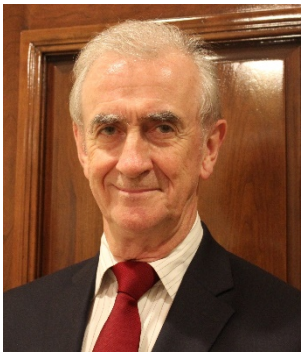
COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

ME Department Seminar

How do we do it?
The puzzle of human performance



Neville Hogan
Massachusetts Institute of Technology

Tuesday, January 22, 2019
Time 10:00 AM
Room Johnson Rooms, LEC

Abstract
Robot dexterity remains inferior to human, yet we have slower motors, communication and computation. How do we do it? I will review evidence that *dynamic primitives* are the key. These dynamic behaviors emerge from neuro-mechanics without continuous central intervention. Classes include oscillations, sub-movements and mechanical impedances, the latter to manage physical interaction. Evidence is found in the behavior of arm amputees and patients recovering after a stroke. Recent work showed that unimpaired subjects cannot sustain the discreteness of rapid actions but 'default' to rhythmic performance. Conversely, rhythmicity of very slow oscillations cannot be sustained; instead performance 'breaks down' into a sequence of sub-movements. Moving an object with internal oscillatory dynamics (motivated by a cup of coffee) is best described by a sub-movement sequence predicted by input-shaping theory. To obviate reactive corrections, humans seek predictability; in fact, predictability out-weighs effort. Predictability is enhanced by movement smoothness, which underlies the widely-reported 2/3 power speed-curvature relation in human movements. Remarkably, subjects' ability to manage physical interaction with a robot was compromised when robot motion deviated from the biological speed-curvature pattern. When curvature variation was eliminated by physical interaction with a circular constraint, subjects' force and motion patterns revealed an underlying speed-curvature relation. Advantages of robot control based on dynamic primitives will be presented.

Bio
Neville Hogan is Sun Jae Professor of Mechanical Engineering and Professor of Brain and Cognitive Sciences at the Massachusetts Institute of Technology. He earned a Diploma in Engineering (with distinction) from Dublin Institute of Technology and M.S., Mechanical Engineer and Ph.D. degrees from MIT. He joined MIT's faculty in 1979 and presently Directs the Newman Laboratory for Biomechanics and Human Rehabilitation. He co-founded Interactive Motion Technologies, now part of Bionik Laboratories. His research includes robotics, motor neuroscience, and rehabilitation engineering, emphasizing the control of physical contact and dynamic interaction. Awards include: Honorary Doctorates from Delft University of Technology and Dublin Institute of Technology; the Silver Medal of the Royal Academy of Medicine in Ireland; the Henry M. Paynter Outstanding Investigator Award and the Rufus T. Oldenburger Medal from the American Society of Mechanical Engineers, Dynamic Systems and Control Division; and the Academic Career Achievement Award from the Institute of Electrical and Electronics Engineers, Engineering in Medicine and Biology Society.