2020 MIT SENSE.nano Symposium: The Body at All Scales (Sept. 21, 22, 29)

September 29, 2020 1:00 pm - 5:00 pm

Day 1 - Monday, September 21, 1:00 PM – 4:30 PM

1:00 PM

Welcoming remarks
Brian W Anthony

Principal Research Scientist, Department of Mechanical Engineering
Associate Director, MIT.nano
Director of Technical Operations, Center for Clinical and Translational Research

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Principal Research Scientist, Department of Mechanical Engineering
Associate Director, MIT.nano
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Dr. Brian Anthony is a leading expert in the design of intelligent, or smart, instruments and methodologies for monitoring, measuring, and controlling complex physical systems. His interdisciplinary work spans mechanical, electrical, and optical engineering, seamlessly integrated with computer science and optimization, to deliver innovative solutions across manufacturing, healthcare, and other industries.

At the core of Dr. Anthony's research is computational instrumentation—the development of advanced tools and techniques to observe and manage intricate systems, particularly in manufacturing and medical diagnostics. His contributions include pioneering measurement and imaging technologies that enhance precision and performance in both industrial and clinical settings.

With over 30 years of experience, Dr. Anthony combines deep academic insight with practical industry expertise in technology innovation, product development, and entrepreneurship. He has successfully guided market-driven solutions from concept to commercialization, especially at the intersection of information technology and advanced manufacturing. His achievements include receiving an Emmy Award from the Academy of Television Arts and Sciences for technical innovation in broadcast engineering.

In the classroom, Dr. Anthony is dedicated to teaching the modeling and analysis of large-scale systems to support decision-making in domains such as manufacturing, medicine, and entertainment. He also leads efforts in developing optimization algorithms and software tools for system design and evaluation.

Dr. Anthony's dual roles in academia and industry position him as a bridge between cutting-edge research and real-world application, driving impactful technologies that shape the future of engineering and innovation.

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Vladimir Bulovi?

Director, MIT.nano,
Fariborz Maseeh (1990) Professor of Emerging Technology, MIT Electrical Engineering and Computer Science (EECS)

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Vladimir Bulovi? is a Professor of Electrical Engineering at the Massachusetts Institute of Technology, holding the Fariborz Maseeh Chair in Emerging Technology. He directs the Organic and Nanostructured Electronics Laboratory, co-leads the MIT-Eni Solar Frontiers Center, leads the Tata GridEdge program, and is the Founding Director of MIT.nano, MIT's new 200,000 sqft nano-fabrication, nano-characterization, and prototyping facility. He is an author of over 250 research articles (cited over 50,000 times and recognized as the top 1% of the most highly cited in the Web of Science). He is an inventor of over 100 U.S. patents in

1:10 PM

Keynote: MATERIALS, MEDICINE, HEALTH: SENSING THE WORLD AROUND US AT ALL SCALES
Elazer Edelman
Director, Institute for Medical Engineering and Science, MIT

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Professor Elazer Edelman is the Director of MIT's Institute for Medical Engineering and Science (IMES) and holds tenured faculty appointments in the Department of Medicine at Harvard Medical School, and in the Division of Health Sciences and Technology at the Massachusetts Institute of Technology. He is the Director of the Harvard-MIT Biomedical Engineering Center and of MIT's Clinical Research Center, and the current occupant of the Edward J. Poitras Chair at MIT.

Elazer Edelman received Bachelor's and Master's Degrees in Electrical Engineering from the Massachusetts Institute of Technology, an M.D. degree with distinction from Harvard Medical School, and then his Ph.D. in Medical Engineering and Medical Physics from the Massachusetts Institute of Technology. He is board certified in Internal Medicine, and in Cardiovascular Medicine, and currently serves as one of the Core Attending Physicians in the acute coronary care unit at the Brigham and Women's Hospital of the Harvard Medical School.

His research interests combine his scientific and medical training. His laboratory has earned international recognition in investigation, diagnosis, and treatment of various cardiovascular diseases. He and his laboratory have pioneered basic findings in vascular biology and the development and assessment of biotechnology, especially at the interface of tissues, devices, and materials and, in particular, imaging in cardiovascular disease and fusion imaging. Most recently, he and his students have focused on machine learning and artificial intelligence in the diagnosis and prognostication of critical diseases like aortic stenosis.

Dr. Edelman also directs the Harvard-MIT Biomedical Engineering Center, dedicated to applying the rigors of the physical sciences to elucidate fundamental biologic processes and mechanisms of disease. Many of his findings are now in clinical trial validation. Almost 350 students and postdoctoral fellows have passed through Dr. Edelman's laboratory, enabling publications of numerous papers and patents. He is a fellow of the American College of Cardiology, American Heart Association, Association of University Cardiologists, American Society of Clinical Investigation, American Institute of Medical and Biological Engineering, American Academy of Arts and Sciences, National Academy of Medicine and National Academy of Engineering, and National Academy of Inventors. As Chief Scientific Advisor of *Science: Translational Medicine,* he has set the tone for the national debate on translational research and innovation.

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(Elazer Edelman video time stamp starts at: 9:46)

We live in a remarkable time – survival from the most fatal and morbid diseases have dropped precipitously concomitant with extraordinary burgeoning of novel biological insights and the introduction of new technology. Technology and science march hand in hand to improve health. Yet, the onset of this newest viral pandemic has created another global crisis. MIT NANO and IMES through its CRC have long come together to use and advance technology to address issues in human health and disease. Together we sense the world around us at multiple dimensions to quantify our environment and anticipate how to influence our world for good. This talk will provide a view as to the power of multiscale investigations and the impact of such collaborations on established and emerging diseases.

