Message from the Dean

“I am very excited about the new faculty members joining the Hajim School this school year. As you will read in this issue, they bring expertise in neuroengineering, integrated photonics, fluid dynamics, video analysis, and high energy density physics.”

In my first months as dean, I’ve been privileged to witness the start of promising research careers—at our annual Xerox Engineering Research Fellows poster session—and the culmination of a truly remarkable one with the presentation of the Hajim School Lifetime Achievement Award to Robert Waag. Professor Waag’s pioneering career in ultrasound sets a fine example for all of our students and faculty.

Professor Waag’s exemplary achievements—and those of our young Xerox scholars—remind us that research is central to all we do at the Hajim School.

Research, both basic and applied, provides engineers with new ways to solve grand challenges. Research informs what we teach in our classrooms. And a thriving research portfolio, bolstered by federal grants and other outside funding, enables us to engage more students in our labs, applying what they’ve learned in the classroom to ‘real world’ challenges and solutions.

For example, several of those rising juniors and seniors in the Xerox Engineering Research Fellows program this summer did work directly related to federally funded projects. The NSF Career awards of Danielle Lin’s $2 million project to develop silicon carbide integrated quantum photonic processors—in collaboration with researchers here and at MIT, Case Western, University of Chicago, and the National Institute of Standards and Technology—is an example of the kind of high-impact, multisite project I would like more of our faculty to become engaged in.

And I am very excited about the new faculty members joining the Hajim School this school year. As you will read in this issue, they bring expertise in neuroengineering, integrated photonics, fluid dynamics, video analysis, and high energy density physics. This will create further opportunities for collaboration, funding, and student engagement.

We are poised to do great things!

My first few months as dean have been fruitful ones, in large part because of the support and feedback I have received from all across the Hajim community. Thank you—and keep the input coming. I look forward to exciting times ahead as we continue to make the Hajim School ever better.

Melissa Wendi B. Heinzelman, Dean

Read more about Dean Heinzelman at the Hajim website www.hajim.rochester.edu/about_dean_heinzelman.html.

Wendi Heinzelman Puts Priority on Student Experience and Research

“I am a newly minted dean, just as you are newly minted students of our school, so we are going to start this journey together, which should be really exciting,” said Wendi Heinzelman in her welcoming address to the Hajim School’s incoming Class of 2020 during freshman orientation.

Heinzelman’s new journey began May 17 when the University announced she would be the school’s first female dean. She was chosen following a nationwide search to find a replacement for Robert Clark, who stepped down to become the University’s new provost.

“Heinzelman is an outstanding choice,” said University President and CEO Joel Seligman. “She is a talented and driven leader who has demonstrated her aptitude for strong academic leadership by cultivating top-notch and innovative graduate programs for the University as well as through her mobile computing and networking research and the key partnerships and collaborations she has created through it. I am delighted with her appointment as the next Hajim School dean.”

Heinzelman stepped into the job after serving eight years as dean of graduate studies in AS&E. She spent much of the summer meeting with and gathering input from the Hajim School senior leadership team and department chairs and from other school and University leaders.

“Thank you so much for the many supportive messages I have received,” she wrote in her first dean’s weekly memo, rebranded Hajim Highlights. “This school has meant a great deal to me; this is where I began my professional career 15 years ago, fresh out of MIT, as an assistant professor of electrical and computer engineering. It is a real plus to already know and respect so many of the people I will be working with!”

In her first presentation to Hajim School faculty last month, she outlined two priorities:

1. Ensuring that Hajim School students continue to receive the best possible educational experience, in part by addressing class size issues associated with the school’s enrollment increase

She also wants as many students as possible to engage in hands-on research, internships, and global experiences outside the classroom. “These are the experiences that bolster our students’ résumés, help them understand what engineering is all about, and, moreover, help them decide and better prepare for their future path—be it grad school or industry,” she said.

2. Bolstering the school’s research portfolio by looking for new opportunities to collaborate within and beyond the University

“We need to explore new opportunities for collaborative and interdisciplinary research, including both academic and corporate partnerships,” she said. “This will provide research, educational, and funding opportunities that can take our school to the next level.”

She also emphasized that she wants the input to continue. “Please, don’t hesitate to ask questions, raise concerns, and throw out new ideas—I will welcome all of them.”

