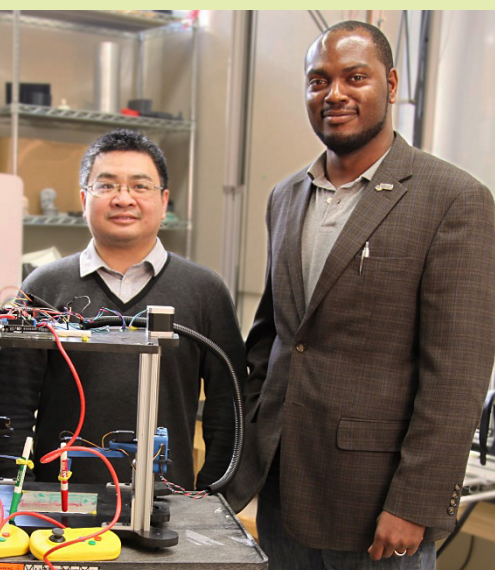
NSF RISE is a research infrastructure award targeted at building innovative research opportunities for graduate students. Dickens also plans to partner with the local school system to develop a summer training program.





MuniMod attracted students from across Florida in a variety of fields, including electrical engineering, public administration and computer science. The event, described as the largest civic tech competition in the Southeast, challenged teams of students from 10 universities to brainstorm solutions for tough problems confronting cities.

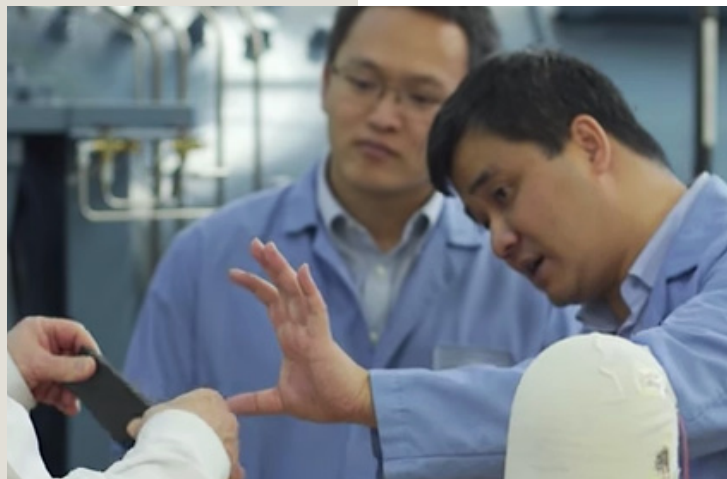
Safebright also earned the grand prize at the 2016-2017 InNOLEvation® competition.



*(Left-right) Carl Moore, Hui Wang, and Tarik Dickens*

## Auxetic foam stimulating economic growth

FAMU-FSU  
College of  
Engineering  
Department of  
Industrial and  
Manufacturing  
Engineering  
associate professor  
Changchun Zeng's  
research into a new  
high performance  
auxetic foam  
is resulting in  
improved health  
and wellness.



Zeng earned a \$4 million two-year grant from the Department of Veterans Affairs, which he has used to develop next-generation, high-tech foam that can be used to make a more functional and comfortable prosthetic sock for amputees. The foam expands outward when stretched, getting thicker rather than thinner.

“We are excited by the life-changing advances we expect to see because of our research,” said Richard Liang, FAMU-FSU Industrial and Manufacturing Engineering Professor and Director of the High-Performance Materials Institute. “In this case, we expect Zeng’s auxetic foam to benefit amputees and athletes; both professional and weekend athletes.”

A report from the university research advocacy group, The Science Coalition, has identified Zeng’s commercialized research among 102 federally funded research projects that initiated economic growth.

In 2015 Auxadyne was founded for the purpose of commercializing the patent pending auxetic polyurethane foam technology.

