UNIVERSITY OF WISCONSIN–MADISON
COLLEGE OF ENGINEERING

SPRING 2022 NEWSLETTER

BIOMEDICAL ENGINEERING

GIVING STUDENTS THE TOOLS TO SUCCEED

New teaching lab expands opportunities

As we near the end of the academic year, I would like to reflect on the successes our BME department has had in the past year, despite the continuing challenges arising from the pandemic.

Many of our faculty received prestigious new grants this past year, both to their individual labs and also as part of a new National Institutes of Health-funded center in partnership with the University of Minnesota. More of our faculty were elected as fellows of the American Institute for Medical and Biological Engineering (AIMBE) professional society; the majority of our associate and full professors have now been recognized with this honor. Several of our faculty members also received awards from campus committees and the College of Engineering.

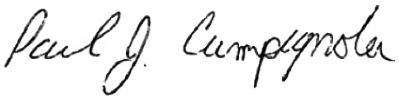
This year we established our department's inaugural industrial advisory board. The board has 10 members, most of whom are UW-Madison alums, and bring a diverse range of perspectives and life experiences. I have given the board the charge of helping to grow our bachelor's, master's and PhD programs, while providing guidance on updating the curriculum to meet the needs of employers. The board will also help with professional advancement of our graduates and encourage the expansion of commercialization efforts of research projects coming from our faculty members' labs.

In a strong sign that we are returning to some level of normalcy, we have been able to provide complete in-person instruction in both the fall and spring terms with no interruption. The impact of this has been significant for all of our classes, but perhaps the most for our undergraduate design sequence. I advise four senior design teams, and I cannot overstate how rewarding it has been for me to have weekly in-person team meetings as well as presentations and poster sessions. I believe our students are also happy to be back.

We continue expanding our efforts in inclusion, equity and diversity to ensure a welcoming environment for all. Importantly, the college has hired Chris Castro as its inaugural associate dean for inclusion, equity and diversity in engineering. We will work closely with Chris to advance our goals for increasing inclusion in the department, in the college, and across campus.

I hope you and your loved ones are well, and I thank you for your support of our department. Stay safe and ...

On, Wisconsin!



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Advisory board roster

Carl Gulbrandsen, Emeritus Managing Director - Wisconsin Alumni Research Foundation

Maneesh Arora, CEO - Elephas Bio

Steve Grundahl, Founder and President - Midwest Prototyping

Thomas "Rock" Mackie, Emeritus Professor, UW-Madison Department of Medical Physics

Fred Robertson, Consultant - Baird Capitol; former CEO - TomoTherapy and GE Marquette Medical Systems

Winslow Sargeant (PhDECE '95), Managing Director - S&T, LLC; Senior Vice President for Partnerships - International Council for Small Business

Karien Rodriguez (PhDBME '10), Research Technical Strategist-Life Sciences, Global Research & Engineering - Kimberly-Clark Corp.

Travelle (Franklin-Ford) Ellis (PhDBME'11), Health Equity Director - Exact Sciences

Marie Lotto (BSBME '02, MSBME '03), Senior Director, Strategy and Business Development - Hologic

Janet White, Board Member - BioForward; retired life sciences executive

New partnership links faculty with emerging companies

An innovative public-private collaboration between our college and growth capital firm WISC Partners will connect high-potential regional technology companies with our leading engineering experts.

In the process, the collaboration also will create a new avenue for funding that can supplement existing college revenue from traditional industry collaborations, federal grants and philanthropy.

