



2015

UNIVERSITY OF PENNSYLVANIA

PRECISE

Cyber-Physical Systems Industry Day

Philadelphia, Pennsylvania  
Friday, October 23<sup>rd</sup>

# WELCOME

MedLogiQ, CEO	William Acevedo
Penn Center for Innovation	Laurie Actman
Galois	David Archer
Alstom Power	Donald Bradley
Penn collaborator	Ari Brooks
GE	Mauricio Castillo-Effen
JCI	William Cole
JCI	Dan Curtis
Mahle GmbH	Joseph Dandy
Penn collaborator	Sanjay Dixit, MD
Drexel University	Tom Guarriello, Ph.D.
Drexel University	M. Ani Hsieh, Ph.D.
Microsoft Research	Ethan Jackson
FDA	Paul Jones
Tata Consultancy Services Innovation Lab	Devadatta M Kulkarni
Siemens	Martin Lehofer
NIST	Yan Lu
Galois	Stephen Magill
GammaTech	Michael McDougall
Bresslergroup	Nicholas McGill
Honeywell	Paul McLaughlin
Boeing Research & Technology	Paul Murray
MathWorks	Meaghan O'Neil
JCI	Youngchoon Park
RTI	Paul Pazandak
The Wharton School	David Robertson
Boeing	Saurabh Sircar
JCI	Joe Villani
Boeing Research & Technology	Vishnu Vithala
Princeton University	David Walker
Intel	Jesse Walker
Penn collaborator	Jin Wen
Verisign Labs	Andrew West
Delaware Valley Regional Planning Commission	Fang Yuan
MedLogiQ	Jim Zerka

# PRECISE

PENN RESEARCH IN EMBEDDED COMPUTING AND INTEGRATED SYSTEMS ENGINEERING

PRECISE's "Cyber-Physical Systems Industry Day" is an informal and intimate day-long symposium for leading executives and engineers involved in designing and developing cyber-physical systems, embedded systems, hybrid and control systems, and Internet of Things.

## GOALS

- Act as a launch pad for conversations to tackle increasing technical challenges resulting from the rapidly growing demand for new capabilities and applications with regards to the smart grid, next-generation air transportation system, intelligent transportation systems, smart medical technologies, smart buildings and smart manufacturing
- Showcase PRECISE's research on real-time systems, control design, sensing, security and applications
- Facilitate the exploration of funding opportunities for private companies, public institutions and other research-based organizations devoted to the development of Cyber-Physical Systems
- Develop an infrastructure for industry to connect with PRECISE to mutually benefit each other to address current and future trends
- Explore the potential for joint technical articles
- Explore the creation of testing and validation tools for distribution to industry

