Planta Piloto de Ingenieria Quimica – Departamento de Ingeniería Química
Universidad Nacional del Sur-CONICET
Centro Cientifico Tecnologico CCT- CONICET – Bahia Blanca

Lectures on Frontiers in Process Systems Engineering

Professor George Stephanopoulos
Massachusetts Institute of Technology

Lecture-1: (Marzo, 15 16:30 h, Auditorio Menor CCT–CONICET)

Process Systems Engineering: An Introduction to its Foundations and a Historical Overview of its Development

The term Process Systems Engineering (PSE) is relatively recent. It was coined about 50 years ago at the outset of the modern era of computer-aided engineering. However, the engineering of processing systems is almost as old as the beginning of the chemical industry, around the first half of the 19th century. Initially, the practice of PSE was qualitative and informal, but as time went on it was formalized in progressively increasing degrees. Today, it is solidly founded on engineering sciences and an array of systems-theoretical methodologies and computer-aided tools. In this lecture I will discuss the foundations of PSE and an overview of its history, i.e. its origin and evolution; a brief illustration of its tremendous impact in the development of modern chemical industry; its state at the turn of the 21st century; and an outline of the role it can play in addressing the societal problems that we face today such as; securing sustainable production of energy, chemicals and materials for the human wellbeing, alternative energy sources, and improving the quality of life and of our living environment. PSE has expanded significantly beyond its original scope, the continuous and batch chemical processes and their associated process engineering problems. Today, PSE activities encompass the creative design, operation, and control of: biological systems (prokaryotic and eukaryotic cells); complex networks of chemical reactions; free or guided self-assembly processes; micro- and nano-scale processes; and systems that integrate engineered processes with processes driven by humans, legal and regulatory institutions. Through its emphasis on synthesis problems, PSE provides the dialectic complement to the analytical bent of chemical engineering science, thus establishing the healthy tension between synthesis and analysis, the foundation of any thriving discipline. As a consequence, PSE emerges as the foundational underpinning of modern chemical engineering; the one that ensures the discipline's cohesiveness in the years to come.

Lecture-2: (Marzo, 16, 16:30 h, Auditorio Menor CCT–CONICET)

Nanoscale Process Systems Engineering: Toward Molecular Factories, Synthetic Cells, and Adaptive Devices

Research in nanoscale science and engineering has been primarily directed toward the design and manufacturing of (a) materials with passive nanostructures (e.g., nanostructured coatings, dispersion of nanoparticles, and bulk nanostructured metals, polymers and ceramics), and (b) active devices with nanostructured materials (e.g., transistors, amplifiers, targeted drugs and delivery systems, actuators and adaptive structures). Research on the design, fabrication and operation of integrated "nanoscale factories", that is, processes with unit operations and materials movement among these units at the nanoscale, along with the requisite energy supply system and monitoring and control infrastructure, is lagging seriously behind. It is progress at this frontier that will enable the research visions of molecular factories, synthetic cells and adaptive devices1 (e.g., artificial tissues and sensorial systems, nanosystem biology for health care and agricultural systems,scalable plasmonic devices, chemico-mechanical processing, targeted cell therapy and nanodevices, human-machine interfaces at the tissue and nervous system level) to become reality. In this lecture I will discuss how PSE methodological approaches can be extended to address the conceptual design of synthetic cells; the fabrication of nano-scale structures with desired geometries; and the design of monitoring and regulatory control systems.

Lecture-3: (Marzo, 21 16:30 h, Auditorio Menor CCT–CONICET)

BioRefineries: A Game-Theoretical Case in Distributed Manufacturing

Advances in technologies for processing biomass feedstocks have resulted in the development of a large number of potential processing schemes for the production of biomass-based fuels and specialty chemicals. The ensuing BioRefineries involve two types of distinct processing phases: Phase-1, treatment of biomass and production of intermediates; Phase-2, production of attractive fuels or specialty chemicals, starting with the available intermediates. These two phases of manufacturing are undertaken by distinct business enterprises, which makes an integrated view of a BioRefinery design an un-natural framework of analysis. In this lecture I will discuss the concept of Distributed Manufacturing as the natural setting in designing a BioRefinery, in contrast to the prevailing settings of most of the published works. Within such a Distributed Manufacturing framework, I will show how Game Theoretical considerations, developed within the framework of a Lagrangian approach, can be used to identify attractive opportunities for the production of fuels or/and chemicals from various types of biomass.

Enrique Rotstein Conference: (Marzo, 22, 18:00 h, Auditorio Mayor CCT–CONICET)

Continuous Reduction of Operations' Uncertainty: The Essence of Continuous Improvement (CI) Programs

An operating plant is plagued with a variety of uncertainties, including the following: Uncertainties in the current state and future trends of operations and operating equipment; Uncertainties in the deployment of standards, organizational behavior, or/and individual human behavior; and Uncertainties in future trends of supply and demand markets. The impact of these uncertainties on the physical and functional integrity of the processing systems, as well as its economic performance and environmental impact are significant, and far outstrip any optimization one could envision through classical approaches. "Continuous Improvement" is the only philosophy and methodological framework that can ensure the safe and efficient operation of processing systems, and though it is poorly understood by process systems engineers and poorly managed by managers of operating plants. In this lecture I will sketch my experience with Continuous Improvement programs in real plants, and offer a methodological framework for its systematic deployment in operating processes.