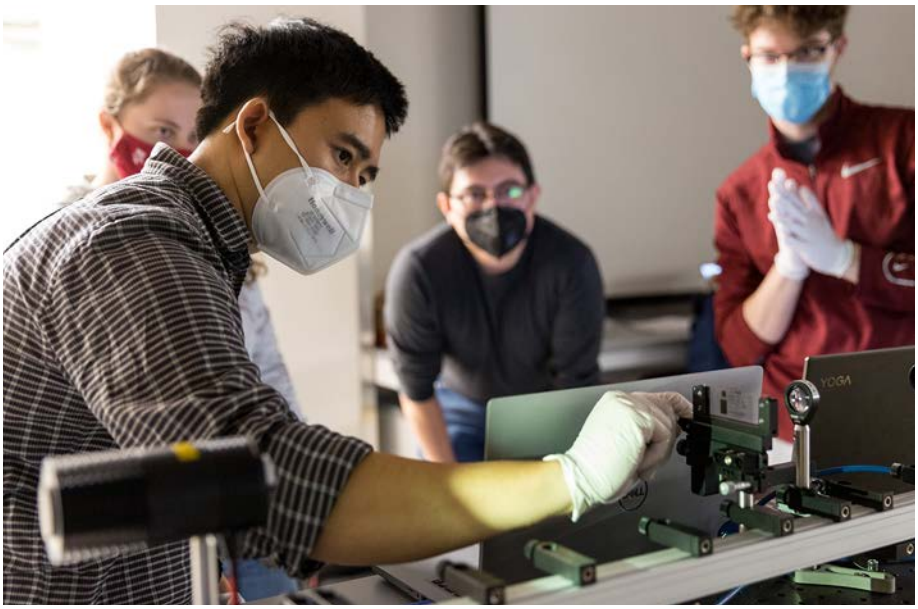
Based in Madison and Silicon Valley, WISC Partners provides strategic operating capital to promising entrepreneurs. Its founding partners, UW-Madison engineering alumnus and retired chairman of Applied Materials Mike Splinter and UW-Madison business alum and veteran entrepreneur David Guinther, are leveraging deep Silicon Valley experience and worldwide networks to play an active role in accelerating the growth and success of the companies in their portfolio.

For WISC Partners, one aspect of actively nurturing the growth of companies in its portfolio involves tapping the technical expertise and knowledge that UW-Madison engineering faculty offer across an array of disciplines. The engineering faculty provide these critical capabilities as service work and consultants, while not competing with research that might lead to future spin-outs of those activities.

The partnership includes a unique tiered funding model designed to return gains to the university as the WISC Partners ventures appreciate in value, similar to the way in which a venture capital firm's general partners might receive a return on their investment.

"Establishing strong industry partnerships is a strategic goal for our college, and our collaboration with WISC Partners creates an avenue for our faculty to contribute their expertise to enhance the success of emerging technology companies," says Ian Robertson, Grainger Dean of the College of Engineering. "Our faculty are innovators who fully embrace the Wisconsin Idea. They want to work more closely with industry. That involvement helps contribute to and accelerate the growth and success of promising companies, drives revenue for our college and provides our faculty valuable understanding of and experience in the entrepreneurial side of innovation."

New hands-on lab course shines light on optical principles



After learning fundamental theory and optical skills in our biophotonics lab, students like PhD candidate Wihan Adi can carry that knowledge into future classes and research experiences. Here, Adi adjusts his group's microscope system while (from left) PhD student Helen Wilson, teaching assistant and PhD student Samir Sanchez Rosas and master's student Zach Gahl look on. Photo: Tom Ziemer

Walk through any of the buildings on the College of Engineering campus and it won't take you long to come across a microscope in a research lab. The device is a workhorse across disparate scientific fields of study.

Yet all too often, student researchers merely learn the functional basics of using microscopes—enough to get by in the short term, but not an expansive command that would allow them to fine tune optical tools for new research questions down the road.

Filiz Yesilkoy

With that in mind, Assistant Professor Filiz Yesilkoy is teaching students from a range of scientific disciplines the ins and outs of microscopes and other optical tools in a new biophotonics lab course.

"The goal of this course is to give a hands-on opportunity for students to use fundamental optical tools, like cameras, light sources, lenses, polarizers," says Yesilkoy, who's leading the course in BME's new teaching lab in the Engineering Centers Building. "They are the fundamental components of a microscope, of any imaging system."

Students learn the foundational theory behind those components, then apply that knowledge while building tools like brightfield microscopes. They practice adjusting their microscope settings per the Kohler Illumination technique for optimal sample viewing. They evaluate different contrast methods across a range of microscopy methods. They use filters and spectrometers to measure and analyze light spectra. And they incorporate their new skills, all while examining biological samples.

Zach Gahl, a master's student, took a lecture-based course on optical theory with Yesilkoy during the fall 2021 semester. He's enjoying the transition from working out problems on paper to putting together pieces in the lab.

