EXPLORING FRONTIERS IN COMPLEX SYSTEMS

A DECADE OF SYSTEMS RESEARCH AT STEVENS

School of Systems & Enterprises
This is a year of note for the School of Systems and Enterprises (SSE) as we mark its 10th anniversary. In this, our second annual research review, we highlight the history of SSE, and provide a glimpse of the future.

ANSWERING THE NEED TO PREPARE 21ST CENTURY TECHNICAL LEADERS

The beginnings of SSE are rooted at an intersection of academia and industry. Failures of large defense and government projects inspired the creation of a panel of government and industry in the late 90’s to determine the root causes. This panel identified technical program management (planning and execution oversight) as a significant root cause of large scale project failures. An initiative was launched to develop recommendations for addressing problems in technical program management. Findings pointed to a scarcity of talent to fill technical program leadership roles as a key issue. The need for a systems engineering educational program emerged.

One of the industry suppliers on the panel was Lockheed Martin. Linkages between Stevens and Lockheed Martin can be traced back to 1938 when the Glenn L. Martin Company commissioned the Stevens’ Davidson Laboratory to test two new seaplane hulls. Stevens alumni at Lockheed Martin engaged Stevens leadership resulting in a decision to launch a new systems engineering program. Lockheed Martin sponsored one of its technical executives to work with the Stevens faculty in 1999 and 2000 to conceive, develop and launch a graduate educational program.

The new systems engineering program was established in the Department of Systems Engineering and Engineering Management (SEEM) within the Schaefer School of Engineering. Initially the program focused on offering graduate certificates to employees of corporate and government agencies at their work locations on flexible schedules. The mix of academics and practitioners involved in program development and delivery were key to the early success of the program and led to rapid increase in educational program demand. As the program grew, master’s degree and doctoral studies offerings were introduced. Strong growth of the educational program ultimately led to the formation of the School of Systems and Enterprises in 2007. Program offerings at the graduate and undergraduate level now include systems engineering, software engineering, systems analytics, and engineering management.

The school’s research capability in the system engineering space grew significantly in parallel with the growth of the educational program.
The Department of Defense (DoD) identified a need for a national University Affiliated Research Center (UARC) focused on systems. A Stevens led team of universities/scholars from across the country, was awarded the Systems UARC lead role. The Stevens led Systems Engineering Research Center (SERC) was born in 2008. The SERC provides the DoD and the Intelligence Community ready access to the top Systems Engineering research talent in the US across 22 of the Nation’s leading universities focused on systems research. The scale of this collaborative network is central to the SERC’s ability to perform research across a demanding set of core competencies.

SERC projects have engaged more than 400 researchers (faculty, research staff, and undergraduate, graduate, and doctoral students) from across its university network. They include members of the National Academy of Engineering, and Fellows of major professional societies such as the International Council on Systems Engineering (INCOSE), Accreditation Board for Engineering and Technology (ABET), National Defense Industrial Association (NDIA), and the Institute of Electrical and Electronics Engineers (IEEE). Several of the engaged faculty are directors and/or deans of their divisions within their respective universities. Greater than 50% of all US-based MS-SE and PhD-SE graduates every year come from the SERC universities.

In 2012, the Center for Complex Systems and Enterprises (CCSE) was launched with significant support from Lockheed Martin and Accenture. Stevens thus expanded its systems research into the areas of healthcare, autonomous systems, data analytics and resilience. Throughout its ten year history, SSE has made significant contributions to building the human capital needed in the area of systems for the nation and the world. This has been accomplished through directly delivered educational programs and through assistance provided in developing academic program capabilities at universities around the world. All of this is rooted in sound research conducted at Stevens and in global partner universities.

We invite you to explore the future with us through the lens of the 2017/2018 edition of our research review.

DR. ANTHONY BARRESE
Interim Dean

HISTORICAL TIMELINE OF SYSTEMS AT STEVENS

1938
Glenn L. Martin
Company commissions
Stevens’s Davidson
Laboratory

1990s
Panel is formed to
determine root causes
of large defense &
government projects

99-2000
Graduate educational
program in systems
engineering is established
within Schaefer School of
Engineering

2007
The Steinwens led
Systems Engineering
Research Center (SERC)
is born

2008
The School of
Systems and Enterprises
is formed

2012
SSE marks 10th
year of leadership
in systems engineering

2017
The Center for
Complex Systems &
Enterprises is
launched

stevens.edu/sseresearch
Our research is structured to help us better understand the forces that drive complexity, determine risks and benefits to society, design and architect appropriate systemic solutions, and provide analytical tools to continually improve and evolve these systems. SSE has defined four research vectors to more fully address complexity in modern large-scale interconnected systems and enterprises.

