Imperial College London

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The Twentieth Professor Roger W.H. Sargent Lecture

The Professor Roger Sargent Lecture is an annual event the Centre for Process Systems Engineering inaugurated as a tribute to Professor Sargent's vision, leadership, significant technical contributions and to his legacy in the field of Process Systems Engineering.

Professor Francis J. Doyle III
University of California, Santa Barbara

Engineering the Artificial Pancreas

In the Chair: **Professor Nilay Shah, Director, Centre for Process Systems Engineering, Imperial College London**

Vote of Thanks: **Professor Claire Adjiman, Centre for Process Systems Engineering, Imperial College London**

Abstract: Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease affecting approximately 35 million individuals world-wide, with associated annual healthcare costs in the US estimated to be approximately $15 billion. Current treatment requires either multiple daily insulin injections or continuous subcutaneous (SC) insulin infusion (CSII) delivered via an insulin infusion pump. Both treatment modes necessitate frequent blood glucose measurements to determine the daily insulin requirements for maintaining near-normal blood glucose levels.

More than 30 years ago, the idea of an artificial endocrine pancreas for patients with type 1 diabetes mellitus (T1DM) was envisioned. The closed-loop concept consisted of an insulin syringe, a blood glucose analyzer, and a transmitter. In the ensuing years, a number of theoretical research studies were performed with numerical simulations to demonstrate the relevance of advanced process control design to the artificial pancreas, with delivery algorithms ranging from simple PID, to H-infinity, to model predictive control. With the advent of continuous glucose sensing, which reports interstitial glucose concentrations approximately every minute, and the development of hardware and algorithms to communicate with and control insulin pumps, the vision of closed-loop control of blood glucose is approaching a reality.

In the last 10 years, our research group has been working with medical doctors on clinical demonstrations of feedback control algorithms for the artificial pancreas. In this talk, I will outline the difficulties inherent in controlling physiological variables, the challenges with regulatory approval of such devices, and will describe a number of process systems engineering algorithms we have tested in clinical experiments for the artificial pancreas.

Biography: Frank Doyle holds the *Duncan and Suzanne Mellichamp Chair in Process Control* in the Department of Chemical Engineering, as well as appointments in the Electrical Engineering Department, and the Biomolecular Science and Engineering Program at UC, Santa Barbara. He is the Director of the UCSB/MIT/Caltech Institute for Collaborative Biotechnologies, and is the Associate Dean for Research in the College of Engineering. He received a B.S.E. degree from Princeton, C.P.G.S. from Cambridge, and Ph.D. from Caltech, all in Chemical Engineering. Prior to his appointment at UCSB, he has held faculty appointments at Purdue University and the University of Delaware, and held visiting positions at DuPont, Weyerhaeuser, and Stuttgart University. He has been recognized as a Fellow of multiple professional organizations including: IEEE, IFAC, AIMBE, and the AAAS. He served as the editor-in-chief of the *IEEE Transactions on Control Systems Technology* from 2004-2009, and was the Vice President for Publications in the Control System Society from 2011-2012. In 2005, he was awarded the *Computing in Chemical Engineering* Award from the AIChE for his innovative work in systems biology, and in 2012 was a finalist for the WYSS Institute - IEEE EMBS Award for Translational Research. His research interests are in systems biology, network science, modeling and analysis of circadian rhythms, and drug delivery for diabetes.

Thursday 5 December 2013 • 17.30

Lecture Theatre 1 (Room 250), Department of Chemical Engineering, ACE Extension Building, South Kensington Campus, Imperial College London SW7 2AZ

Tea and coffee will be served before the lecture from 16.30 in the Common Room (Room 228), Department of Chemical Engineering, Level 2, ACE Extension Building

Professor Francis J. Doyle III