"This is an opportunity to work with the hardware and actually get to set up a lot of the systems that we learned about," says Gahl, who's pursuing BME's two-year, research-based master's program while working in the lab of Associate Professor Kevin Eliceiri. "Rather than having everything in our brain, we actually get to see it all play out in real life."

For the course, which was funded by a College of Engineering Education Innovation grant, Yesilkoy is using lab kits created by Thorlabs in partnership with optics instructors at the University of California, Berkeley. But she likens those kits to boxes of Legos whose pieces can be used to build new setups—some designed by students themselves—down the road. She already has plans to weave her research, which combines photonics, nanotechnology and biomedical science to develop novel biosensors, into the course in the future by asking students to investigate light's interaction with nanomaterials.

While her spring 2022 cohort skews heavily graduate student, Yesilkoy hopes to reach more undergrads in future semesters as the course moves from a special topics class to a regular offering.

Regardless of how the course evolves, though, Yesilkoy is committed to imparting fundamental optical lessons to students from a broad swath of scientific disciplines—biology, chemistry, all engineering fields and beyond—empowering them to return to their coursework and research labs with the knowledge and skills to adapt to future challenges.

"I don't care which department, which background you're coming from, you're going to learn microscopy taking my course," she says. "You will have the toolbox in your hands."

Co-op confirms undergrad's career plans

It's hard to say which was the bigger challenge for undergraduate student Gabrielle Ibrahim in 2021: navigating pandemic-enforced travel delays and restrictions to get to her cooperative education experience at Siemens Healthineers in Germany in the first place, or picking up a new programming language on the fly and learning the ins and outs of a range of medical devices upon arriving.

"It was definitely a little bit of a head spin," she says.

But Ibrahim persevered through each and every hurdle and emerged with new skills and emboldened confidence in both her intended career path and her ability to traverse it.

Ibrahim spent the second half of 2021 with the global medical device and technology company's Innovation Think Tank in the mechatronics products department, based in the small Bavarian town of Kemnath.

During her six-month co-op, she helped design new solutions to improve existing angiography and fluoroscopy imaging devices, visualized technological add-ons for a mammography device, and analyzed radiation leakage in X-ray collimators. In the process, she taught herself to program in the C# language for visualizing device designs in a simulation software and nailed a presentation for colleagues outside of her team.

"I realized what the real-life working world looks like. I learned so much," she says. "I've really gained so much just being here and working here."

And that's precisely the point of engineering co-ops: acquiring on-the-job experience, testing knowledge learned in coursework and rounding out a professional toolkit that includes both technical acumen and so-called soft skills. The college's co-op program allows employers to interview and hire as many students as they're interested in (provided the experiences they're offering mesh with academic outcomes). Students get paid plus earn academic credit.

Roughly 85% of undergraduates in the college's most recent graduating class completed at least one co-op or internship before earning their diplomas.

"Anytime we are talking to employers about wanting to increase their candidate pool or if they're really trying to establish credibility with students, we talk to them about co-op and how no one's a better ambassador than somebody who's just spent a good six to eight months working side by side with other engineers," says Stephanie Salazar Kann, an associate director in Engineering Career Services who oversees the college's co-op and internship program.

Ibrahim leveraged her experience working on device prototypes and interacting with project clients in BME's design course sequence while interviewing with Siemens Healthineers. And she says many of the skills she developed in BME Design—assessing needs for clients, compiling design specifications and working as part of a team—translated directly to her work in Germany.

"The structure was really similar to how things work in real-life corporate environments, especially in a medical device company," says Ibrahim, who transferred to UW-Madison as a sophomore with encouragement from her parents, both alumni. Her dad earned his bachelor's degree in mechanical engineering and his master's in industrial engineering from UW-Madison.

Ibrahim, a senior who's also spent time working in Assistant Professor Filiz Yesilkoy's lab, says her experience at Siemens Healthineers confirmed her plans to work in the medical device industry, either before or after adding a master's degree. As a native of Indonesia, she particularly appreciated the company's diverse environment—with fellow students from countries like Brazil, Mexico, Sri Lanka, Turkey and Tunisia—and global infrastructure.

"I like what I'm doing. I really enjoy how what I do really impacts people's health—I can see it," she says. "I like that the thing I'm doing directly impacts those who are in need."

