

## **38. (KEYNOTE) PATHWAY TO FUTURE VIRTUAL PRODUCT CREATION IN THE COMING INTELLIGENCE / CONVERGENCE ERA**

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### **SUMMARY**

The current trend towards building large-scale Intelligent Cyber-Physical systems and environments that feature tight integration / convergence of computing, communication, control, and other leading-edge technologies is ushering in a new era – *the Intelligence / Convergence era* ( post-information age). The new era will feature the convergence / integration of hardware, intelligent software, simulations, measurements and actuation resulting in smart engineering systems consisting of heterogeneous mixes of electronics, sensors, actuators, embedded software, mechanical linkages and motors. Examples include networked autonomous vehicles, and swarm robotics. The systems have to be designed as complex adaptive systems – networks of highly interacting components, which are expected to function in uncertain, complex environments, and to adapt to unforeseeable contingencies.

The complexities of future systems go beyond the boundaries that conceived their components. New interdisciplinary fields need to be developed to address the complexities of future systems. There is a profound need for a new framework for system design, as well as a transformative change of, and a paradigm shift in, engineering education to focus on future complex adaptive systems-of-systems, and to redefine what it means to be an engineer in the next decades. The new framework for system design should enable the system to grow, function and stabilize, adapt and improve, in a bottom-up fashion. That is the domain of the interdisciplinary field of *Emergent (complexity) Engineering*, through which the system is designed from the bottom-up, by designing individual components and their interactions that can lead to a desired global response.

The presentation will identify some of the characteristics of the coming intelligence / convergence era, future complex adaptive systems, and their implications on virtual product creation. The need is described for establishing an Intelligent Cyber-Physical Ecosystem for facilitating interdisciplinary collaborations among engineers, researchers, scientists, software developers and other stakeholders working on the development and applications of the new interdisciplinary fields and the future complex adaptive systems. The new interdisciplinary fields will yield critical advances in engineering practice, and help in addressing future challenges in broad array of sectors, from manufacturing to energy, transportation, climate, and healthcare. They will stimulate creativity and innovation; invigorate engineering education, accelerate the development of skilled workforce needed in the new era. The major components of the ecosystem will be identified in the presentation.