# Aero-Propulsion, Mechatronics and Energy Center (AME)

*Prof. Chiang Shih, Director*



The Aero-Propulsion, Mechatronics and Energy Center (AME) at Florida State University encompasses three major themes:

### Energy

At AME we are focused on advanced battery technology, fuel cell research, and high temperature sensing for combustion applications. Advances in lithium-ion based capacitors that exhibit high energy density and fatigue resistance to charging cycles is one major research emphasis. The utilization of carbon nanotubes and nanofibers in various forms is also under development to design high performance fuel cells. Manufacturing optical based pressure sensing is also under development for applications at temperatures exceeding 1000 degrees Celsius.

Several AME faculty members have received external recognition: Dr. Jim Zheng was named to the prestigious 2015 National Academy of Inventors Fellows and Dr. Sam

Taira earned his second Young Investigator Award. Our graduate students have also received national awards: Theodore Worden received the Navy SMART Fellowship, and Yiyang Sun and Puja Upadhyay received the Amelia Earhart Fellowship. Two recent graduates, Dr. Erik Fernandez and Dr. Phil Kreth have accepted faculty positions.

AME faculty have also been successful in attracting new research grants and generated more than \$5.2 M with an average of more than \$430K per faculty in the previous year. One example is the research by Dr. Jim Zheng to create hybrid power systems for the U.S. Army. (See page 21.)

Beyond traditional federally-funded research programs, AME faculty have also successfully pursued industry sponsored programs. Dr. Farrukh Alvi and his colleagues have developed a microjet flow control system and applied the novel technique in engine exhaust emission control

(supported by Cummins, Inc.) and active flow control of a magnetic-levitating compressor system (supported by Danfoss-Turbocor).

The center has many outreach activities including the NSF-sponsored Research for Undergraduates (REU) program which engaged 60 undergraduate students for the past five years into advanced research with more than 40% of the REU alumni pursuing doctoral degrees after their undergraduate career.

### Aero-Propulsion

For information on the Florida Center for Advanced Aero-Propulsion (FCAAP), see page 31.

### Mechatronics

For information on the Center for Intelligent Systems, Control, and Robotics (CISCOR), please see page 30.

## Applied Superconductivity Center (ASC)

*Prof. David Larbalestier, Director*

The Applied Superconductivity Center (ASC) advances the science and technology of superconductivity and particularly superconductivity applications. We do this by investigating low temperature and high temperature materials through our research grants and through our collaborations with other universities, national laboratories and industry.

### Research Areas

- BSCCO (Bi-2212)
- Coated Conductors
- Grain Boundaries
- Low-Temperature Superconductors
- MgB<sub>2</sub>

### Facilities & Capabilities

- **Crystallography**  
The ASC has a Philips XRD system (PW1830/40) that provides routine X-Ray Powder Diffraction.
- **Dual Beam Focused Ion Beam/Field Emission Scanning Electron Microscope**  
The Zeiss 1540EsB is a multi-technique dual beam (electron and Ga ion) field emission Scanning Electron Microscope (SEM) with a spatial resolution for imaging of 1 nanometer (0.8 nm STEM).
- **Electromagnetic Testing Facility**
- **Low Temperature Laser Scanning Microscope**  
This technique allows us to visualize the voltage change



responses on local heating from a low power diode laser at constant bias current at temperatures 3.7 K – 300 K with magnetic fields up to 5 tesla.

- **Magneto-Optic Imaging Facility**  
Magneto-optical imaging allows us to image and measure the local uniformity of current flow or magnetization in fields up to 0.15 T and temperatures down to ~6 K using the Faraday effect, by applying an in-plane magnetized Bi-YIG imaging film to the sample surface and imaging using polarized light microscopy.
- **Mechanical Processing and Heat Treatment Lab**

- **Metallography and Imaging Lab**

A metallographic preparation laboratory allows preparation of complex structures with minimal polishing artifacts from initial diamond saw sectioning to final vibratory polishing.

- **Scanning Laser Confocal Microscope**

SLCM, Olympus OLS 3100, is a high resolution light microscope with a 10 nm depth resolution and 0.12  $\mu\text{m}$  spatial resolution.

- **TEM Sample Polishing Lab**  
provides high precision tripod polishing for TEM samples and BCP and EP polishing for SRF samples. High resolution TEM facilities are available in the NHMFL.

