Exemplifying industrial engineering through manufacturing

Department of INDUSTRIAL & MANUFACTURING ENGINEERING

FAMU-FSU Engineering

Exemplifying industrial engineering through manufacturing
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MESSAGE FROM THE CHAIR

Okenwa Okoli, Ph.D.
Chair and Professor, Industrial & Manufacturing Engineering

In a time when our current and future behaviors will be gilded by how best we handle a pandemic, we are grateful and proud of the accomplishments of our dedicated team. These outstanding staff, teaching and research-intensive tenure-track faculty share a common goal of student success and readying them for the labor force. Indeed, a number of our faculty have given their time in service and research to proffering solutions for our community and healthcare workers.

Established in 1986, our industrial and manufacturing engineering (IME) department is the youngest of five in the FAMU-FSU College of Engineering. The college of Engineering was established in 1982 as the only partnership between a Historically Black College and University (HBCU) and a Research I predominantly white institution (PWI). With obvious advantages, we have successfully educated students in the nurturing environment of one of the nation’s most prominent HBCUs (FAMU), with the infrastructure and focus of a Research I university (FSU), recognized as one of Florida’s two preeminent research universities.

The IME department is structured to engage industry in practical research endeavors. We lean strongly on using core industrial engineering principles to address manufacturing issues. We created a strong and unique presence in the research and manufacture of advanced engineered materials, while at the same time continuing to focus on the optimization and modeling of processes and systems. Many of our faculty are leaders in the High-Performance Materials Institute (HPMI), which provides our graduates a strong advantage with their unique training founded on the interdisciplinary nature of our program; a program which gives greater opportunity for diverse learning and research.

The IME department seeks to provide a globally competitive environment for our students, enabling world-class learning through our curricular and extracurricular activities. Our BSIE curriculum is entwined with experiential learning such that all our students—from their first year through their tenure—are encouraged to engage in funded research opportunities and projects. These opportunities are year-round, with particular emphasis on our REU programs funded through the NSF and AFRL. IME manufacturing research is based out of the 45,000 sq. ft Materials Research Building, which houses more than $20M state-of-the-art equipment for the characterization and manufacture of advanced materials, structural composites and additive manufacturing.

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When a motorist has a fender bender, he sees the obvious damage, goes to an auto body shop where workers knock out the dent, paint it over and it’s fixed.

When a child tries to break a green tree branch, she’ll bend it back and forth. It will take time for it to break, yet it eventually does – each fiber in that tree branch gives it strength—there lies the power of composite materials.

But unless a composite structure (for instance, a tree branch, bridge, wind turbine blades or airplane component) is broken into pieces, or has sustained damage visible to the naked eye, it is difficult to determine if any damage has been suffered from a child, hurricane, lightning, or even a bird strike.

Dr. Okenwa Okoli, Chair and professor of industrial and manufacturing Engineering at the FAMU-FSU College of Engineering, is working on a way to change that in manmade structures and save lives. Okoli has a focused interest in developing sensors and structural health monitoring systems for
Okenwa Okoli has a focused interest in developing sensors and structural health monitoring systems for advanced structural composites.
advanced structural composites.

“When there is a low velocity impact on an object, you may not notice it. So my work is creating a central nervous system,” he explained. “When something strikes a structure, say for instance a bird strikes an airplane, you first want to know that a bird has struck the plane and then whether it has caused any damage. We have designed materials that will start to glow when the bird has struck.”

If the strike is hard enough to make the composite materials of the structure break, “then you will have a bright flash of light.”

With development of the ITOF sensor, Okoli’s research group used triboluminescent crystals to develop a first-of-its-kind, self-powered sensor. Those crystals are what releases the flash of light on cracking, fracture or impact.

After the sensor, the focus pivoted into researching and developing semi-conducting materials that would form a self-powered damage sensor. The photovoltaic research led the group into the successful creation of wire-shaped carbon-based dye-sensitized solar cells, wire-shaped perovskite photodetectors, flexible perovskite solar cells and perovskite/TL sensors.

“So we have sensors that glow when stressed and then a structure that senses and converts the light emissions to useable data,” Okoli said. “Now, the pilot will know the criticality of the damage…..with Go/No Go information on whether or not to keep flying the plane.”

Okoli said he first grew interested in the idea in his early years at FAMU-FSU Engineering.

“I read a paper about composites that glow,” he remembers. “I thought, we can save lives. Understanding failure in engineered composite structures can be difficult, especially where measuring techniques work by determining if there is a change in dimension of the contact surface. These are mostly localized, and not distributed. To measure internal subsurface damage, we have to think differently.”

Although his method would allow new warning systems, it would have to be built into new buildings or airplanes or even windmills – any composite structure that needs to be monitored. And Okoli said that final realization of his dream is probably “long range.”