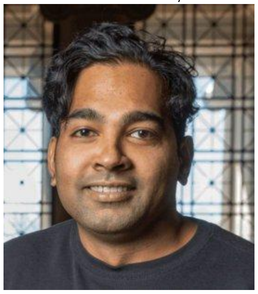
1:40 PM

Peek into research

(Video time stamp starts at: 51.35)

1:45 PM Session Introduction

1:50 PM Democratizing Single Molecule Nanoarrays
Ashwin Gopinath
Assistant Professor, Mechanical Engineering



Ashwin Gopinath
Assistant Professor, Mechanical Engineering

Ashwin Gopinath joined MIT in January 2019 as an assistant professor in Mechanical Engineering where his lab is working on projects at the intersection of molecular self-assembly, surface-chemistry, CMOS nanofabrication, and synthetic biology. Dr. Gopinath earned his PhD in electrical engineering from Boston University for his work on understanding light transport in disordered media. Subsequently, he was a senior research scientist at Caltech and then a research scientist at Google [X]. Dr. Gopinath has co-authored 21 papers in journals including Nature, Science and PNAS as well as received several awards, most recent of which is the 2017 Robert Dirk Prize in Molecular Programming for his seminal contributions in merging DNA nanotechnology with conventional semiconductor nanofabrication.

View full bio

(Ashwin Gopinath video time stamp starts at: 57.22)

Arrays of individual molecules or nanoparticles can combine the advantage of microarrays and single-molecule experiments. They facilitate miniaturized high-throughput assays with low sample and reagent consumption while also revealing heterogeniety hidden in ensemble measurements. However, creating single molecule arrays are particularly difficult since conventional nano-fabrication techniques can't be used to organize individual molecules onto defined positions on a substrate. In this context 'DNA origami placement' is an appealing technique as it allows any molecule (or nanoparticle) that can be labeled with DNA to be organized on arbitrary substrates using standard lithographic processes. The challenge now becomes one of reducing cost, developing applications, and increasing the capabilities.

In this talk, Gopinath will introduce a bench-top technique to create cm-scale DNA origami nanoarrays that does not require any nanopatterning step, at a cost of $1 per cm^2 and Gopinath will also discuss the application of this technique for point-of-care diagnostics. Finally, Gopinath will end by introducing strategies for performing non-aqueous organic reaction on immobilized DNA origami for creating arrays of extremely hydrophobic molecules.

2:05 PM

Interferometric Imaging for Studying Sickle Cell Disease and Cancer Metastasis
Peter So
Professor, Mechanical Engineering and Biological Engineering

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Professor, Mechanical Engineering and Biological Engineering

Peter So is a professor in the Department of Mechanical and Biological Engineering at the Massachusetts Institute of Technology. Prior to joining MIT, Professor So obtained his Ph.D. from Princeton University in 1992 and subsequently worked as a postdoctoral associate in the Laboratory for Fluorescence Dynamics at the University of Illinois in Urban-Champaign. His research focuses on developing high resolution and high information content microscopic imaging instruments. These instruments are applied in biomedical studies such as the non-invasive optical biopsy of cancer, the mechanotransduction processes in cardiovascular diseases, and the effects of neuronal remodeling on memory plasticity. Peter So is currently the Director of the MIT Laser Biomedical Research Center, an NIH NIBIB P41 research resource.

(Peter So video time stamp starts at: 71.11)

Quantitative interferometric microscopy is a power non-invasive technique to extract quantitative cellular biomechanical and morphological information. On one hand, we will describe several generations of quantitative interferometric microscopic systems with improved spectral contrast, depth resolution, and enhanced sensitivity. In conjunction with these advances in optical imaging techniques, important biomedical applications have become possible including the identification of biophysical markers of sickle red blood cells and the study of cancer cell nuclear mechanics in relationship to their metastasis potential.

2:20 PM

Dynamic Lens Systems for Biosensing
Timothy Swager
John D. MacArthur Professor of Chemistry

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John D. MacArthur Professor of Chemistry

Timothy M. Swager is the John D. MacArthur Professor of Chemistry the Department of Chemistry at MIT and the Faculty Director of the Deshpande Center for Technological Innovation. In this latter role, Professor Swager works with the Center's Executive Director to define the Center's strategy for fostering innovation, assists with the commercialization of MIT technologies, and plays a key role in the grant selection process. Professor Swager also serves as the Center's liaison to the MIT academic community, and senior leadership, sitting on faculty and academic committees. Following Professor Swager's postdoctoral appointment at MIT, he joined the chemistry faculty at the University of Pennsylvania, returning to MIT in 1996 as a Professor of Chemistry, and served as the Head of Chemistry from 2005-2010. Professor Swager's research interests are in design, synthesis, and study of organic-based electronic, sensory, high-strength and liquid crystalline materials. He has published more than 400 peer-reviewed papers and more than 80 issued/pending patents. Professor Swager is the founder of four companies (DyNuPol, Iptyx, PolyJoule, and C2Sense) and has served on a number of corporate and government boards.He received a B.S. from Montana State University in 1983 and a Ph.D., from the California Institute of Technology in 1988.

View full bio

(Timothy Swager video time stamp starts at: 86.35)

This lecture will focus on the design of systems wherein reconfiguration of complex liquid emulsions (droplets) can be triggered chemically or biochemically. The utility of these methods is to generate new transduction mechanisms by which chemical and biological sensors can be developed. Complex liquid droplets behave as optical lens systems and small changes in surface tensions can change focal lengths or cause systems to switch between optically transmissive or scattering states. Central to this scheme is that the fluids in the droplets have different densities and hence are aligned by the earth's gravity. The induced optical changes can be triggered with chemical, photochemical, or biochemical stimuli and thereby create new generations of sensors. Demonstrations of these methods for the detection of proteins, antibodies, and pathogens will be presented.

2:35 PM

Panel Q&A

(Panel Q&A video time stamp starts at: 103.57)

3:10 PM

Peek into research

3:15 PM

Session Introduction

3:20 PM

Modulation of Neural Function with Electronic, Optical, and Magnetic Tools

Polina Anikeeva
Professor, MIT Materials Science and Engineering and MIT Brain and Cognitive Sciences,
MIT Brain and Cognitive Sciences

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Professor, MIT Materials Science and Engineering and MIT Brain and Cognitive Sciences
MIT Brain and Cognitive Sciences

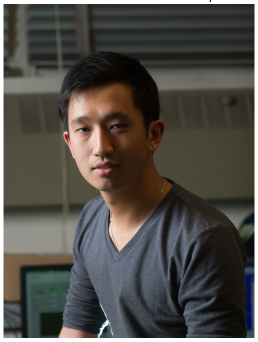
Polina Anikeeva received her BS in Physics from St. Petersburg State Polytechnic University, and a PhD in Materials Science and Engineering from MIT. She completed her postdoctoral training at Stanford, where she created devices for optical stimulation and recording from brain circuits. Polina joined the MIT faculty in 2011 and is currently a Matoula S. Salapatas Professor of Materials Science and Engineering and a Professor of Brain and Cognitive Sciences. She serves as the director of the K. Lisa Yang Brain-Body Center. Anikeeva's Bioelectronics research group focuses on the development of minimal approaches to record and modulate the physiology of the nervous system, especially in the context of brain-body communication. Anikeeva is a recipient of the NSF CAREER Award, the DARPA Young Faculty Award, the TR35, the Vilcek Prize for Creative Promise, and the NIH Pioneer Award.