- **Thin Film Deposition Capabilities**

Complex and high quality single and multilayer structures can be grown using our Pulsed Laser Deposition Facility (Lambda Physik LPX<sup>®</sup> 210i, KrF excimer laser) with dielectric rare mirror for 248 nm a Neocera deposition chamber, and 6 targets.

### Image Gallery

What do superconducting materials look like up close? Follow this link to check out the library of 2-D and 3-D images and animations:

<https://nationalmaglab.org/magnet-development/applied-superconductivity-center/asc-image-gallery>

# Center for Accessibility and Safety for an Aging Population (ASAP)

*Prof. John Sobanjo, Director*

The Center for Accessibility and Safety for an Aging Population (ASAP) is supported by researchers from disciplines including civil engineering, urban planning, geography, psychology, and health care management.

Established as a Tier 1 University Transportation Center and funded at \$4.2 million by the U.S. Department of Transportation, the center addresses two of the department's strategic goals: improving highway safety; and strengthening transportation planning. Motivated in part by Florida's large number of senior residents, the center focuses on four interdisciplinary areas:

- accessibility and community connectivity among older adults;
- human factors affecting the older population, especially regarding acceptance of emerging technologies;
- geometric design research, especially regarding elder crash mitigation; and
- health, wellness and safety of seniors as it relates to multi-modal transportation and emergency operations.

Providing seniors with safe and convenient access to the goods and services they need to participate fully in society is a key issue explored by the center.

Current research projects include safety investigation



of elder drivers and pedestrians at roundabouts, multi-modal emergency transportation operations with a focus on an aging population, and improving cutaway bus safety for aging passengers. Current collaborators and partners include FSU's Pepper Institute on Aging and Public Policy and the Institute for Successful Longevity.

### Center Themes and Focus Areas

#### Improving highway safety

- Safety assessments and decision-making tools
- Innovative operational improvements and designs of roadway and roadside features

- Safety measures for vulnerable road users, including bicyclists and pedestrians
- Human factors studies

#### Strengthening transportation planning and environmental decision-making

- Creation of models and tools for evaluating transportation measures and transportation system designs, including the costs and benefits
- Transportation and economic development planning in rural areas and small communities

#### Ongoing Projects

<http://utc.fsu.edu/Cycle2/Ongoing-Projects.html>

### Center for Advanced Power Systems (CAPS)

*Prof. Roger McGinnis, Director*



The Center for Advanced Power Systems (CAPS) is a multidisciplinary research center focused on electric power systems modeling and simulation, power electronics and machines, control systems, thermal management, cyber-security for power systems, high temperature superconductor characterization, and electrical insulation research.

With support from the U.S. Navy, Office of Naval Research (ONR), the Naval Sea Systems Command, and the U.S. Department of Energy, CAPS has established unique research, test and demonstration facilities with one of the largest real-time digital power systems simulators along with 5 MW AC and DC test beds with advanced hardware in the loop capabilities.

CAPS is dedicated to creating a Systems Driven Strategy focused on system level issues of power

distribution, control, advanced technologies, performance and needs of tightly coupled power components typical of advanced power systems.

CAPS concentrates on power system R&D in:

- advanced controls,
- performance,
- power and energy density improvements,
- thermal management,
- high temperature superconductivity advancement,
- power semiconductors - control, performance, and
- new control technologies.

Development of new technologies should take place in the broadest possible context such as “dual use” product development.

Many of the issues surrounding electric power network reliability, robustness, and controllability are common to the military, industry, and utilities. We exploit these commonalities to accelerate the development and deployment of new power technologies.

