LEGACY

Rensselaer Department of
Mechanical, Aerospace, and Nuclear Engineering

ANNUAL REPORT 2013

Rensselaer

FACTS & FIGURES

DEPARTMENT OF MECHANICAL, AEROSPACE, AND NUCLEAR ENGINEERING

STUDENTS

- 1,115 Undergraduates
- 152 Graduate

2013 US NEWS & WORLD REPORT GRADUATE RANKINGS

- Aeronautical Engineering 21
- Mechanical Engineering 24
- Nuclear Engineering 14

DEGREES OFFERED

- Aeronautical Engineering (B.S., M.Eng., M.S., Ph.D.)
- Engineering Physics (M.S., Ph.D.)
- Mechanical Engineering (B.S., M.Eng., M.S., Ph.D.)
- Nuclear Engineering (B.S., M.Eng., MS)
- Nuclear Engineering & Science (Ph.D.)

DEGREES AWARDED IN (AY) 2013

- 293 Bachelors
- 36 Masters
- 30 Ph.D.

GRADUATE STUDENT SUPPORT (FALL 2013)

95% of current full-time doctoral students received financial assistance

AFFILIATED RESEARCH CENTERS

- Center for Automation Technologies and Systems | cats.rpi.edu
- Center for Flow Physics and Control www.scer.rpi.edu/cefpac
- Center for Modeling, Simulation and Imaging in Medicine www.scer.rpi.edu/cemsim
- Center for Engineering-based Patient Modeling | cepm.rpi.edu
- Scientific Computation Research Center | scorec.rpi.edu

RESEARCH AREAS

AEROSPACE SCIENCE AND ENGINEERING

- Fluid Dynamics/Aerodynamics
- Advanced Structures/Materials
- Optimization
- Space
- Combustion/Propulsion

MECHANICAL SCIENCE AND ENGINEERING

- Mechanics and Materials
- Thermal and Fluids Engineering
- Design and Manufacturing
- Dynamics and Controls

NUCLEAR SCIENCE AND ENGINEERING

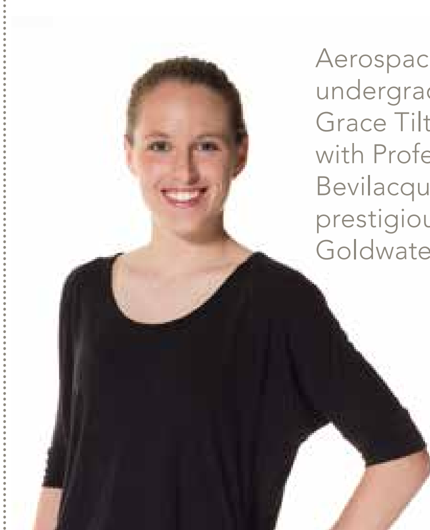
- Nuclear Power Systems
- Applied Radiation Technologies
- Radiation Protection, Medical and Industrial Uses of Radiation
- Nuclear Materials

CROSS-CUTTING RESEARCH AREAS

- Energy Science and Engineering
- Materials, Materials Processing and Controls
- Human Health and Safety

SELECTED STUDENT HIGHLIGHTS

Congratulations to our Design/Build/Fly team who placed 3rd out of 81 teams in the competition held in Tucson, Arizona.



Aerospace Engineering undergraduate student Grace Tilton, working with Professor Riccardo Bevilacqua, has won the prestigious Barry M. Goldwater Fellowship.

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MESSAGE FROM THE DEPARTMENT HEAD

It is my privilege to present to you this Annual Report for academic year 2012-2013. We have had a terrific year and I would like to share with you highlights of some of our recent successes, including:

- Continued excellence in faculty research and teaching with outstanding accomplishments and honors
- New recruitment and promotion of exceptional faculty
- Student success and recognition
- New events to celebrate alums and integrate them into the life of the department

Dr. Suvranu De, Professor and Head

I would like to start by congratulating my colleague **Professor Farhan Gandhi** for being elected Technical Fellow of the American Helicopter Society. You may recall that Professor Gandhi joined us last year as John J. Redfern Jr. '33 Professor of Engineering. Congratulations are also due to **Dr. Peter Caracappa** who has received the prestigious Elda E. Anderson Award from the Health Physics Society.

Winning a single young investigator award from a federal agency is considered a laudable achievement in the life of a junior faculty member. **Professor Riccardo Bevilacqua** has won his second young investigator award in as many years, this time from the Office of Naval Research. Professor Bevilacqua will use the three-year award to further his research into creating highly maneuverable and inexpensive low-orbit satellites for space weather forecasting. The shoebox-sized satellite, known as a CubeSat, will be equipped with a suite of sensors to monitor changes in wind direction, atmospheric ions, and atmospheric neutral densities during flight.

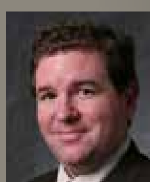
MANE control systems expert, **Professor Sandipan Mishra** has won the prestigious Faculty Early Career Development Award (CAREER) from the National Science Foundation (NSF). He will use the five-year grant to investigate and develop new sensing and controls paradigms to help push forward the leading-edge field of additive manufacturing.

We would like to extend a warm welcome to **Professor Aram Chung** who joined MANE this year as Assistant Professor. Aram's research area is micro-fluidics - the science of precisely controlling and manipulating fluids in microscopic channels. During his doctoral studies, he was one of the first researchers to fuse microfluidic devices with living insects - creating so-called "insect cyborgs"- to control their flight as part of a DARPA funded project that received much media attention. We are also happy to report that **Professors Jie Lian** and **Emily Liu** have been promoted to the rank of Associate Professor with tenure and **Professor Theodorian Borca-Tasciuc** has been promoted to the rank of Full Professor in MANE. **Professor Yoav Peles** has assumed the position of Director of the Mechanical Engineering Program.

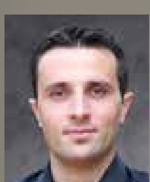
Our faculty have also been very successful in winning Rensselaer awards. **Professor Catalin Picu** has been awarded the School of Engineering Teaching Award in Classroom Excellence and the Rensselaer Alumni Association Teaching Award while **Professor Emily Liu** was awarded the School of Engineering Teaching Award in Education Innovation as well as the Class of 1951 Outstanding Teaching Award. **Professor Matt Oehlschlaeger** has won the James M. Tien '66 Early Career Award for Faculty and **Professor Jie Lian** has won the School of Engineering Research Excellence Award for Junior Faculty. **Professor Theodorian Borca-Tascuic** has received the School of Engineering Outstanding Team Award. Finally, **Professor Kurt Anderson**, who also serves as Associate Dean of Engineering, received the inaugural Excellence in Assessment and Continual Improvement from the School of Engineering.

This has been a great year for MANE students as well. Our Design/Build/Fly team placed 3rd out of 81 teams in the competition held in Tucson, Arizona.

Dr. Farhan Gandhi



Dr. Peter Caracappa



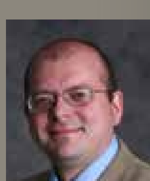
Dr. Riccardo Bevilacqua

Dr. Sandipan Mishra

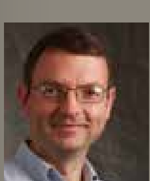
Dr. Aram Chung

Dr. Jie Lian

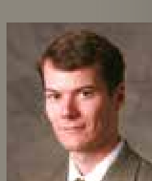
Dr. Emily Liu



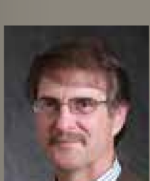
Dr. Theodorian Borca-Tasciuc



Dr. Catalin Picu



Dr. Matthew Oehlschlaeger



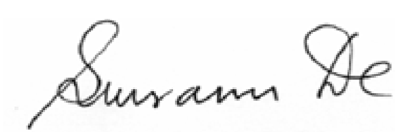
Dr. Kurt Anderson

Aerospace Engineering undergraduate student **Grace Tilton**, working with Professor **Riccardo Bevilacqua**, has won the prestigious Barry M. Goldwater Fellowship. Six of our students have received the Society for Women Engineers (SWE) fellowships and nine have received the Founders Award. **Cary Kaczowka**, a senior in MANE has received the Collegiate Emerging Leader Award of the SWE. Both **Lauren Bolden** and **Brian McDermott** have received the 2013-2014 American Nuclear Society Graduate Scholarship Award.