# AGENDA

9 am - 9:30 am

## BREAKFAST & CHECK-IN

9:30 am - 9:40 am

## WELCOME

**Sampath Kannan**, Penn Engineering - Welcome

**Insup Lee**, Penn Engineering - Welcome

9:40 am - 10:40 am

## THEME 1: INTERNET OF THINGS

**Mauricio Castillo-Effen**, General Electric - *GE's Digital Twins, Robots & Other CPS Examples*

**Devadatta M Kulkarni**, Tata Consultancy Services - *IoT Analytics for Supply Chain Management and Manufacturing*

**Youngchoon Park**, JCI - *Towards Self-Conscious Buildings through Connected Products*

**Paul Pazandak**, RTI - *Critical Infrastructure Research Ideas & Collaboration Opportunities*

**Jesse Walker**, Intel - *IoT Challenges & Questions*

**Paul McLaughlin**, Honeywell - *Industrial Automation & the Internet of Things*

10:40 am - 10:50 am

## BREAK

10:50 am - 11:40 am

## 2-MINUTE MADNESS

11:40 am - 1:30 pm

## POSTER + DEMO

## LUNCH

1:30 pm - 1:40 pm

## EDUCATION

Embedded Systems Masters Program

Autonomous Car Racing Club

Medical Device Club

1:40 pm - 2:50 pm

## THEME 2: CPS DEVELOPMENT ENVIRONMENT & TOOLS

**Ethan Jackson**, Microsoft Research - *Expedition on Safe Cyber Physical Systems*

**Martin Lehofer**, Siemens - *Engineering, Evolving & Securing Heterogeneous CPS at Scale*

**Yan Lu**, NIST - *Cyber Physical Systems for Smart Manufacturing and Related Standards*

**Stephen Magill**, Galois - *Formal Methods for Cyber-Physical Systems*

**Michael McDougall**, GrammaTech - *Ensuring Software Integrity in Cyber-Physical Systems*

**Meaghan O'Neil**, MathWorks - *Design & Testing Complex Systems with Model-Based Design*

**Vishnu Vithala**, Boeing's Research & Technology - *Model-Based Design Activities*

2:50 pm - 3 pm

## BREAK

3 pm - 3:30 pm

## THEME 3: FITNESS, MEDICAL DEVICES & HEALTHCARE

**Sanjay Dixit**, Penn Medicine - *Heart Model for Cardiac Arrhythmias: Clinical Applications*

**Paul Jones**, FDA - *Regulatory Challenges in Safety Critical Medical Cyber-Physical Systems*

**Nicholas McGill**, Bresslergroup - *Wearing Thin: Unbuttoning Complexity in Wearable PCB Design*

3:30 pm - 4 pm

## FOSTERING COLLABORATION, TECHNOLOGY TRANSFER & CLOSING REMARKS

**Ari Brooks**, Penn Medicine - *What does collaboration really look like in medical device development?*

**Laurie Actman**, Penn Center for Innovation - *How PCI fosters innovation and entrepreneurship at Penn?*

**Insup Lee**, Penn Engineering - *Q&A / Closing remarks*

4 pm - 5 pm

## RECEPTION



**Laurie Actman**  
*Chief Operating Officer*  
*Penn Center for Innovation*

Laurie Actman serves as the COO of the Penn Center for Innovation (PCI) a new organization at the University of Pennsylvania that catalyzes creative commercialization opportunities with the private sector. Laurie as part of the Executive Team oversees the strategic implementation of PCI's growth including the development of strategic programs and partnerships, marketing, communications, legal affairs, intellectual property and finance. Previously, she served as Deputy and Interim Director for the Energy Efficient Building Hub (EEB Hub) in Philadelphia, one of five Energy Innovation Hubs established by the Department of Energy under the Obama Administration. Previous to joining the EEB Hub, Laurie was the Director of Strategic Partnerships and Public Policy for Viridity Energy, a leading-edge smart grid and load management technology company where she developed projects and partnerships with cities, transit agencies and large energy. She joined Viridity in March 2010 after serving as a consultant for two years to Philadelphia Mayor Michael Nutter, helping to launch the Mayor's Office of Sustainability and the Metropolitan Caucus. Her work through both those efforts helped lead to the region's success in winning a \$25 million Recovery through Retrofit grant from the U.S. Department of Energy for regional commercial and residential energy efficiency and retrofit activities.

Actman has worked for several other notable economic development organizations including serving as Chief Policy Officer for the CEO Council for Growth, a leadership group coordinated by the Greater Philadelphia Chamber of Commerce, the Central Philadelphia Development Corporation and Greater Philadelphia First.

She received her undergraduate degree from Washington University in St. Louis and a Masters Degree from UNC-Chapel Hill. Actman lives in Bala Cynwyd with her husband and three children and is an elected Board Member of the Lower Merion School District.