#### **The CAPS Program Approach**

- Develop an advanced modeling and simulation capability
- Provide the experimental capability needed to validate models
- Support the technology base-through selected system driven basic research in devices, components, and control
- Provide excellent hands on experience for both undergraduate and graduate level students
- Focus on the system level issues of new and emerging electric power system concepts

# Center for Intelligent Systems, Control, and Robotics (CISCOR)

*Prof. Emmanuel Collins, Director*

The Center for Intelligent Systems, Control, and Robotics (CISCOR), provides a cooperative approach for conducting interdisciplinary research in the automated systems area. The Center's goal is to provide a means for the state of Florida to achieve national recognition in automated systems with application in such areas as robotics, process optimization, aerospace control, image processing, power systems, and structural control. With major collaboration from defense agencies, the Center focuses on the development and implementation of automated systems technology for transfer to entities capable of sustaining Florida's economic growth for both private enterprise and government sectors.

### Our Vision

The vision of CISCOR is to use state-of-the-art technology to develop practical solutions to challenges in systems, control and robotics for applications in industry and government.

CISCOR employs a cooperative approach for conducting interdisciplinary research in the automated systems area across two departments, Mechanical Engineering and Electrical and Computer Engineering, in the FAMU-FSU College of Engineering and the FSU Departments of Scientific Computing and Computer Science, which works with the affiliated labs: STRIDe Laboratory, Florida Center for Advanced Aero-Propulsion (FCAAP), and the Computer

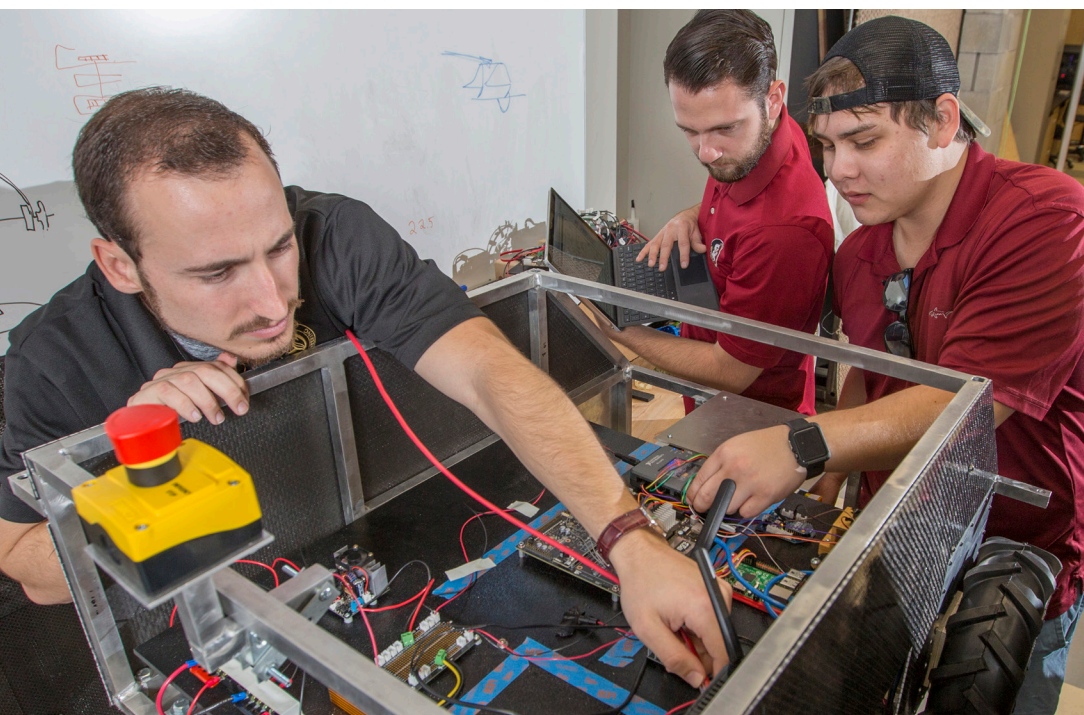
Vision Lab at FSU. Established in 2003, CISCOR has become a leading center in Florida for the development and implementation of technologies related to Intelligent Systems, Control, and Robotics.

### Overview

CISCOR is dedicated to world class research in its three overlapping areas of emphasis: Intelligence, Control, and Robotics. No center can perform research in all areas related to its specializations, instead it must carefully choose to make contributions that fit the background and aspirations of its key researchers. CISCOR works in:

- applied optimization,
- bio-inspired robot design,
- compliant mechanisms,
- haptics,
- intelligence for robot motion planning,
- machine intelligence,
- manufacturing process,
- control and optimization,
- mechatronic design,
- model predictive control,
- pattern recognition,
- robot cooperation,
- robot modeling and control, and
- robot teleoperation.