View full bio

To understand the function and dynamics of the nervous system, and to find treatments for the neurological and psychiatric conditions that increasingly affect our aging society, new tools capable of addressing neuronal signaling complexity are urgently needed. These tools must also match the mechanical and chemical properties of the neural tissue to avoid foreign body response and functional perturbation to local circuits. By leveraging fiber-drawing methods from the telecommunications industry, our group creates flexible and stretchable probes capable of recording and stimulation of neural activity as well as delivery of drugs and genes into the brain and spinal cord. We use these probes to interrogate brain circuits, such as those involved in anxiety and fear, and to promote recovery following spinal cord and nerve injury. Simultaneosly, we develop a broad range of magnetic nanotransducers that convert externally applied magnetic fields into thermal, chemical, and mechanical signals, which can then be perceived by ion channels on neurons. Since biological tissues exhibit negligible magnetic permeability and low conductivity, magnetic fields can penetrate deep into the body with no attenuation, allowing us to apply the nanomagnetic transducers to remotely control deep brain circuits associated with reward and motivation, as well as adrenal circuits involved in regulation of corticosterone and (nor)epinephrine release.

3:35 PM

Non-Contact Laser Ultrasound
Xiang (Shawn) Zhang
Postdoctoral Associate, Computational Instrumentation Lab at Mechanical Engineering



Xiang (Shawn) Zhang
Postdoctoral Associate, Computational Instrumentation Lab at Mechanical Engineering

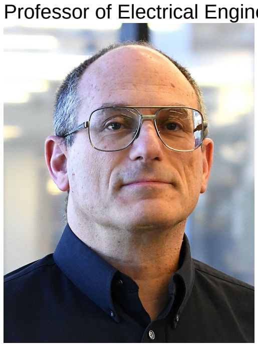
Xiang (Shawn) Zhang is a Postdoctoral Associate in the Computational Instrumentation Lab advised by Dr. Brian Anthony. Shawn's research focuses on non-contact laser ultrasound and design of novel systems to enhance/extend ultrasound beyond present capabilities. Shawn completed his Ph.D. and Master's at MIT in Mechanical Engineering with research focusing on non-contact ultrasound, including laser ultrasound and ultrasound tomography. Shawn received his undergraduate degree in Mechanical Engineering at the University of Maryland-College Park (UMCP); during which he completed a co-op at National Institute of Standards and Technology (NIST) designing the Watt Balance to redefine the SI kilogram. Outside of research, Shawn was a mentor at MIT MakerWorkshop and a team lead for MIT Hyperloop.

(Xiang (Shawn) Zhang video time stamp starts at: 23.19)

Full non-contact laser ultrasound (LUS) imaging has several distinct advantages over current medical ultrasound (US) technologies: elimination of coupling mediums (gel/water), operator-independent image quality, improved repeatability, and volumetric imaging. Current light-based ultrasound utilizing tissue penetrating photoacoustics (PA) generally uses traditional piezoelectric transducers in contact with the imaged tissue or carries an optical fiber detector close to the imaging site. Unlike PA, LUS minimizes optical penetration and specifically restricts optical to acoustic energy transduction at the tissue surface, maximizing the generated acoustic source amplitude. LUS operates analogous to conventional ultrasound by using light to replace piezoelectric elements. Experimental LUS images at ~5 cm image depths with meter scale standoff successfully demonstrates the feasibility of LUS for human imaging at eye and skin safe optical exposure levels. First human LUS images inspire further LUS development and is a significant step toward clinical implementation of LUS.

3:50 PM

Hand-Held Magnetic Resonance Imaging
Jacob K. White
Professor of Electrical Engineering and Computer Science



Jacob K. White
Professor of Electrical Engineering and Computer Science

Professor White has been a faculty member at MIT since 1987, is currently the C.H. Green Professor in Electrical Engineering and Computer Science, and recently became a MacVicar Faculty Fellow. His research area is in numerical algorithms and software for engineering design, and his current focus is on using novel combinations of computation and commodity hardware to develop medical and educational technology with minimal economic barriers.

View full bio

(Jacob White video time stamp starts at: 38.36)

The costs and complex infrastructure for high-field (> 1.5 Tesla) magnetic resonance (MR) imaging has relegated this extremely-safe and remarkably-revealing clinical tool to high-end hospital care. Recently-developed low-field MR imagers (0.05 to 0.2 Tesla) are changing this situation, because they can accurately image an adult brain, yet are portable enough to wheel to an ICU or NICU.

In this talk, White will discuss his group's nascent effort to go even further—an imager that a clinician could slide over an arm (or a leg, or an infant's head), and "see beneath the skin" in real time. White will start by describing the techniques used in their $100, student-assembleable, finger-sized imager, and then discuss the daunting challenges in moving beyond their very small educational device.

4:05 PM

Panel Q&A

(Panel Q&A video time stamp starts at: 55.03)

4:25 PM

Peek into research

4:30 PM

Closing remarks

Day 2 - Tuesday, September 22, 1:00 PM – 4:30 PM

1:00 PM

Welcoming remarks
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1:10 PM Introducing Analog Devices' Digital Health business and the role of sensors in Medtech

Brendan Cronin
Director, Digital Healthcare Group at Analog Devices

(Brendan Cronin video time stamp starts at 6.21)

The growing diversity and complexity of healthcare systems brings with it a support challenge for clinicians and Medtech companies alike. This is particularly true within the emerging Digital Healthcare market, where the number of applications is growing rapidly, and the ecosystems are typically large and complex. Understanding these systems and aligning key sensor and interface technology is critical to driving growth in both existing and emerging applications. This talk will provide insight into ADI's Healthcare business and share details on our version of Digital Health. Examples of new applications will be analyzed, focusing on key challenges and relevant sensor technology (e.g. nano-sensors for rapid point-of-care diagnostics and monitoring for disease management, smart sensor systems for synthetic biology, etc.). The talk will conclude with a discussion on future needs and initiatives needed to drive further adoption of digital health solutions.