Our four research vectors serve as a foundation for these capabilities by understanding the behavior of people actually working with systems, determining how to design human-centric complex systems and educating the designers, creating architecture and models of these systems, and leveraging system and simulation data to enable informed risk and critical decisions. Our research is decidedly broad-based and has significant interplay with other disciplines and domains such as economics, computational social sciences, public policy, healthcare and financial services.

1. SYSTEMS, SOCIETY AND TECHNOLOGY

Social systems – healthcare, aerospace, finance, marine, military and telecommunications to name a few – are grappling with the challenge of modernizing their technology. At the same time, the technologies needed to support these systems are growing increasingly complex. SSE research takes a deeper look at the interplay between complex systems and human enterprises, revealing insights about the nature of socio-technical interactions and its impact on society. SSE research is backed by rigorous analytical thinking and considers policy, individual rights, and organizational and ethical issues at points where people and technology intersect.

Insights from our research expand our understanding of how people and technology interact, with a bent toward human behavior and community. Thus, it enables systems thinkers to design effective complex systems and improve human interaction with these systems.

2. DESIGN, INNOVATION AND EDUCATION

Human-based, complex systems require a combination of the empathetic, human-centric characteristics of design thinking and the deep understanding of systems-level behavior enabled by systems thinking. The integration of systems and software engineering combines these problem-solving approaches and facilitates the translations of these designs into reality throughout the system life cycle. SSE researchers are investigating the future of design and systems and software engineering to determine the principles and approaches necessary for success, as well as the means by which to instill these capabilities into our future systems decision makers, designers and engineers from K-12 through post-secondary and graduate education.

This area of research evaluates systems and design thinking. It includes reviewing the principles and state of the art in parallel disciplines, determining overlap and gaps in design, and conducting anthropological studies to understand behavior and determine issues and improvements. It enables us to find improved ways to design large, complex systems, while also improving product design in the context of a complex, multi-disciplinary society. Another aspect of this research is to improve
the effectiveness of the education process, providing “experience acceleration” through experiential learning, case studies, flight simulations, game-based learning and other methods.

Insights from this research narrow the gap between industry and academia, and provide innovators and problem solvers with the systems and design thinking background needed to effectively address the challenges of complex systems.

3. COMPLEXITY, ARCHITECTURE AND MODELING

As today’s large-scale systems become increasingly complex, discovery of effective modeling techniques and tools to understand, structure and optimize systems architecture becomes increasingly relevant. SSE research has revealed that complexity and systems are about transformation, communication of information and how information is being used by decision-makers.

This area of research investigates methods for measuring complexity. Through innovative approaches, unique systems perspectives and complexity analysis methods, researchers enable accurate measurement of complexity and systemic risk, and facilitate proper system architecture synthesis and assessment. To do this, SSE research leverages ontologies, model interoperability and classification, stochastic modeling, the theory of modularity and collaborative design, amongst other methods.

Insights from this research help to specify system architectures that lower risk and reduce complexity. Thus, it enables systems thinkers to assess the level of complexity of a system and develop effective models to build successful systems.

4. ANALYTICS, INFORMATICS AND VISUALIZATION

Government and industry have much to gain from applying analytics and visualization to improve upon their processes, products, services and systems. SSE researchers are conducting research on analytics, informatics and visualization based on data produced by citizens, society and the internet of things.

This area of research assesses the social perspectives of real systems. From a citizen science perspective, this research looks at the behavior of human systems in the community. It combines computational methods and visualization, and social media analytics to identify conversations in data and assess how communities behave and respond to different events during certain times.

Insights from this research enable leaders in government and industry to make informed decisions and reduce community risk. Through analytics, this research also identifies ways to “sense” the community and assess community resilience.

CONCLUSION

Society is in the midst of a period of greatly accelerating complexity. As a result of the exponential increase in the interaction between people, technology and the natural world, a deeper understanding of complexity in our largest socio-technical systems is essential to design and develop effective, sustainable solutions that improve the lives of billions of people in an unpredictable world. Through collaboration with members of the social sciences and industry, systems researchers at SSE are developing new approaches, investigating novel models and deepening our understanding of complexity, which is fundamental to the success of our society, nation and global community.
SYSTEMS ENGINEERING RESEARCH CENTER
The Systems Engineering Research Center (SERC) provides broad systems research, and through the development of new methods, processes and tools, advances the practice of systems engineering in the defense and intelligence communities to address challenges posed by massive complexity, rapid pace of innovation, and increasing technological and operational change.