Read more at: [www.ciscor.org](http://www.ciscor.org)



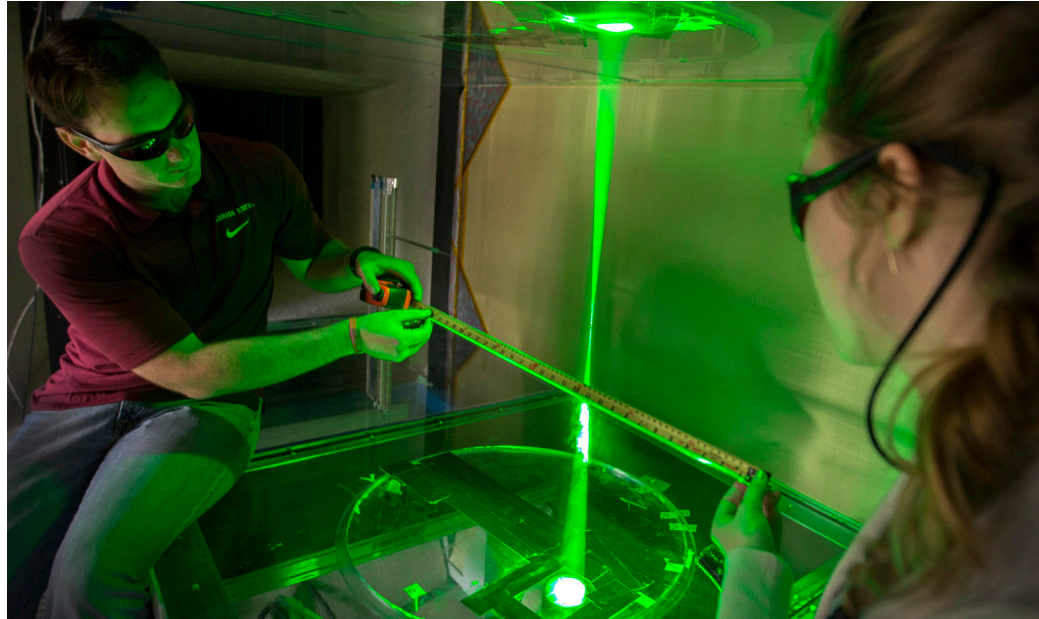
### Florida Center for Advanced Aero-Propulsion (FCAAP)

*Prof. Louis Cattafesta, Director*

The Florida Center for Advanced Aero-Propulsion was established as a Center of Excellence (COE) in 2008 by the Florida Board of Governors and is a partnership between Florida State University (lead institution), the University of Florida, the University of Central Florida, and Embry-Riddle University. Since its inception, it has fostered a multi-institutional, state-wide collaboration to establish a sustainable, collaborative center that builds upon and greatly expands the state's strength in Aerospace, Aviation, Commercial Space Transportation and related areas.

Research at FCAAP focuses on the following primary areas:

- thermo-fluid dynamics and aerodynamics with emphasis on active flow control and aeroacoustics in fundamental problems and applications;
- nonlinear mechanics and multiscale functional materials, including computational modeling, design, and characterization of photo-electro-mechanical actuator and sensor systems;
- high fidelity multiphysics simulations, including computational fluid dynamics, multiscale fluid-structure, land-atmosphere interactions, and energy sustainability;
- advanced methods, including non-intrusive optical diagnostics, uncertainty estimation, sparse network models, modal analysis, and reduced-order modeling; and



- autonomous systems and control, including robotics and feedback control.

The center occupies 7600 ft<sup>2</sup> of laboratory space in the new 55,000 ft<sup>2</sup> AME Building located in Innovation Park next to the FAMU-FSU College of Engineering. It has 10 affiliated engineering faculty members, 11 postdoctoral researchers, 32 Ph.D. students, 11 M.S. students and numerous undergraduate students.