This year, the theme of the Annual Report is "legacy." MANE's legacy is defined by its distinguished alumni and alumnae. We organized two events to celebrate this rich heritage. In the Spring of 2013 the Emerging Frontiers in Aerospace Engineering @ Rensselaer was organized to honor graduates of Rensselaer's aerospace engineering program and to build a vibrant community of alumni, faculty and students to foster engagement, support and a rich exchange of ideas and expertise. Honors were conferred on **Mr. Mark Goldhammer '71** upon his upcoming retirement and his 10 years of service as Boeing's executive focal to RPI and **Dr. Robert Loewy '47,** a seminal figure in rotorcraft research and development, who has inspired generations of academic colleagues. A *Reconnect to MANE!* event was organized coinciding with the Homecoming and Reunion weekend in October, 2013 where all MANE alums for all years were invited to join us for breakfast followed by lab tours and student posters.

As we celebrate our legacy, we take the time to pause and remember, with a sense of pride and sadness, the passing of **Lois Graham '46** - one of the first women to earn a degree in Mechanical Engineering at Rensselaer. Her list of "firsts" is long. She was the first woman at the Illinois Institute of Technology (IIT) to earn advanced degrees in Mechanical Engineering, the first woman in the U.S. to earn a Ph.D. in Mechanical Engineering, and the first woman to receive a fellow award from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, honoring her for contributions as an educator in thermodynamics and cryogenics.

In closing, it is an incredible honor to lead this distinguished Department. Our world class faculty, our brilliant and motivated student body, our dedicated staff and our highly accomplished alumni serve as constant inspiration to me. I hope you enjoy reading this Annual Report and share my sense of enthusiasm and pride for what we have accomplished as a team and the optimism we feel is in store for us next year.



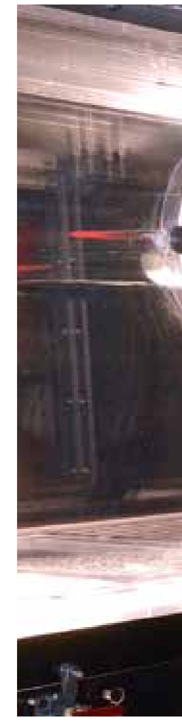
Professor and Head

Alumni of all ages were represented at the "Reconnect to MANE!" event during Homecoming and Reunion Weekend. Professor Emeritus Henrik Hagerup enjoyed meeting alumni from both his very first year and his very last year of teaching—a span of 45 years.

Dr. Robert Loewy '47

Mark Goldhammer '71

Dr. Lois Graham '46



Professor Emeritus Henrik Hagerup

The MANE *Legacy*

Roots and Branches on the Rensselaer Family Tree

John A. Tichy

Richard T. Lahey, Jr.

The notion of the academic "family tree" is not a new one. For as long as higher learning has existed, scholars have attempted to trace academic genealogies of teachers and their students. Chemists and mathematicians seem especially devoted to the discovery of their academic ancestors, with some genealogies claiming relationships dating to the Middle Ages.

Nearly two centuries of notable graduates have produced a Rensselaer academic family tree with substantial roots and a thicket of limbs and branches. We asked two stalwarts of the Department of Mechanical, Aerospace and Nuclear Engineering (MANE) – both recipients of the William H. Wiley Distinguished Faculty Award – professors Richard T. Lahey, Jr. and John A. Tichy, with more than 70 years of teaching and research between them, to reflect about their own roots and about Rensselaer graduate students they advised. MANE alumni continue to expand the Rensselaer legacy in a broad array of fields around the world.

John A. Tichy

"I always thought that this was what I wanted to do, right from the beginning."

John Tichy, professor of mechanical engineering and former head of the department, has been a member of the faculty since 1976, when he was hired by department chair Fred Ling. Tichy is an ASME Fellow, an STLE (American Society of Mechanical Engineers), a past chairman of the ASME Tribology Division, and the former Technical Editor of the ASME Journal of Tribology.

He is also listed in the Who's Who in Rock & Roll and the Rolling Stone Encyclopedia of Rock & Roll for his work as singer, songwriter and guitarist with *Commander Cody and his Lost Planet Airmen*.

Tichy was hired by Fred Ling in 1976 as an assistant professor, just as his touring days with the band were winding down. He always knew he was going to be a professor, even though for a time, playing music helped to pay the bills. "I always thought that this was what I wanted to do, right from the beginning."

"I played music all through my undergrad years and basically put myself through school," he said. "It wasn't that difficult because it was cheaper to go to school then." As an undergraduate, the hard part was getting up for 8:00 classes after having played until three in the morning. "It was a lot easier being a doctoral student," Tichy claimed. "You just had to get the work done."

With the success of *Commander Cody*, "one thing led to another, and I decided to go for it," he remembered. "I thought this was a crazy aberration, but reality would surely sometime take hold." His father was not too happy about it, Tichy recalled. "He was probably as flabbergasted as I was that the whole music thing was successful."

But married and with a young family, soon it became time to settle down, and Tichy accepted a position at Rensselaer. Even in 1976, "it was a pretty square place," but by that time, his haircut had evolved "kind of within the realm of respectability."

When asked about the difference between playing to a stadium full of people and standing in front of a classroom, Tichy said, "Frankly, it can be scarier in front of the students." In a big arena, with the bright lights, it is harder to see individual faces. "If my music career had been in front of smaller audiences, I would have been scared, too."

Tichy said most alumni would remember him from teaching fluids-related courses, but in recent years he has taught dynamics. "I worried about myself that I would get bored, but I don't," he claims. "I can't say I have to give myself new challenges to keep it fresh. I just enjoy it on its own terms."

He is back-to-basics in the undergraduate classroom – no texting, and no laptops. He gives regular quizzes. He takes attendance. "I'm old, old school," he says. "I do very little theory. I work problems in class. They get a ton of example problems. They know what they've got to do!"

About his graduate students, Tichy says, "I always gave them a lot of rope. I would say: this is an area I am interested in, this is an avenue worth pursuing, here are some articles to read. Go, come back and tell me what you think," he recalls. "I would say all these people had a lot of initiative."

One of them was **Dr. C. Fred Higgs III,** who today is Clarence H. Adamson Career Faculty Fellow and professor at Carnegie Mellon University. "We would meet regularly. I would say, what you got for me this week, Fred? And he was always off on some tangent," Tichy remembers. "But that's why they were the best ones. They had the ideas and just needed to be pointed in the right direction."

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Today Higgs conducts particulate flow modeling and experimental research using principles of tribology, fluid and rheological mechanics. And he, too, is creating the next branches on the academic tree. Two of Higgs' students are professors now, too. Dr. Elon J. Terrell is assistant professor at Columbia University, directing an energy and tribology lab, and Dr. Emmanuel Wornyoh is assistant professor at the University of Wisconsin in Milwaukee.

John Tichy has advised a number of students who have continued in academic careers in the U.S. and abroad, adding more branches to MANE's academic tree.

Richard T. Lahey, Jr.