Recently, his group did some promising work geared towards the wind energy industry. Especially when located offshore, he pointed out, windmills are difficult to get to and would be much easier to monitor for bird strikes and environmental damage if they were equipped with his sensor program, especially since it generates its own power and is dormant until needed.
IME Ph.D. student Sean Jackson working with the custom designed nScrypt 3DN 300 printer built with a U.S. Army equipment grant. Jackson is one of the first CREST students in the IME program, receiving the AAAS/ERN student competition award in 2019.

More to Know: New custom-designed and built 3D printer expands engineering innovation at the microscopic scale

It sounds like science fiction, but engineering researchers are working on microscale 3D-printed devices that can be manufactured directly onto fabrics, films and other flexible materials—transforming our idea of “wearable devices” forever.

The grant will not only enable new research at the college, but it dovetails with other federally-funded grant work currently underway at the college. For instance, the CREST CoManD center is funded by NSF. The program Co-PIs are Tarik Dickens and PI S. Ramamkrishnan. The work is unique becase it is a combination of high-precision 3D printing and lasering for applications in rGO circuitry, creating continuous reinforcement. This will be the third installment of such a machine creating a nano-advanced manufacturing center.”

Other members of the team will use the new printer in different, but equally intriguing ways. Okenwa Okoli and Richard Liang, both professors of industrial and manufacturing engineering will work on graphene-based sensors and electrode assemblies, and develop nanoparticle-based embedded electronic devices.

Source: https://www.eng.famu.fsu.edu/news/US-Army-3Dprinter-grant
“When we can communicate with each other, we can build something of value. I call it a data challenge.”

—Hui Wang
Helping people and artificial intelligence (AI) better use and exchange information and data to improve products, respond faster to emergencies and even help people walk without pain is the goal of Hui Wang’s work at the FAMU-FSU College of Engineering.

Wang, an associate professor of industrial and manufacturing engineering, develops scientific methodologies and enabling technologies to improve engineering system performance, focusing especially on cloud data fusion to support AI in Internet-of-Things applications.

“When I first started my training as a graduate student, I wanted to look at how to use analytics and model simulation to understand how to improve efficiency, improve service and provide high quality products,” Wang said of his dream to make machines worker smarter and learn faster by gleaning information from each other. “Today we have this information exchange, this shared data, this cloud. How can we use what wasn’t there before to improve systems? We call this cloud analytics.

“You have all kinds of data stored online in an interconnective environment. When we can communicate with each other, we can build something of value. I call it a data challenge.”

Wang and his research team are putting the idea into practice by working with a local orthopedic clinic on developing correction insoles for patients with chronic gait problem and pain. Currently, doctors eyeball how the patient walks and may have to go through “lots of trial and error” before finding a final fit.

“What kind of analytics can be used, instead of having the patient coming in again and again?”

“Think of the cloud data. If we can collect patient data from across the world and find similarities, finding those with similar gaits, we can build data for our patient with confidence,” he explained.

His research has also explored using multi-dimensional data from sensors worn by patients to establish a faster and more accurate way of determining a prescription for a prosthetic or orthotic – improving clinical efficiency and potentially reducing cost.

The collection and sharing of data between machines is also essential to help improve the manufacturing
In a crisis, like the current COVID-19 coronavirus epidemic, even something as simple as a face mask can suddenly become a hot commodity. In the wake of a disaster, supplies can run out and getting time-sensitive medicines to people in need could mean life and death for someone from an affected area.

Two researchers at the FAMU-FSU College of Engineering hope a new concept called “factory-in-a-box” may provide a solution for disruption in the supply chain that occurs in a disaster.

The idea is to bring a fully functional mobile factory to the people directly affected by a disaster. Once the need is met, the factory can be packed up and moved to another location. The logistics of this involves many moving parts, from setting up the facility, to providing raw material, to finding suppliers. Timing is everything according to Hui Wang, an associate professor of industrial engineering at the college.
Continued from page 6

process and improve the reaction of communities to emergencies such as hurricanes and earthquakes, Wang said. “When an engineering system fails...how do you train AI to forecast when something will go wrong?” he asked. “How do we borrow knowledge from other systems and contribute to our system’s lack of data? We need to collect information from older factories and try to build more reliable systems.”

The objective is to find a way to integrate multi-disciplinary data and engineering knowledge to improve a machine’s learning accuracy.

For instance, Wang points out that a lack of maintenance records in some cities means there is no detection of faulty events in their electrical grid. His research seeks to improve the detection of problems for communities lacking that historical information, helping those areas prepare in advance for future power outages that occur with events such as hurricanes and earthquakes.