CENTER FOR COMPLEX SYSTEMS AND ENTERPRISES
The Center for Complex Systems and Enterprises (CCSE) addresses the growing complexity of socio-technical systems, adjoining wide-ranging disciplines — engineering, economics, finance, management, and behavioral and social sciences — to find solutions that improve public-private systems of great importance to society.

DAVIDSON LABORATORY
The Davidson Laboratory is one of the nation’s largest and most renowned hydrodynamic and ocean engineering research facilities dedicated to solving problems that improve our ability to anticipate, detect, understand, predict and respond to extreme natural events.
Today’s critical defense and intelligence systems are increasingly adaptive, resilient, secure and complex. Part of the work of systems engineers is to understand what is needed to develop cost effective solutions and ensure that these defense systems effectively work together. They achieve this aim by integrating disciplines, fostering cross-collaboration, balancing conflicting characteristics, affordably delivering capabilities, and facilitating cross-disciplinary collaboration. However, while systems engineers are in prime position to tackle these issues, they have often been constrained by the limitations of existing and classical systems methods, models and tools. Designated a University Affiliated Research Center (UARC) by the United States Department of Defense (DoD), the SERC, led by Stevens Institute of Technology and principal collaborator, University of Southern California (USC), conducts research to help solve the aforementioned challenges.

The SERC at Stevens facilitates collaborative dialogue between academia, government and industry to understand and formulate interesting and relevant research questions. More than 400 researchers with diverse interests and from domains such as finance, telecommunications, computing and transportation have engaged on SERC projects since its establishment by the DoD in 2008.

The SERC research portfolio is structured into four research thrusts: enterprises and systems of systems, trusted systems, systems engineering and management transformation, and human capital development.

The emphasis in each of these research areas vary, but they all aim to provide the DoD with an overwhelming competitive advantage over adversaries in regards to increasingly complex, dynamic, cyber-physical-human net-centric systems and systems of systems of the future.

The SERC enables the DoD to achieve this aim through the application of a systems approach; development of systems engineering principles, methods, processes and tools; and accelerated professional development of highly capable systems engineers and technical leaders in the DoD and the defense industrial base.
Most complex organizational systems involve phenomena at multiple levels. At the bottom level are human activities and work -- assembling components, delivering services or combatting adversaries. At the next higher level, processes deliver the physical resources and information that enable human activity and work. At the next level, there are organizations, often-independent businesses, which own processes or elements of processes, which they operate in pursuit of their own market objectives. At the highest level is society with its objectives, values and norms.

Regardless of domain – healthcare delivery, financial systems, urban resilience and national security – these systems rely on expanding levels of networked connectivity and feedback loops, making prediction and control of these systems far more challenging than in the past. As such, the whole enterprise system associated with any of these domains must be characterized as a large-scale public-private enterprise.

An understanding of the limitations and challenges highlighted above is essential to generating and delivering knowledge and expertise that contributes to fundamental transformation of complex systems. Working together with partners in academia and industry, the CCSE is mobilizing transdisciplinary research vision, experience, talent, creativity and capabilities to find human solutions for our increasingly complex world.

The CCSE focuses its research on four key domains: healthcare delivery, financial systems, urban resilience and national security.

The CCSE has found that a powerful mechanism that combines multi-level computational models of complex systems and enterprises with an immersive and interactive visualizations environment is essential to addressing complexity.

The CCSE is enabling rapid conceptualization, development and validation of multi-level computational models with associated interactive visualizations, with a paradigm that facilitates modeling any complex enterprise. The innovative CCSE research environment, combined with educational programs at Stevens, develops skilled people who can create and deploy high value, affordable solutions in a wide range of complex systems and enterprises.
Davidson Laboratory research uniquely integrates the fields of coastal engineering, physical oceanography, naval architecture, marine hydrodynamics, and maritime systems to create a trans-disciplinary enterprise that can address both the highly-specialized issues confronting each discipline, as well as the more complex, integrated issues facing natural systems, maritime activities, and the world’s coastal cities.

Coastal floods are one of the most dangerous and damaging natural hazards that societies face, and climate change and coastal population growth are causing a dramatic rise in vulnerability. Davidson Laboratory researchers are using science to serve the growing global coastal urban population in innovative ways, most notably applying their expertise in coastal ocean physics and forecasting to problems that affect the 20 million residents of the New York metropolitan area in which they are embedded.

