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Digitalization for intelligent biomanufacturing and engineering education: status and perspectives / new practices

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Digitalization and especially Digital twins have become a new frontier in the biomanufacturing- and processing industries. The development of these technologies promises to improve lean and intelligent production opportunities within these sectors by addressing model complexities with more data driven and hybrid modeling approaches. These methods employ a tight integration between the digital and physical entities to achieve this goal. Therefore, one of the essential supporting tools in its implementation is addressing how to proactively respond to the ever-evolving market demand for chemical engineers with expanded data science knowledge and the challenges associated with implementing this type of production system in industrial settings. Hence, tools such as high-fidelity modelling (white, black, hybrid), process system engineering (methods and software) and data management should be part of any engineer's toolbox. Furthermore, the know-how on tackling unforeseen challenges is leading, now more than ever, to a high demand for theoretical and hands-on knowledge.

The first requirement to accomplish a successful development of a digital twin/shadow is the facilitation of a bidirectional physical-to-digital information loop which should be prudently developed and curated on the go. It requires continuous synchronization between the physical entity (data) and digital representation. Notably, embedding a quasi-flawless flow of information will empower the prediction of optimal states and system interventions becoming a tool for knowledgeable online decision-making, minimizing manual intervention. However, a major caveat in the biomanufacturing industry is the high degree of unique and strict requirements towards characteristics and regulations of the products.

Therefore, one of the most essential tools in its transformation to become a reality, data collection methods (e.g., smart and soft sensors), signal processing and models (e.g., mechanistic, data-driven or hybrid) should be like bread and butter.

This presentation/talk will cover a general review of ongoing research activities within digitalization in the biomanufacturing field, our interpretation of digitalization, up-to-date solutions, and enabling technologies and applications. Two ongoing development cases will be presented. The first example covers the development and application of digital we will show a proof of concept on how AI-powered models can be used to automate educational processes. Secondly, a more practical example is presented where we present an approach to develop a digital twin of a pilot scale fermentation, highlighting the use of Non-Linear State Estimation for improving induction timing in GFP production. The developed tool can help operators by predicting an estimated time for induction based on a glucose concentration target.

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