**Ari Brooks**  
*Professor of Surgery*  
*Chief, Endocrine and Oncologic Surgery*  
*Breast Center Director*  
*Pennsylvania Hospital*  
*Penn Medicine*



Dr. Brooks is a Surgical Oncologist practicing at the University of Pennsylvania. He has a special interest in translational engineering research, that is the application of new technologies to address problems in surgery and medicine. He has formed multiple successful collaborative teams in many areas of engineering including computer science, plasma physics, material science, electrical and mechanical engineering. He has co-authored 8 patent applications and these have led to 3 start-up companies, all with varied degrees of success. He enjoys mentoring engineering as well as medical students in the area of medical device development.

**Mauricio Castillo-Effen**

*Research Engineer  
General Electric*



Dr. Mauricio Castillo-Effen is a Research Engineer in the Controls, Electronics, and Signal Processing organization at the General Electric Global Research Center. His background is in control and estimation as applied to robotics, unmanned systems, and automation. He performs research for multiple customers within GE such as Aviation, Oil and Gas, and Transportation, as well as customers external to GE, like the Department of Defense, the Department of Homeland Security, and NASA. He is a member of GE's Verification and Validation team that is focused on streamlining the development and certification of safety critical systems. He is also heavily involved in GE's Robotics Initiative that seeks to leverage advances in robotics technologies to improve safety, productivity, and efficiency for GE and its customers.

Dr. Castillo-Effen's current interests lie in the deployment of "smarter" machines and systems in real and unstructured environments considering multiple perspectives: technical, economic, commercial, social, etc. His expanded interest agenda includes formal analysis, Test and Evaluation, cyber-physical systems, model-based development, human factors, human-machine teaming, trusted autonomy, and ecosystem creation.

Besides his work at GE, Dr. Castillo-Effen is an adjunct faculty member of the Rensselaer Polytechnic Institute and a visiting Professor at Universidad Privada Boliviana. Dr. Castillo-Effen's work has been published in the form of patents, academic publications at conferences, journals, and books. He holds a Ph.D. from the University of South Florida, a M.Sc. from the University of San Simon/TU Delft, and a B.Sc. from the University of Applied Sciences of Hannover—all in Electrical Engineering.

**Sanjay Dixit**

*Associate Professor*

*Perelman School of Medicine at the University of Pennsylvania*

Dr. Sanjay Dixit is Associate Professor in the Perelman School of Medicine at the University of Pennsylvania. He is the Director of the Cardiac Electrophysiology program at the Philadelphia Veterans Administration Medical Center and is on faculty as staff electrophysiologist at the Hospital of the University of Pennsylvania. Dr. Dixit is board certified in Cardiovascular Medicine and Clinical Cardiac Electrophysiology. He performs a variety of invasive procedures to treat heart rhythm disorders including pacemaker, defibrillator implants and ablation for all types of cardiac arrhythmias. He is internationally renowned for his expertise in the field of advanced arrhythmia ablation to treat life threatening cardiac conditions such as atrial fibrillation and ventricular tachycardia. Dr. Dixit has authored over 150 papers, is invited faculty at major national and international meetings in the field of cardiac electrophysiology and serves as member of editorial board / reviewer for several high impact journals in the field of cardiovascular medicine.



**Ethan Jackson**  
*Researcher*  
*Microsoft*

Dr. Ethan Jackson is a Researcher in The Research in Software Engineering (RiSE) Group at Microsoft Research focusing on formal methods for cyber physical systems. He is the creator of the FORMULA system for formalizing modeling languages and enabling formal analysis of complex software, which has been used in large academic and industrial settings. He is also co-creator of the P programming language which allows developers to specify complex systems of communicating asynchronous components, and has been used to design critical components of Windows. Ethan leads a Microsoft Research Expedition focusing on safe and robust autonomous systems, and has been exploring CPS for disease surveillance. Ethan joined Microsoft Research 2007 after receiving his PhD from Vanderbilt University in Computer Science.