Modeling by the Davidson Laboratory CURES team was highlighted in New York City’s 2013 flood mitigation plan, showing that if the wind-blown storm surge caused by Hurricane Sandy had occurred 7-10 hours earlier—when the tide was high for regional waterways—the consequences would have been even more catastrophic, including inundation of the region’s central food distribution port facilities*.

Davidson Laboratory experts created and maintain the New York Harbor Observing and Prediction System (NYHOPS) and the Stevens Flood Advisory System (SFAS), vital forecasting resources for emergency preparedness. They also create and evaluate novel coastal resilience solutions, and assess the effectiveness of urban flood protection initiatives, beach erosion mitigation plans, and zoning laws that reduce vulnerability to future natural disasters.

Davidson Laboratory facilities are used to conduct physical experiments on marine craft, and marine and coastal structures to understand how they interact with their environment. The Lab’s unique facilities and special expertise are utilized daily by our research teams, as well as by marine, aerospace and defense industry leaders, federal and municipal agencies, and a host of private and academic research groups.

Professor Blackburn's research focuses on methods, models, and automated tools for reasoning about complex systems of systems using formal methods, modeling, simulation, visualization and computation in support of design, architecting and testing. He’s currently investigating the use of semantic technologies and ontologies for cross-domain model integration of complex and cyber physical systems, and Bayesian networks for prediction, estimation and decision-making. In six years at Stevens he has received over $6.7 million in research funding. He has been the principal investigator (PI) for four years on a System Engineering Research Center research task for the U.S. Naval Air Systems Command (NAVAIR) and is also the PI on U.S. Army Armament Research, Development and Engineering Center (ARDEC) on Systems Engineering Transformation through Model-Centric Engineering. He has also been principal on a Federal Aviation Administration NextGen project and co-PI for research funded by the National Science Foundation. He developed and teaches a course on Systems Engineering of Cyber Physical Systems.

Prior to joining Stevens, Dr. Blackburn worked in industry for more than 25 years, and received over $10 million dollars from industry primarily focused on applied research in formal method-based modeling, analysis, simulation and test generation tools and methods. He has been the PI to the National Institute of Standards and Technology on projects dating back to 2000 involving model-based tools and methods for verification and validation of security-related products and applications. Dr. Blackburn holds a Ph.D. from George Mason University, a M.S. in Mathematics (emphasis in C.S.) from Florida Atlantic University, and a B.S. in Mathematics (C.S. option) from Arizona State University.

Professor Blumberg is renowned for his research in urban oceanography, predictive modeling and ocean physics with particular focus on the mutual dependent interactions between coastal waters and urban environments. His research has contributed to understanding the physical dynamics of estuarine and coastal ocean circulation, and to the creation of ocean observing and forecasting systems which are used for environmental studies, surface vessel operations, and as a basis for maritime security. General numerical models have been developed such as the Princeton Ocean Model (POM) and its shallow water derivative, the Estuarine and Coastal Ocean Model (ECOM) – which are now adopted by over 3,000 research groups worldwide. Long-term research interests address new perspectives on the evolution of urban-environment interactions to create sustainable and resilient 21st century coastal city regions.

Dr. Blumberg is the recipient of multi-year funding and grant awards and is a member of professional societies such as the American Meteorological Society, American Geophysical Union, American Society of Civil Engineering, Estuarine Research Federation, and Oceanography Society. He is a fellow of the American Society of Civil Engineers and a fellow of the American Meteorological Society.

After receiving his B.S. from Fairleigh Dickinson University, Professor Blumberg received his M.A. and Ph.D. from The Johns Hopkins University, and his Post-Doctoral degree from Princeton University.
Professor Chandramouli is the Thomas Hattrick Chair Professor of Information Systems in Electrical and Computer Engineering and a professor in the School of Systems and Enterprises. Prior to joining Stevens he was on the ECE faculty at Iowa State University. His research covers cognitive radio networking, text analytics and forensics, social media analytics and prototyping/experimental systems research in these areas. His research and technology commercialization projects are funded by the National Science Foundation (including the CAREER award), National Institute of Justice, Department of Defense and the industry.

He was an IEEE COMSOC Distinguished Lecturer, invited member to the U.S. Office of Science and Technology Policy roundtable discussion on Collaborating on Public Safety Broadband, editor of IEEE Journal on Selected Areas in Communications (JSAC)--Cognitive Radio Series, founding chair of the IEEE COMSOC Technical Committee on Cognitive Networks (TCCN), and a member of the IEEE COMSOC Standards Board.