Dean Heinzelman talks with Catherine Yip ’17 of mechanical engineering about her summer as an Engineering Research Fellow this summer.
Our latest CAREER Award recipients

From February 2015 to February of this year, three Hajim School faculty members—Danielle Benoit of biomedical engineering, Douglas Kelley of mechanical engineering, and Nick Vamivakas of quantum optics and quantum physics—received Faculty Early Career Development (CAREER) Awards, the most prestigious grants given by the National Science Foundation to junior faculty members.

Here’s a look at the research they are doing with their awards.

Placing drugs exactly where they’re needed

“The challenge with trying to deliver therapeutic drugs to bone tissue is that there’s currently no good way to target the drugs exactly where they are needed,” Benoit says. Her goal: Develop a drug delivery system that can be targeted to specific parts of the skeleton to treat osteoporosis.

Key components of her strategy include the following:

- The osteoblasts and osteoclasts that continually remodel our bone tissue to maintain a healthy skeleton. In osteoporosis, there is an excess of bone resorption by osteoclasts and insufficient formation of replacement bone by osteoblasts.
- The Wnt signaling pathway, which helps activate regeneration of bone and other body tissue.
- Current anabolic drug treatments that stimulate this signaling pathway do so indiscriminately causing “aberrantly high levels of Wnt activation all over your body, which can lead to things like tumors,” Benoit notes.
- Molecular signals left behind where osteoclasts excavate bone as part of skeletal remodeling.
- Peptides that are known to bind to one of these molecular signals

By “decorating” these peptides on polymers that also contain the anabolic drugs, Benoit says, the peptides should be able to direct the drugs to bone tissue: Current anabolic drug treatments that stimulate this signaling pathway do so indiscriminately causing “aberrantly high levels of Wnt activation all over your body, which can lead to things like tumors,” Benoit notes.

One current approach is to fill shipping containers with thousands of liquid metal batteries the size of coffee cups and create stacks of containers bigger than a house, “because that’s what it takes to store enough energy for neighborhoods and cities,” Kelley says.

Kelley is using ultrasound to study how the flow of fluids in those liquid metal batteries affects their performance. He hopes to create mathematical models, based on detailed measurements taken in the lab, which could then be used to predict battery efficiency and stability in the field based solely upon what an operator would know: how much current is running, the amount of charge, and the battery’s temperature.

Currently, it is easier to prevent the formation of solids, which could short out the batteries, when the batteries are kept the size of coffee cups. “I think the mixing work we’re doing could explain that and enable larger cells,” Kelley says. “Larger is nicer because you don’t have to spend as much money on all those cases.”

Storing enough energy to power a city

“Maybe the biggest challenge of our time is to learn to live sustainably” by developing reliable sources of alternative energy, says Kelley. He is researching the use of liquid metal batteries as a way to store enough energy for neighborhoods and cities.

“As much as people talk about intermittent wind and solar generation, there are no good ways to store the energy so that large power grids using intermittent wind and solar generation can maintain seamless and efficient operation,” Kelley says. “Not only in terms of power, but the flexibility of the grid as well.”

One current approach is to fill shipping containers with thousands of liquid metal batteries the size of coffee cups and create stacks of containers bigger than a house, “because that’s what it takes to store enough energy for neighborhoods and cities,” Kelley says.

“Storing enough energy to power a city is definitely a basic research project,” Kelley says. “This will not happen overnight.”

Unleashing photons from quantum dots

Something interesting happens when you overlap two layers of tungsten diselenide that are each only a few atoms thick. Vamivakas and his lab have discovered the layers create regions where stray electrons like to gather in quantum dots. Vamivakas likens this to hills and valleys, with the layers of tungsten diselenide being hills.

“Each time an electron falls into one of the valleys, it emits a photon (particle of light). If we can control this to continually happen, you have a stream of single photons coming out.”

Photons are governed by quantum physics, not classical physics, which means novel, transformative applications are possible in fields as diverse as metrology and information processing. For example, imagine if one of these photon-emitting tungsten diselenide nanostuctures could be substituted in place of lasers in integrated photonic chips, Vamivakas says. “You could do things like computing and information processing that would be much faster. You could solve problems that you couldn’t solve with an ordinary IP chip.”