#### **The FCAAP Facilities and Capabilities**

- Polysonic Wind Tunnel (Mach 0.2 to Mach 5 blowdown wind tunnel in 12" x 12" test section, Reynolds number of 5-30 x 10<sup>6</sup>/ft)

- Subsonic Wind Tunnel Facility (30" by 30" wind tunnel up to 180 mph)
- Short Take-Off and Vertical Landing (STOVL) Jet Facility (up to Mach 2.2 and 1000 °F)
- Heated Anechoic Jet Facility (up to Mach 2.6 ideally expanded w/ 2.8" diameter jet, 2200 °F, 300 Hz cutoff)
- Aeroacoustic Flow Facility (up to 170 mph in an open-jet, closed-wall, or Kevlar wall wind tunnel inside a 200 Hz anechoic chamber)
- Sensor and Actuator Labs (with a variety of non-intrusive, multiscale optical flow and electromechanical diagnostics)

# High-Performance Materials Institute (HPMI)

*Prof. Richard Liang, Director*



The High-Performance Materials Institute (HPMI) focuses on four technology areas:

- high-performance composite and nanomaterials,
- structural health monitoring,
- multifunctional nanomaterials and scalable sensors,
- additive manufacturing and process modeling.

HPMI is a multidisciplinary research institute and hosts 16 affiliated faculty, 40 Ph.D. students amongst over 70 student researchers. HPMI has proven several technology concepts that can potentially narrow the gap between fundamental research and practical applications, such as scale-up manufacturing of nanotube membranes or buckypaper, and unique auxetic foams for medical and sports applications.

HPMI established Florida's first NSF Industry/University Cooperative Research Center

(I/UCRC). In 2006, the Florida Board of Governors designated HPMI as a Center of Excellence in Advanced Materials R&D and technology transfer.

HPMI's \$21M 45,000 square foot Materials Research Building, houses over 70 state-of-the-art instruments with a value more than \$12M; especially designed for research in composites, nanomaterials and additive manufacturing. The capabilities include:

- comprehensive composite manufacturing,
- nanomaterial synthesis and dispersion,
- additive/3D printing manufacturing facilities for both structure and electronics,
- a full spectrum of thermal and spectroscopic analysis, and
- a 5000 square foot high-bay lab for scale-up manufacturing demonstrations.

HPMI currently hosts 15 NSF projects, including SNM, RISE and REU programs, and multiple DoD projects. HPMI also hosts two newly awarded multi-million dollar projects from Lockheed Martin for affordable composite technology, and the first Space Technology Research Institute (STRI) sponsored by NASA for nanotube composites manufacturing. (See page 16.)

HPMI enjoys great student successes. During 2016-17, more than 25 students won various doctoral fellowships, scholarships and student awards, including Adelaide Wilson, Cytec Solvay, McKnight Doctoral Fellowships; Zonta Amelia Earhart Fellowship; P.E.O. International Peace and DoD Smart scholarships. The team contributed 40-50 high-impact journal papers and 5-10 U.S. patent awards each year.

Detailed HPMI information can be found at:

<http://hpmi.research.fsu.edu>.



## National High Magnetic Field Laboratory (NHMFL)

*Prof. Greg Boebinger, Director*

The only facility of its kind in the United States, the National High Magnetic Field Laboratory (NHMFL) is the largest and highest-powered magnet laboratory in the world. Every year, more than a thousand scientists from dozens of countries come to use the unique magnets with the support of highly experienced staff scientists and technicians. Thanks to funding from the National Science Foundation and the State of Florida, these researchers use the facilities for free, probing fundamental questions about materials, energy and life. Their findings result in more than 400 scientific publications a year in peer-reviewed journals such as *Nature*, *Science* and *Physical Review Letters*. The NHMFL's primary facility is located just a few hundred yards from the FAMU-FSU College of Engineering, and several of our faculty are deeply engaged either in developing new capabilities for the user community, or taking advantage of this unique facility in our backyard.