“We want to learn what will be the most impacted, but we have to collect a sufficient amount of data to validate. Usually, these data are not limited. In that case, how do you prepare the community for a hurricane when it is two days out?” he asked. “I’m focused on the AI engineering system’s behavior in emergencies, like with traffic and power systems failure, so it can help local officials make decisions in advance of the storm or any disaster when historical information is limited.”

*Internet of Things: the networking capability that allows information to be sent to and received from objects and devices (such as fixtures and kitchen appliances) using the Internet. (Source: Merriam-Webster)*

“Factory-in-a-box is an emerging concept for flexible manufacturing,” says Wang. “A traditional factory is in a fixed location but now we can take the factory to the customer on-site. This concept is particularly suitable for the production under emergent scenarios that have a requirement of material freshness or on-site production for a certain period. It might be used in vaccine manufacturing in response to a spatial disease outbreak or on the battlefield. Or it can be deployed in a logistic base to produce consumable parts for the military. There are many uses.”

Wang is the principal investigator for a $300,000 National Science Foundation (NSF)-funded research project developing analytical tools for decision-making in supply chain network design and assembly planning for factory-in-a-box manufacturing. The NSF Excellence in Research (EiR) grant provides funding for operations engineering research and includes an educational component for undergraduate research. Additional funding of $16,000 per year goes to support undergraduate research.

Wang’s three-person team includes Maxim Dulebenets, Ph.D., an assistant professor of civil and environmental engineering at the college, and Weihong Guo, Ph.D., an assistant professor of industrial and systems engineering at the Rutgers School of Engineering.
Zhibin Yu foresees a future where individuals will be empowered to take more responsibility for their health by wearing a monitor that looks like a tattoo.
WEARABLE HEALTH CARE

Zhibin Yu, Ph.D.

Polymer matrix composites are already a popular part of daily life because of their light weight, mechanical strength and ease of manufacturing. But Yu and his research group are working on ways to make them more attractive for public and military use, which includes reducing costs. His research is being financially supported by the Air Force Office of Scientific Research, the National Science Foundation, and the Florida State University Office of Commercialization.

Using composites allows properties to be made more flexible and enables electronic and optical devices to be made stretchable, helping them to mimic biologic tissues and brain nervous systems that are soft in nature. Highly flexible devices that can be worn to track human physiological signals, including temperature, hydration, blood pressure, tissue oxygenation and glucose concentration.

“Right now, a lot of this can be done only in the hospital,” Yu said. “But you could wear those devices the whole day without going to the hospital. This would be a paradigm shift from where we are to where we need to go.”

He said the material used would be something along the lines of rubber or Scotch tape, but “would have to feel like human skin.” And he suggested there might also be a Scotch tape-sized LED read-out panel of the sensors’ recordings a user could wear.

Using this type of material, Yu has already developed a prototype solution for diabetics who need to go to the hospital to have light therapy on the soles of their feet. Applied to the bottom of the foot, it provides light from an LED panel 24 hours a day, seven days a week and keeps the patient out of the hospital.

While the health project is likely of most interest to the public, Yu said the military is focused on his work...
using low cost, lightweight composite sensors for homeland security purposes—to detect nuclear materials that may be smuggled across the border.

“We have such a very long border and we can’t stop people from coming in,” Yu said. “Twenty pounds of material can make a nuclear bomb, and you can always hide it somewhere. It could be hidden in an airplane’s hold or a ship’s container. It’s hard to ensure 100 percent that you can catch them all. But we have some technology available for that.”

While humans cannot feel or detect nuclear materials, sensors made with composites could easily find them.

“Nuclear materials that make atomic bombs are unstable. They release gamma rays. We need something that knows where the gamma rays come from so we can stop that dirty material from entering the country,” he said. “We need more sensors. These are easy to make and make them very large. And by using a composite—cost won’t be an issue anymore.”

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**More to Know: GAP awards help propel College of Engineering research from lab to market**

One of four GAP award winners, **Zhibin Yu**, an associate professor in the college’s Department of Industrial & Manufacturing Engineering, used recent advances in single-layer and highly flexible LEDs to develop affordable, lightweight and ultrathin phototherapeutic products.

Yu’s stretchable light source will be able to stick to human skin like a tattoo or bandage, enabling the application of phototherapeutic treatment for skin conditions like jaundice, psoriasis and acne without the need for large and cumbersome light-emitting apparatuses. —Zachary Boehm, FSU News
“This is a collaborative effort including different departments and different colleges,” says Wang. “Dr. Guo brings her expertise in systems engineering and statistics to the project. I am involved with the manufacturing side of it, how we design and optimize the “factory-in-a-box” system and Dr. Dulebenets is involved with the transportation side, getting the goods to a location.”

