Internal Logistics Integration by Automated Storage and Retrieval Systems: A Reengineering Case Study

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1 Introduction

Nowadays, factors like globalization, productivity, and reduction of time-to-market make the impact of logistics on production by far wider than in the past. Such a complex scenario originated considerable interest for the design, planning and control of warehousing systems as new research topics (De Koster et al. 2007). However, in spite of the importance of warehouse design and management, authors agree on the lack of systematic approaches (Baker and Canessa, 2009). Moreover, the existing contributions do not typically consider the problem of warehouse design in a continuous improvement context. On the contrary, with the enhanced customer demand, for most manufacturing industries it has become increasingly important to continuously monitor and progress the internal logistics. This paper presents a preliminary study for the reengineering of the logistics in a Southern Italy firm producing shoes and accessories based on formal modeling. We address a widely used solution for warehouse material handling, i.e., Automated Storage and Retrieval Systems (AS/RSs) (Dotoli and Fanti 2007). These systems are a combination of automatic material handling and storage/retrieval equipments characterized by high accuracy and speed. In order to reengineer the logistic system, a Unified Modelling Language (UML) (Miles and Hamilton, 2006) model is adopted (Dassisti, 2003).

2 The Company Current Internal Logistics

The company logistics is currently organized with a low-tech and low information contents, hence the firm plans to set up an integrated logistics platform to match its needs of growth. By the year 2015 it is expected to reach approximately 5,000,000 moved pieces, almost tripling current flows. The logistics area covers all the activities from procurement to the delivery of products to stores.

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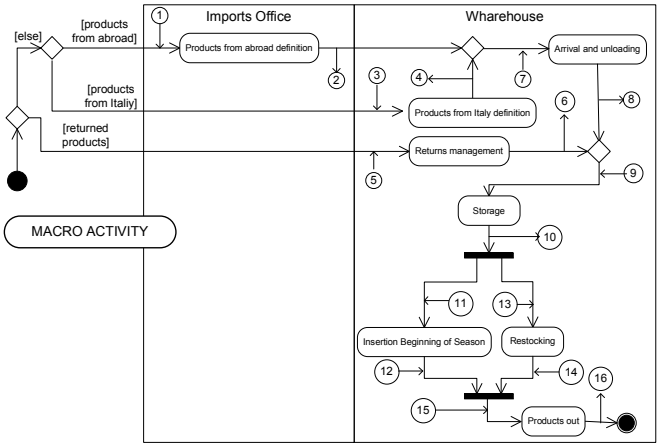

Fig. 1. Macro Activity Diagram of the Current Internal Logistics

Procurements are typically planned a year ahead, based on a statistical analysis of the demand, and according to the expected growth. Once in Italy, products are placed in containers that may stay up to 14 days at the port of arrival. Afterwards products are sent to the firm according to the available warehouse storage space and employees, as well as the priority of a product over another. Products manufactured in Italy, instead, arrive on articulated trucks, according to business needs, and they are delivered and discharged directly in the warehouse, mainly by manual handling. Here the Internal Logistics Manager makes a quantitative and qualitative test of products which, if the test is successful, are placed in the first free warehouse position in the storage area of similar products. Products are stored in packages, each typically containing 8 pairs of shoes (rarely 10 or 12) of the numbered pair sizes 35-40 or 36-41, in which the two central numbers, statistically the most popular and selling ones, are doubled. The mix of different types of packages is determined by the Purchasing Office, based on experience and available space in stores. Accessories also come in packages with dimensions comparable with those containing shoes. Currently, shoes are moved in 8 different types of packages, some of which differ only slightly. The company aims at standardizing types into three main families (large, medium and small), to simplify handling, and likewise it will be agreed with providers to use packages that contain only 8 pairs each. The product is characterized by high seasonality throughout the year, divided into Spring/Summer (S/S) and Fall/Winter (F/W).

Figure 1 depicts the Macro Activity Diagram of the Current Internal Logistics. Supplies to stores are of two kinds: the “Insertion of the beginning of the season”, which represents 60% of the overall supplies, and “Restocking”, representing the remaining 40%. The Sales Management and the Internal Logistics Manager decide the list of stores to which products are delivered according to their available space and turnover. When the available space for temporary storage is over, a transport document is prepared with an optical reader, one for each store. Merchandising material is handled with the same logic. In case of restocking, the Sales Management

sets specific lists of fixed weekly replenishment, taking into account the relative importance of the seller and its sales data from the previous week. The administration provides logistics, with a kanban logic, to issue a pick list for each store. Accordingly, packages are newly made, depending on space optimization, and choosing from boxes that were previously emptied and are still intact or taking new ones. A transport document is prepared for each store and packages are sent via an internal or external service. Another activity is the receipt of "Returned Products" that can be devoted to manage non-complying products, infra-season unsold products or end of the season unsold products. Returned products of the first type are stored in a safe area before being sent for waste, second type products are managed by the restocking activity, while the last type of products are sent to a network of outlets. Among the previously described activities, the analysis of critical issues led us to focus on the stages of "Products Storage", "Insertion of the Beginning of the Season" and "Restocking".

3 The Company Internal Logistics Reengineering

The chosen solution to improve efficiency is an Automated Storage and Retrieval System (AS/RS) serviced by a Rail Guided Vehicle (RGV) system (Dotoli and Fanti, 2007). The reengineering driver was the increase of efficiency in terms of automation, resource utilization, throughput. Hence, the selected AS/RS has to take care of handling operations of packages and to be interfaced with the other logistics operation, such as "Restocking" and "Returned Products Management". The AS/RS ensures a greater speed of operations as well as flexibility. It was decided to discard the possibility of using unit loads, such as pallets or similar, because the currently employed packages have sizes that are not compatible with the standard palletizing units.

