

# MIT Industrial Liaison Program Faculty Knowledgebase Report

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Water and Industry @MIT

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April 6, 2021 10:00 am - 12:00 pm

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10:00 AM

Welcome and Introduction  
J.J. Laukaitis  
Program Director, [MIT Corporate Relations](#)



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Program Director  
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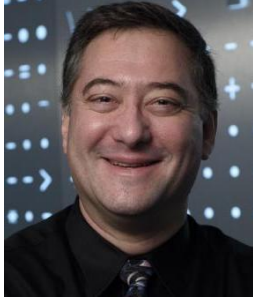
J.J. Laukaitis joined the Industrial Liaison Program in 2012 and is a strong believer in the amplifying power that comes from building enduring relationships between industry leaders and MIT researchers and innovators.

J.J. has over 25 years of experience in engineering, product management and commercial sales management across multiple industries including mechanical design and manufacturing, electronics, semiconductor equipment, health care IT and renewable energy.

In his work for PTC, Continuum, Teradyne, DFT Microsystems and GE, J.J. has managed programs to conceive, design and launch new products and services and has led major initiatives to transform customer information into insight for revenue growth.

10:05 AM

Non-intrusive sensing of industrial equipment  
Steven Leeb  
Professor of Mechanical and Electrical Engineering and Computer Science



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Steven B. Leeb received his doctoral degree from the Massachusetts Institute of Technology in 1993. He has served as a commissioned officer in the USAF reserves, and he has been a member of the M.I.T. faculty in the Department of Electrical Engineering and Computer Science since 1993. He also holds a joint appointment in MIT's Department of Mechanical Engineering. He currently serves as MacVicar Fellow and Professor of Electrical Engineering and Computer Science in the Laboratory for Electromagnetic and Electronic Systems. In his capacity as a Professor at M.I.T, he is concerned with the design, development, and maintenance processes for all kinds of machinery with electrical actuators, sensors, or power electronic drives. A major thrust in his current research is the development of power electronic drives and supplies for servomechanical and industrial applications, including medical drug delivery devices, battery chargers, motion controllers and fluorescent lamp ballasts. Another research interest related to power quality issues and on-line machine diagnostics involves the development of a Nonintrusive Load Monitor (NILM). The NILM determines the operating schedule of the major electrical loads in a commercial or industrial building from measurements made solely at the electrical utility service entry. He is currently working to develop the NILM into a virtually sensorless platform to determine power quality, perform critical load diagnostics, and monitor manufacturing processes and actuator performance on ships, aircraft, automobiles, and satellites. He is the author or co-author of over 200 publications and 20 US Patents in the fields of electromechanics and power electronics.

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When did it become normal for unprecedented quantities of data about you to automatically become the property of others? Why have we returned to a "server" model of information exchange for so many of our data services, reminiscent in ways of the early days of mainframe computing, where "someone else" is responsible for data security and service availability?

We are considering approaches for developing nonintrusive sensors that are relatively easy to install. These sensors offer several potential advantages. They can be installed at a central location and used to monitor the aggregate behavior of a collection of devices, reducing installation costs. Signal processing techniques can be used to disaggregate the behavior of individual devices influencing the aggregate stream. Data from these nonintrusive sensors is inherently collated. This talk will review three different examples of nonintrusive sensors: the Electronic Stethoscope, WaterWolf, and VAMPIRE. These three sensor systems permit nonintrusive monitoring of electric power consumption, water or fluid consumption, and electromechanical system performance including vibration monitoring, respectively. This talk will examine approaches for deploying and coordinating the operation of these sensors to secure data, minimize the need for communication bandwidth, and ensure the presentation of actionable information for enhancing system operation.