Dulebenets says that the “factory-in-a-box” concept has been used by several companies over the years but says there is a lack of methods to effectively address problems associated with it.

“What we plan to do is to develop algorithms and theories to assist stakeholders in planning their “factory-in-a-box” operations,” says Dulebenets. “We are developing a supply chain optimization plan that determines the appropriate sequence of visiting suppliers, manufacturers and we are looking at how delivery delays affect our end customer.”

Undergraduate and graduate researchers are a big part of the project. Graduate students will be taking the lead and will be exploring manufacturing design and supply, vehicle routing and resilience issues. Undergraduate students will be performing simulations and working with doctoral students to evaluate their research.

“One research area our graduate students will be working will be to develop an optimization model for vehicle routing issues,” says Dulebenets. “Dr. Wang and I are planning to connect undergraduate students with graduate students so they can share their knowledge. We hope to introduce the undergraduate students to basic optimizations concepts so they can learn how to apply this to solving real-life challenging problems.”

Research from this project could help build a framework for supply chain network design and provide valuable insight into the logistics of materials delivery and planning.
Yanshuo Sun is working to show that people in urban environments can be moved faster and more efficiently.
Using mathematical models and optimization methods, Yanshuo Sun is working to show that people in urban environments can be moved faster and more efficiently – resulting in less city traffic, lower emissions and reduced transportation costs for governments around the world.

His ideas include a new low-cost approach to ride-sharing and a revamping of dial-a-ride programs that turn them into a more responsive Uber-like experience that will be particularly useful for the disabled and older adults who are unable to drive. An assistant professor of industrial and manufacturing engineering in the FAMU-FSU College of Engineering, Sun specializes in large-scale optimization theories and applications. He is especially interested in multi-modal transportation systems, having finished several state and federal research projects that include ridesharing programs for the poor and transportation accessibility for the aging.

“My overall research objective is to narrow the gap between the research community and the practitioners’ world...in order to improve the planning, operations and management of transportation systems,” he said. His interests include public transportation, freight transportation, airports, transportation economics and transportation data analytics.

Three ongoing projects include: “Enhancing Transportation Accessibility for Aging Population through Mobile Computing and Service Optimization,” sponsored by the Institute for Successful Longevity; “An Incentive Mechanism to Enable Flexible Peer-to-Peer Ridesharing,” sponsored by the Florida State University Council on Research and Creativity; and “Florida Index for Transportation: A System of Systems Approach to Understanding the Changing Nature of Transportation,” sponsored by the Florida Department of Transportation.

The peer-to-peer program “holds great promise for those living in neighborhoods without good transit coverage,” Sun said. “But it’s quite challenging mathematically.” The program would require drivers to send their availability and riders to send their requests for transportation to a ride-sharing platform that would then
determine which riders go with which vehicle—and then determine what is the best route for the vehicle to take.

“Peer drivers would be people who would only be making a small detour along the route they were planning to drive. Costs could be shared with riders, but drivers would not be making any profit from it,” Sun explained. The goal would be to provide transportation for those in need and take cars off the road through a better data-driven ride-sharing program.

The elderly and disabled accessibility project is designed to help those who now depend on a transportation program where they must reserve space a day or more in advance to get van rides to services they need, such as doctor visits. Sun’s plan would set up a program where they could summon a ride like an Uber and no longer have to schedule their ride perhaps days ahead.

“If they want services, some people have to wait a significant amount of time before they can get a ride. They have to call and tell where they want to go and then wait until a ride is available,” he said. He envisions vans being constantly out on the road, responding to calls and available in a relatively short time.

“I’m trying to reduce the time gap by developing an app so that we can provide service in real time” by the van closest to the person taking the call and providing the ride, Sun said. “We would see the level of service be significantly improved and better utilize our resources.”

His other major projects involve: working with China to analyze online booking data to understand passenger preferences—do they want faster, cheaper or more comfortable trains—which will help when decisions are being made on adding new services; and working with the Florida Department of Transportation (FDOT) on emerging trends, including the impact of external factors, such as population growth, natural disasters and changing demographics.

“We’ll collect the data and see if there need to be changes,” Sun said of the FDOT project. “There may
Researchers at Florida State University are digging deeper into the various impacts of COVID-19 in our society. The campus grounds are empty, but students and staff are still making a difference.

Florida State University Research is distributing $400,000 to fund 27 research projects related to the pandemic.

“There’s a lot of pieces to this,” said Gary Ostrander, Ph.D., Vice President of Research. “There’s the biomedical side when you’re talking about vaccines, and there’s the treatment side. But there’s also the affects on businesses, there’s the socio-economic on communities, and then there’s a significant personal impact of COVID.”

