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Emergence as Innovation in Systems of Systems – a Three Systems Model

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While emergence tends to be discussed as an outcome of a system of systems (SoS), it should be viewed as a process. Emergence is often the result of innovation within a SoS. We contend that, due to the complex adaptive nature of a SoS, the assessment of the potential for innovation to create positive change is necessary for effective evolutionary planning. Innovation potential represents the convergence of three systems: the system of interest, the innovation system, and the context where these interact and come together. The three-systems model is a useful perspective to assess the potential impact of innovation on the evolution of a SoS, and to describe the context of SoS emergence as enabled or constrained by its innovation system. We describe a set of methods and tools adapted from both SoS engineering and human-centered design which can be used for strategic design and planning of SoS evolution. The methods and tools are discussed with respect to the potential emergence of Internet of Things (IoT) technologies into the context of urban transportation systems, a complex adaptive SoS.

Biographies

Mr. Tom McDermott is a leader, educator, and innovator in multiple technology fields. He currently serves as Deputy Director of the Systems Engineering Research Center at Stevens Institute of Technology in Hoboken, NJ, as well as a consultant specializing in strategic planning for uncertain environments. He studies systems engineering, systems thinking, organizational dynamics, and the nature of complex human socio-technical systems. He teaches system architecture concepts, systems thinking and decision making, and the composite skills required at the intersection of leadership and engineering. A graduate of Georgia Tech, he has over 30 years of background and experience in technical and management disciplines, including over 15 years at the Georgia Tech Research Institute (GTRI) and 18 years with Lockheed Martin. He developed his career in the defense electronics industry, culminating in a leadership position with Lockheed Martin as Chief Engineer and Program Manager for the F-22 Raptor Avionics Team. Tom was the GTRI Director of Research and interim Director from 2007-2013. During his tenure the impact of GTRI significantly expanded; research awards doubled to over \$300M, faculty research positions increased by 60%, and the organization was recognized as one of Atlanta's best places to work as well as one of the nation's leaders in employee development.

Ms. Molly Nadolski is a Research Associate at GTRI, supporting the Technology Policy Initiative and based at the Sam Nunn School of International Affairs. Her research interests include issues related to national and international security, geopolitics, cyberspace, urban

resilience, decision-making, human behavior, and regional development. Her role at GTRI involves framing and leading policy research in these areas, while expanding and exploring the applications of systems thinking methods. Prior to her position at GTRI, she worked at several consultancies in Brussels, Belgium that carried out EU funded projects focused on technology, innovation, and security. Molly received her Master's degree (M.Sc) from Vrije Universiteit Brussel (Brussels, Belgium) in Political and Social Science with a concentration on cyber security public policies, and an undergraduate degree from Vesalius College (Brussels, Belgium) in Political Communication and Public Diplomacy.