In the meantime, Vamivakas notes in his project summary, these nanostuctures offer a “rich condensed matter physics playground to explore the coupling of quantum dots and atomically thin semiconductors.”

Other current Hajim School faculty members who have received CAREER Awards:

**BIOMEDICAL ENGINEERING**
- Catherine Koe, Mechanosignaling in Teneurin Signaling (2013)

**COMPUTER SCIENCE**
- Sandhya Dwarkadas, Enhanced Software Distributed Shared Memory as a Compiler Target (1997)
- Chen Ding, Compiler-Assisted Data Adaptation (2005)

**ELECTRICAL AND COMPUTER ENGINEERING**
- Enegin Ipek, Overcoming the Many-Cores Power Wall with Resilient Computation (2011)

**OPTICS**
As Center for FREEFORM OPTICS grows, so do opportunities for Hajim students

By creating lenses and mirrors in a range of shapes—not just spheres or rotationally symmetric aspheres—freeform optics promises to deliver increasingly compact, lightweight, and easily targetable LED lighting, space sensing instruments, mobile displays, and a host of other applications.

By showing how to achieve this game-changing way of making optical components, the Center for Freeform Optics is bringing new industry partners to the University of Rochester. This, in turn, provides Hajim School students not only research opportunities but valuable experience working with outside companies.

For example, Di Xu, a PhD student, began working with CeFO in January on a project that uses optical coherence tomography to measure freeform optical surfaces. Aaron Bauer, who finished his PhD in June, demonstrated the feasibility of using freeform optics to create compact head-worn displays and related technologies. He will stay on at least another year as a research engineer developing prototypes for projects spawned by CeFO.

“I had been doing freeform optics even before the Center for Freeform Optics started, so it gave me some validation that what I had been working on was important and useful,” says Bauer.

Since its 2013 launch under an award from the National Science Foundation, CeFO has been shaping the future of optical instrumentation on a global scale. Starting with seven pioneer members—Air Force Research Laboratory (AFRL), Ball Aerospace and Technologies Corp., OptPhe Systems, Polyform Plus LLC, Rochester Precision Optics, Schott North America Inc., and Zygo Corporation—CeFO has more than doubled that number during the past year with Aperture Optical Sciences Inc., Corning, Enphase Technologies, Jet Propulsion Laboratory, L3 Communications, Microsoft, Nikon Research Corporation of America, Otsuka, and global partners ABB, PerkinElmer Health Sciences, and Zeiss joining the center. Funding for the center recently expanded to reach more than $1 million in cash flow in 2016 alone.

“PerkinElmer sees great opportunities in working together with faculty and students to advance related research,” says Dennis Yates, a senior research scientist with the company. “Collectively, we are all able to better understand the role that freeform optics can have in optical spectroscopy instrumentation and in innovative technologies of the future.”

The joint venture of the University of Rochester and the University of North Carolina (UNC) Charlotte brings the universities and companies together at the precompetitive stage of this promising new technology. The projects they share are at the interface between fundamental and applied research and are driven by applications that companies could eventually market.

The Rochester team, Rolland adds, represents a “good synergy” between the Department of Mechanical Engineering and the Institute of Optics. John Lambropoulos, chair of mechanical engineering, serves as CeFO’s associate director. Miguel Alonso, James Fienup, and Nick Vamivakas of optics, and Stephen Bums, Jonathan Ellis, and Paul Funkenbusch of mechanical engineering are the other faculty members involved in supervising a total of 11 current projects.

Affiliates’ membership dues are an important source of funding, giving the companies a major say as to which projects to pursue next. “Faculty generate many of the ideas, which the companies work with us to refine and then endorse as a high priority,” Rolland says. “Many of our industry members are interested in large-volume manufacturing of freeform optics. We collaborate closely on getting there.”

The funding and intellectual property are jointly shared by affiliates. In addition, companies can simultaneously pursue private projects with CeFO faculty. Members have engaged in partnerships among themselves as a result of relationships developed under CeFO. There are also pathways as a member to obtain first rights to an exclusive license, Rolland explains.

“The program is also an opportunity for students and companies to ‘size each other up’ for potential longer-term relationships—including employment after graduation,” Rolland adds.

