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A novel methodology to integrate Manufacturing Execution Systems with the lean manufacturing approach

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Abstract

In order to deal with global competition, industries have undertaken many efforts directed to improve manufacturing efficiency. From a broad perspective, two possible approaches are the adoption of lean manufacturing methodologies or the implementation of information tools: for several years, these two approaches have been assumed to be mutually exclusive. The present work aims to define a methodology to support developers and practitioners in the integration of Manufacturing Execution Systems with the lean manufacturing approach. A case-study in the field of aeronautics is presented to validate the method.

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1. Introduction

Nowadays enterprises are driven by a market demand characterized by fierce competition, rapid pace of business and continually compressed time schedules. On the one hand, manufacturing is experiencing shortened production cycles and reduced batch sizes; on the other hand, the variety of product types and their customization are increasing, as well as customer demands rapidly change. Hence, to maintain and improve their competitive advantage, leading organizations in different industrial sectors need to improve process optimization and efficiency.

One initiative that a company may undertake is the implementation of *lean manufacturing* practices: this term has been introduced by Womack et al. [1] to describe the working philosophy deployed in Japanese companies, with

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particular concern for Toyota. This methodology relies on the elimination of wastes and non-productive processes, in order to focus on value added operations and produce high-quality products, at the customers demand pace, with ideally no waste. Another approach is the deployment of automation and Information Technology (IT) tools, which allow to improve process planning and control, as well as to enhance the performance of each step of the manufacturing process. The landscape of software classes and their purposes has been changing over the years, and is still evolving at a high pace. Today, the focus is on the integration and the communication between different information tools and among systems deployed by different companies (for example, among firms belonging to the same supply chain).

For several years, lean manufacturing and IT tools have been considered mutually opposed [2]. On one side, the philosophy of lean is “less is better”: to improve company performance, inventory, variability, material handling, options and choices must be reduced as much as possible. Conversely, IT philosophy is “more is better”: IT tools allow to better manage more information, increased flexibility, functions and features. However, according to [2], the two classes of instruments are complementary both in the concept and in the application: IT tools are a kind of higher-level planning system, while lean practices were related to shop-floor control and execution activities.

Nevertheless, in order to define improvement strategies and assess their impact, data collection and analysis is mandatory: the adoption of methodologies for lean manufacturing cannot exclude the integration of IT tools. Hence, in the last years, IT instruments have been widely adapted, upgraded and expanded to deal with process monitoring and control activities. In this field, Manufacturing Execution Systems (MES) play a key role: they are in charge of collecting data, perform analyses and dispatch the resulting information. At the state of the art, a comprehensive methodology for the deployment of MES to support the implementation of lean practices is still lacking. The present paper aims to fill this gap. In Section 2 the background on both MES and lean manufacturing is presented. In Section 3, a novel methodology to integrate the functionalities of a MES with the principles of lean manufacturing is presented. A case study in the field of aeronautics is presented in Section 4. Conclusion and final remarks are presented in Section 5.

2. Background

2.1. Manufacturing Execution Systems

Manufacturing Execution Systems are IT tools commonly deployed in companies involved in traditional manufacturing. A MES enables information exchange between the organizational level, commonly supported by an Enterprise Resource Planning (ERP), and the control systems for the shop-floor, usually consisting in several, different, highly customized software applications [3]. A schematic of MES positioning in the framework of information tools supporting manufacturing is provided in Fig. 1. MES were initially deployed in industries focused in the fields of chemistry and pharmaceuticals; then, the spread of such systems increased, but for long time this tool has been considered useful only for large industries. In the early 2000s, it was understood that the benefits provided by a MES can profitably support even smaller companies [4].

The tasks in charge of a MES are defined in the standards ISA95 [5] and IEC62264 [6]. A MES has two principal purposes. First, the system has to deal with the top-down data flow: the requirements and the necessities provided by the organizational level must be transformed into an optimal sequence planning meeting such targets. This sequence must be identified by best exploiting the available resources (such as staff, machines, materials, inventory) and taking into account the constraints of the process, such as processing and setup times, and workstations capacity.

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