He is a Co-Founder and the CEO of Spectronn, a New Jersey based start-up developing cutting-edge solutions at the intersection of mobile edge computing, communications and artificial intelligence.

He is a recipient of the Provost’s Award for Academic Entrepreneurship and Enterprise Development (2012), New Jersey Inventors Hall of Fame Innovator Award (2012) and the Master of Engineering Honoris Causa (2014) from Stevens Institute of Technology.

Professor Grogan is researching and developing information-based tools for engineering design in domains with distributed system architectures such as aerospace, defense and critical infrastructure. His current research falls into three general categories: interoperable modeling frameworks for systems-of-systems, collaborative design experiments and interactive simulation for federated systems.

His research of future engineered systems involves investigating the challenges in overcoming the limited capacity of human organizations to understand and anticipate long-term and interdisciplinary effects of design decisions. He recently developed interoperable simulation gaming as a design method – an approach which combines the capability of simulation models to share technical information with an interactive design session and live participants to communicate non-technical information and topics out of scope of the technical model. This method builds on tools and techniques developed for military war-gaming and concurrent engineering. Past projects consider diverse application cases such as space exploration campaigns, fractionated and federated satellite systems, and local- and national-scale infrastructure planning.

Professor Grogan received his B.S. in engineering mechanics and astronautics from the University of Wisconsin–Madison. He then attended MIT where he received his S.M. in aeronautics and astronautics and Ph.D. in engineering systems.
Professor Hayeri’s research focuses on transportation systems, connected and automated vehicles, and infrastructure, climate and energy security. As part of the project, Connected and Autonomous Vehicles 2040 Vision, she studied the impacts of autonomous and connected vehicles on infrastructure, design, communications, investment decisions, freight, driver licensing, real time data usage and workforce training. In another recent project, Energy Impacts of Autonomous Vehicles, she examines potential energy impacts of autonomous vehicles for various levels of automation defined by the National Highway Traffic Safety Administration (NHTSA).

Professor Hayeri attended the University of Nebraska-Lincoln where she received her B.Sc. in civil and environmental engineering and University of California, Berkeley where she received her M.Eng. in transportation engineering - civil and environmental engineering. She received her dual Ph.D. (civil and environmental engineering / engineering and public policy) from Carnegie Mellon University, where she was also a researcher with the T-SET UTC (Technologies for Safe and Efficient Transportation) program from the U.S. Department of Transportation (USDOT).

She completed her post-doctorate research fellowship at the University of Pennsylvania, working with the GRASP lab (General Robotics, Automation, Sensing and Perception).

Professor Heydari, director of Complex Evolving Network Systems (CENS) lab, has published over 50 papers in peer-reviewed journals and conferences. His interdisciplinary research aims at bridging engineering system design and computational social sciences. He received the NSF CAREER award in 2016 and his research is funded by DARPA, NASA, and several private corporations.

His research interests include: complex networks, systems science, platform-based systems, computational social sciences, and system resilience. Active projects include impact of product/systems architecture on dynamics of innovation and competition in platform-based products; coordination dynamics in hybrid teams, composed of human and autonomous agents; formation and diffusion of behavioral risk; and resource sharing mechanisms for sharing economy platforms. He is an associate editor of the Journal of Systems Engineering, secretary and executive board member of Council of Engineering Systems Universities (CESUN), technical co-chair of CESUN2014 International conference at Stevens, and a member of the scientific advisory committee of the ETH-Singapore Future Resilient Systems (FRS) center.

He received his B.Sc. in electrical engineering and chemistry from the Sharif University of Technology, and his M.Sc and Ph.D. in electrical engineering (Ph.D. minor in economics) from the University of California at Berkeley, where he also received his management of technology graduate certificate from the HAAS Business School.
Professor Hoffenson’s research focuses on sustainable design, systems thinking, policy and design, design optimization, and trade-off analysis. His research looks into the ways that people design products, drawing from different disciplines to understand product development and design optimization as a multi-stakeholder system that accounts for how designers’ decisions interact with those of consumers, corporations, and policy-makers. This work combines engineering models, decision theory models, economic models and a systems framework to build an understanding of how different decisions with respect to product development and adoption will affect the economic, environmental, and social sustainability of the surrounding world.