"My job was to train young men and women for the practice of engineering. They bet their career on me and I tried not to disappoint them."

Another is **Dr. Donna Meyer**, who after 15 years in the nuclear industry, is associate professor at the University of Rhode Island and director of its Thermomechanics and Tribology Lab.

Overseas, **Dr. Yoon Chul Rhim** is professor of mechanical engineering at Yonsei University, one of Korea's top private universities, and one of the oldest. At Korea Polytechnic University, **Dr. Unchung Cho** is professor of mechanical engineering. And **Dr. Mahmut Aksit** is associate professor and department head at Sabanci University in Istanbul, Turkey.

After 37 years at Rensselaer, of teaching, Tichy says, "It's a good life."

"I get immense satisfaction from a whole lot of things, in particular seeing my students go out and do well – and not just personally, but institutionally," Tichy said. "I am very proud of students from this department, and from Rensselaer, who do well."

"Teaching," he says, "has enabled me to do so much more than in any other kind of profession. With teaching, you are making a mark on the future."

"With teaching, you are making a mark on the future."

Richard T. Lahey, Jr. is the Edward E. Hood, Jr. Professor Emeritus of Engineering. He joined Rensselaer in 1975 as chair of the department of nuclear engineering and science, and was recruited by Dean George S. Ansell from the General Electric Company, where he led R&D for boiling water nuclear reactor (BWR) thermal-hydraulic and safety technology. An international authority and a pioneer in multiphase flow and heat transfer technology, Dr. Lahey has received numerous national and international awards, including the prestigious E.O. Lawrence Memorial Award of the USDOE. He is a member of the National Academy of Engineering, the Russian Academy of Science-Bashkortostan branch, and is a Fellow of the American Nuclear Society (ANS) and the ASME.

Although retired from academic life at Rensselaer, Dr. Lahey regularly serves as an engineering consultant and expert witness for matters related to nuclear reactor safety. Moreover he is currently a member of the Board of Managers for PJM Interconnection, LLC, the largest high voltage electric grid and market operator in the country. He was also widely sought out by the media for comment on the destruction of the Fukushima nuclear plants. Before arriving at Rensselaer in 1975, Lahey oversaw GE's safety research for Fukushima-1, which was destroyed by the tsunami. "All our engineered safety systems worked like a champ," he said. "It was the tsunami that overwhelmed everything. It was over 800 years since they had that kind of tsunami and so the Japanese did not design for it."

Lahey's nuclear engineering career began after his graduation from the United States Merchant Marine Academy with a degree in marine engineering. After a stint at sea as an operating engineer aboard a super tanker, he realized that a maritime career would keep him too far away from home and his new bride, Ellee. So he took a job in the nuclear development & safety group at Knolls Atomic Power Laboratory (KAPL), operated by General Electric at the time. He also enrolled part-time at Rensselaer and earned a Master's degree in mechanical engineering. "I got a very good education at RPI. It was a really good, no nonsense engineering school and I learned a lot," he recalled. "That's why, later on, I came back."

After KAPL, Lahey took a degree in engineering mechanics at Columbia University, where he did research on biomechanics (in particular blood flow and pulmonary mechanics), while his wife completed her own degree. However in those days jobs were scarce in that field, so Lahey joined GE's nuclear R&D group in San Jose, California, where he worked while completing his Ph.D. at Stanford University, and leading GE's nuclear safety group. "I really built my initial reputation in that job," Lahey said. "Nuclear energy was state-of-the-art in those days. People in the field knew me, and we were doing excellent research. I had a great group." He rose to lead the R&D efforts in San Jose and was preparing to become a General Manager for GE.

One day he got a call at work from George Ansell, dean of engineering at RPI. “He asked me, how would you like to become the Chairman of the department of nuclear engineering and science at RPI?” said Lahey. “And I said, who the hell are you? Later I found out he got my name because I had a good reputation in the field.”

Anyway, because of his own RPI experience and because he wanted to continue doing research, Lahey agreed to make the career change. “I was hired basically to bring the department into the mainstream of nuclear engineering,” he recalled. For the first few years he focused his activities on new curriculum and hiring new professors, and the program developed an excellent reputation. He said, “When they did the rankings in the 70’s and 80’s we were always in the Top 3 – it was always MIT, Cal Berkeley, and RPI, in varying order depending on the year.”

But as construction of new nuclear power plants and R&D waned in the United States, Lahey expanded his research to many areas, always in his field of multiphase flow and heat transfer, and the behavior of vapor/liquid systems. “It doesn’t matter too much to me if it’s an off-shore oil well, a spacecraft, a nuclear reactor, or a chemical process plant. So my graduate students have worked on all kinds of different problems,” Lahey said. “Fortunately over the years I’ve been lucky to have a lot of very good graduate students.”

Lahey also enjoyed research collaborations with Rensselaer faculty, particularly Donald Drew, former chair of applied mathematics; Joseph Flaherty, professor of mathematics, and former dean of science; Michael Podowski and Robert Block, both of nuclear engineering, and Kenneth Jansen, formerly of MANE. “We got to work together and brought different things to the table so it was a real synergistic relationship,” he reflected. “Because of the unique environment at RPI I’ve been very fortunate to have the opportunity to do a lot of different things, things that I couldn’t have done alone.”

“The nice thing about the graduate students I had was that they were very smart, hardworking and they really wanted to learn. It was a real pleasure to spend time with them,” Lahey said. “At some point they stop doing exactly what you tell them to do, and they start bringing back things that are even more interesting than what you suggested to them. At that point, you know they are about ready to graduate.”

“At some point they stop doing exactly what you tell them to do, and they start bringing back things that are even more interesting than what you suggested to them. At that point, you know they are about ready to graduate.”

Over the years, Lahey has advised 30 master’s degree and 50 doctoral candidates, and many have gone on to distinguished careers. “My job was to train young men and women for the practice of engineering,” Lahey said. “They bet their career on me and I tried not to disappoint them. I tried to get them up to the state-of-the-art, and after that it’s entirely up to them. I couldn’t make them successful, but at least I gave them the tools.”

He keeps in communication with many of his former students. “If I go to Korea, it’s incredible. There are many of our Ph.D.’s who meet me there, and they take care of my wife and I like we are royalty.”

One of them is **Dr. Goon-Cherl Park**, president of KEPCO’s International Nuclear Graduate School (KINGS), affiliated with Seoul National University (“the MIT of Korea,” according to Lahey). Opened in 2012, this state-of-the-art school is designed to produce professionals for the burgeoning Korean nuclear power industry.

Many of Lahey’s other students are also doing very well, some in charge of large companies. One of these is **Dr. Tagir Nigmatulin**, general manager of the Russian branch of GE’s Oil & Gas Division. “He is in charge of all the gas and oil production and all the related technology for GE in Russia,” Lahey said. “That’s a huge job. He’s responsible for GE’s activities in 12 time zones.”

In the U.S., former Ph.D. student **Dr. Susana Navarro-Valenti** is the founder, president and CEO of Navarro Research and Engineering, Inc., a top government contractor and an award-winning provider of environmental and technical services to government agencies. *(See the profile on Susana in this report.)*

Another of Lahey’s graduate students, **Dr. Gary Arnold,** is a full-time judge for the Atomic Safety and Licensing Board (ASLB) of the U.S. Nuclear Regulatory Commission (USNRC), after 20 years at KAPL. The ASLB conducts all licensing and other hearings as directed by the Commission. Membership selection for the ASLB includes “persons of recognized caliber and stature in the nuclear field.”