Dr. Yanshuo Sun, an assistant professor of industrial manufacturing engineering at FAMU-FSU College of Engineering, is helping lead a project looking at how COVID impacts hurricane evacuation and how people might respond.

It’s a collaboration with Tingting Zhao with the Department of Geography, Minna Jia with FSU Survey Foundry and Tian Tang with the Askew School of Public Administration.

According to their research by Colorado State University, Sun says this season is expected to bring more, and stronger storms. This project will help emergency management agencies be prepared.

“If they do go to the public shelters, can they maintain social distancing, or if they are transported by public transit vehicles, how could those authorities keep the occupancies of those vehicles relatively low so that people are not going to be affected,” Sun said.

The group is sending out a survey asking about evacuation concerns, like financial constraints or public health worries, like following social distancing or stay at home orders.

That information will then go to emergency management so they can better understand how the community will respond.

“Those government agencies can know what kind of factors are constraining people, so that they can do something, they can modify this matter. That way we can see some improvement,” Sun said.

FSU Research says this funding will also help teams attract national and federal funding, giving them a “leg up” when applications for funding projects go out later this year.

Dr. Sun says they will be sending out 3,000 questionnaires at the end of the month. They will be distributed online and by mail to people in the Big Bend, Jacksonville and Tampa.

The university is fast tracking these projects, putting a 90-day deadline to get results.

—Emma Wheeler, Tallahassee, Fla., WCTV
IME STUDENTS TAKE SAMPE TOP HONORS

FAMU-FSU College of Engineering, Department of Industrial & Manufacturing Engineering students from the High-Performance Materials Institute (HPMI) consistently take top honors for their research at the SAMPE university research symposiums. The SAMPE symposium is an event where student members have the opportunity to present the results of their technical research at a major conference. The event offers awards for senior undergraduates, masters and doctoral candidates.

Over the past eight years, FAMU-FSU Engineering students from IME have won awards at the SAMPE University Research Symposium at different levels. In fact, Dr. Rebekah Sweat, now an IME assistant professor, won first place as a master’s student in 2013.

The best presentations in each student category receive cash prizes, while winners in the Ph.D. category are further sponsored to present at SAMPE conferences in Europe and Japan. In 2019, Marquese Pollard won first place for his research at the master’s level. Pollard was the first FAMU-RISE student to win such an award according to Dr. Tarik Dickens, associate professor of industrial and manufacturing engineering. As an NSF RISE MS graduate student, Pollard’s prize-winning work was funded by the Research Infrastructure for Science and Engineering (RISE) grant. Abiodun Oluwalowo won second place...
for his work at the Ph.D. level. Oluwalowo is a pursuing his doctorate through FAMU.

At the virtual 2020 SAMPE conference, IME student Lucas Braga Carani won first place at the MS level, while Yourri-Samuel Dessureault and Mayowa T. Akintola were awarded third place and honorable mention respectively in the Ph.D. level.

FAMU-FSU IME 2019 Winners

**PH.D. CATEGORY**
Abiodun Oluwalowo - Second place, “Electrical and thermal conductivity improvement of carbon nanotube and silver metal matrix composites.”


**M.S. CATEGORY**
Marquese Pollard - First place, “Porosity Evaluation of Additive Manufactured Tooling for Intelligent Composite Fabrication.”

**B.S. CATEGORY**
Stefan Spiric - First place, “Carbon Nanotube Composite Cutting.”

FAMU-FSU IME 2020 Winners

**PH.D. CATEGORY**
Yourri-Samuel Dessureault - Third place (tie), “Microstructures and Engineering Properties of High-Strength Continuous Carbon Nanotube Yarns.”

Mayowa T. Akintola - Honorable Mention, “Additive Manufacturing of Functional Polymer-Based Composite with Enhanced Mecholuminescence (ZnS:Mn)”

**M.S. CATEGORY**
Lucas Braga Carani - First Place, “Investigation of Single Crystal Perovskite for Mechanoluminescence-Based Sensor Applications”

Members of the SAMPE Bridge team sorting fiber tows before lining up uni-directional carbon fiber mats. FAMU-FSU Chapter of SAMPE—https://sampefsufamu.wixsite.com/sampe
Abiodun Oluwalowo is a Florida A&M University graduate student and HPMI researcher.

FAMU-FSU College of Engineering industrial and manufacturing engineering Ph.D. candidate and High-Performance Materials Institute (HPMI) research assistant Abiodun Oluwalowo has racked up several accolades since the first of the year. Oluwalowo is a Florida A&M University student at the college.

As lead author, his article “Electrical and thermal conductivity improvement of carbon nanotube and silver composites” was published in the May edition of the highly cited journal Carbon. In fact that was not the only article he had published in Carbon. In the April edition, he was a contributing author for the article “Carbon nanotube/carbon composite fiber with improved strength and electrical conductivity via interface engineering,” in which another Ph.D. candidate from the same college department, Songlin Zhang, was lead author.