New collaborative research center to provide clearer image of tumor microenvironment

Immunotherapies, in which care teams harness and augment patients' immune systems to battle diseases, have emerged as promising treatments for a range of cancers. Yet their effectiveness remains largely blunted in solid tumors—a roadblock that a group of biomedical engineers and cancer researchers from UW-Madison and the University of Minnesota hope to overcome through a new research collaboration.

Associate Professor Kevin Eliceiri and Paolo Provenzano (PhD '03), an associate professor at the University of Minnesota, will lead the Center for Multiparametric Imaging of Tumor Immune Microenvironments, funded by a five-year, $6.7 million grant from the National Cancer Institute.

Kevin Eliceiri

The collaboration aims to inform new immunotherapy designs and strategies by developing, testing and deploying an integrated toolkit of imaging and data analysis technologies, shared across institutional lines. By applying advanced optical imaging, nano- and microfabrication and biophysical modeling techniques specifically to solid tumor microenvironments and studying how they influence immune function, Eliceiri hopes the team can unlock new solutions for therapies.

"We're realizing that the microenvironment matters a lot in cancer invasion and progression," says Eliceiri, the Retina Research Foundation Walter H. Helmerich Research Chair and a leader in developing imaging hardware and software for cell biology applications. "So instead of imaging that takes cells out of the natural context and puts them flat on glass, we want to look at environments that are more natural and we want to be more holistic in our imaging, where we track the microenvironment plus all the cell types, not just the cancer cells themselves."

The UW-Madison group, which also includes Professors Paul Campagnola (Peter Tong Department Chair) and Melissa Skala (Retina Research Foundation Daniel M. Albert Chair) and Assistant Professor Suzanne Ponik from the Department of Cell and Regenerative Biology, will handle the technology development side of the project.

For Eliceiri's research group, that will include further developing a suite of machine-learning-based tools for studying the microenvironment; building hardware that allows for label-free imaging of fibers of collagen (a prevalent connective tissue component that plays a key role in cancer metastasis) in commonly used pathologist's microscopes; and honing a system capable of measuring the dynamic "fingerprint" of metabolism in cancer cells. Skala will add her expertise in metabolic imaging techniques, while Campagnola has pioneered ways of translating collagen imaging to fabrication, allowing the group to 3D print biologically relevant scaffolds for therapeutic testing. Ponik, an expert in engineered and in vivo tumor microenvironment models, will help evaluate the new technologies.

The UW-Madison researchers will then share their technology with the team at Minnesota, a group of 13 investigators who will test it all while studying glioblastoma, the most common form of brain cancer, and pancreatic cancer.

"The structure of this center is particularly satisfying, considering the longstanding collaborations between Kevin and me, and my history with the UW Department of Biomedical Engineering," says Provenzano, who in 2003 was the fifth student to graduate from BME's PhD program.

The UW Carbone Cancer Center and the University of Minnesota Masonic Cancer Center are providing additional funding for the effort, which Eliceiri says will allow the center to connect with even more collaborators on both campuses.

"We always want to advance the technologies available to our cancer research community," says Eliceiri. "By the end of the grant, our tools will be better, they'll be vetted by collaborative cancer biology projects, but also our tools will be present in Minnesota for continued use. Everyone's research goals are benefited this way. It's a very synergistic collaboration."

By developing new imaging techniques and technologies, our biomedical engineers are improving our understanding of the tumor microenvironment, knowledge that can bolster immunotherapies. PhD students Helen Wilson (left) and Mike Nelson use an automated multiphoton microscope to acquire collagen images of pancreatic cancer in Associate Professor Kevin Eliceiri's lab. Photo: Tom Ziemer

Connecting students to careers, each other

For student organizations aimed at building community and connection, the COVID-19 pandemic represented a giant pause button.

Yet the Biomedical Engineering Society (BMES) undergraduate student group has roared back, boosting its membership and putting on a range of events to connect students with future career possibilities and each other.

During the fall 2021 semester, the group hosted industry meetings with Biosense Webster, Epic Systems and GE Healthcare and put on a resume workshop in partnership with the latter. But chapter president Annika Rossebo says she and the rest of the group's officer team made a conscious decision to also infuse its programming with more events focused on academic research pathways.

BMES students toured the labs of Associate Professor Megan McClean, postdoc Christa Wille and cardiovascular researcher Timothy Hacker, representing three of the four specialization areas available to BME undergraduates (biomedical imaging and optics, biomechanics, and biomaterials, cell and tissue engineering).