**Paul L. Jones**  
*Senior Systems/Software Engineer*  
*U. S. Food and Drug Administration*



Paul Jones works at the U. S. Food and Drug Administration. He is a Senior Systems/Software Engineer in the Center for Devices and Radiological Health, Office of Science and Engineering Laboratories (OSEL) where he serves as an in-house consultant on regulatory matters involving medical device software system safety, software engineering, risk management, and safety/security assurance cases. He divides his time between transitioning high confidence software and systems (cyber-physical systems) research work into FDA's regulatory science process and national and international standards development, and managing OSEL's software lab.

Prior to joining FDA, Mr. Jones worked in industry for 20 years gaining extensive experience in systems/software engineering developing business systems, operating systems, configuration management systems, and quality assurance systems.

Mr. Jones earned a MS degree in Computer Engineering from Loyola College in 1999 and BSE degree in Naval Architecture and Marine Engineering from the University of Michigan in 1974.



**Devadatta M. Kulkarni**  
*Principal Scientist*  
*Tata Consultancy Services*

Devadatta M. Kulkarni is a Principal Scientist for the TCS Innovation Lab in Cincinnati, OH and working on TCS's Supply Chain Management and Manufacturing research projects globally. Dr. Kulkarni is a well-known professional consultant and expert in Commodity Sourcing and Supply Chain Management (SCM) technologies, along with decision models in Product Development and Total Cost management areas. He has worked on both innovation and finance sides of a major automotive OEM business and brings in unique experience of architecting and implementing technology frameworks for enterprise transformation. Dr. Kulkarni has successfully extended his accomplished academic career into productive industrial researcher role with sustained publications including filing 4 U.S. patents, over 50 internal GM R&D reports, and over 25 external, archival publications in leading professional journals. Dr. Kulkarni was awarded his B.S., Mathematics in 1979 at Pune University, his M.S., Mathematics in 1982, and his Ph.D., in 1985, both from Purdue University.



**Martin Lehofer**

*Software Architect  
Siemens*



Martin Lehofer works as Researcher and Software Architect for Siemens Corporate Technology in Princeton, NJ. Before joining Corporate Technology in 2014, Martin worked as R&D project manager for Siemens' Industry Sector in Austria. His research interests are Cyber-physical systems, Cloud computing and Software product lines. Martin holds a BSc in Computer Science and a MSc degree in Software Engineering from Johannes Kepler University in Linz, Austria.

**Yan Lu**

*Senior Research Scientist  
National Institute of Standards and Technology*

Dr. Yan Lu obtained her B.S. and M.S degrees from Tsinghua University and PhD degree from Carnegie Mellon University in Electrical Engineering. She is a member of the Systems Engineering group in the Systems Integration Division (SID) of the Engineering Laboratory (EL) at the National Institute of Standards and Technology (NIST).

Her research interest covers distributed control, fault detection & diagnosis, information modeling and predictive analytics with applications in smart manufacturing, smart building and grid. Before joining NIST, she was the head of Grid Automation Research Group at Siemens Corporation, Corporate Technology (SCR) where she has led and successfully delivered more than 10 million dollars of government funded research projects in the areas of survivable control systems, energy management and smart grid automation. Dr. Lu also worked for Seagate Research Center for two years on developing hard disk drive servo controller.

**Stephen Magill**

*Research Manager  
Galois, Inc.*



Dr. Stephen Magill is a research lead in software security at Galois, Inc., where he is the principal investigator for Galois' team on DARPA's Cyber Fault-tolerant Attack Recovery project (CFAR). Prior to joining Galois in 2014, Stephen was a Research Scientist at the Institute for Defense Analyses Center for Computing Sciences (IDA/CCS). Before that, he was a post-doctoral researcher with Michael Hicks at the University of Maryland, College Park. His work has addressed software correctness, security, and robustness and spanned both dynamic and static approaches to software analysis.