In addition, Abiodun is a vital member of the HPMI team making up the NASA Space Technology Research Institute, which is conducting research to make materials lighter and stronger for deep space travel. In May, he traveled to the University of Utah in Salt Lake City, to update NASA officials on his work in the thermal characterization of materials being researched.
Researchers from the High-Performance Materials Institute, FAMU-FSU College of Engineering have developed and investigated a new technique for 3D printing that could produce much stronger materials that could be used in a variety of engineering applications.

In a paper published in the journal *Additive Manufacturing*, Madhuparna Roy (a Spring 2020 Florida State University Ph.D. graduate from the college) and advising professor Tarik Dickens, Ph.D. showed the possibility of using magnetic fields near a 3D printer to change the alignment of fibers inside an object as it was being printed—a term Dickens calls ‘magneto-assisted printing.’ This tweak in the mechanical properties of the material could greatly improve its overall quality and strength.

“3D-printed materials are not strong on their own because they’re just plastic layers sitting on top of each other,” said Roy, the paper’s lead author. “The gap in the research world is to improve mechanical properties. With improved mechanical properties, you could create solutions for any kind of application, depending on what that particular application requires.”

3D printing is a relatively new manufacturing technology. It has grown significantly because of the availability of different types of printing and different materials that can be used with the technology. A wide variety of items

*Continued on next page*
are already being 3D-printed, including musical instruments, houses, medical equipment and parts needed in manufacturing.

Because the technique is still so new though, researchers are still finding ways to improve the process.

3D printing sometimes adds fibers made from various materials to the plastic or other substances used in printing, a technique that can improve the strength of the finished piece. When those fibers come out of a nozzle, they are oriented parallel to the direction of the flow from that nozzle. But by applying a magnetic field near the printer, the researchers were able to create objects with fibers oriented perpendicularly to the nozzle’s flow.

The alignment of fibers inside an object can give it certain properties that scientists or engineers might find useful. For example, a printed object with the fibers oriented in certain alignments could be structurally stronger than one made normally. Or engineers might want a 3D-printed part that is well-suited for conducting electricity, which they could make by aligning conductive fibers inside a material.

Along with showing the possibility of this technique, the research also examined how different flow rates, magnetic field strength and the shapes of nozzles affected the ability to change the fiber alignment. A theoretical model developed by FSU assistant professor of scientific computing Bryan Quaife, was used to study the process regime of the assisted flow-geometry. The study found that the more viscous the printing substance, the stronger the required magnetic field for realigning the magnetic fibers. The experiments also seemed to show that as the material is moved through the nozzle faster, the less the interior fibers will be realigned—potentially improving the printability as a consequence.

This paper showed the possibility of using this technique for a material with low viscosity, so future investigations could study the process with a more viscous material that requires a stronger magnetic field to realign the interior fibers, Roy said. Mechanical tests of the finished 3D-printed product would also be helpful.

“There are still plenty of gaps that need to be addressed in terms of what materials can be used and what printers can be used in conjunction with them,” Roy said. “In this work, we’re talking about using plastics with metal particles in them. We’re combining the two major groups of 3D-printing materials to make a new material that gives you added functionality when it comes to making anything else.”

Co-authors of this study include FAMU-CREST postdoctoral researcher Phong Tran, Ph.D., and Bryan Quaife, Ph.D. FAMU-FSU College of Engineering Associate Professor Tarik Dickens is the corresponding author and principal investigator of the funded work.

—Bill Wellock, FSU Office of Research Communications & Publications

Researchers present findings during an NSF CREST visit.
HIGH-PERFROMANCE MATERIALS INSTITUTE

Members of the IME faculty and staff established and operate the High-Performance Materials Institute (HPMI). HPMI strives to recruit, develop and retain top quality faculty and staff who will develop HPMI into a center of excellence for innovation, research and education in the field of advanced materials, composites and nanomanufacturing. Currently, HPMI is involved in several technology areas: High-Performance Composites and Nanomaterials, Auxetic Foams and Structures, Structural Health Monitoring, Advanced Manufacturing, New LED and Solar Cell Materials, and Data Science-driven Materials Research and Manufacturing Process Modeling.

Over the last several years, HPMI has proven a number of technology concepts that have the potential to narrow the gap between fundamental research and practical applications. These technologies include auxetic foams, continuous alignment of nanotubes, roll-to-roll fabrication of nanotube membranes or buckypapers, multifunctional nanotube composites for mechanical properties, electrical conductivity, thermal management, radiation shielding and EMI attenuation, mechanoluminescent structure health monitoring and carbon nanomaterials for energy storage and sensor applications.

