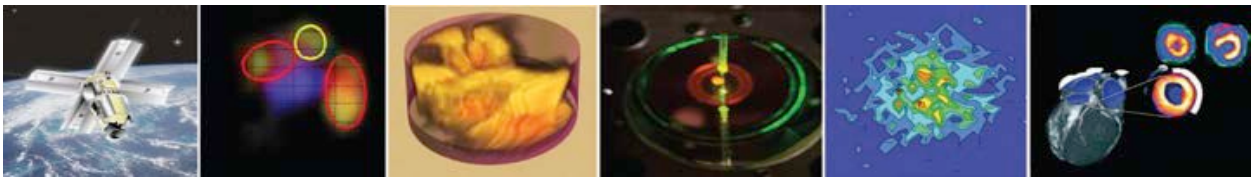

Science of Signatures
Advanced Studies Scholars Program 2014

Speaker: David Mascareñas, Ph.D., Institutes Office, Engineering Institute (EI)

Title: A Vibro-Haptic Human-Machine Interface for Structural Health Monitoring (The Story of My Learning Journey)

Abstract: The goal of the structural health monitoring (SHM) community has been to endow physical systems with a nervous system not unlike those commonly found in living organisms. Typically the SHM community has attempted to do this by instrumenting structures with a variety of sensors, and then applying various signal processing and classification procedures to the data in order to detect the presence of damage, the location of damage, the severity of damage, and to estimate the remaining useful life of the structure. This procedure has had some success, but we are still a long ways from achieving the performance of the nervous systems found in biology. Primarily because contemporary classification algorithms do not have the performance required. In many cases expert judgment is superior to automated classification. This work introduces a new paradigm. Instead of trying to build a nervous system from scratch, we propose interfacing the human nervous system to the distributed sensor network located on the structure and developing new techniques to enable human-machine cooperation. Results from the field of sensor substitution suggest this should be possible. Sensor substitution is a process by which a human can partially regain the use of a lost sense using a different sense as a surrogate. The plasticity of the human brain allows the human to interpret the stimuli to the alternative sense as coming from the original sense that was lost. Recent advances in smart structures haptic technology have enabled a wide range of new human-machine interfaces to facilitate sensory substitution. I will also discuss my architecture/framework for making a more human-like machine that leverages nearly all existing algorithms developed by the computer science community. My suspicion is that we are not at a want for algorithms to enable human-like machines. What we are lacking is a suitable framework to chain them all together. I believe the reason for this shortcoming is the static, Cartesian models that are currently in vogue among academic personality researchers. I propose a dynamic system

approach that I believe will feature emergent phenomena that can essentially be thought of as "machine personality." My approach is significantly different than current research efforts to give machines personality and improve human-machine cooperation.

Bio: David D. L. Mascareñas earned his Ph.D. and M.S. in structural engineering at the University of California San Diego, in La Jolla,CA in 2008 and 2006 respectively. He received the B.S. in mechanical engineering at Colorado State University in Fort Collins, CO in 2004. He worked as a laboratory manager at SAIC/Sullivan International in 2009 to develop systems health monitoring software for ground-based robots. In 2010 he was a Director's funded postdoctoral researcher at Los Alamos National Laboratory. In 2012 he was converted to a technical staff member at the Los Alamos National Laboratory where he currently performs research on cyber-physical systems at the Engineering Institute. He currently performs research on the application of compressive sensing techniques to structural health monitoring, the deployment of wireless sensor networks, standoff experimental mechanics, and the development of techniques to interface humans to data using vibro-tactile interfaces.