The group also put on a BME master's program panel; heard from Associate Professor Kip Ludwig about his career journey through a medical device startup, the regulatory side of the industry at the National Institutes of Health, and academia; and collaborated with the Global Health Innovation Club for a talk with Dr. Jessica Schmidt, director of global health in the Department of Emergency Medicine, about working in low-resource settings.

"We hope to provide exposure to both industry contacts and different career opportunities in research," says Rossebo. "We also just want to provide our members with some fun outside of school and opportunities to make friends and meet other people in their major."

Faster, simpler diagnostic test offers hope for future pandemics

In early March 2020, just as the COVID-19 pandemic was forcing Duane Juang and other graduate student researchers to work remotely, he came across an article sounding a warning about how a dearth of lab supplies was hampering COVID testing across the United States.

Juang, who had experience working on fast, efficient diagnostic technologies in the lab of John D. MacArthur Professor and Claude Bernard Professor David Beebe, emailed his mentor to ask if their research might offer a solution to the problem.

More than two years later, Juang has completed his PhD and is working toward commercialization of a faster, simpler and less expensive alternative to PCR tests, the gold standard for detecting SARS-CoV-2. The test, which could easily be adapted to other infectious diseases, is based on an innovative combination of technology that he, Beebe, PhD student Terry Juang and other UW-Madison collaborators outlined in a study published in the journal *Nature Communications*.

Given the costs and complexities of PCR-based tests, which need to be processed in large batches at a centralized lab, patients generally have to wait a minimum of 24 hours to receive their results. By contrast, the team's oil immersed lossless total analysis system (OIL-TAS) features a simpler setup, allowing it to produce results within an hour while requiring only minimal equipment.

Like a PCR-based test, the OIL-TAS uses RNA extraction and then a chemical reaction to detect nucleic acids from a virus. However, the OIL-TAS employs a rapid extraction method pioneered by Beebe's lab. It eliminates the need to wash samples and relies on a less complex chemical assay and a quicker detection technique. It also includes a microfluidic technology called exclusive liquid repellency, created by Beebe lab scientist Chao Li about five years ago, that prevents sample loss.

While the ultimate goal of Juang's ongoing work on the project with Flambeau Diagnostics (one of Beebe's several spinoff companies) is to create an at-home test, the road to regulatory approval is long and mired with hurdles. The first aim of the effort, which is being funded through a State Economic Engagement and Development grant from the Wisconsin Economic Development Corporation, is to create a rapid test for healthcare settings.

Faculty News

Associate Professor Randolph Ashton and postdoctoral researcher Gavin Knight (PhD '17) launched a biotechnology startup company, Neurosetta, and received a $1.7 million Small Business Technology Transfer award from the National Institutes of Health (NIH).

Associate Professor and Retina Research Foundation Walter H. Helmerich Research Chair Kevin Eliceiri was named a fellow of SPIE, the leading international society for optics and photonics researchers. Eliceiri was also earned a spot on the Web of Science Highly Cited Researchers list for 2021.

Professor and Retina Research Foundation Daniel M. Albert Chair Melissa Skala will use a two-year, $480,135 grant from the National Eye Institute to develop a new imaging method for quantifying melanin levels in human eyes, allowing for earlier disease detection and monitoring, as well as better treatment evaluation in retinal diseases.

Vilas Distinguished Professor and H.I. Romnes Faculty Fellow Kristyn Masters is among the winners of the UW-Madison Vilas Associates Competition, which recognizes outstanding new and ongoing research and provides funding support.

Professor Emeritus and BME affiliate Thomas "Rock" Mackie was selected as a fellow by the National Academy of Inventors.

Vilas Distinguished Professor Shaoqin "Sarah" Gong is leading a project, funded by a $2.3 million grant from the NIH, to further develop a unique nanocapsule-based nonviral gene editing delivery system. Associate Professor Krishanu Saha is among the collaborators on the grant. Gong is also part of a team that won a Wisconsin Alumni Research Foundation Innovation Award for a project combining a novel nanoparticle, radiation therapy and a cellular division checkpoint inhibitor to try to expand the number of tumors responsive to immunotherapy.