Graduate students, working on projects in teams of two or three, update their industrial clients with monthly slide presentations.

“They learn to meet deadlines,” Rolland says. “They have to show they’ve done something every month. This is also a fascinating way for students to develop their presentation skills in addition to doing research and learning to publish papers.”

Xu acknowledges that preparing the slides can be time consuming. However, she adds, “It’s great to interact with people in industry. Their feedback is really helpful.”

Working with CeFO “is sort of in between an internship and purely academic studies,” Bauer adds. “It gives you a glimpse into the industry environment. You see what you would expect of an employee if you worked for one of these companies.”

The University of Rochester and UNC Charlotte partnership, she explains, resulted from the unique strengths each institution can bring to this field “We lead in design, while UNC Charlotte is strong in manufacturing optics. We both are leaders in metrology of freeform optics.”

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The Hajim School welcomes seven new tenured or tenure-track faculty members this academic year.

**Biomedical Engineering**

Edmund Lalor, who joins the department as an associate professor, researches how the human brain selects and encodes information from the many signals sensed in everyday life. He has made important contributions to understanding how neural signatures of natural speech processing reflect the encoding of specific speech features and how that processing is affected by attention and visual input.

He has developed novel methods for decoding brain signals for use in brain-computer interfaces and for investigating the specificity of sensory processing deficits in psychiatric and developmental disorders. He comes from Trinity College Dublin, where he was an assistant professor from 2011 to 2016. Prior to that, he was a postdoctoral research associate at University College London, Trinity College Dublin, and the Nathan Kline Institute for Psychiatric Research. Later he received his PhD degree from University College Dublin in 2007.

The research of Ross Maddox, who joins the department as an assistant professor, has two main thrusts: (1) to investigate how the visual system interacts with the auditory system to improve selective attention under noisy conditions and (2) to identify and dissociate the neural causes of disabled listening, particularly in people who show no signs of hearing impairment as defined by current audiologic testing. He comes to Rochester from the University of Washington Institute for Learning and Brain Sciences, where he was a postdoctoral fellow. He earned his PhD in biomedical engineering from Boston University.

**Computer Science**

Chenliang Xu joins the department as an assistant professor, after finishing his PhD at the University of Michigan–Ann Arbor. His research interests include computer vision, robot perception, and artificial intelligence. His work has focused primarily on the problems in high-level video understanding, such as video segmentation, activity recognition, and visual language. His dissertation stimulated and advanced the use of supervision hierarchies as a new type of generative video representation in video analysis. He is currently working on a book project on video.

**Electrical and Computer Engineering**

Stephen Wu, assistant professor, is an Argonne National Laboratories postdoctoral researcher working on thermal spin transport devices in oxide thin films through the spin Seebeck effect. He made headlines last year when he discovered that you don’t need a magnetic material to create spin current from insulators. This has important implications for the field of spintronics and the development of high-speed, low-power electronics that use electron spin rather than charge to carry information. He received his BS in electrical and computer engineering and his MS and PhD in physics from the University of California, Berkeley.

**Mechanical Engineering**

Gilbert “Rip” Collins, previously director of the Center for High Energy Density Physics at Lawrence Livermore National Lab, will start a similar center here as professor of mechanical engineering and senior scientist at the Laboratory for Laser Electronics. He has led a multidisciplinary group of scientists, postdoctoral researchers, and students in exploring fundamental properties of matter at extreme densities, high strain rate phenomena, and fusion microphysics. His work on matter at high energy density, from thousands to billions of atmospheres, finds applications in planetary science, stellar evolution, and controlled fusion. He will take a leading role here in exploring the behavior of matter under extreme pressure.

**The Institute of Optics**

Edmund Jaime Cardenas, who joins the institute as an assistant professor, will form a research group to focus on next-generation photonic devices integrated on a chip using novel 2D materials. The group will work on solving the critical technological problems preventing integrated photonics from becoming mainstream in consumer applications and enabling integrated photonics to enhance scientific discovery in various fields. Cardenas plans to leverage the opportunities created by the new AIM Photonics initiative. He received his PhD in optical science and engineering at the University of Alabama in 2003. Before joining the University of Rochester, Cardenas was a research scientist in the group of Michal Lipson at Cornell and then Columbia University.

