# Integrating control with process operations: Process resiliency and digital transformation for the process industry

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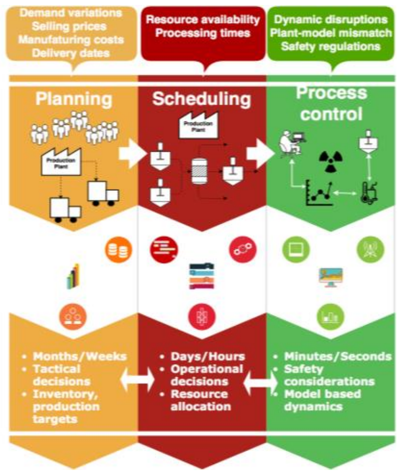


Figure 1. The integrated planning, scheduling and control problem under uncertainty.

In recent years advances in computing power along with the widespread availability of data has led process industries to consider a new paradigm for automated and more efficient operations. This trend is commonly referred to as "Industry 4.0" and many reports indicate that it can result in cost reductions of up to 20% while improving asset utilisation by 30 to 40%. Despite the research effort dedicated on techniques for the interpretation and efficient employment of big-data within the industry, the development of mathematical modelling and optimisation techniques that serve the requirements for seamless communication among the different levels of decision making has received considerably less attention. Contemporary process industries are part of a progressively complex global market network and the need to account for efficient and integrated solutions becomes increasingly mandatory. Nonetheless, as industries are moving towards more digitalised and continuous paradigms to need for designing computationally efficient frameworks for real-time decision making is becoming urgent. Integrating control with operations has gained considerable amount of research interest (Charitopoulos et al., 2018; Zhuge and Ierapetritou, 2012) due to the benefits of exploiting their underlying interdependence and optimising process operations. So far, most of the research works have dealt with integrating cyclic scheduling and control with little work done on the integration of planning, scheduling and control (iPSC). While considering process planning together with scheduling and control poses an additional degree of complication by exacerbating the multi-scale nature of the problem, their rigorous integration can result in enhanced and more resilient process operations in the face of uncertainty. In this talk, the development of a systematic model-based framework for the efficient online closed-loop implementation of the iPSC of continuous manufacturing processes will be presented. Results from case studies of the petrochemical industry highlight the importance of integrated optimisation so as to increase flexibility and resilience in the face of uncertainty.

# Bio

**Dr. Vassilis Charitopoulos** is a Lecturer (2019-) in the Department of Chemical Engineering, CPSE at UCL and an Associate Researcher at the EPRG at Cambridge Judge Business School. He specialises in developing mathematical programming models and methods to incorporate uncertainty considerations for chemical process and energy systems engineering problems.

Before joining UCL, he was a Research Associate at EPRG where he developed a UK-wide integrated heat and electricity model to examine heat decarbonisation pathways together with Dr. Reiner. Because of his expertise in the decarbonisation of the UK heat sector, Vassilis has given invited talks at the interdisciplinary Energy@Cambridge network as well as the Corporate Strategy team of National Grid plc. Dr. Charitopoulos research has been published in distinguished international process and energy engineering journals such as Applied Energy, Computers and Chemical Engineering and AIChE Journal. He is the author of a recent research monograph on optimisation under uncertainty methods (Springer).

Dr. Charitopoulos has received global recognition for his excellent research activity including: UCL Rooke Prize (2016), IChemE Best Young Researcher finalist (2018; 2019), Springer Thesis Award (2019), UCL David Newton Prize (2019). He was the recipient of an Early Career Fellowship (2019) from the Isaac Newton Trust, University of Cambridge for a project related to the stochastic optimisation of heat decarbonisation pathways in the UK.

His current research focuses on the development of novel techniques for model-based and data-driven optimisation frameworks for digital process manufacturing and carbon-neutral energy systems engineering.