In 2007, the Florida Board of Governors designated HPMI as Florida Center of Excellence in Advanced Materials to provide leading materials and manufacturing innovation, research and working force training to support industrial and economic growth. In 2002, HPMI personnel also established Florida’s first National Science Foundation (NSF) Industry/University Cooperative Research Center (IUCRC).

HPMI has a comprehensive set of state-of-the-art materials processing, testing, characterization and computing facilities for nanomaterials research housed in the 43,000 square foot Materials Research Building.

In addition to conducting numerous projects sponsored by the National Science Foundation, over the years, HPMI has worked with most military research centers, including Air Force Research Labs, Air Force Office of Scientific Research, Army Research Lab and Office of Naval Research. HPMI has also worked with other industrial entities including Boeing, General Dynamics, Lockheed Martin, and Raytheon.

HPMI is currently a major participant in NASA’s first Space Technology Research Institute related to materials. The project is using nanotechnology to produce stronger and lighter materials for deep space exploration to Mars and beyond. The IME personnel associated with HPMI is partnering with Michigan Tech University, University of Utah, Massachusetts Institute of Technology, Johns Hopkins University, Georgia Institute of Technology, University of Minnesota, Penn State University, and the University of Colorado to make this objective a reality.
The department is actively involved in basic research, which expands the frontiers of knowledge, as well as applied research designed to solve both present and future technological needs of society. Research activities span a variety of disciplines related to industrial and manufacturing engineering and are largely conducted in cooperation with other research centers and their accompanying state-of-the-art research laboratories.

Research facilities: https://eng.famu.fsu.edu/ime/research/facilities
APPLIED OPTIMIZATION
Complex problems can often be solved by starting with a simple version of the problem. Applied optimization uses numerical continuation methods to solve numerical equations and numerical optimization problems by following paths containing approximate solutions, beginning with the solution of a simple version or problems, until an acceptable approximate solution is reached. For instance, applied optimization can be used to maximize production under resource constraints or to minimize resource usage under production schedule constraints.

Faculty: Samuel A. Awoniyi

DATA SCIENCE RESEARCH
The primary research interest of our data science research group is statistical machine learning. This group is particularly interested in modeling and analysis of unstructured data: image, video, function, shape, direction and text data. With many industrial and engineering applications, the group’s research is modeling time-lapsed unstructured data for understanding and controlling time-varying processes involving changes in unstructured data. Examples of IME data science research, supported by NSF, AFOSR and DOE, are listed below.

- Material image big data
- Human motion analysis
- Using Machine Learning & AI for autonomous research experimentation

Faculty: Chiwoo Park
MATERIALS RESEARCH

Advanced Materials for Energy and Power
The use of fuel cells and supercapacitors is expected to grow exponentially over the next few years. New energy generation and storage devices must be made more efficient. Optimizing the micro-/nano-structure of the electrodes used in these devices will make a major stride in improving efficiency.

Emerging Processing Techniques for Advanced Materials
Researchers at HPMI are exploring emerging processing techniques for composites and nanomaterials, such as developing and testing supercritical fluids (SCF) assisted process. SCF can be a cost effective tool for micro-/nano-structures control during materials processing.

Quality and Manufacturing Engineering for Advanced Composites Materials
Manufacturing of advanced materials such as composites and nanomaterials often involves multiple constituent materials and complex processing steps.

Faculty: Richard Liang, Okenwa Okoli, Hui Wang, Chiwoo Park, Jin Gyu Park, Chad Zeng, Mei Zhang, Tarik Dickens, Zhibin Yu and Rebekah Sweat

RISK ANALYSIS AND DECISION MAKING FOR ENGINEERING AND SOCIAL SYSTEMS

Applied statistics and process improvement techniques are finding more widespread applications as more data is becoming available at a higher rate and less cost in our everyday lives. The risk analysis and decision making research group focuses on utilizing advanced statistical modeling and estimation techniques for problems involving a large variety and volume of data. These new techniques will aid in making effective decisions in diverse fields ranging from manufacturing and engineering to health care, roadway safety and navigation. We have successfully tackled calibration and uncertainty quantification of predictive models for nanocomposite manufacturing, geospatial surveillance for disease outbreak detection, traffic crash surveillance for roadway safety, quantification of structural and socioeconomic losses under hurricanes and robust localization and navigation of autonomous vehicles.

Faculty: Arda Vanli
NSF SCHOLAR PROGRAMS
CREST/COMAND

The CREST CoMand focuses on the additive manufacturing of conventional and novel device structures. Specifically, the effort towards ab-initio fundamental understanding of material-property relationships that govern the working forces behind high-rate applications for bio, energy and production of light-weight structures. The three focused research areas are:

- Nanostructured lightweight magnetic materials for shielding/sensing applications
- Nanostructured materials for energy applications, and
- Nanostructured materials for biological application—such as a 3D Printed tumor Biosystem-on-a-Chip.

