TUESDAY, MAY 2, 2017
LECTURE 1: Role of Process Systems Engineering in Chemical Engineering
Reception: 3:30 pm, Cheney Room
Lecture: 4:00-5:00 pm, room 1800, Engineering Hall, 1415 Engineering Drive

In this talk we give a general overview of the nature of Process Systems Engineering, discuss some current major trends, and show how it fits in Chemical Engineering and the role it might play in the future. After briefly reviewing the history of Chemical Engineering, we highlight how academic research over the last decade has had a strong push towards science, largely due to emergence of areas like nanotechnology and biotechnology, which has caused some disconnect between academia and industry. However, despite these trends, Process Systems Engineering (PSE) remains a core area in Chemical Engineering that on the one hand has expanded its scope from the process engineering level down to the molecular level, and up to the enterprise and global level. Furthermore, PSE is again regaining prominence due to the increasing importance of the areas of energy and sustainability. Traditionally, PSE has been subdivided into process design, process control and process operations. In this talk we argue why PSE is becoming broader in terms of scope due to future trends.

We describe three major trends in Process Systems Engineering that have emerged over the last decade and that can potentially help the industry to innovate and to remain competitive. First, we describe efforts for simultaneous product and process design, where the emphasis lies in tying the molecular structure of the products with the processing and macroscopic properties of the product. Second, we describe work that is aimed at modeling and optimizing processes for effectively exploiting fossil fuels like shale gas and alternative sources like biomass. We also address the issue of efficiently managing natural resources such as water. Third, we describe research efforts in enterprise-wide optimization that are aimed at designing and operating supply chains for the process industry in which planning, scheduling and control can be integrated more effectively. We conclude that Process Systems Engineering is broadening its scope in order to address problems that are of current and future interest.

THURSDAY, MAY 4, 2017
LECTURE 2: Recent Advances in Computational Models for the Discrete and Continuous Optimization of Industrial Process Systems
Reception: 3:30 pm, Cheney Room
Lecture: 4:00-5:00 pm, room 1800, Engineering Hall, 1415 Engineering Drive

In this seminar we give an overview of recent models and algorithms for the discrete and continuous optimization of a variety of challenging applications in Process Systems Engineering, and that have been largely the result of collaborations with industry. We first provide a brief overview of deterministic models based on mixed-integer linear/nonlinear programming (MILP/MINLP) to highlight the progress that has been made. Next, we provide a brief review of global optimization for which the progress is illustrated with the synthesis of integrated water networks, with the design of centralized and distributed manufacturing for biomass, and with the design and planning of infrastructures for shale gas production that involve large scale nonconvex MINLP models. In order to improve the prediction of lower bounds for convex and nonconvex MINLP problems, we describe theoretical procedures based on generalized disjunctive programming for strengthening the corresponding continuous relaxations, and for which effective cutting plane methods have been developed as will be shown with numerical results on test problems. Finally, we address the handling of uncertainty in discrete/continuous models through approaches that are based on robust optimization and stochastic programming. For the former, we consider affine-adjustable recourse to avoid overly conservative results, and which is illustrated in cryogenic storage in air separation plants that participate in the electricity and operating reserve markets. For the case of stochastic programming, we consider first the development of strategies based on decomposition that can handle a very large number of scenarios. We illustrate this with optimal design of supply chains that are subjected to disruptions in their distribution centers. Finally, we consider multistage stochastic programming models that involve exogenous and endogenous parameters for which effective theoretical and solution methods are proposed. These are applied to the design and planning of offshore facilities with uncertain crude oil prices and reservoir sizes.