For example, the Applied Superconductivity Center, described on page 27, is led by our faculty member, David Larbalestier, together with his colleagues: Eric Hellstrom, Lance Cooley,

Seunyong Hahn and Fumitake Kametani, of the FAMU-FSU College of Engineering Department of Mechanical Engineering. They are developing state-of-the-art high temperature superconductors that have been used to produce, for example, the world-record magnetic field. Professor Cooley

among other applications. And Dr. Samuel Grant, in the FAMU-FSU Department of Chemical and Biomedical Engineering, is a leading figure in the application of high-field magnets in biological uses of Magnetic Resonance Imaging and Spectroscopy.



and Professor Sastry Pamidi from the FAMU-FSU Department of Electrical and Computer Engineering are also examining the future use of high-temperature superconductors in rotating machinery as part of the Center for Advanced Power Systems,

Read more about the NHMFL and its facilities, which are open to general users from around the world, at [www.nationalmaglab.org/](http://www.nationalmaglab.org/)

# Department Chairs



## Teng Ma

**Chemical & Biomedical**

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Ph.D., Chemical Engineering,  
The Ohio State University, 1999

### Research Interests

Cell and tissue engineering  
Biomaterials



## Lisa Spainhour, P.E.

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Ph.D., Civil Engineering,  
North Carolina State University, 1994

### Research Interests

Traffic safety  
Aging and transportation



## Simon Y. Foo

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Ph.D., Electrical & Computer Engineering,  
University of South Carolina, 1988

### Research Interests

Computational intelligence  
High efficiency solar cells  
Machine intelligence



## Okenwa Okoli

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Ph.D., Manufacturing Engineering,  
University of Warwick, 1997

### Research Interests

Multiscale composites  
Structural health monitoring techniques  
Energy harvesting



## Emmanuel G. Collins

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Ph.D., Aeronautics and Astronautics,  
Purdue University, 1987

### Research Interests

Model predictive control  
Robot planning

## Engineering Degree Programs

Biomedical	MS	Ph.D.	
Chemical	BS	MS	Ph.D.
Civil	BS	MS	Ph.D.
Computer	BS		
Electrical	BS	MS	Ph.D.
Industrial	BS	MS	Ph.D.
Mechanical	BS	MS	Ph.D.

[www.eng.famu.fsu.edu/prospective/degree\\_programs.html](http://www.eng.famu.fsu.edu/prospective/degree_programs.html)

**All undergraduate degree programs are accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>**

**Thank you** to the chairs, center directors, faculty and their staff for their cooperation in producing this book.

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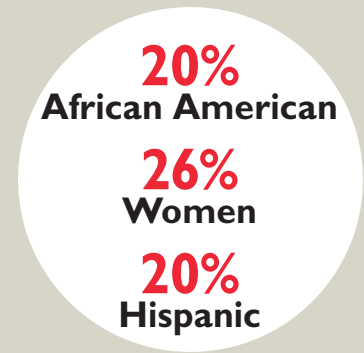
**Photographers:** Trisha Radulovich, Laurie Herring, Garit Poire, Michael Haimowitz with Michael Arrow Photography, Jonas Gustavson, Fermilab, FSU photographers, and the researchers whose work is shown.



## Enrollment



## Undergraduates



## Associate Deans Assistant Dean



### Reginald Perry

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Ph.D., Electrical Engineering,  
Georgia Institute of Technology, 1989

#### Research Interests

Engineering education  
Embedded systems



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Ph.D., Mechanical Engineering,  
Pennsylvania State University-  
University Park, 1992

#### Research Interests

Experimental gas dynamics  
Aerodynamics & propulsion  
Microfluidics and optical diagnostics



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Ed.S, Higher Education,  
Florida State University



# FAMU-FSU College of Engineering



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<https://www.Instagram.com/FAMUFSUCOE>