Faculty: Tarik J. Dickens, Subramanian Ramakrishnan, Mandip Sachdeva, Nelly Mateeva, Satyanarayan Dev, Daniel Hallinan and Komalavalli Thirunavukkarasu

OPPORTUNITIES FOR UNDERGRADUATES

The IME department is proud to have two decades of mentoring students through experiential learning. We offer students opportunities to engage in paid cutting-edge research activities from their freshman year to graduation, through our Research Scholars (RS) and Transformational Research Scholars (TRS) programs. Our TRS students are those with a GPA of a 2.7 who have at least two years to complete their BS degrees. The goal is to transform such students to be high achievers scholastically through our activities. Our students are exposed to and are trained on using state-of-art research and manufacturing equipment at the High-Performance Materials Institute.

Since 2009, we have offered summer research internships funded through the AFRL (DREAM), and the NSF (REU RETREAT, CREST-RISE) to students from across the United States.
Continued, Message from the Chair

Many undergraduate and graduate students have access to HPMI equipment.

Our graduate programs were created with an industry focus, while concentrating on cutting-edge novel technologies. Our MSIE offerings include a non-thesis concentration in Engineering Management and a Data Analytics track. We have recently launched a fast growing MS Systems Engineering program which integrates engineering disciplines with industrial and management practices. Students develop skills required in the national workforce for growing areas in the technology-driven global economy. Our SE faculty have broad experience in defense and industrial settings, making the program applicable to military and civilian engineering professionals. Our doctoral program continues to grow, producing significant numbers of graduates annually at Florida A&M and Florida State universities.

As we grapple with the effects of COVID-19, we are constantly reminded of the racial injustice perpetuated against People of Color. We all must have seen the several videos showing the extrajudicial killing of George Floyd, a black man who died after a white police officer pressed his knee on his neck until he stopped breathing, videos of Ahmaud Arbery, who was chased, shot and killed while jogging. We have also heard of Breonna Taylor, an EMT worker who was shot and killed in her Louisville, Kentucky home by police while sleeping. As FSU President Thrasher said, “It is everyone’s responsibility to stand up against abuse of power...”. In our College of Engineering community, there are many People of Color particularly African American students who may face racial injustice on a day-to-day basis. To address these issues at the FAMU-FSU College of Engineering, Dean Murray Gibson has started the #LetsStartHere initiative as an extensive and inclusive process to honestly identify any barriers—whether based on race, gender or other individual differences—that exist in the college, and to work on eliminating them. He acknowledges that the process will be challenging, uncomfortable and possibly painful at times as we work through difficult and divisive issues. The Let’s Start Here initiative at the college is a serious attempt to improve the environment at the college for all—students, faculty and staff.

Okenwa Okoli, Ph.D.
Chair and Professor
Department of Industrial & Manufacturing Engineering
NEW GRADUATE DEGREE PROGRAM TAKES OFF

From industries to defense, systems engineers are in high demand everywhere.

Graduating its first dozen students in May 2020, the Master of Science in Systems Engineering (MSSE) program is the fastest growing degree at the FAMU-FSU College of Engineering.

Teaming with Florida State University Panama City Campus and the Naval Surface Warfare Center Panama City Division (NSWC PCD), the industrial and manufacturing engineering department launched the new master’s degree program Fall 2018.

Tailored to meet the strong demand from the Department of Defense (DoD) and Industry for well-trained systems engineers, the MSSE program has been an immediate success, admitting over 60 students through Fall 2020.

A course-based, non-thesis degree with a curriculum specifically designed for working professionals, MSSE is offered in the classroom on both the Tallahassee and Panama City campuses and as an 100% online degree. The online option provides access to this preeminent program to students from all over the globe.

Program details can be found at: https://www.eng.famu.fsu.edu/msse

Student Tasneem Salman and classmates listen during the Master of Science System Engineering (MSSE) class at the FSU Panama City Campus in Panama City, Florida.

The MSSE program is led by Dr. Daniel Georgiadis, Director of Systems Engineering. Dr. Georgiadis has over 20 years’ experience as a practicing Systems Engineer working DoD programs specializing in naval systems, platform integration and test, requirements, risk analysis, and strategic decision making. In 2020, the program added a new faculty member, Dr. David Gross, with over 30 years’ experience as a practicing aerospace systems engineer specializing in systems architecture, modeling and simulation and human factors.
One college, two universities, unlimited opportunity.

Department of Industrial & Manufacturing Engineering