Several of Lahey’s former Ph.D. students are building their reputations in academia. **Dr. Rusi Taleyarkhan** is a professor of nuclear engineering at Purdue University. Also at Purdue is another of Lahey’s Ph.D. students, associate professor **Dr. Martin Lopez de Bertodano.**

At the University of Tennessee **Dr. Art Ruggles**, is a professor of nuclear engineering, and at North Carolina State University, **Dr. Igor Bolatnov** is an assistant professor of nuclear engineering. In warmer climes, **Dr. Silvia Cancelos** is an assistant professor of mechanical engineering and runs the Bubble Dynamics Laboratory at the University of Puerto Rico.

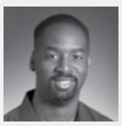
Lahey is modest about the recognition he has earned. “I started in the early days of what we now call the field of multiphase flow and heat transfer. It wasn’t even a field then, so I was able to help develop it. I could pioneer a lot of things,” he observed. “I was lucky to get in a field that I could help develop. If you do that, you can be the best in it, because most everybody is using your work.”

“It’s been fun,” he mused. “I still do a lot of consulting, and I enjoy it, and I certainly enjoyed the time I spent at RPI. “

Academic Family Tree

Dr. John A. Tichy

advised

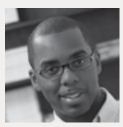


Dr. C. Fred Higgs III

Clarence H. Adamson Career Faculty Fellow and Associate Professor of Mechanical Engineering

Carnegie Mellon University

advised



Dr. Elon J. Terrell

Assistant Professor of Mechanical Engineering and Director, The Energy and Tribology Laboratory

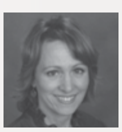
Columbia University

Dr. Emmanuel Wornyoh

Assistant Professor

College of Engineering and Applied Science

University of Wisconsin, Milwaukee



Dr. Donna Meyer

Associate Professor

University of Rhode Island

Dr. Yoon Chul Rhim

Professor of Mechanical Engineering

Yonsei University, Korea.

Dr. Unchung Cho

Professor

Department of Mechanical Engineering

Korea Polytechnic University

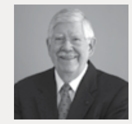
Dr. Mahmut Aksit

Associate Professor and Department Head

Faculty of Engineering and Natural Sciences

Sabanci University

Istanbul, Turkey



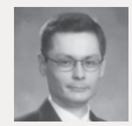
Dr. Richard T. Lahey, Jr.

advised

Dr. Goon-Cherl Park

President, KINGS (KEPCO International Nuclear Graduate School)

Seoul National University



Dr. Tagir Nigmatulin

General Manager G.E. Oil & Gas Division, Russian Branch

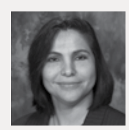
Moscow, RU

Dr. Byong Ryung Koh

President & CEO

Korean Nuclear Technology (KNT) Co.

Korea



Dr. Susana Navarro Valenti

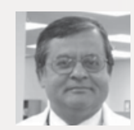
President & CEO

Navarro Research and Engineering, Inc.

Dr. Gary Arnold

Technical Judge

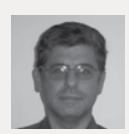
United States Nuclear Regulatory Commission



Dr. Rusi P. Taleyarkhan

Chaired Professor of Nuclear Engineering

Purdue University



Dr. Martin Lopez de Bertodano

Associate Professor of Nuclear Engineering

Purdue University

Dr. Art Ruggles

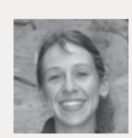
Professor of Nuclear Engineering

University of Tennessee

Dr. Igor Bolatnov

Assistant Professor of Nuclear Engineering

North Carolina State University (NCSU)



Dr. Silvina Cancelos

Assistant Professor of Mechanical Engineering and PI of the Bubble Dynamics Lab

University of Puerto Rico

Frederick F. Ling

Ling's Legacy

Noted professor and researcher Frederick F. Ling spent 30 years (1956-1986) at Rensselaer, serving for the last dozen as the William Howard Hart Professor and chair of the department then called mechanical engineering, aeronautical engineering, and mechanics. Today Ling is Earnest F. Gloyna Regents Chair Emeritus in Engineering at The University of Texas at Austin. He is well known for his seminal contributions to the fields of tribology, biomechanics and machine durability.

Among Ling's students at Rensselaer were two who would become major branches of its academic family tree: bioengineering pioneer **Van C. Mow,** and tribologist **Francis E. Kennedy.**

Mow is the Stanley Dicker Professor of Biomedical Engineering and Orthopedic Bioengineering, and founding chairman of the Department of Bioengineering at Columbia University. He followed several older brothers in attending Rensselaer, and he is something of a Rensselaer legend. After earning his bachelor's in aeronautical engineering, he earned his Ph.D. in applied mechanics. He later returned to the Rensselaer faculty as associate professor, then full professor of mechanics.

During the 1970s Mow began to study biomechanics, after reading new and important literature in the field. He then spent a sabbatical year at Harvard Medical School, returning to Rensselaer to become the John A. Clark and Edward T. Crossan Professor of Engineering. He was also named adjunct professor of surgery at Albany Medical College, and lecturer in orthopaedics at Harvard Medical School. After 17 years on the Rensselaer faculty, Mow was recruited in 1986 to join Columbia University's College of Physicians and Surgeons.

Mow is highly regarded for his teaching, his inspiring lectures, and his warm relationships with his graduate students. He has trained and mentored many who have become leaders in biomedical engineering, mechanical engineering and orthopaedic surgery.

Mow has earned countless distinguished honors for his seminal contributions to the development of biomedical engineering, including membership in both the National Academy of Engineering and the National Academy of Sciences. At Rensselaer, Mow received the Davies Medal for Engineering Achievement, and during its centennial celebration, the department selected Mow as one of the Top 10 graduates.

Another student Fred Ling advised was **Francis E. Kennedy,** who earned his Ph.D. in mechanics at Rensselaer. Today he is Professor of Engineering Emeritus at Dartmouth College. Kennedy's branch of the academic family tree includes his advisement of more than 50 master's theses, including that of Rensselaer MANE Professor **Thierry Blanchet**.

Blanchet, in turn, advised **W. Gregory Sawyer,** who is today the N.C. Ebaugh Professor at the University of Florida. And it doesn't stop there – Sawyer's lab has already graduated eight Ph.D. students. Among them are David L. Burris, assistant professor and NSF CAREER Award winner at the University of Delaware, and Brandon A. Krick, assistant professor at Lehigh University.

Among Ling's students at Rensselaer were two who would become major branches of its academic family tree: bioengineering pioneer Van C. Mow, and tribologist Francis E. Kennedy.

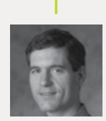
Dr. Frederick F. Ling
Earnest F. Gloyna Regents Chair Emeritus in Engineering
The University of Texas at Austin

advised

Dr. Van C. Mow
Stanley Dicker Professor of Biomedical Engineering and Orthopedic Bioengineering
The Columbia University Department of Biomedical Engineering

Dr. Francis E. Kennedy, Jr.
Professor of Engineering Emeritus
Thayer School of Engineering
Dartmouth College