His research is published in several journals. Professor Hoffenson attended the University of Michigan, earning his M.S.E. and Ph.D. in mechanical engineering, where his research focused on design optimization of vehicles for safety accounting for uncertainty, human factors and market considerations. In his postdoctoral position in the Department of Product and Production Development at Chalmers University of Technology in Gothenburg, Sweden, he researched interdisciplinary product design for variation-related quality and sustainability. Prior to Stevens, he served as a Congressional Science & Engineering Fellow sponsored by the American Association for the Advancement of Science (AAAS) in Washington, D.C. •

Professor Kruse’s research is about model-based systems engineering with the general-purpose graphical modeling language SysML. His focus lies on supported modeling, model reuse, traceability and model interoperability. Recently, Dr. Kruse is extending this with semantic technologies and ontologies for multi-disciplinary model integration and design reasoning together with the OpenMBEE platform. This platform supports the construction of models following the formal view and viewpoint paradigm to extract specific design information and connect with a model management system for model integration and management across tools.

Benjamin Kruse acquired his mechanical engineering degree in the field of aerospace at the Technical University Munich where he also started his doctorate before finishing his Sc.D. at ETH Zurich. There he investigated formal and reuse-based support for multi-disciplinary concept design in SysML. It formally implements functions, elements from a commercial simulation tool and a service catalogue into generic design libraries to offer a foundation of proven design knowledge together with multi-solution patterns for further cross-cutting reuse potential. •
DR. CARLO LIPIZZI

Industry Assistant Professor; Graduate Engineering Management Program Lead

Professor Lipizzi's research interests include data mining, text mining and network analysis with a focus on social media and its use as a backchannel for real life activities, extracting semantic and topological metrics to analyze virtual conversations. His research has been published in diverse publications, including the International Journal of Information Management and Technological Forecasting & Social Change.

In addition to his current role as industry assistant professor at Stevens, where he teaches engineering management students the major techniques and solutions to discover knowledge in data and text, Professor Lipizzi is the principal at a boutique data consulting firm. He specializes in providing behavior analysis, predictive modeling, analytics, data and text mining for industry in Europe and the U.S.

Professor Lipizzi received his Laurea in mathematics from Università La Sapienza in Rome, Italy, Executive MBA in management from IMD Business School and Ph.D. in system engineering from Stevens Institute of Technology.

DR. MO MANSOURI

Research Associate Professor; Program Lead for Systems Engineering and Socio-technical Systems

Professor Mansouri has various research interests with a focus on designing resilience in infrastructure systems and governance of networked systems. His research of governance frameworks for complex adaptive sociotechnical systems includes the development of frameworks, models, mechanisms and methods for influencing desired behavioral patterns, as well as performance output of complex adaptive sociotechnical systems through quantifying, estimating and optimizing methodologies. Other areas of research include governing patterns of human behavior in online social networks, and designing resilience, decision-making under uncertainties, and policymaking in networked systems. His research is published in various scientific journals including IEEE Systems Journal, IEEE Transactions on SMC: Systems, International Journal of System of Systems Engineering, Journal of Transportation Research Board, Marine Policy, Maritime Policy and Management, International Journal of Industrial and Systems Engineering, Enterprise Information Systems, among many others.

His industry experiences include working as research fellow and scientist to evaluate the effectiveness of operations systems and create systemic tools and methods to assist decision-making processes for the World Bank, HAND Foundation, NIAC and other non-profit entities.

After receiving his B.S. from Sharif University of Technology and M.S. from the University of Tehran both in industrial engineering, he received his Ph.D. in engineering management from The George Washington University.
Professor Nilchiani has researched various dimensions of complex systems response to change and uncertainty as well as modeling and measuring the complexity content of complex engineered systems. Her three research tracks include: complex systems formation, evolution and tipping point, assessing the value of adaptation, flexibility and other system's utilities and their relationship to the level and measure of complexity of the system (application to large-scale critical infrastructures, DoD acquisition programs and more), quantitative assessment of the risks at various stages of complex engineering system development by appropriate complexity characterization, and bi-directional application of the biological and cell models of complex system to engineered systems.

She received her Ph.D. in aerospace systems from MIT, where she focused on designing, embedding and measuring flexibility in space systems and spacecrafts, sponsored by DARPA's Orbital Express Program. She has used various decision-making tools, uncertainty modeling, options and decision analysis tools and integrated them into her models for measuring the value of flexibility.

Dr. Nilchiani's research has been funded by the Department of Homeland Security (DHS) Center of Excellence, DARPA's Fractionated Systems Program (F6), SERC Research and ONR/Naval Postgraduate School. She has authored over 65 refereed journals and conference articles, and is an associate member of American Institute of Aeronautics and Astronautics (AIAA) and Society of Women Engineers.