1:35 PM Peek into research

(Video time stamp starts at 35.50)

1:40 PM Session Introduction

1:45 PM Rapid Antigen Diagnostics for Emerging Pathogens
Lee Gehrke
Hermann L.F. von Helmholtz Professor of Health Sciences

Lee Gehrke
Hermann L.F. von Helmholtz Professor of Health Sciences

Lee Gehrke is Hermann L.F. von Helmholtz Professor of Health Sciences at MIT and Professor of Microbiology at Harvard Medical School. His laboratory studies host-pathogen interactions in virus infections, in addition to developing rapid antigen diagnostics for human viral infections, including dengue virus, Zika virus, Chikungunya virus, and SARS-CoV-2. The goal of the rapid test development is to design rapid, inexpensive, easy to use tests that can be scaled for use anywhere in the world without need for power, special chemicals, or special training.

A large number of animal species are hosts to viruses in geographic areas that have historically beenseparated from humans. With climate change, deforestation, and increased urbanization, what was once rare human contact with these pathogens is increasing, leading to spillover events that cause emerging virus infections. Rapid diagnostic tests are needed for population surveillance to identify circulating pathogens, as well as to serve health care workers in detecting and distinguishing pathogens for optimal patient care. The goal of our work is to develop low cost tests that are simple to use, do not require power, and do not require special chemicals. In COVID19 disease, the absence of a vaccine means that active vigilance, accomplished by regular testing (every 2-3 days) is required to prevent superspreader transmission. This regular testing requires an inexpensive test that can be used as a point-of-care diagnostic. We are actively pursuing technologies to reduce the cost of developing rapid antigen tests, permitting advance diagnostics development that precedes outbreaks and epidemics.

2:00 PM

GI device development in a few movements
Giovanni Traverso
Assistant Professor, Mechanical Engineering

Giovanni Traverso
Assistant Professor, Mechanical Engineering

Giovanni Traverso is an Assistant Professor in the Department of Mechanical Engineering at the Massachusetts Institute of Technology (MIT) and also a gastroenterologist in the Division of Gastroenterology, Brigham and Women's Hospital (BWH), Harvard Medical School. Dr. Traverso grew up in Peru, Canada and the United Kingdom. He received his BA from Trinity College, University of Cambridge, UK, and his PhD from the lab of Prof. Bert Vogelstein at Johns Hopkins University. He subsequently completed medical school at the University of Cambridge, internal medicine residency at the Brigham and Women's Hospital and his gastroenterology fellowship training at Massachusetts General Hospital, both at Harvard Medical School. Dr. Traverso's previous work focused on the development of novel molecular tests for the early detection of colon cancer. For his post-doctoral research, he transitioned to the fields of chemical and biomedical engineering in the laboratory of Professor Robert Langer at MIT where he developed a series of novel technologies for drug delivery as well as physiological sensing via the gastrointestinal tract.

His current research program is focused on developing the next generation of drug delivery systems to enable safe and efficient delivery of therapeutics as well developing novel ingestible electronic devices for sensing a broad array of physiologic and pathophysiologic parameters. Additionally, Dr. Traverso continues his efforts towards the development of novel diagnostic tests that enable the early detection of cancer.

(Giovanni Traverso video time stamp starts at 57.10)

Medication non-adherence (non-compliance) represents a major barrier to effective clinical care. In developed nations, only 50% of patients take their medications as prescribed, manifesting in more than $100 billion in avoidable hospitalizations every year in the United States alone, and the numbers are far worse in the developing world. In his talk, Dr. Traverso will present a series of novel technologies being developed with the goal to enhance and facilitate medication administration. Specifically, Dr. Traverso will discuss the development of new technologies for the delivery of macromolecules through the oral route.

2:15 PM

Electronic Textile Conformable Suit (E-TeCS)
Canan Dagdeviren
Assistant Professor, Media Arts and Sciences
LG Career Development Professor of Media Arts and Sciences, MIT Media Lab

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Assistant Professor, Media Arts and Sciences
LG Career Development Professor of Media Arts and Sciences, MIT Media Lab

Canan Dagdeviren joined the faculty in January 2017 to direct the new Conformable Decoders research group at the MIT Media Lab. The group will create mechanically adaptive electromechanical systems that can intimately integrate with the target object for sensing, actuation, and energy harvesting, among other applications. Dagdeviren believes that vital information from nature and the human body is 'coded' in various forms of physical patterns. Her research focuses on the creation of conformable decoders that can 'decode' these patterns into beneficial signals and/or energy.

Dagdeviren created a wide range of piezoelectric systems that can be twisted, folded, stretched/flexed, wrapped, and implanted onto curvilinear surfaces of human body, without damage or significant alteration in device performance. She received her PhD in materials science and engineering from the University of Illinois at Urbana-Champaign with a focus on exploring patterning techniques and creating piezoelectric biomedical systems. Her collective PhD research involved flexible mechanical energy harvesters, multi-functional cardiac vessel stents, wearable blood pressure sensors, and stretchable skin modulus sensing bio-patches. As a Junior Fellow of the Society of Fellows of Harvard University, she conducted her postdoctoral research at MIT David H. Koch Institute for Integrative Cancer Research to design and fabricate multi-functional, minimally invasive brain injectrodes that can simultaneously deliver drugs on demand and electrically modulate neural activity precisely and selectively for the treatment of neurological disorders such as Parkinson's disease.

