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An Industry 4.0 case study in fashion manufacturing

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Abstract

We present an application of the Industry 4.0 enabling technologies to Bottega Veneta, an Italian luxury goods house renowned in the world for its leather goods. In particular, we address the production process throughout the supply chain. The proposed framework introduces a uniform data model, used by all the actors involved in the production process to collect and represent the large amount of data involved in the production process. A DSS (Decision Support System) allows the production planner to focus on different scenarios to take better decisions.

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1. Introduction

The "Piano Nazionale Industria 4.0", the Italian plan for the adoption of the Industry 4.0 paradigm by the Italian manufacturing system, indicates a set of enabling technologies that must be used to be able to achieve the rewards that such paradigm promises. Advanced manufacturing solutions, simulation, horizontal/vertical integration and Big Data and analytics are among them.

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We present an application of these enabling technologies to the world-wide known luxury leather goods producer Bottega Veneta. In particular, we address the production process, which is distributed across several elements of the supply chain and the relative the management issues.

We show how the integration among the different entities in the supply chain and the interoperability of systems within each entity leads to the availability of a large set of data and information, that can be effectively used to feed data analytics systems such as decision support systems. These data are hence processed with advanced tools (analytics and algorithms) to generate meaningful information.

The Bottega Veneta supply chain includes: the main firm, controlled factories and several independent producers, which provide the ability to perform specific parts of the production process. The "as is" production management is conducted using different systems: an ERP system for the main firm, a vertical ERP solution tailored for fashion companies in the factories, an APS (Advanced Planning and Scheduling) tool to provide plans for the factories. The integration among the systems is achieved through traditional data exchange tools. The traditional ERP processes customers' orders data to feed the APS, which provides its processed results in terms of due dates and production orders to the factories' vertical ERPs. Independent producers are individually managed outside these systems.

We propose an Industry 4.0 inspired framework as an evolution of the current situation, introducing a uniform data model, used by all the actors involved in the production process. This model is used to collect and represent the large amount of data that are involved in the production process, including logistic information such as due dates and customers' data, production details such as production cycles, technological constraints and feedback data from the floor shop.

The continuously collected data are both used to effectively coordinate the different actors in the supply-chain as well as within each factory and to feed a complex analytics system that includes, among the other, visual representations of the data that are meaningful to the proper user and a DSS (Decision Support System) that allows production planner at different levels to focus on different automatically generated and locally optimized scenarios to support them in taking better decisions. A specific insight in the algorithms and mathematical models used by the DSS is also presented.

2. Towards Industry 4.0

Industry 4.0 is the next step in a long process of development. The term Industry 4.0 was first introduced during the Hannover Fair event in 2011 (see [1]). It comes from an initiative launched by the German Federal Government as part of its comprehensive High-Tech Strategy. It describes both the fourth stage in the process of industrialization. An introduction to Industry 4.0 concepts can be found in [2]. In the recent work [3], a possible architecture for Industry 4.0-based manufacturing systems is presented.

One of the key objectives of Industry 4.0 is to combine two principles that are actually opposites, strictly speaking – production line manufacturing and custom manufacturing – in a smart environment referred to as smart factory; contributions to this subject were recently provided by the authors in [4, 5]. The concept of a smart factory makes the rather abstract idea of Industry 4.0 easier. This is where the Internet of Things comes into play, i.e. non-human parties communicating with each other. That could be a plant sending out a signal that it needs new material and the smart factory automatically and independently forwarding this information. The communication between these "things" takes place through the Internet in a smart way. This is the core point about Industry 4.0 – the Process Knowledge Automation. The Process Knowledge Automation resolves and enables the problem that work-pieces don't have the technical capabilities to communicate on their own transforming physical systems into "cyber-physical systems" (CPS), whereby the work-piece is the physical element and the Knowledge Automation is the digital element. The role of humans in CPPS (Cyber-Physical Production Systems), however, should not be disregarded, as highlighted in [6].

In this paper, a method to support the decision process along the supply-chain is de- scribed, focusing on the coordination of the supply-chain of an actual manufacturing case. The knowledge support system has been the result at the end of a development process. The first step was the knowledge capture. In this first phase, a deep insight on the production flow and production rules was conducted in strict synergy with the production engineers who own of the decision process. The second step was the formalization of such knowledge structures according to the ISA95 standard. Finally, in the third step, a mathematical model was developed in order to solve the problem among all the