Southwest Mechanics Lecture Series

SEMINAR

Dr. Morteza (Mory) Gharib

Vice Provost; Hans W. Liepmann Professor of Aeronautics and Professor of Bio-Inspired Engineering

Friday, April 8, 2011
3:00 p.m. – 4:00 p.m.
Junkins 113

"LESSONS FOR BIO-INSPIRED DESIGN: MORPHO-DYNAMICS OF EMBRYONIC HEART"

ABSTRACT:

Nature has shown us that some hearts do not require valves to achieve unidirectional flow. In its earliest stages, the vertebrate heart consists of a primitive tube that drives blood through a simple vascular network nourishing tissues and other developing organ systems. Traditional developmental dogma states that valveless, unidirectional pumping in biological systems occurs by peristalsis. However, our *in vivo* studies of embryonic Zebrafish heart (Nature 2003) where we mapped the movement of both the myocardial cells in the developing heart tube wall as well as the flow of blood through the tube contradicts the notion of peristalsis as a pumping mechanism in the valveless embryonic heart. Instead, we have discovered an intriguing wave reflection process based on impedance mismatches at the boundaries of the heart tube (Science 2006). From these observations we have developed a physio-mathematical model that proposes an elastic wave resonance mechanism (JFM 2006) of the heart tube as the more likely pumping mechanism. In this model fewer cells are required to actively contract in order to maintain the pumping action than are necessary in a peristaltic mechanism. Inspired by this design, we have succeeded in constructing a series of mechanical counterparts to this biological pump on a range of size scale including scales comparable to that of embryonic zebrafish heart (e.g. ~400 microns). This new generation of biologically-inspired pumps functions on both the micro- and macro-scale and do not possess valves or blades. These advantages offer exciting new potentials for use in applications where delicate transport of blood, drugs or other biological fluids are desired. Also, in this lecture, we will discuss some of our recent experimental observations that may teach us how to grow biological micro valves.

BIO:

Dr. Mory Gharib is Vice Provost for Research and a Hans W. Liepmann Professor of Aeronautics and Professor of Bio-Inspired Engineering at the California Institute of Technology. He received his B.S. degree in Mechanical Engineering from Tehran University (1975) and then pursued his graduate studies at Syracuse University (M.S., 1978, Aerospace and Mechanical Engineering) and Caltech (Ph.D., 1983, Aeronautics). After two years as a senior scientist at the Jet Propulsion Laboratory (NASA/CIT), he joined the faculty of the Applied Mechanics and Engineering Sciences Department at UCSD in 1985. He became a full professor of fluid mechanics in 1992 and, in January 1993, he joined Caltech as a professor of aeronautics. Dr. Gharib's current research interests include bio-inspired engineering for the development of medical devices, wind energy harvesting and propulsion systems. His other active projects include the development of advanced 3-D imaging systems, and nano and micro-fluidics. His biomechanics work includes studies of the human cardiovascular system and physiological machines. Dr. Gharib has a keen interest in the history of science and engineering. His work on using wind power to lift heavy objects is the subject of a one hour History Channel documentary titled "Flying Pyramids-Soaring Stones". His work on Leonardo's studies of heart valves has been published in technical journals and referenced in four books on Leonardo's work. Also, his work on Leonardo's heart studies has been featured in a PBS series titled "Leonardo's Dream Machine". Currently, he is working on a manuscript that describes the scientific significance of Leonardo's work in fluid and hydraulic engineering. Dr. Gharib holds 173 publications in refereed journal and 45 U.S. Patents.