Dagdeviren's work has been recognized by various prestigious media outlets, such as *the Smithsonian*, *MIT Technology Review*, *Popular Mechanics*, CBS News, LA Times, BBC News, *New Scientist, Medical Daily, IEEE Spectrum, Physics World, Nature Materials, C&ENews, Forbes, and Qmed/Medical Product Manufacturing News*. In 2015, Dagdeviren was named to the "Top 35 Innovators Under 35" (inventor category) by *MIT Technology Review*, and to the "Top 30 Under 30 in Science" by *Forbes*. Dr. Dagdeviren has been named as the 2017 Innovation and Technology Delegate of the American Academy of Achievement. In 2019, Dr. Dagdeviren has been named as one of the nation's 87 brightest young engineers by the National Academy of Engineering (NAE) to take part in the NAE's 25th annual US Frontiers of Engineering (USFOE) Symposium.

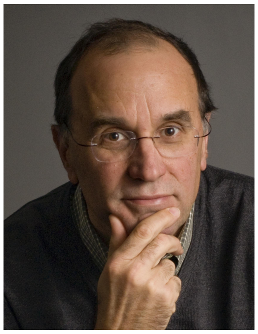
View full bio

(Canan Dagdeviren video time stamp starts at 111.33)

The rapid advancement of electronic devices and fabrication technologies has further promoted the field of wearables and smart textiles. However, most of the current efforts in textile electronics focus on a single modality and cover a small area. In this work, we introduce a new platform of modular, conformable (i.e., flexible and stretchable) distributed sensor networks that can be embedded into digitally-knit textiles. This platform can be customized for various forms, sizes, and functions using standard, accessible, and high-throughput textile manufacturing and garment patterning techniques. Here, we have developed a tailored, electronic textile conformable suit (E-TeCS) to perform large-scale, multi-modal physiological (temperature, heart rate, and respiration) sensing *in vivo*.

2:30 PM

MR relaxometer for improving clinical outcomes in hemodialysis
Michael Cima
David H. Koch Professor of Engineering, MIT Koch Institute for Integrative Cancer Research



Michael Cima
David H. Koch Professor of Engineering, MIT Koch Institute for Integrative Cancer Research

Dr. Michael J. Cima is the David H. Koch Professor of Engineering, co-director of MIT's Innovation Initiative and Associate Dean of Innovation for the School of Engineering. He also holds the David H. Koch Chair of Engineering at MIT.

Prof. Cima was the recipient of the W. David Kingery Award in 2019, was elected to the National Academy of Inventors in 2016 and the National Academy of Engineering in 2011. He is faculty director of the Lemelson-MIT Program which inspires youth to be inventive and

Michael is author or co-author of over 250 peer-reviewed scientific publications and 80 US patents, and is a recognized expert in materials processing. He is the co-inventor of MIT's three-dimensional printing process.

Prof. Cima has extensive entrepreneurial experience. He co-founded SpringLeaf Therapeutics, a specialty pharmaceutical company, Taris Biomedical, a urology products company acquired by Johnson & Johnson, MicroChips Inc., a developer of microelectronic based drug delivery and diagnostic systems and T2 Biosystems, a medical diagnostics company for which he also serves as director.

View full bio

(Michael Cima video time stamp starts at 127.45)

We recently discovered in a human clinical trial that the MR signal originating from skeletal muscle is an absolute measure of excess volume in end-stage renal disease (ESRD) patients undergoing hemodialysis (HD). HD patients are prescribed a volume of fluid to be removed by ultrafiltration during their dialysis session based on an assumed “dry weight”. Current real-time assessment measures include hematocrit with the objective of keeping it constant. The vascular volume is maintained during dialysis using this technology. Hematocrit does not, however, provide a measure of how close the patient is to his/her dry weight. Clinical signs and symptoms are used to identify hypovolemia due to excessive fluid withdrawal. These non-specific indicators often lag behind the onset of hypovolemia and their presentation is highly variable between patients. Excessive fluid removal during HD is associated with nausea, vomiting, cramping, and chest pain. We have constructed a sensor that will measure the tissue relaxivity of muscle without the need for an MRI. This bedside instrument is portable and compatible with the dialysis suite. Our goal is to improve management of ESRD patient during HD and ultimately improve outcomes.

2:45 PM

Panel Q&A

(Panel Q&A video time stamp starts at 144.30)

3:15 PM

Session Introduction

3:20 PM

A Framework for Biomarkers of COVID-19 Based on Neuromotor Coordination in Speech
Thomas F. Quatieri
Senior Staff, Human Health and Performance Systems Group, Lincoln Laboratory

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Senior Staff, Human Health and Performance Systems Group, Lincoln Laboratory

Thomas F. Quatieri received his B.S. degree (summa cum laude) from Tufts University in Medford, MA, and S.M., E.E., and Sc.D. degrees from the Massachusetts Institute of Technology (MIT) in Cambridge, MA. He is a senior member of the technical staff with MIT Lincoln Laboratory, Lexington, focused on speech and auditory signal processing and neuro-biophysical modeling with application to detection and monitoring of neurological, neurotraumatic, and stress conditions.

Dr. Quatieri holds a faculty appointment in the Harvard-MIT Speech and Hearing Bioscience and Technology Program. He is an author on more than 200 publications, holds 12 patents, and authored the textbook Discrete-Time Speech Signal Processing: Principles and Practice. He is a recipient of four IEEE Transactions Best Paper Awards and the 2010 MIT Lincoln Laboratory Best Paper Award. He led the Lincoln Laboratory team that won the 2013 and 2014 AVEC Depression Challenges and the 2015 MIT Lincoln Laboratory Team Award for their work on vocal and facial biomarkers. He served on many IEEE technical committees and the IEEE James L. Flanagan Speech and Audio Awards Committee. He has also served on the editorial board of the IEEE Transactions on Signal Processing, and is currently an associate editor of Computer, Speech, and Language. He co-led the mHealth group on Monitoring COVID Patients and Clinical Personnel under the Mass General Brigham Center for COVID Innovation. He is a Fellow of the IEEE and a member of Tau Beta Pi, Eta Kappa Nu, Sigma Xi, ICSA, and ASA.