Stephen earned his Ph.D. in Computer Science from Carnegie Mellon University under the guidance of Peter Lee, Stephen Brookes, and John Reynolds. His thesis work centered on the use of separation logic to prove termination and other liveness properties of heap-manipulating programs. Current research interests include security and predictability of cyber-physical systems, reasoning under uncertainty, and formal aspects of privacy preservation.



**Michael McDougall**

*Associate Vice President of Autonomic Technologies  
GammaTech*

Michael McDougall received a PhD in Computer and Information Science from the University of Pennsylvania in 2005. He has a BSc (Hons) in Mathematics and Computer Science from McGill University. Dr. McDougall’s graduate work focused on applying formal reasoning to problems in software engineering and security. Since joining GammaTech in 2005, he has led and contributed to research projects in the areas of software engineering and security. Past projects include a NASA-funded effort developing static analysis tools for safety-critical systems; assessing avionics systems for security and safety problems; and visualizing large systems-of-systems. He currently leads GammaTech’s research on autonomic security, developing techniques to enable systems to monitor themselves and respond to attacks or faults.

**Nicholas McGill**

*Electromechanical Engineer  
Bresslergroup*



Nick McGill is an Electromechanical Engineer at Bresslergroup, a product design firm in Philadelphia. At Bresslergroup, Nick works on electronics in a range of fields - from wearables to medical devices. When he’s not capturing a schematic or routing a PCB, he’s writing firmware for embedded devices. Nick graduated from both undergraduate and Masters programs at the University of Pennsylvania in electrical, mechanical, and robotics engineering.



**Paul McLaughlin**

*Chief Engineer  
Honeywell*

Paul McLaughlin is the Chief Engineer for Honeywell Process Solutions. Paul has worked in Industrial Automation for 35 years, as a development engineer, Chief Architect, Director of Development, and now Chief Engineer, where he oversees all HPS product roadmaps, architecture, and development with significant customer interaction. Paul has over 30 US patents granted in areas such as embedded systems, high availability solutions, and cloud computing. Most recently, Paul is leading Honeywell Process Solutions’ development for Internet of Things (IoT).

Paul is a 1986 graduate of the University of Pennsylvania with a Masters in Computer Science Engineering, and a 1980 graduate of the University of Delaware in Mathematics and Computer Science. Paul currently serves on the Board of Directors for Penn’s Engineering Alumni Society.

**Meaghan O'Neil**

*Marketing Manager  
The MathWorks, Inc.*



Meaghan O'Neil is the technical marketing manager for the new Simulink Test product at MathWorks. Prior to joining MathWorks, Meaghan spent a decade in industry in system design and software implementation (Johnson & Johnson, GE Energy, and Accenture). Following her graduate research with advisor Nancy Leveson, PhD, Meaghan provided system safety consulting expertise for accident investigations and safety driven design. Meaghan served as the chair of the Biomedical and Healthcare Working group within INCOSE (International Council on Systems Engineering) and currently serves as an industry ambassador. Meaghan has a B.S. in chemical engineering from Cornell University and an S.M. in System Design and Management from the Massachusetts Institute of Technology.

**Youngchoon Park**

*Technical Fellow & Director of Technologies  
Johnson Controls, Inc.*

Dr. Youngchoon Park is a technical fellow and director of technologies in Johnson Controls, Inc. Currently, he is leading connected product development and associated services and develops technology strategy. He has built few building management products and solutions and involved in many real-life complex building automation and security system developments and deployments. Dr. Park's major research interests are distributed computing, multimedia information processing, data analytics, automation and control system design. He is a frequent contributor of articles in his area of interests and actively participate many international conferences, standard organizations. He is a member of IEEE, and ACM and holds a Ph.D and a M.S from Arizona State University in Computer Science.

**Paul Pazandak**

*Research Manager  
Real-Time Innovations*



Paul leads RTI's efforts to acquire and execute government-funded research. He also leads a team of computer scientists seeking to push the edge in the area of real-time complex distributed systems, data analytics & the Industrial Internet of Things (IoT), and security. He has participated and has led government-funded and commercially-funded military research for over 15 years.