Professor Pennock is associate director of the Center for Complex Systems and Enterprises (CCSE). His research interests involve modeling of enterprise systems and systems of systems, multi-scale modeling, and model uncertainty. His research application domains include health care, national security and finance. His research has been published in IEEE Systems, Applied Ergonomics, and Systems Engineering.

Additionally, he has presented his research at conferences including IEEE Systems, Man, Cybernetics, IEEE Systems and CESUN. His industry experience includes working as a senior systems engineer in various lead technical roles for Northrop Grumman Corporation where he specialized in system architecture, model based systems engineering and requirements development.

Professor Pennock attended the University of Virginia and received both his B.S. and M.S. in systems engineering. He received his Ph.D. in industrial engineering from Georgia Tech.
DR. WILLIAM ROUSE
Alexander Crombie Humphreys Professor; Director, Center for Complex Systems & Enterprises (CCSE)

Professor Rouse’s research and development interests focus on understanding and managing complex public-private systems such as healthcare delivery, urban systems and national security, with emphasis on mathematical and computational modeling of these systems for the purpose of policy design and analysis. His research in human-centered design methodology has resulted in successful training and aiding systems spanning multiple functions in public and private enterprises. He is professor emeritus, and former chair, of the School of Industrial and Systems Engineering at the Georgia Institute of Technology.

The author of hundreds of articles and book chapters, and many books, including most recently Universities as Complex Enterprises (Wiley, 2016), Modeling and Visualization of Complex Systems and Enterprises (Wiley, 2015), and Understanding and Managing the Complexity of Healthcare (MIT Press, 2014), Professor Rouse is well-known for his systems-oriented research, with particular regard to the roles and performance of people and organizations in relation to complex systems.

Previous roles include chair of the Committee on Human Factors (now Board on Human Systems Integration) of the National Research Council, member of the U.S. Air Force Scientific Advisory Board, and member of the DoD Senior Advisory Group on Modeling and Simulation. He is a lifetime national associate of the National Research Council and National Academies. He was elected to the National Academy of Engineering in 1991, as well as elected a fellow of four professional societies: IEEE, INCOSE, INFORMS and HFES. Rouse received his B.S. from the University of Rhode Island, and his S.M. and Ph.D. from MIT.
Dinesh Verma received the Ph.D. (1994) and the M.S. (1991) in Industrial and Systems Engineering from Virginia Tech. He served as the Founding Dean of the School of Systems and Enterprises and Professor in Systems Engineering at Stevens Institute of Technology from 2007 through 2016. He currently serves as the Executive Director of the Systems Engineering Research Center (SERC), a US Department of Defense sponsored University Affiliated Research Center (UARC) focused on systems engineering research. During his fifteen years at Stevens he has successfully proposed research and academic programs exceeding $150m in value. Verma served as Scientific Advisor to the Director of the Embedded Systems Institute in Eindhoven, Holland (2003-2008).

His professional and research activities emphasize systems engineering and design with a focus on conceptual design evaluation, preliminary design and system architecture, design decision-making, life cycle costing, and supportability engineering. In addition to his publications, Verma has received three patents in the areas of life-cycle costing and fuzzy logic techniques for evaluating design concepts.

Dr. Verma has authored over 100 technical papers, book reviews, technical monographs, and co-authored three textbooks. He was honored with an Honorary Doctorate Degree (Honoris Causa) in Technology and Design from Linnaeus University (Sweden) in January 2007; and with an Honorary Master of Engineering Degree (Honoris Causa) from Stevens Institute of Technology in September 2008. Verma has served as a member of the Engineering Systems and Design (ESD) Advisory Board at the Singapore University of Technology and Design (SUTD) since 2016.

Professor Vesonder’s current research interests include: software engineering and system development, cyber-physical and socio-technical systems, Smart Cities, human computer interaction, and evolvability. He has over 35 years of industry experience, including serving as executive director of the Cloud Platforms Research Department at AT&T Labs Research, which focused both on cloud platforms and mobile and pervasive systems. Today, he is both a Bell Labs and an AT&T Fellow.

His committee experience includes serving as member of the editorial board of the International Journal of Information Quality and the International Journal of Computer Systems Science and Engineering. A noted author of over 40 research papers, Professor Vesonder has experience serving as associate editor in charge of telecommunications and network management for the journal, Intelligent Systems Review. Additional experience includes guest editor of the IEEE Communications Magazine. With 4 patents to his name, he is noted for his early contributions to artificial intelligence (AI) when he developed a system for monitoring communications cables among other systems.