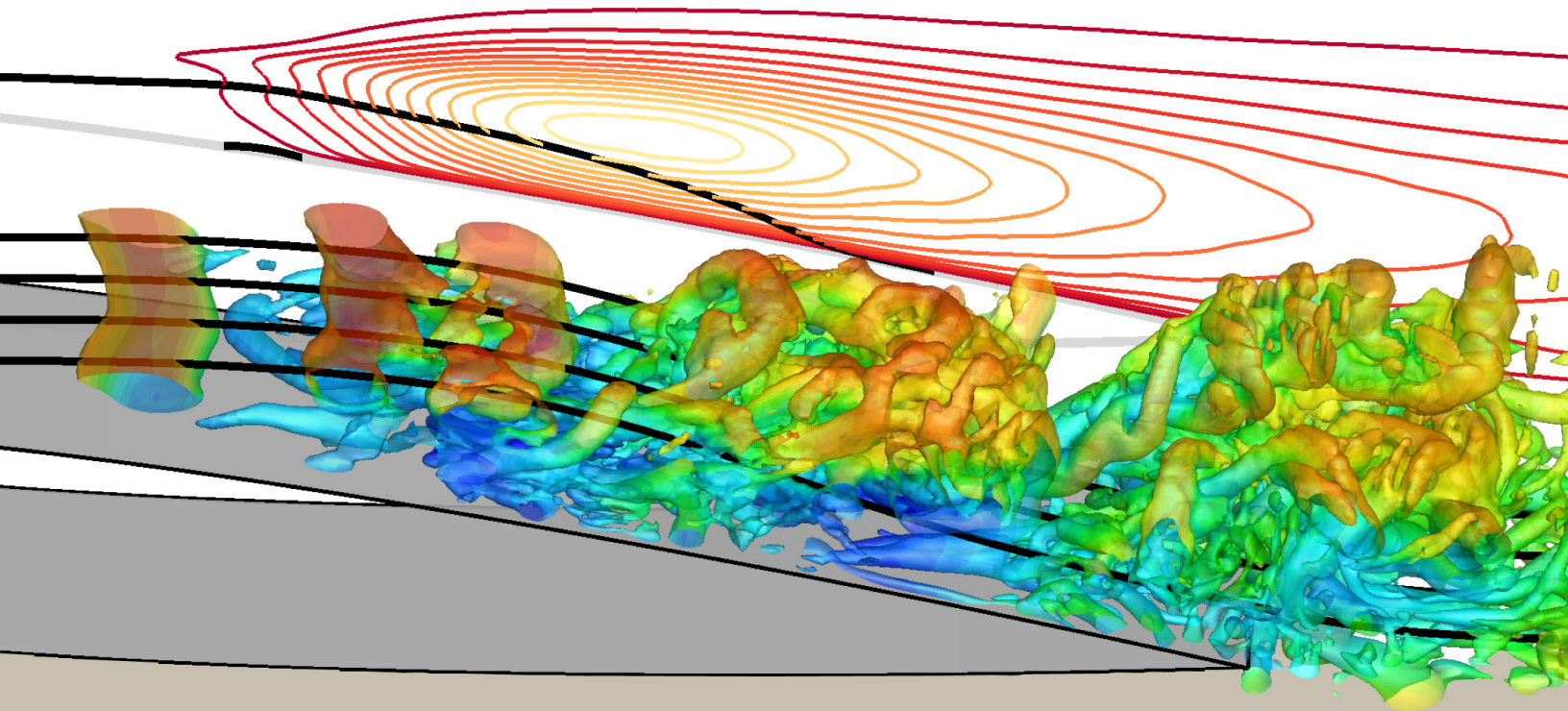
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<https://www.youtube.com/FAMUFSUCOE>



<http://eng.famu.fsu.edu>



## **Florida A&M University- Florida State University College of Engineering**

offers excellent research opportunities through its affiliated research facilities. At the Florida Center for Advanced Aero-Propulsion, graduate student Chi-An Yeh and Associate Professor Kunihiko Taira, FAMU-FSU Department of Mechanical Engineering, are analyzing complex dynamics of turbulent flows and control techniques to alleviate stall. The cover image shows a large-eddy simulation of turbulent separated flow over a NACA0012 airfoil – a section of a simplified aircraft wing. See stories on pages 8-9 and page 31 inside.