# INVITED SPEAKERS



**Vishnu Vithala**  
*Software Engineer*  
*Boeing's Research & Technology*

Vishnu Vithala graduated from the University of Michigan-Ann Arbor with a Masters in Mechanical Engineering. He worked at Chrysler for 4.5 years on Engine Thermal Management and has developed production control system for coordinating multiple electromechanical actuators regulating engine temperature. Mr. Vithala joined Boeing six months back as Mechatronics Systems Engineer and has been focusing on understanding application Formal Verification Techniques for Hybrid Systems.

**Jesse Walker**  
*Research Director*  
*Intel*



Jesse Walker is a member of Intel Lab's Security and Privacy Research, and is the research director for security and privacy in cyberphysical systems. Dr. Walker's previous role was Intel Corporation's chief cryptographer from 2005 through 2015. Among his contributions are the discovery of the flaws in Wi-Fi WEP and creation of its successors WPA and WPA2, creation of the theory underlying Intel's RDRAND instruction, co-designer of the anonymous attestation algorithm in TPM 2.0 and ISO 20009, and co-designer of SHA3 finalist Skein. Dr. Walker earned a Ph.D. in mathematics from the University of Texas at Austin in 1980.

- (1) *Model-Based Clinical Trials for Medical Device Software* - **Houssam Abbas**
- (2) *Closed-Loop Testing & Validation of Implantable Cardiac Devices* - **Marco Beccani**
- (3) *Sometimes, Money Does Grow On Trees: Data-Driven Control as a Service* - **Madhur Behl**
- (4) *Online Planning for Energy-efficient and Disturbance-Aware UAV Operations* - **Nicola Bezzo**
- (5) *Retrofitting Authentication on OpenICE* - **Liang Cheng**
- (6) *Design & Verification for Autonomous Systems Interacting with Human Operators* - **Lu Feng**
- (7) *Guaranteeing Timing Requirements for Multi-Service Flows in the Cloud* - **Dagaen Golomb**
- (8) *Robust Estimation Using Context-Aware Filtering* - **Radoslav Ivanov**
- (9) *xLAB: Experience Design and Technology Lab* - **Kuk Jang**
- (10) *Managing Model Coverage and Complexity with Abstraction Tree* - **Zhihao Jiang**
- (11) *Publish/Subscribe Middleware with Real-Time Guarantees via SDN* - **Andrew L. King**
- (12) *Data-Driven Robust Taxi Dispatch Approaches* - **Fei Miao**
- (13) *Compositional Synthesis with Parametric Reactive Controllers* - **Salar Moarref**
- (14) *How to Get Your Self-Driving Car a License: Autonomous Vehicle Plan Verification and Execution* - **Matthew O'Kelly**
- (15) *Fast Cars and Faster Decisions: Co-Design of Anytime Computation and Robust Control* - **Yash Vardhan Pant**
- (16) *Automatic Verification of Linear Controller Software* - **Junkil Park**
- (17) *Quadrotor PID Autotuning* - **Sangdon Park**
- (18) *Minimum Actuation and Leader-Selection for Large-Scale Complex Systems: Performance and Minimum Cost Guarantees* - **Sérgio Pequito**
- (19) *Regular Programming over Data Streams* - **Mukund Raghothaman**
- (20) *How can we decrease Alarm Fatigue? An Evaluation of ICU Alarms* - **Alex Roederer**
- (21) *Markov Decision Processes that Hedge* - **Nimit Singhania**
- (22) *Automatic Completion of Distributed Protocols with Symmetry* - **Abhishek Udupa**
- (23) *From Compositional Scheduling to Real-Time Virtualization* - **Meng Xu**
- (24) *NetEgg: Scenario-based Programming for Network Policies* - **Yifei Yuan**

# NOTES



Lined writing area for notes.

**NOTES**