10:20 AM

MIT Startup Exchange Lightning Talk

[Akselos](#): Digital twins for industrial installations

David Knezevic  
Co-founder & CTO  
[Akselos](#)

10:25 AM

Machine Intelligence for Manufacturing and Operations  
Duane S. Boning  
Professor, Electrical Engineering and Computer Science  
Engineering Faculty Co-Director, Leaders for Global Operations (LGO) Program  
MTL Associate Director, Computation and CAD



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Professor, Electrical Engineering and Computer Science  
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Dr. Duane S. Boning is the Clarence J. LeBel Professor in Electrical Engineering, and Professor of Electrical Engineering and Computer Science in the [EECS Department](#) at MIT. He is affiliated with the MIT [Microsystems Technology Laboratories](#), and serves as MTL Associate Director for Computation and CAD. He is also the Engineering Faculty Co-Director of the [MIT Leaders for Global Operations \(LGO\)](#) program, serving in that role since September 2016. From 2004 to 2011, he served as Associate Head of the EECS Department at MIT. From 2011 through 2013 he was the Director/Faculty Lead of the [MIT Skoltech Initiative](#), and from 2011 through July 2018, he was the faculty Director of the [MIT/Masdar Institute Cooperative Program](#).

Dr. Boning received his S.B. degrees in electrical engineering and in computer science in 1984, and his S.M. and Ph.D. degrees in electrical engineering in 1986 and 1991, respectively, all from the Massachusetts Institute of Technology. He was an NSF Fellow from 1984 to 1989, and an Intel Graduate Fellow in 1990. From 1991 to 1993 he was a Member Technical Staff at the Texas Instruments Semiconductor Process and Design Center in Dallas, Texas, where he worked on semiconductor process representation, process/device simulation tool integration, and statistical modeling and optimization.

Dr. Boning is a Fellow of the IEEE, and has served as Editor in Chief for the IEEE Transactions on Semiconductor Manufacturing, and as chairman of the CFI/Technology CAD Framework Semiconductor Process Representation Working Group. He is a member of the IEEE, Electrochemical Society, Eta Kappa Nu, Tau Beta Pi, Materials Research Society, Sigma Xi, and the Association of Computing Machinery.

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10:40 AM

MIT Startup Exchange Lightning Talk

[Sourcewater](#): Real-time geospatial water and energy activity intelligence

Joshua Adler  
Founder & CEO  
[Sourcewater](#)

10:45 AM

MIT Startup Exchange Lightning Talk

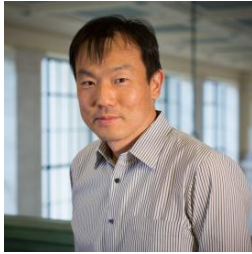
[SiTraction](#): Ultra-durable filtration membranes for cost- and energy-efficient industrial separations

Brendan Smith  
Co-founder & CEO  
[SiTraction](#)

10:50 AM

Detecting and Removing Emerging Contaminants from Water  
Jongyoon Han

Professor of Electrical Engineering, [Department of Electrical Engineering & Computer Science \(EECS\)](#)  
Professor of Biological Engineering, [Biological Engineering Division](#)



Jongyoon Han

Professor of Electrical Engineering, [Department of Electrical Engineering & Computer Science \(EECS\)](#)  
Professor of Biological Engineering, [Biological Engineering Division](#)

Dr. Jongyoon Han is currently a professor in the Department of Electrical Engineering and Computer Science and the Department of Biological Engineering, Massachusetts Institute of Technology. He received B.S.(1992) and M.S.(1994) degree in physics from Seoul National University, Seoul, Korea, and Ph.D. degree in applied physics from Cornell University in 2001. He was a research scientist in Sandia National Laboratories (Livermore, CA), until he joined the MIT faculty in 2002. He received NSF CAREER award (2003) and Analytical Chemistry Young Innovator Award (ACS, 2009). His research is mainly focused on applying micro/nanofabrication techniques to a very diverse set of fields and industries, including biosensing, desalination / water purification, biomanufacturing, dentistry, and neuroscience. He is currently the lead PI for MIT's participation for NIIMBL (The National Institute for Innovation in Manufacturing Biopharmaceuticals).

