

Abstract

Not just since the financial crisis in 2008, have manufacturing enterprises been confronted with increasing challenges. Besides factors like quality and cost, time and innovative capabilities (e.g., product design) have become critical success factors in global markets. Enterprises have to react instantly to changing market conditions and disturbances that occur during execution of value creation processes. Depending upon the processes' context, the goal is to significantly reduce lead times, reaction times, and time-to-market, among others. The vision of a real-time enterprise (RTE), which is able to sense and analyze events from internal and external sources, and perform adequate (re-) actions, has been envisaged by manufacturing enterprises. Here, the realization of an RTE has to incorporate management, engineering and computer science perspectives.

The main objective is the realization of closed-loop controls using feedback among the processes' targets (e.g., quality, cost, quantity) defined by responsible process owners and the actual manufacturing process performance at the shop floor level during the execution of value creation processes. Unfortunately, in many instances, the vertical integration of enterprise levels is inadequately implemented. Hence, manufacturing execution systems (MES) try to mitigate the vertical integration gap by introducing feedback among enterprise levels. Nevertheless, the exchange of data is manual or semi-automatic because of the inflexible and proprietary interfaces. Also, process data from automation devices is often not reasonably incorporated. Consequently, the realization of multiple closed-loop controls is still pending.

The concept of an RTE requires information technologies to sense, (pre-) process, and analyze events, and further, deduce appropriate (re-) actions based on detected critical situations. The (software) components of an event-driven architecture (EDA) interact through the exchange of events. Therefore, concepts of an EDA are promising building blocks to implement a vertically integrated (manufacturing) enterprise and establish an RTE. In recent years, the processing of (complex) events, which is an indispensable part of an EDA, has been discussed in the context of complex event processing (CEP).

In this research work a framework based on EDA and CEP is presented towards the realization of RTE in manufacturing. The framework closes the aforementioned vertical integration gap, and further, establishes feedback in (near) real-time among enterprise levels. As such, the framework provides a holistic and closed-loop control of (manufacturing) processes. The framework encompasses results and insights from management, engineering, and computer science. This has been implemented for Ohm & Häner Metallwerk GmbH & Co. KG, Olpe, i.e., a small and medium sized foundry. Here, the framework is employed to monitor and control sand casting processes. The developed control approach has led to a significant increase in (manufacturing) processes' efficiency (i.e., performance, quality, and availability).

The Concept of a Real-Time Enterprise in Manufacturing
Design and Implementation of a Framework based on
EDA and CEP

Metz, D.

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