View full bio

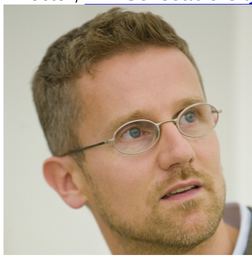
(Thomas Quatieri video time stamp starts at 6.16)

A framework is proposed to detect and track COVID-19 based on changes in neuromotor coordination across speech subsystems involved in respiration, phonation, and articulation. The approach is motivated by evidence of widespread inflammation of COVID-19 throughout the body including lower (i.e., bronchial tubes, diaphragm, lower trachea) and upper (i.e., laryngeal, pharyngeal, oral and nasal) tract injury, as well as by the growing evidence of the virus' neurological impact. An exploratory study is described involving a small set of pre-COVID-19 (pre-exposure) versus post-COVID-19 (after positive diagnosis but presumed asymptomatic) audio interviews and a larger cohort of control versus post-COVID-19 participants in an online protocol designed by Voca.ai in collaboration with Carnegie Melon University.

For each cohort pair, Cohen's d effect sizes were measured using coordination of respiration (as measured through the acoustic speech envelope) and laryngeal motion (fundamental frequency and cepstral peak prominence), and coordination of laryngeal and articulatory (formant center frequencies) motion. While there is a strong subject-dependence, group-level morphology of effect sizes indicates a reduced complexity of subsystem coordination. For the later (larger) cohort, an encouraging detection/false alarm tradeoff was estimated using a Gaussian mixture-based classifier. Validation is needed with larger more controlled datasets and addressing confounding influences such as different recording conditions, unbalanced data quantities, and changes in underlying vocal status from pre-to-post time recordings including changes in emotional state.

3:35 PM

Senseable Cities
Carlo Ratti
Director, MIT Senseable City Lab



Carlo Ratti
Director
MIT Senseable City Lab

An architect and engineer by training, Professor Carlo Ratti teaches at the Massachusetts Institute of Technology (MIT), where he directs the Senseable City Lab, and is a founding part-ner of the international design and innovation office Carlo Ratti Associati. He graduated from the Politecnico di Torino and the École Nationale des Ponts et Chaussées in Paris, and later earned his MPhil and PhD at the University of Cambridge, UK.

A leading voice in the debate on new technologies' impact on urban life and design, Car-lo has co-authored over 500 publications, including "The City of Tomorrow" (Yale University Press, with Matthew Claudel), and holds several technical patents. His articles and interviews have appeared on international media including The New York Times, The Wall Street Journal, The Washington Post, Financial Times, Scientific American, BBC, Project Syn-dicate, Corriere della Sera, Il Sole 24 Ore, Domus. His work has been exhibited worldwide at venues such as the Venice Biennale, the Design Museum Barcelona, the Science Museum in London, MAXXI in Rome, and MoMA in New York City.

Carlo has been featured in Esquire Magazine's 'Best & Brightest' list and in Thames & Hud-son's selection of '60 innovators' shaping our creative future. Blueprint Magazine included him as one of the '25 People Who Will Change the World of Design', Forbes listed him as one of the 'Names You Need To Know' and Fast Company named him as one of the '50 Most Influen-tial Designers in America'. He was also featured in Wired Magazine's 'Smart List: 50 people who will change the world'. Three of his projects – the *Digital Water Pavilion*, the *Copenhagen Wheel and Scribit* – have been included by TIME Magazine in the list of the 'Best Inventions of the Year'.

Carlo has been a presenter at TED (in 2011 and 2015), program director at the Strelka Insti-tute for Media, Architecture and Design in Moscow, curator of the BMW Guggenheim Pavilion in Berlin, and was named Inaugural Innovator in Residence by the Queensland Government. He was the curator of the Future Food District pavilion for the 2015 World Expo in Milan and chief curator of the "Eyes of the City" section at the 2019 UABB Biennale of Architecture and Urbanism of Shenzhen. He is currently serving as co-chair of the World Economic Forum's Global Future Council on Cities and Urbanization.

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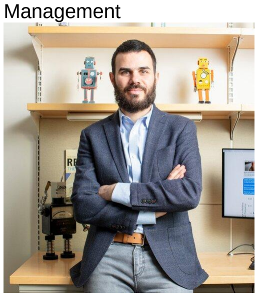
The way we live, work, and play is very different today than it was just a few decades ago, thanks in large part to a network of connectivity that now encompasses most people on the planet. In a similar way, today we are at the beginning of a new technological revolution: the Internet is entering the physical space – the traditional domain of architecture and design – becoming an "Internet of Things" or IoT. As such, it is opening the door to a variety of applications that – in a similar way to what happened with the first wave of the Internet - can encompass many domains: from energy to mobility, from production to citizen participation. The contribution from Prof. Carlo Ratti will address these issues from a critical point of view through projects by the Senseable City Laboratory, a research initiative at the Massachusetts Institute of Technology, and the design office Carlo Ratti Associati.

3:50 PM

Fighting COVID-19 Misinformation on Social Media
David Rand
Erwin H. Schell Associate Professor of Management Science, MIT Sloan School of Management



David Rand
Erwin H. Schell Associate Professor of Management Science, MIT Sloan School of Management

David Rand is the *Erwin H. Schell Professor* and Professor of Management Science and Brain and Cognitive Sciences at MIT, the director of the Applied Cooperation Team, and an affiliate of the MIT Institute of Data, Systems, and Society, and the Initiative on the Digital Economy. Bridging the fields of cognitive science, behavioral economics, and social psychology, David's research combines behavioral experiments run online and in the field with mathematical and computational models to understand people's attitudes, beliefs, and choices. His work uses a cognitive science perspective grounded in the tension between more intuitive versus deliberative modes of decision-making. He focuses on illuminating why people believe and share misinformation and "fake news," understanding political psychology and polarization, and promoting human cooperation. David received his BA in computational biology from Cornell University in 2004 and his PhD in systems biology from Harvard University in 2009, was a post-doctoral researcher in Harvard University's Department of Psychology from 2009 to 2013, and was an Assistant and then Associate Professor (with tenure) of Psychology, Economics, and Management at Yale University prior to joining the faculty at MIT.

(David Rand video time stamp starts at 37.31)

The COVID-19 pandemic represents a substantial challenge to global human well-being. Not unlike other challenges (e.g., global warming), the impact of the COVID-19 pandemic depends on the actions of individual citizens and, therefore, the quality of the information to which people are exposed. Unfortunately, however, misinformation about COVID-19 has proliferated, including on social media. In this talk, Rand will present evidence that people share false claims about COVID-19 partly because they simply fail to think sufficiently about whether or not the content is accurate when deciding what to share.