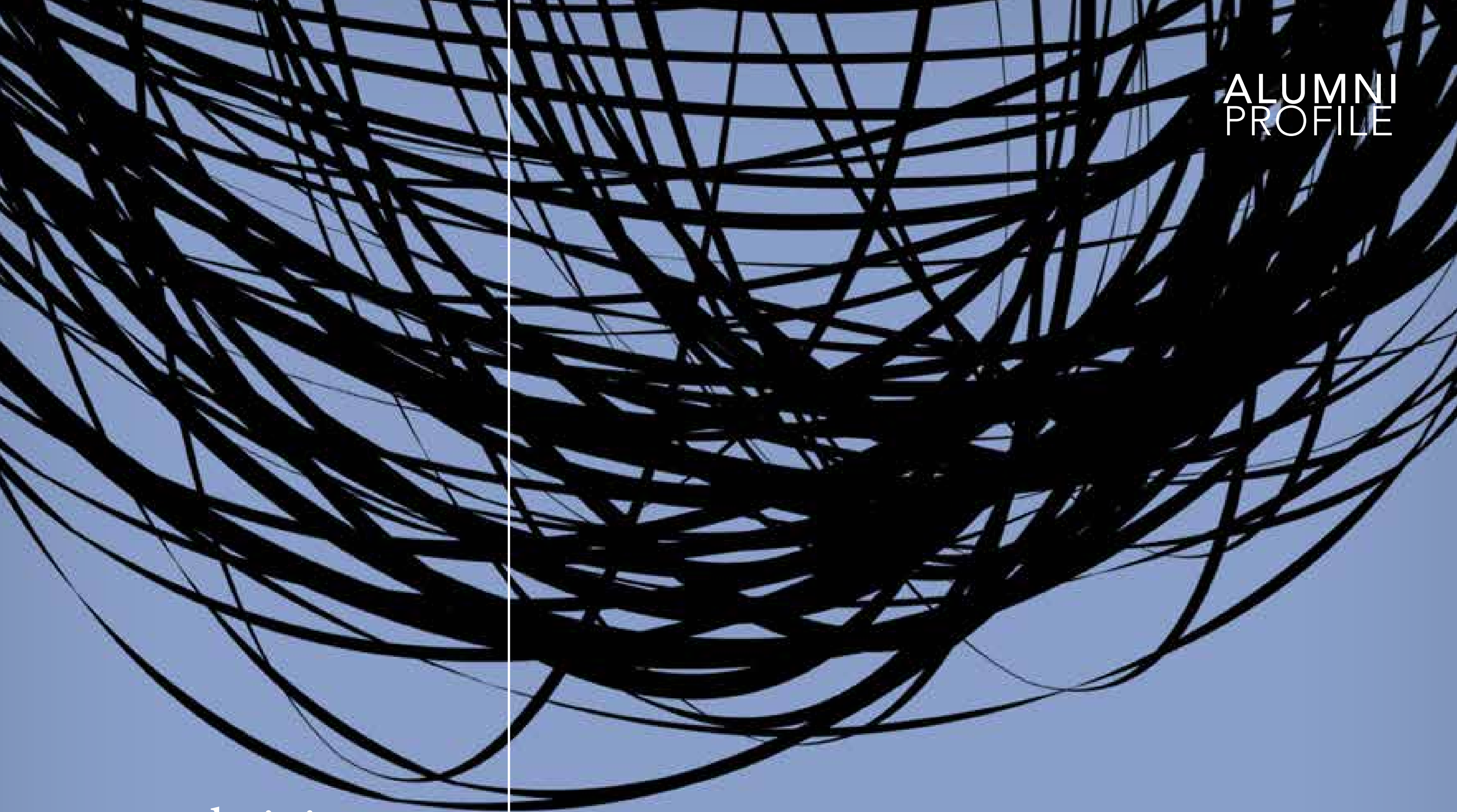
advised



Dr. Theirry Blanchet
Professor of Mechanical Engineering
Rensselaer Polytechnic Institute

advised

Dr. W. Gregory Sawyer
Distinguished Teaching Scholar
N.C. Ebaugh Professor
U.F. Research Foundation Professor
University of Florida



thriving ON complexity

"I always thought I was going to be a professor," says Dr. Susana Navarro-Valenti '90, president and CEO of Navarro Research and Engineering, Inc. Growing up in Mexico City, she was part of an academic family. Her mother was a chemical engineer, one of the first women of her generation in that profession in Mexico, and a professor herself. Susana earned her undergraduate degree in engineering physics at Autonomous Metropolitan University in Mexico City. For graduate study, she decided to pursue nuclear engineering because of its complexity. "When you are a nuclear engineer you get involved with many areas of practice – with electrical, with materials – and I liked the complexity and the broad scope."

That's a good thing, because today Susana manages complexity across a broad range of services in the company she founded, Navarro Research and Engineering, Inc.

Navarro Research and Engineering, Inc. is one of the nation's strongest, most successful, and most stable small business government contractors.

Navarro is an award-winning provider of environmental and technical services to the United States Department of Energy (DOE), the United States Department of Defense (DOD), the National Nuclear Security Administration (NNSA), and the National Aeronautics and Space Administration (NASA).

It is one of the nation's strongest, most successful, and most stable small business government contractors. With its headquarters in Oak Ridge, Tennessee and fourteen offices nationwide, Navarro provides environmental remediation, characterization, decontamination and decommissioning services; long term surveillance and maintenance; nuclear, safety and quality services; and waste management. Under Susanna's leadership and vision, the company has grown from two employees at inception to over 400 today, with expected 2013 revenues of $85 million.

The company has earned numerous accolades. *Hispanic Business Magazine* has listed it as one of the fastest growing Hispanic 500 for seven consecutive years. *Inc Magazine* named it one of America's top 500 entrepreneurial growth leaders. The *Engineering News-Record* ranked it in the Top 200 Environmental Firms in 2008, and *BusinessTN* included it in the "Hot 100" list for three years. In 2011, Navarro was listed among the top 250 General Services Administration (GSA) vendors.

With over 20 years of experience in the nuclear and safety fields, Susana has a strong commitment to ensure that Navarro provides the best in services and remains extremely high-quality, efficient and customer focused. She has successfully managed the company's growth by proactively building up the company infrastructure to accommodate growth while maintaining the level of excellence in services its clients expect.

Susana chose Rensselaer to pursue her career after one of her undergraduate professors in Mexico recommended its nuclear engineering program. The professor had studied at Rensselaer with Dr. Richard T. Lahey, Jr., the Edward E. Hood Professor Emeritus of Engineering. Susana emigrated to the United States in 1986 to pursue her post-graduate degrees with Dr. Lahey at Rensselaer, where she completed her master's and Ph.D. in the area of thermal hydraulics and multiphase flow. She recalls Dr. Lahey as a very good mentor, very knowledgeable, and a good teacher and researcher. "He expected a lot from his students," she recalled. "He expected a lot of independence but he was a good teacher, too. "

In Dr. Lahey's laboratories, Susana also met her future husband, Mark Valenti. Both were doctoral students in nuclear engineering at Rensselaer and each completed their Ph.D.'s in 1992. "But I finished mine one day ahead," Susana laughed. Susana's thesis also earned the American Nuclear Society's Mark Mills Award, nominated as the best submission that year.

It seemed that an academic career lay ahead, and Susana considered an offer of a tenure-track professorship in Madison, WI. But the married couple found it was going to be a challenge to begin two careers in the same place. They kept looking and found opportunities for both in Oak Ridge, Tennessee, Susana doing research in nuclear safety in the National Laboratory and Mark in the Y-12 Weapons Plant.

"I never actually thought that I would like managing a business. It was very far from what I thought I wanted to do," Susana recalls. But after working at the laboratory, and then doing process design and development in another corporation for a year or so, she thought, "I should be able to do this for my own company, and maybe I will enjoy it." The first contract they got was for criticality safety, and with husband Mark doing that work, the company was launched in 1993.

"At that point we decided that one of us needed to run the company. We couldn't have two cooks in the kitchen," said Susana. She turned to the task of managing and growing the business. With a research background and no experience in business or management, she did not have contacts in the government, or anywhere else, for that matter. She did have her finely trained mind and so, "I learned everything as I went."