**A New Department Chair**

Diane Dalecki has been named chair of the Department of Biomedical Engineering, a joint program shared by the Hajim School and the School of Medicine and Dentistry. She succeeds Richard Waag, who founded the department 15 years ago. Dalecki is the Distinguished Professor of Biomedical Engineering, holds a secondary appointment in the Department of Electrical and Computer Engineering, and serves as director of the Rochester Center for Biomedical Ultrasound.

She is an expert in biomedical ultrasound. Her laboratory is dedicated to developing novel diagnostic ultrasound techniques and discovering new applications of ultrasound for therapy, tissue engineering, and regenerative medicine.

Dalecki is a fellow of the American Institute of Ultrasound in Medicine (AIUM), of the Acoustical Society of America (ASA), and of the American Institute of Medical and Biological Engineering (AIMBE). She completed her BS in chemical engineering and MS and PhD in electrical engineering at Rochester.

The Department of Biomedical Engineering was established in 2000. The department consists of 18 primary faculty members with expertise spanning biomechanics, biomaterials, regenerative medicine, neuroscience, nanotechnology, imaging, and biomedical optics. The department enrolled 360 undergraduates and 70 graduate students during the 2015–16 academic year and led the Hajim School’s female undergraduate enrollment with 48 percent.

**Faculty AWARDS**

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**Faculty AWARDS**

Andrew Berger, associate professor of optics, received the Edward Pekk Curtis Award for Excellence in Undergraduate Teaching.

Robert Boyd, professor of optics, received the Optical Society’s 2016 Charles Hard Townes Award.

Laurel Carney, professor of biomedical engineering, received the Student’s Association Engineering Professor of the Year Award.

Robert Clark, professor of mechanical engineering and former Hajim School dean, received the 2015 Engineer of the Year Award from the Rochester Engineering Society.

Ehsan Hoque, assistant professor of computer science, was named one of 35 “Innovators under 35” by MIT Technology Review.

Douglas Kelley, associate professor of mechanical engineering, received a Faculty Early Career Development (CAREER) Award from the National Science Foundation. (See page 6.)
Young Leadership Council
helps recent alumni stay connected, share their knowledge

Both are doing so as members of the Hajim School Young Leadership Council.

Now 18 members strong, the council was formed in 2015 to build positive relationships between recent alumni and the school’s current students and faculty. Council members are encouraged to share their experience, time, and resources to help strengthen the quality of education, to promote alumni engagement and professional development, and to increase philanthropy as a way to make the Hajim School ever better.

“As a recent graduate, I am all too familiar with the transition from the last day of school to the first day of work and the challenges my peers and I faced. The Leadership Council is a perfect avenue to help students prepare for that transition and to encourage them to stay in touch with the University after graduation.”

The council gathers on campus during Meliora Weekend and also meets once a year via Skype.

“People are very involved and it’s been instrumental in helping us reach other young alumni in their cities,” Meeks says. “And the fact that all of them give faithfully each year (most as associate George Eastman Circle members) sets a great example for others.”

“Since the council currently has 18 members, there is a two-way flow of benefits. The input from the students is being used to support them in their current workplace, connect with other recent graduates, and build mentoring and internship opportunities for current students. Members, in turn, are kept abreast of what’s happening at the school and enjoy networking opportunities that can be useful for their own professional development.”

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“Not only are we finding innovative ways to keep them connected to current students, and they have been instrumental in helping us reach other young alumni in their cities,” Meeks says. “And the fact that all of them give faithfully each year (most as associate George Eastman Circle members) sets a great example for others.”

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FAST FACTS

• The Hajim School’s undergraduate enrollment has more than doubled since 2008–09.

• The number of master’s students enrolled in the Hajim School increased from 63 in fall 2004 to 310 in fall 2015.

• Female students made up 31 percent of the Hajim School’s undergraduate enrollment in the 2015–16 academic year. The biomedical engineering department led with 48 percent female undergraduate enrollment followed by chemical engineering with 45 percent.

Cover photo: PhD student Di Xu began working with the Center for Freeform Optics in January on a project that uses optical coherence tomography to measure freeform optical surfaces.

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