In a first study, participants were far worse at discerning between true and false content when deciding what they would share on social media relative to when they were asked directly about accuracy. Furthermore, greater cognitive reflection and science knowledge were associated with stronger discernment. In a second study, we found that a simple accuracy reminder at the beginning of the study (i.e., judging the accuracy of a non-COVID-19-related headline) nearly tripled the level of truth discernment in participants' subsequent sharing intentions. Our results, which mirror those found previously for political fake news, suggest that nudging people to think about accuracy is a simple way to improve choices about what to share on social media.

4:05 PM

Panel Q&A

(Panel Q&A video time stamp starts at 54.55)

4:25 PM

Peek into research

4:30 PM

Closing remarks

Day 3 - Tuesday, September 29, 1:00 PM – 4:00 PM

1:00 PM

Introduction
Brian W Anthony

Principal Research Scientist, Department of Mechanical Engineering
Associate Director, MIT.nano
Director of Technical Operations, Center for Clinical and Translational Research

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Principal Research Scientist, Department of Mechanical Engineering
Associate Director, MIT.nano
Director of Technical Operations, Center for Clinical and Translational Research

Dr. Brian Anthony is a leading expert in the design of intelligent, or smart, instruments and methodologies for monitoring, measuring, and controlling complex physical systems. His interdisciplinary work spans mechanical, electrical, and optical engineering, seamlessly integrated with computer science and optimization, to deliver innovative solutions across manufacturing, healthcare, and other industries.

At the core of Dr. Anthony's research is computational instrumentation—the development of advanced tools and techniques to observe and manage intricate systems, particularly in manufacturing and medical diagnostics. His contributions include pioneering measurement and imaging technologies that enhance precision and performance in both industrial and clinical settings.

With over 30 years of experience, Dr. Anthony combines deep academic insight with practical industry expertise in technology innovation, product development, and entrepreneurship. He has successfully guided market-driven solutions from concept to commercialization, especially at the intersection of information technology and advanced manufacturing. His achievements include receiving an Emmy Award from the Academy of Television Arts and Sciences for technical innovation in broadcast engineering.

In the classroom, Dr. Anthony is dedicated to teaching the modeling and analysis of large-scale systems to support decision-making in domains such as manufacturing, medicine, and entertainment. He also leads efforts in developing optimization algorithms and software tools for system design and evaluation.

Dr. Anthony's dual roles in academia and industry position him as a bridge between cutting-edge research and real-world application, driving impactful technologies that shape the future of engineering and innovation.

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Vladimir Bulovi?

Director, MIT.nano,
Fariborz Maseeh (1990) Professor of Emerging Technology, MIT Electrical Engineering and Computer Science (EECS)

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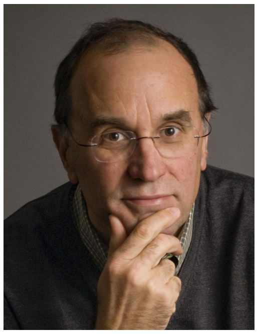
Director, MIT.nano,
Fariborz Maseeh (1990) Professor of Emerging Technology, MIT Electrical Engineering and Computer Science (EECS)

Vladimir Bulovi? is a Professor of Electrical Engineering at the Massachusetts Institute of Technology, holding the Fariborz Maseeh Chair in Emerging Technology. He directs the Organic and Nanostructured Electronics Laboratory, co-leads the MIT-Eni Solar Frontiers Center, leads the Tata GridEdge program, and is the Founding Director of MIT.nano, MIT's new 200,000 sqft nano-fabrication, nano-characterization, and prototyping facility. He is an author of over 250 research articles (cited over 50,000 times and recognized as the top 1% of the most highly cited in the Web of Science). He is an inventor of over 100 U.S. patents in

1:10 PM

Panel discussion: Needs and innovation
Michael Cima
David H. Koch Professor of Engineering, MIT Koch Institute for Integrative Cancer Research



Michael Cima
David H. Koch Professor of Engineering, MIT Koch Institute for Integrative Cancer Research

Dr. Michael J. Cima is the David H. Koch Professor of Engineering, co-director of MIT's Innovation Initiative and Associate Dean of Innovation for the School of Engineering. He also holds the David H. Koch Chair of Engineering at MIT.

Prof. Cima was the recipient of the W. David Kingery Award in 2019, was elected to the National Academy of Inventors in 2016 and the National Academy of Engineering in 2011. He is faculty director of the Lemelson-MIT Program which inspires youth to be inventive and

Michael is author or co-author of over 250 peer-reviewed scientific publications and 80 US patents, and is a recognized expert in materials processing. He is the co-inventor of MIT's three-dimensional printing process.

Prof. Cima has extensive entrepreneurial experience. He co-founded SpringLeaf Therapeutics, a specialty pharmaceutical company, Taris Biomedical, a urology products company acquired by Johnson & Johnson, MicroChips Inc., a developer of microelectronic based drug delivery and diagnostic systems and T2 Biosystems, a medical diagnostics company for which he also serves as director.

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Amy Moran-Thomas
Alfred Henry and Jean Morrison Hayes Career Development Associate Professor of Anthropology at MIT

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Alfred Henry and Jean Morrison Hayes Career Development Associate Professor of Anthropology at MIT

Amy Moran-Thomas is Alfred Henry and Jean Morrison Hayes Career Development Associate Professor of Anthropology at MIT. Her research bridges the anthropology of health and environment (chronic disease; ecological and agricultural change; metabolism and nutrition) with ethnographic studies of science and technology (medical devices; chemical infrastructures; technology and kinship). She is the author of the book *Traveling with Sugar: Chronicles of a Global Epidemic* (2019), and teaches courses on "The Social Lives of Medical Objects" at MIT.