The key, she said, was her very strong technical background. "When we started, it was just the two of us, so I had to do everything on the business side to run the company. I had to write the proposals, hire the people…but because we had the technical expertise, we were able to do it. We hired a lot of criticality safety experts, and nuclear safety experts, and that is how we started."

After a couple of years, the company expanded across the country and had grown to around 30 employees. Susana says that she learned by growing her network of contacts and gathering referrals to find experts in the field. "You have to learn by talking to people to find out who are the best out there," she said. Trusting her own judgment, Susana would talk with potential colleagues to discern their capabilities and fit. She was able to hire people in Denver, Richmond, and Washington, working closely together and holding frequent telephone meetings. "Because these experts knew our background was in the nuclear area, we had credibility. We had a lot of people join us."

With growing success in nuclear safety services, the time came for Susana to decide whether to aim the company to become the leading provider of such services, or to expand into other areas. "It was a very good area to be in," Susana said, "because you could really grow and become a very good, strong niche contractor in that specific practical area." But, she decided, "I wanted to do more." Navarro would expand. The first step was to build upon their nuclear safety expertise into industrial and other kinds of safety work.

Then, she thought, the next logical step was to grow into environmental services. "I wanted to do long projects, not just services, but turnkey projects," she said. Navarro began to do decontamination projects, because the demand was there, and continued to expand to do low-level waste removal and remediation of contaminated soil and materials. Today, Navarro has also expanded into alternative energy projects. "We have been awarded many new contracts," she said, "Today, we have about 400 employees, and we estimate our revenue will be between $80 and $90 million by the end of this year."

While growing Navarro Research and Engineering, Inc. is one of her occupations, Susana and Mark are also raising a family, with two children: daughter Susy and son John, who is keeping the Rensselaer legacy going as a second-year student in nuclear engineering.

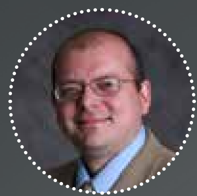
AN INSIDE LOOK AT

CROSS-CUTTING RESEARCH

OVER THE PAST YEAR, OUR FACULTY HAVE FOCUSED ON CONSOLIDATING RESEARCH EFFORTS INTO THREE CROSS-CUTTING COMMITTEES CENTERED AROUND THREE THRUSTS:

01

Energy Science and Engineering



chaired by
Theodorian Borca-Tasciuc

02

Human Health and Safety

chaired by
Assad Oberai

03

Materials, Materials Processing and Controls

chaired by
Nikhil Koratkar

Each committee has drawn members from different program areas who bring their own perspective, with overall objectives that include:

» growth in research funding
» fundamental and applied research that can rapidly translate toward solutions to key global challenges
» recruitment and support of leading faculty
» establishment of partnerships across multiple sectors
» advancing impact, reputation, and leadership through faculty recognition and research growth

01 Energy Science and Engineering

According to Professor Theodorian (Theo) Borca-Tasciuc, the Energy Science and Engineering committee has developed a plan to address engineering Grand Challenges using the expertise in the MANE department, examining what is needed to be competitive in this arena. "We are looking at our research, we are looking at our courses, we are thinking about what is going to be needed in the future, and we are planning for the projects and funding directions we think will be coming in the near future," he said. "We want to be proactive, and to develop the agenda in our areas of strength."

The group, which consists of faculty across the Institute as well as experts from industry and national laboratories, meets regularly to discuss topics such as the engineering Grand Challenges, how they are aligned with Rensselaer strengths, and where the Department is competitive or could become more competitive. It identified two directions in which the members believe the department could be very relevant in energy areas:

- Solid state thermal energy conversion and storage
- Thermal management

"Our department is very strong in heat transfer, energy conversion processes, and related application areas," said Borca-Tasciuc. "We are very strong in materials internally as well as with collaborators. With very strong computation and modeling at RPI, putting these three together – our thermal-fluids expertise, materials, and multiscale modeling, we have a very strong case."

A number of faculty in the department are engaged in research of thermo-fluids phenomena in macroscale, microscale and nanoscale materials, devices, and energy conversion systems; novel materials development; and examining the properties of these materials. Working with industry, Professor Yoav Peles leads a program on microscale phase change heat transfer for thermal management. His development of cutting edge technologies in this area has secured funding from the Defense Advanced Research Projects Agency (DARPA). Professor Michael (Mike) Podowski leads research projects funded by the Department of Energy in the area of modeling and simulation of multiphase flow, phase-change, and heat transfer in supercritical carbon dioxide energy conversion systems, as well as, fuel assemblies relevant for nuclear power reactors. Professor Matthew (Matt) Oehlschlaeger leads several research projects supported by federal funding agencies or industry to develop critical diagnostics techniques for combustion experiments and perform fundamental investigations of the oxidation and ignition characteristics of conventional and alternative fuels.

"We have strong efforts in materials development for solid state energy conversion and for thermal energy management," Theo Borca-Tasciuc said, "and we also work on new materials that are good for packaging the new devices that electrical engineers make." An example in solid-state lighting is LEDs, which still produce a great deal of heat. If temperature is not controlled, efficiency and life can drop significantly, something that is also true for computer chips. "For some of the devices we are looking at, about a third of the total thermal resistance comes from just a couple of interfaces. Researching low interface thermal resistance solutions by paying particular attention to nanomaterials and to packaging surfaces is where we can make a positive contribution in this field."

Critical expertise in nanomaterials for thermal management is brought by Prof. Jie Lian and Prof. Nikhil Koratkar, who develop graphene and other nanolayer sheets based foams and nanocomposites. As batteries become stronger, heat management will become even more important in portable devices. "The field is wide open," said Borca-Tasciuc. "We are actually players in this area, and we plan to be even stronger than we are."

In solid-state energy conversion, the group has efforts in fluorescent solar concentrators, vibration harvesting, and thermoelectrics. Prof. Diana Borca-Tasciuc investigates the use of luminescent solar concentrators (LSCs) to concentrate sunlight onto photovoltaic (PV) cells. LSC-PV systems have potential as building envelope materials that can act simultaneously as power generators. She is also investigating microscale power generators, harvesting mechanical vibration energy to power miniaturized sensors for building automation applications.

Professors Borca-Tasciuc and Ganpati Ramanath work together on solid-state thermoelectric energy conversion, using nanomaterials concepts they developed. In solid-state thermoelectric power generation devices, instead of using thermal energy from conventional fluids, the "working fluid" consists of electric charges moving through junctions between solid materials, and generating voltage and electrical power when a temperature gradient is applied.

These materials could also have application in solid-state heat pumps, using the thermal energy of the electric charges moving under an electric field to generate similar effects as commercial heat pumps, which are based on vapor compression and phase change. A recent graduate student of Ramanath's has co-founded a company (ThermoAura Inc.) with the two professors, licensing the technology from RPI. The company is now upscaling it to create novel materials for the thermoelectric device industry that can be used for solid-state energy generation or cooling. "It is a good example of how research we are doing is impacting the world," Borca-Tasciuc said. "It is a high-tech company based in New York State."

Professor Assad Oberai is leading the department's team on human health and safety, but, he said, "You can think of HHS as anything related to biomedical research, and how mechanical engineering can play an important role. The focus is clearly on human health, and we want to make an impact sooner rather than later."

The group is action-oriented. Recently Oberai held a "mixer," reaching out to faculty in the School of Engineering and asking them to give brief snapshots of their research in this area. With participation of the MANE department and biomedical engineering, the point was to give talks with "sticky ends," so that, as he put it, "other researchers in the audience could find something to latch on to, contribute to, and get together and make advances."

