From data to knowledge: the role of process chemometrics in the implementation of Quality-by-Design paradigms in pharmaceutical development and manufacturing

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"Quality by Design" (QbD) is an initiative set forth by the pharmaceutical regulatory agencies (such as the U.S. Food and Drug Administration and the European Medicines Agency) a decade ago. QbD encourages pharma companies to adopt systematic *science-based* tools, as opposed to experience-based ones, to support pharmaceutical development and manufacturing activities. According to QbD, the quality of a product must be "built into" the product and ensured *since its design*, through an extensive understanding of the relations between the product quality and the parameters that can have an impact on it. The ultimate objective of this approach is to promote faster and more consistent product and process development activities, and to increase manufacturing flexibility and process robustness in order to reduce production costs.

After the launch of the QbD initiative, the interest of the (bio)pharmaceutical industry toward process chemometrics has grown tremendously. The traditional role of chemometrics has been that of analyzing "chemical" data to improve the understanding of chemical information and to correlate quality parameters or physical properties to analytical instrument data (typically, spectra). Process chemometrics goes well beyond that, considering the application of chemometrics to industrial process data characterized by a large number of correlated process measurements, with the intent of extracting information useful to optimally design or operate the manufacturing process.

This seminar will review some process chemometrics approaches that the CAPE-Lab group at the University of Padova has recently developed to support the practical implementation of QbD paradigms in the pharmaceutical industry. Attention will be given to latent variable models, and reference will be made to some real-world applications, such as monitoring the operation of a vaccine manufacturing (bio)process, transferring a latent variable model across two different spray drying plants, scaling-up a nanoparticle production process, and periodically reviewing massive historical datasets of manufacturing data.