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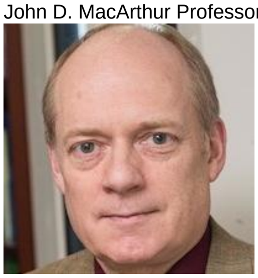
Timothy Swager
John D. MacArthur Professor of Chemistry



Timothy Swager
John D. MacArthur Professor of Chemistry

Timothy M. Swager is the John D. MacArthur Professor of Chemistry the Department of

1:50 PM	Peek into research

2:00 PM MIT Startup Exchange Presentations

Empatica - AI systems to monitor human health through wearable sensors - video time stamp: 8.21

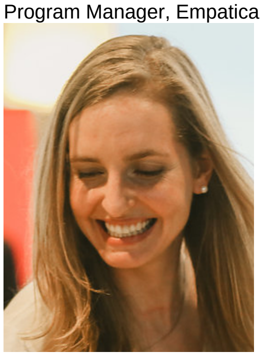
C2Sense - Miniaturized mobile sensing solutions for a healthier and safer world - video time stamp: 18.22

Dynocardia - Wearable, continuous, non-invasive blood pressure measurement - video time stamp: 26.26

Lelantos – Revolutionizing vapor sensing for threat detection, air quality monitoring and medical diagnosis - video time stamp: 33.07

Nextiles – Smart performance and injury monitoring apparel with more accessible and scalable technology - video time stamp: 43.32

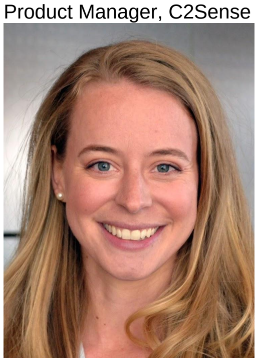
Chelsea Trengrove
Program Manager, Empatica



Chelsea Trengrove
Program Manager, Empatica

Dr. Chelsea Trengrove is Program Manager at Empatica, and has 5+ years of experience in international program management, business development, consulting, speaking, proposal writing, and regulatory compliance in the pharmaceutical and medical device industries. A Ph.D. with strong foundations in neuroscience and pharmacology research, she joined Empatica's team as a program manager just prior to their FDA clearance in 2018 for their seizure monitoring and alerting wearable device, Embrace. At Empatica, Chelsea guides biotechnology companies through the framework, science, and applications of Empatica's wearable technologies, as well as coordinates research initiatives, and clinical trials using Empatica's Embrace and E4 devices from ideation to execution.

Merry Smith
Product Manager, C2Sense



Merry Smith
Product Manager, C2Sense

Merry Smith is a Product Manager at C2Sense for the AuthenTags technology line, focusing on anti-counterfeiting applications in the pharmaceutical and high-end goods industries. She has a doctorate in chemistry from Wesleyan University (P.I. Prof. Brian Northrop) and prior to joining C2Sense in 2017, served as postdoctoral chemist at Dartmouth College (P.I. Prof. Katherine Mirica). She is co-inventor on 1 patent application and has published 12 peer-reviewed papers in the fields of carbon-rich nanomaterials and chemical sensor engineering.

Mohan Thanikachalam
President & CEO, Dynocardia

3:10 PM

Panel discussion: Experiences and lessons learned from COVID-19
Tolga Durak
Managing Director of Environment, MIT Health and Safety (EHS) Programs

Tolga Durak
Managing Director of Environment, MIT Health and Safety (EHS) Programs

As MIT's Managing Director of Environment, Health and Safety (EHS) Programs, Durak is the responsible administrator for health, safety and environmental programs for all MIT academic and administrative units. Durak leads EHS to assure university activities are conducted in compliance with applicable laws, regulations, best business practices as well as by supporting development, implementation, and monitoring of prevention control strategies and initiatives. In addition to the main MIT campus, EHS provides support for and oversight over all off-site and international departments, laboratories and research centers.

Durak holds a BS in Mechanical Engineering, a MS in Industrial & Systems Engineering and a PhD in Building Construction / Environmental Design and Planning. He has over 20 years of experience in engineering and EH&S in higher education. During his career, he has served in the capacity of EHS Director, Authority Having Jurisdiction, Responsible Official, Fire Marshal, Risk Manager, Radiation Safety Officer, Laser Safety Officer, Safety Engineer, Project Manager and Emergency Manager for government agencies as well as universities with extensive healthcare and research facilities. He is a practicing professional engineer, certified safety professional, certified building and fire official and an associate in risk management. During his academic tenure, Durak held engineering and public health faculty appointments. In addition to occupational safety and health, he has research interests in building sciences with emphasis on performance, energy efficiency, retrofitting solutions, systems integration, integrated control strategies and smart building materials. Durak is a proud father of twins Sam and Sloane and a competitive rower who races nationally and internationally in masters category.

Anette (Peko) Hosoi
Professor of Mechanical Engineering and Applied Mathematics

Anette (Peko) Hosoi
Professor of Mechanical Engineering and Applied Mathematics

Anette (Peko) Hosoi is a professor of Mechanical Engineering at MIT. She received her PhD in Physics from the University of Chicago and went on to become an NSF Postdoctoral Fellow in the MIT Department of Mathematics and at the Courant Institute, NYU. She is a leader in the study of the hydrodynamics of thin fluid films and in the nonlinear physical interaction of viscous fluids and deformable interfaces. Her work spans multiple disciplines including physics, biology and applied mathematics, and is being used, in collaboration with Schlumberger-Doll Research, Bluefin Robotics, and Boston Dynamics to guide the engineering design of robotic crawlers and other mechanisms.

Prof. Hosoi is an exceptional, innovative teacher and an inspiring mentor for women in engineering. She was awarded the Ruth and Joel Spira Award for Distinguished Teaching, and a MacVicar Fellowship. She is a recipient of the 3M Innovation Award and has held the Doherty Chair in Ocean Utilization at MIT. She is a Radcliffe Institute Fellow and a Fellow of the American Physical Society. Her research interests include fluid mechanics, bioinspired design and locomotion, with a focus on optimization of crawling gastropods, digging bivalves, swimming microorganisms and soft robotics. Prof. Hosoi is also an avid mountain biker and her passion for sports has led her to create STE@M, Sports Technology & Education at MIT. STE@M is a program that is designed to build an interconnected community of faculty, students, industry partners, alums and athletes who are dedicated to applying their technical expertise to advance the state-of-the-art in sports.

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Robert Sege
Professor of Medicine, Tufts Children's Hospital

3:50 PM	Closing remarks and looking to the future