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A framework for dynamically managing multi-stage manufacturing processes

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Multistage manufacturing processes (MMPs) are complex processes involving multiple manufacturing stations with processes occurring sequentially as well as concurrently in time. These systems embody characteristics of both mechanical and control systems and their design is complicated because the performance is hard to predict without information of the complete design. Further, the desire for flexible and agile manufacturing systems makes this design task even harder. In this keynote talk, in the context of Industry 4.0, we outline a framework for dynamically managing multistate manufacturing processes that ensures robust, fault-tolerant MMPs and guarantees product quality even in the presence of fixturing and tool/sensor errors. Concepts such as detectability and controllability from controls engineering are incorporated into the design process and a step-by-step procedure is laid out for enabling the design engineer to evaluate tradeoffs during the design cycle. Examples from automobile parts assembly are used to illustrate the proposed framework. We will conclude with a discussion of the challenges facing the manufacturing industry and areas for improvement.

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