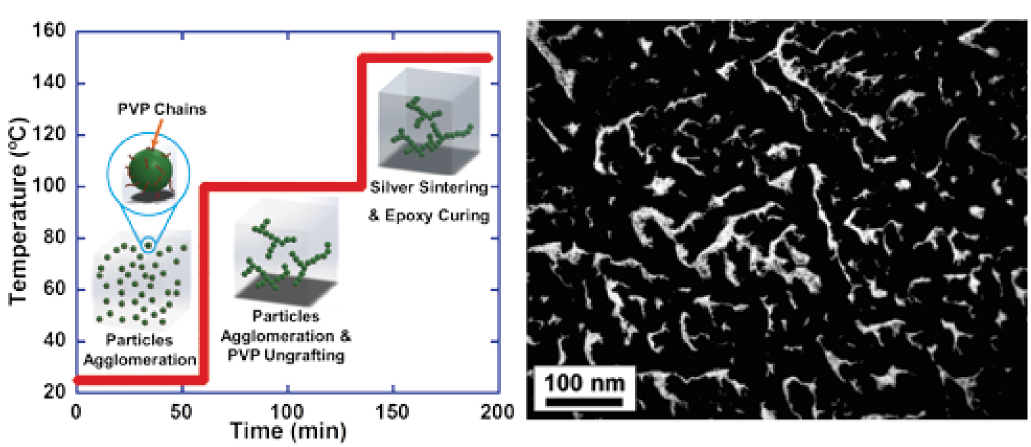
Oberai is collaborating with researchers at the University of Wisconsin and Boston University in utilizing ultrasound images to find a better way to visualize tumor tissue. He does this through modeling of the mechanical behavior of human tissue. They take a sequence of ultrasound images as the tissue is compressed, and use these to determine exactly how much each point moves within the tissue. The benefit is simple, because healthy tissue compresses differently than tumor tissue, which tends to be much stiffer. "Breast tumors are most commonly found by palpation," Oberai said. "Instead of relying on the patient's touch, which is great, we are trying to find quantitative images where these things will stand right out."

For his study, Oberai and his collaborators created a sequence of ultrasound images. Using these images, they calculated the deformation inside the tissue. "Using that," he said, "you can figure out what the material properties are, in particular the stiffness, of every point inside the tissue. In images of tissue stiffness, tumors light up and can be seen clearly." The resulting images are much more clear than ultrasound images, and can be used to diagnose whether the tumor is malignant. They can also be used to create virtual models of human tissue and then create haptic interfaces to train surgeons and plan surgeries. "That is something that (department head) Suvranu De pioneered and has been working really hard on," said Oberai. "It's really taking off."

Professor De designs those types of algorithms as well as the corresponding hardware, and leads the Computational Simulation Consortium (CoSCo) with surgeons from multiple medical institutions including Harvard Medical School and Yale University School of Medicine. Another Rensselaer faculty member, Professor George Xu, does radiation cancer treatment planning.

"That's the cool thing in our department," Oberai said. "We attack all aspects of biomedical research, all the way from detection, diagnosis, the work that I do, and then the planning of surgery and training surgeons, and then, even planning treatment, which is what George does – what is the right radiation dose on a given part of the tissue, so that you only affect that part. "

Professors Mark Shephard and Onkar Sahni do computation on blood flow. There was over a decade of joint Stanford/Texas/RPI research supported by NIH and NSF to develop and demonstrate the technologies that have been used to show medical practitioners a number of things that have improved the techniques they use in treating vascular disease. Starting in 2007 the lead Stanford professor has been working to bring the technologies to everyday use. The result to date is the HeartFlow service that uses non-invasive methods to determine the needs of specific patients for stents. At the core of these services are Computational Fluid Dynamics and meshing technologies developed at RPI by SCOREC researchers.

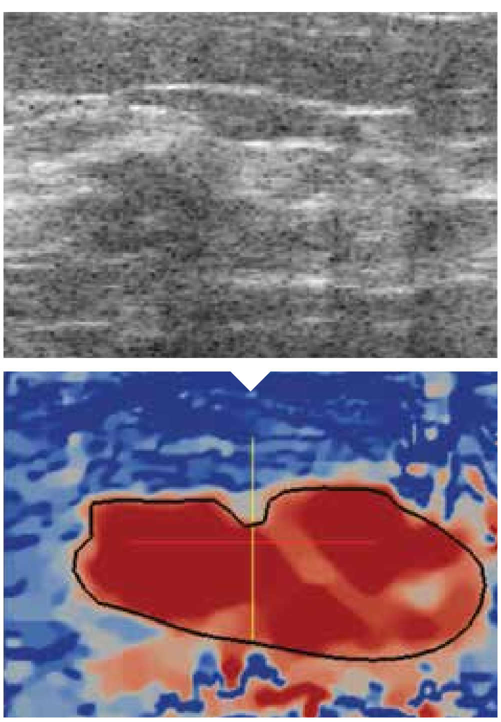


Self-assembled tree-shape nanosilver networks in epoxy developed by controlled agglomeration and sintering of dispersed nanoparticles. The research led by T. Borca-Tasciuc was published in the journal Nanoscale in 2014. It yielded the highest thermal conductivity polymer composites to date and provides a basis for development of new polymer nanocomposites for thermal transport and storage applications.

Researcher Lucy Zhang is figuring out how voice is created. “Voice is about air being pushed through the vocal folds, and they vibrate at a certain frequency. How do you change pitch? If the tissue is stiffer, it moves at a higher frequency. If it is relaxed, at a lower frequency,” said Oberai. She is modeling the physics of that process in order to help with restorative procedures.

People in the department are also working at a much smaller scale. Diana Borca-Tasciuc does work with nanoscale particles for treatment and drug delivery. “We hired a bright young faculty member named Aram Chung,” said Oberai. “He takes cells and puts them through a microchannel, and depending on their deformability, determines the state of cells. We have discovered there is a connection between deformability of cells and illness.”

“RPI has a strong legacy in this area, and it is continuing,” said Oberai. “Van Mow was one of the pioneers in the field of biomechanics. So we try, we give it our best. It is fun.”



The image on the top is a B-mode ultrasound image of a malignant tumor in the breast. A sequence of these images is acquired as the breast is gently compressed. These are used to generate the shear modulus image on the botton in which the tumor is seen clearly. It is observed that the margins of this tumor, as well as its interior appear very heterogeneous. This heterogeneity is the hallmark of cancer and may be used diagnose cancerous tumors.

03 Materials, Materials Processing and Controls

The materials, materials processing and controls group of about ten faculty covers all three areas of materials, manufacturing and controls and also the coupling or integration of these three disciplines. “It gives us a unique ability to tackle basic materials levels challenges, as well as the scale-up of novel materials into devices and system-level applications,” said Professor Nikhil Koratkar, John A. Clark and Edward T. Crossan Chair of Engineering and chairman of the committee.

Over the past year the group has held a number of meetings and brainstorming sessions, which have led to several large, multi-million dollar grant proposal efforts.

“Nanotechnology in general requires all kinds of backgrounds and people who have to work together. Mine is mostly materials science. Theorists and experimentalists have to work together,” said Koratkar. “Theory here is very complicated. You are talking about modeling at the molecular scale , which is way beyond my expertise. So I have to work with a theorist to see whether theory, modeling and simulations can be used to explain my experimental data. Why are certain properties different at nanoscale than at the larger? This is what we are trying to answer using a multi-disciplinary approach.”

He continued, “There are a lot of theorists, modeling and simulation people at RPI. We have the CCI, so there are lots of opportunities for collaboration with folks who like to work with the experimentalists. That improves the quality of their work, so it’s a win-win for everybody.”

Current efforts in Koratkar’s laboratory involve growing new nanomaterials “from the bottom up.” New materials behave differently at the nanoscale, so his team manufactures them, and then studies their physical, chemical, electrical, thermal and mechanical properties. The last step is to find applications for their use, which helps to attract support from the funding agencies. Researchers are looking at four areas: composites, devices, coatings, and energy.

