Two Generalizations of the Design of Experiments Methodology for Enhanced Process Understanding

Christos Georgakis,

Systems Research Institute and Chemical and Biological Engineering,
Tufts University, Medford, MA 02155, USA

Abstract

Motivated by recent robotic advances, a host of automated, high-throughput devises are enabling a data-rich experimental environment. This talk will address two recently introduced methodological advances that enable the design of information-reach experiments and model the time-resolved data that are collected. They both contribute significantly to the optimization of a multitude of processes and enhance our understanding of them. In such data-rich environment, the traditional Design of Experiments (DoE) and the Response Surface Methodologies are showing their limitations. We introduce the Design of Dynamic Experiments (DoDE) methodology, a generalization of DoE, and the Dynamic Response Surface Methodology (DRSM) to model time-resolved data. The first, DoDE, enables the design of experiments with time-varying inputs. The second one, DRSM, enables the estimation of a single model that incorporates all time-resolved data of a process output. Exploring the interrelationship among DRSM models of several measured reacting species, one can be led to the discovery of the stoichiometry of the reactions taking place. This enhances our understanding of complex kinetics and the discovery of optimal operating conditions that minimize the generation of unwanted byproducts. Examples from a series of industrial collaborations will be sited.

Brief Biographical Note

Dr. Christos Georgakis is Professor of Chemical and Biological Engineering at Tufts University where he has also been the Gordon Senior Faculty Fellow in Systems Engineering. He received his Chemical Engineering Diploma (1970) from National Technical University in Athens, Greece; his MS (1972) from the University of Illinois and his Ph.D. (1975) from the University of Minnesota. Starting in 1975, he served as du Pont Assistant Professor and Edgerton Associate Professor of Chemical Engineering at MIT, and as Professor of Measurement and Control at the University of Thessaloniki in Greece where he initiated the Chemical Process Engineering Research Institute. He joined Lehigh University in 1983 where he founded and directed the Chemical Process Modeling and Control Research Center. Lehigh honored him in 2001 with the Iacocca Professorship. After two years as the Othmer Distinguished Professor at the Polytechnic University of New York, he moved to Tufts in 2004. In 2017, he has been recognized with the University's Distinguished Senior Scholar Award. His research activities have been recognized by a multitude of awards both nationally and internationally. He was awarded in 1978 a Dreyfus Foundation Teacher-Scholar Grant. In 2001, he was the recipient of the Computing Award of the CAST Division of the American Institute of Chemical Engineers. He is a fellow of the American Institute of Chemical Engineer, the American Association for the Advancement of Science, of the International Federation of Automatic Control. In 2002-03 he served as the President of the American Automatic Control Council. Six years ago, he initiated a new series of conferences called Future Innovation in Process Systems Engineering (FIPSE). The fourth one took place in June 2018 in Chalkidiki, Greece