While the conventional water treatment technology is relatively well-established, we see a continuously increased list of emerging water contaminants (heavy metals, PFAS, infectious pathogens, pharmaceuticals, etc.), which poses challenges for both detection/monitoring and removal technologies. Many of these emerging contaminants need to be detected at the lowest abundance level, challenging our ability to monitor environmental contamination continuously. Besides, targeted removal processes (often based on chemical treatment) are deployed as 'add-on' to existing water treatment processes, increasing the cost significantly without offering the flexibility for dealing with various emerging contaminants. In the Han group (MIT), we approach these challenges by developing electrokinetic contaminant concentration/removal processes called Ion Concentration Polarization (ICP). A diverse class of contaminants (TSS, heavy metal, biomolecules, cells, salt ions, etc.) can be concentrated for more sensitive detection and removed to generate clean water in a single-step process. Our vision is to combine advanced monitoring with advanced removal, providing technical options for intelligent contamination management for many different application scenarios such as industrial/agricultural/domestic water generation.

11:05 AM

MIT Startup Exchange Lightning Talk

[Gradient](#): Solving complex water and wastewater treatment challenges

Anurag Bajpayee  
CEO  
[Gradient](#)

11:10 AM

Unconventional Materials and Paradigms for Water Purification and Quality Control in the 21st Century

Rohit Karnik

Professor of Mechanical Engineering, [Microfluidics & Nanofluidics Research Laboratory](#)



Rohit Karnik

Professor of Mechanical Engineering

[Microfluidics & Nanofluidics Research Laboratory](#)

Rohit Karnik is Professor of Mechanical Engineering at the Massachusetts Institute of Technology, where he leads the Microfluidics and Nanofluidics Research Group. He obtained his B. Tech. degree from the Indian Institute of Technology at Bombay in 2002, and his PhD from the University of California at Berkeley in 2006 under the guidance of Prof. Arun Majumdar. After postdoctoral work with Prof. Robert Langer at MIT, he joined the Department of Mechanical Engineering at MIT in 2007. His research focuses on the physics of micro- and nanofluidic flows and design of micro- and nanofluidic devices for applications in healthcare, energy systems, and biochemical separation and analysis. Among other honors, he is a recipient of the Institute Silver Medal (IIT Bombay, 2002), NSF Career Award (2010), Keenan Award for Innovation in Undergraduate Education (2011), DOE Early Career Award (2012), and IIT Bombay Young Alumni Achiever Award (2014).

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Innovations across the entire spectrum of technology, policy, business, and society are needed to address the challenge of providing an adequate amount of clean water in the 21<sup>st</sup> century. In this talk, I will present our work on exploring unconventional materials and paradigms for water purification and quality control to address this challenge. At the smallest scale, we present the development of atomically thin membranes made from a single atom-thick layer of graphene, where water can rapidly flow through engineered angstrom-sized pores that reject contaminant molecules and salt ions. I will discuss advances in pore creation, fabrication, and scale-up that illustrate the feasibility of realizing this new class of membrane that could lead to more energy-efficient, compact, and versatile water purification systems. At a larger scale, we show that the sapwood of conifers can be used as natural, chemical-free, low-cost, and easily manufactured filters to remove microbes and turbidity from drinking water. These filters exploit the naturally-occurring membranes in the xylem tissue of plants to remove microbes and present opportunities to create unique pay-as-you-go business models for household water filters with replacement costs of only a few cents. We also present human-centric filter device design and field studies that illustrate the potential of xylem filters to provide clean water to people without access to existing water purification technologies. At the systems scale, we present our findings through field studies in India and technology development to address the gap in monitoring trace contaminants in water by 'dry sampling' – a paradigm that repurposes materials developed to easily preserve and convey water samples from the water source to a central laboratory, thereby enabling the measurement of trace contaminants that is not possible with local infrastructure. These studies illustrate the opportunities and challenges involved in fundamental research and development and its translation to ground reality to provide clean water in the coming decades.

11:25 AM

Closing Remarks