Student News

PhD student Namita Khajanchi was chosen as a Kohler Fellow at the Wisconsin Institute for Discovery. She'll work with other fellows to create public science-art fusion projects, bridging disciplines and promoting antiracism, justice, equity and inclusion.

PhD student Maribel Torres-Velazquez was honored as one of the 2021 Massachusetts Institute of Technology Electrical Engineering and Computer Science Rising Stars. She presented her work using deep learning techniques to better inform epilepsy treatment.

Alumni News

Tasso, a startup founded by Erwin Berthier (PhD '11) and Ben Casavant (PhD '13), raised $100 million to support its at-home blood-draw technology.

Marissa Harkness (BS '21) cofounded a startup called Pill Skills that helps teach adults and children to swallow pills. The company received $15,000 in seed funding from the Ideadvance Seed Fund through the UW System's Center for Technology Commercialization.

College welcomes inaugural associate dean for inclusion, equity and diversity

Chris Castro joined the college as its inaugural associate dean for inclusion, equity and diversity in January 2022.

Castro brings more than a decade of experience leading efforts to strengthen teaching and learning practices rooted in the principles of inclusion, equity, diversity and justice. He spent the previous six years working for Madison Teaching and Learning Excellence (MTLE), a UW-Madison fellowship that helps early career faculty members professionalize their educational skills.

Castro, who took over as MTLE program director in 2019, also serves as a facilitator and educational expert for the National Science Foundation-funded program Aspire: National Alliance for Inclusive and Diverse STEM Faculty, helping to disseminate inclusive teaching practices at the national level.

"For me, there's no such thing as good teaching if we're not starting with the students as human beings," says Castro. "As my colleague Dr. Rosemary Russ in the Department of Curriculum and Instruction says, 'There's no such thing as good teaching if it's not teaching that's grounded in equity, diversity, inclusion and justice.' Starting a conversation about teaching from any other angle has never made sense to me."

While integrating those two perspectives in MTLE, Castro also built relationships with 41 engineering faculty members (from six departments) who participated in the two-semester fellowship program. Additionally, Castro has collaborated with six engineering faculty members on the educational impact portions of their National Science Foundation CAREER Awards.

As associate dean, Castro is keen to take a collaborative and transparent approach to creating communal solutions while elevating and empowering others.

"I'm going to be on the ground, talking to folks," he says. "I'm not going to be in my office, closed behind a door. I'm going to be building relationships and really getting to know the humans who make up the College of Engineering, so that we can make this a human work, human process, rather than just a policy-driven or metric-driven process. All those things are important, but they're not the most important."

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Two more AIMBE Fellows gives us 14

Associate Professors Christopher Brace and Krishanu Saha have earned election to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows.

Their induction means our department now counts 14 AIMBE Fellows among our faculty. AIMBE Fellows are considered to represent the top 2% of medical and biological engineers in the United States, receiving the distinction for outstanding teaching, research and innovation.

Christopher Brace

Krishanu Saha

Brace, who previously served as the college's assistant dean for graduate affairs, is being recognized for his work improving research mentor training, as well as his translational research developing and disseminating microwave ablation devices and techniques for clinical audiences. He is also a faculty member in the School of Medicine and Public Health's Department of Radiology.

Saha, who's also a faculty member with the Wisconsin Institute for Discovery, is a leader in developing cell and gene therapies at the intersection of stem cell bioengineering, genome editing and ethics.

Our other AIMBE Fellows are: John D. MacArthur Professor & Claude Bernard Professor David Beebe; Professor Walter Block; Peter Tong Department Chair Paul Campagnola; Associate Professor and Retina Research Foundation Walter H. Helmerich Research Chair Kevin Eliceiri; Vilas Distinguished Professor Shaoqin "Sarah" Gong; Professor Pamela Kreeger; Associate Professor Kip Ludwig; Vilas Distinguished Professor and H.I. Romnes Faculty Fellow Kristyn Masters; Professor Beth Meyerand; Harvey D. Spangler Professor and H.I. Romnes Faculty Fellow William Murphy; Retina Research Foundation Daniel M. Albert Chair and Professor Melissa Skala; and Vilas Distinguished Achievement Professor Justin Williams.

Professors Emeritus Thomas "Rock" Mackie and Willis Tompkins are also AIMBE Fellows.