Professor Vesonder received his B.A. in cognitive psychology from the University of Notre Dame. He attended the University of Pittsburgh where he received both his M.S. and Ph.D. in cognitive science.
Professor Wade's research falls within the areas of the use of technology in systems engineering and STEM education, and complex systems and complexity management. His industry experience includes serving as executive vice president of engineering at International Game Technology (IGT) where he created corporate vision, led product development, championed the development of a corporate architecture and system development practices, and managed corporate wide research and development. His previous industry experience includes managing the development of the UltraSPARC V based Enterprise Server family at Sun Microsystems and leading supercomputer development at Thinking Machines Corporation.

In addition to his publications, Professor Wade is the recipient of 12 patents in the areas of integrated circuits, computer architecture, networked systems and internal combustion engines. He is an elected member of Sigma Xi, Tau Beta Pi and Eta Kappa Nu honorary societies. He has served on the boards of organizations such as Software and Systems Consortium, the Reno Philharmonic Association, DigiDeal Corporation and the Center for Excellence in Education.

Professor Wade attended MIT where he received his S.B., S.M., E.E. and Ph.D. degrees in electrical engineering and computer science.

Professor Xiao’s research interests lie in software engineering, particularly in software architecture, software economics, cost estimation and software ecosystems. Throughout her career, she has focused her research on the software modularization and software maintenance. She has presented at various conferences including the International Conference on Software Engineering (ICSE), International Symposium on the Foundations of Software Engineering (FSE), the International Symposium on Empirical Software Engineering and Measurement (ESEM), and Working IEEE/IFIP Conference on Software Architecture (WISCA). Her work has also appeared in the Journal of Systems and Software and in the book Economics-Driven Software Architecture.

She has been breaking new grounds in her research covering: cyber-physical systems, socio-technical issues, software testing, and software performance. For example, in one of her projects, she is investigating modularity violations in cyber-physical systems. In another project, she is investigating the social structure of software development team to evaluate the team robustness and detect socio-technical misalignment and its maintenance consequences. She is also working on modeling software architecture for providing testing guidance and for addressing performance issues.

Prof. Xiao received her B.E. in network engineering from Beijing University of Posts and Telecommunications, and Ph.D. in computer science from Drexel University, where she was the recipient of several awards including first prize at the ACM Student Research Competition in 2015.
Professor Yang’s current research which lies in the area of empirical software engineering includes: measurement studies software crowdsourcing, economic models for traditional and emergent software development crowdsourcing market, recommendation systems for task-resource allocation, and machine learning-based quality prediction. She has served as Program Co-Chairs for Actionable Analytics Workshop 2015, ICSP 2010, Steering Committee member for PROMISE 2012-2013, and Program Committee member for a number of international conferences including ASE, ICSE SEIP, ESEM, APSEC, etc. She has co-edited three conference proceedings, published over 90 research papers in leading software engineering journals and conferences including Journal of Information Science and Technology, Journal of Empirical Software Engineering, IEEE Software, ICSE, ASE, ESEM, etc. Some of them won Best Research Paper Awards at International Conference on Predictive Models in Software Engineering, Evaluation of Novel Approaches to Software Engineering, Hawaii International Conference on System Sciences, and Conference of the International Society of Parametric Analysts.

Professor Yang received her B.S. in computer science and economics from Peking University and M.E. in software engineering from the Institute of Software Chinese Academy of Sciences. She attended the University of Southern California where she received her Ph.D. in computer science.

Professor Yu is a Research Assistant Professor in the School of Systems and Enterprises at Stevens Institute of Technology and a faculty member of the Center for Complex Systems and Enterprises. Dr. Yu’s research crosses multiple disciplines including applied statistics, optimization, data visualization, simulation, text-mining, and socio-economics. She is currently focused on understanding and managing complex systems in healthcare, including decision support systems for health management; impact of healthcare policies relative to public health outcomes such as access to care; evaluation of healthcare provider networks; chronic disease management; and health care operations.

Dr. Yu has presented her research findings in national and international conferences such as INFORMS, Academy Health, CESUN and JSM, and delivered over 50 presentations to executives and senior managers in public sectors and private industry, including Northwell Health, Emory Healthcare, North Shore-LIJ Health System, CareFirst BlueCross BlueShield, UnitedHealth, Bell Labs, National Weather Service, Publicis, and MITRE. She is a member in INFORMS, IIE, and IEEE.

Dr. Zhongyuan Yu holds a Ph.D. in System Engineering from Stevens Institute of Technology, M.S. in Operations Research and M.S. in Industrial Engineering from Georgia Institute of Technology.
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