Composites

In composites, the team is working to improve the mechanical, thermal, and electrical properties of large aerospace, mechanical and civil structures. Composites involve a host structure, which could be a polymer, ceramic or metal, which are injected with nanostructures. The researcher then tries to determine how the properties change – for example, why are nanofillers more effective than the larger microfillers? The reason, Koratkar explains, is that there are more interfaces. “If I take something very big, the area of contact is not much. But if I split it into billions of nanotubes or nanosheets, there are many more. Interfaces are what allow you to control the properties at very low loadings.”

This makes it possible to create lighter, stronger, and safer composite materials. “Look at the new Boeing Dreamliner,” Koratkar observed. “Most of it is composites.” He says that the fracture properties of composite polymers are enhanced significantly by the use of nanofillers. When cracks attempt to propagate, they encounter the nanofillers, which make it difficult for the crack to grow since they are deflected by the nanofillers. “The fracture toughness is much better. The lifetime is much better. The number of cycles to failure under load is much better. This makes for a safer material,” he said.

Devices

A second research focus is devices. One example is an optical filter that could be used in the hundreds of windows found in skyscrapers to screen sunlight and save energy. The best coatings available now take a long time to change tint from light to dark, and there is no shaded state in between. “So we are actually looking at graphene sheets and making them buckle to block most of the light,” he said. “Then unbuckle it, and it is transparent. You can have gradients of shading, and it can be done quickly.” Sandwiched between two layers of glass, the graphene acts as durable, single-molecule-thick adjustable shade. “I reached out to Professor Anna Dyson of the CASE Center at RPI to work on what we are calling graphene based dynamic glazing units.”

Coatings

The third research area is graphene coatings. Because it is a two-dimensional surface, graphene can be very easily used as a coating. There are many applications for this, Koratkar says, for moving water on surfaces, or preventing surfaces from being soiled, both useful applications. “How water interacts with surfaces is very important. There are also advantages in phase change from water to vapor, or vapor back to liquid," he said. "You need less time to do the phase change." If it can be done faster, that rate is important in heat transfer applications. As computer chips become more powerful, they run hotter. The more efficiently that energy that can be extracted from such a hot spot, the better the device can work.

Economics play a role in application, too. "Nanoscale materials are much more feasible when you look at high-end, performance driven applications," Koratkar said. "For example, in the aircraft application, look at the part that is prone to failure. So you find the part that is most in threat, and you can introduce nanomaterials in that location. It has to make sense from a cost point of view to be practical."

Energy

The fourth area of research in the materials group is energy. "Our main focus is on lithium-ion batteries," he said. "It's a billion-dollar market. We are looking at how much energy we can store in the battery – increasing the energy density, and also increasing power density. A car, for example, needs a lot of energy very quickly, especially during start-up and acceleration. That is where batteries don't work very well because of the limitations of the rate of lithium ions diffusing into a host structure. For high power now they use supercapacitors to get the energy out at a high rate, a different concept that is cumbersome and costly to use. We want to increase the battery cycle life, as well," he said which is equally important from a cost point of view.

"We are finding that graphene in particular and 2D nanomaterials in general are working out great in terms of all these things," he observed. But, he cautions, "You have to find the right application where it is cost effective."

Materials Processing and Controls

The department is also very strong in materials processing and controls. One example of crosscutting research in this area is that of Dr. Johnson Samuel, whose advanced manufacturing-centered research projects have interfaced with researchers in diverse fields such as material science, controls and automation, and biomedical engineering. On the material science front, his NSF-funded collaborative work with Dr. Koratkar has been exploring the feasibility of using graphene as a high performance lubricant for micro-machining applications.

The controls and automation expertise of Dr. Sandipan Mishra brought synergies to his collaboration with Samuel on a U.S. Department of Defense funded research effort that explored the design of 3D printing systems with application in the training of surgeons.

Most recently, with his 2014 NSF CAREER award, Samuel will collaborate with renowned bone expert Dr. Deepak Vashishth of the department of biomedical engineering to develop patient-specific bone surgery techniques which aim to reduce the extent of post-operative complications in total joint replacement surgeries. This work is also likely to leverage the medical expertise available at the Icahn School of Medicine at Mount Sinai, in its new affiliation with Rensselaer.

Nuclear Materials

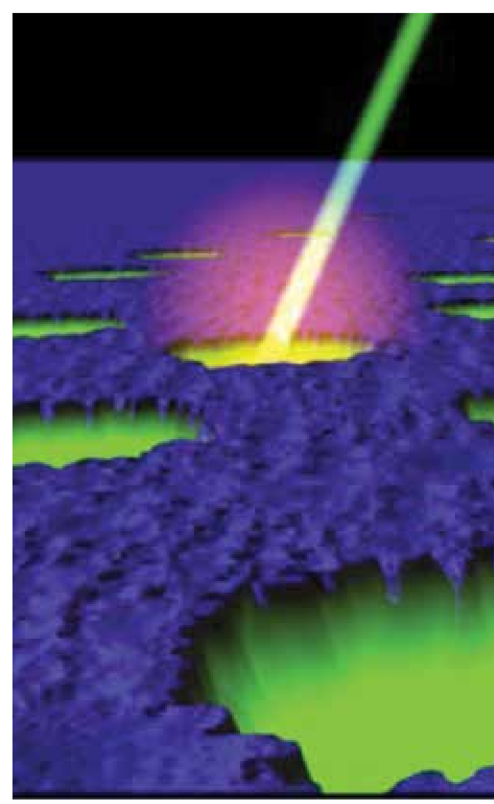
A focus on nuclear materials is a major strength of MANE. Dr. Jie Lian's research program is focused on materials under extreme conditions. His team's work aims toward a better understanding of advanced materials, including ceramic materials and nanomaterials, to help further nuclear energy production and alternative energy applications. Future designs of nuclear reactors and other nuclear technologies will require the development of better-performing materials able to sustain exposure to radiation, high temperatures, and corrosion. Such radiation-tolerant materials might extend the lifetime of components and contribute to safer, more reliable operation of nuclear systems.

Dr. Emily Liu's research on reactor materials, nanomaterials, radiation damage and nuclear threat detection are not only important from the perspective of materials research, but have deeper implications toward nuclear waste remediation, safety and environmental impact.

Liu is doing molecular dynamics simulations of uranium dioxide fuel, a common nuclear fissile fuel used in higher-temperature "generation IV" reactors. It is critical to understand its properties in varied environmental conditions in order to evaluate potential failure mechanisms. Her simulations are an effective tool in which to simulate and control factors not easy or possible to observe in the reactor environment.

Liu also studies complex "soft matter" systems, which consist of a variety of physical states such as colloidal solutions, liquids, manmade nanoparticles and biological materials that are easily deformed by thermal stresses or fluctuations. They typically contain a suspension of nano-particles and solvent molecules with many orders of magnitude in size, making them difficult to observe. Liu uses using scattering techniques such as neutron, X-ray or light scattering to study the structure and associated dynamic processes of these materials.

Another research focus for Liu is developing a method to detect nuclear threats using materials that are shielded or hidden. Current research focuses on individual components. Her team is working to develop a fully coupled, multi-physics computational model – a "Monte Carlo Simulation" – of the system for nuclear threat detection, using nuclear databases and building on existing experimental collaborations.



Materials, Manufacturing and Controls in MANE includes; Energy Storage and Thermal Management, Micro-Machining and Composites Cutting, Nano-Composites, Materials Behavior Under Extreme Environments (pictured), Additive Manufacturing and 3D Printing, Scalable Nano Manufacturing.

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