The development of the UML model of the To-Be system was a crucial issue because it allowed to understand how to effectively interface the proposed processes and consequently to find the best solutions to ensure the effectiveness and efficiency of the flows. We present in the following the proposed modifications only for the activities interested by changes in the diagram of Fig. 1.

Activity 5 – Products Storage As-Is / To-Be: in the re-designed activity (Fig. 2b) the AS/RS is involved, instead of the warehouse Manager of the As-Is case (Fig. 2a). The flow is divided according to whether products are unpacked or in packages: in the first case they are stored in an area that is specially designed for unpacked products, while in the latter the AS/RS is involved, that operates a fully automated storage in a way described in the following Activity 5b.1.

Activity 5b.1 – Packages Storage Area: in this new stage (Fig. 3), involving the Warehouse Worker and the AS/RS system, the first one stores packages in an input storage station and then the activity is taken over by the AS/RS. A free RGV is waited for and, when this arrives, the package is loaded on the RGV and is brought to the first free storage conveyor. Otherwise, if none of these are free, the RGV turns in circles and retries to make the allocation. When the storage conveyor is free, the package is unloaded and brought into the crane loading position. If the crane is busy,

the system waits until it becomes free, hence the crane loads the package and brings it in the storage position to deposit it.

Activity 6 – Insertion of the Beginning of the Season As-Is / To-Be: in this new step the AS/RS, Warehouse Worker and Logistics Administrative Management are involved. The first creates the Insertion Batch, consisting of whole packages, for each store, according to the subsequent Activity 6b.1. Once this batch is defined, an optical reading of the packages code is done by the Warehouse Worker, and according to whether shipments are handled by an external courier or are directly managed by the firm, the Logistics Administrative Management respectively prints the transport document and labels packages, or just prints the transport document.

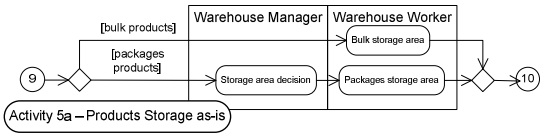

Fig. 2a. Activity 5a – Product Storage As-Is

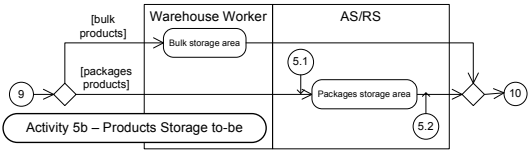

Fig. 2b. Activity 5b – Product Storage To-Be

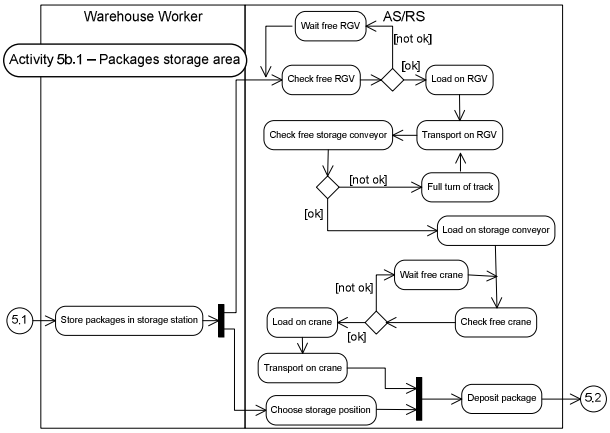

Fig. 3. Activity 5b.1 – Packages Storage Area To-Be

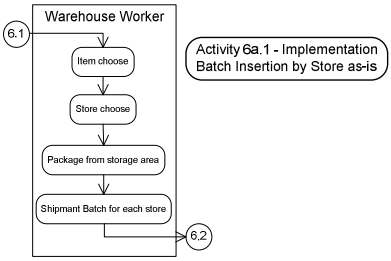

Fig. 4a. Activity 6b.1 – Implementation Batch Insertion by Store As-Is

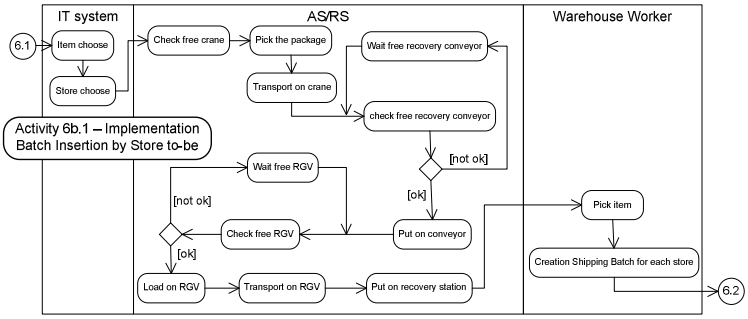

Fig. 4b. Activity 6b.1 – Implementation Batch Insertion by Store To-Be

Activity 6b – Implementation of the Insertion Batch by Store As-is / To-Be: (Figs. 4a and 4b) the IT system chooses the item to send to stores, on the basis of items in stock and according to a suitable algorithm that takes in account priorities and precedence. Then the AS/RS checks if there is a free crane, hence the package is loaded and transported to the conveyor, where it waits for a free RGV; when this arrives, the package is loaded and led to the retrieval station, where the Warehouse Worker picks it up and puts it in the temporary storage area.

With the same logic adopted for Activity 6, we re-engineered Activity 7 concerning the "Restocking". We do not report details for the sake of brevity.

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