HIGH SPEED SHOE FACTORY – A NEW FOOTWEAR FACTORY MODEL

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The footwear industry is traditionally characterized by production units consisting of sections physically separated from each other and with autonomous organizational and management processes. This type of organization creates areas of intermediate stocks, large production lead times, excess of materials and product handling, thus long delivery times. High Speed Shoe Factory project developed and implemented a new model of footwear factory for quick response, able to produce pair-to-pair, in order to satisfy internet sales, small orders and quick replacements. The shoe production was designed in a logic of a "single section" with high flexibility and materialised by developing and implementing new agile and reliable technological solutions, including an interactive online shop, a new multi tool cutting system and an integrated logistics flexible production system, which crosses in a single step, the traditional productive sections of cutting, sewing, assembling and finishing.

Keywords: footwear, production systems, consumer tools.

INTRODUCTION

The Portuguese footwear industry has registered a strong performance over the last five years, with exports growing by 54% from 700 to 1850 million euros. Portugal is highly specialized in leather footwear which it actually exports to 152 countries. Despite the global constrains, during this period, footwear continued to growth also in terms of the number of jobs created (2534), the result of a concerted effort on the part of the manufacturers themselves, the industry association APICCAPS, the political authorities, national and international research and development (R&D) partners and CTCP.

Worldwide production of shoes is typically organized in three main phases: the cutting of upper and lining materials, the stitching of the pieces in the shoe's upper part and the assembly and finishing of the final product. These production stages are, in general, physically separated from each other and managed in an independent way within different departments or production units under specific organizational processes supported by different enterprise software management systems.

This type of organization may create, namely: important levels of stock of intermediate products along the manufacturing chain; large lead times of production; and excessive handling of raw materials, components and products; with significant impact in the delivery time of customer orders, that generally are not less than about 3-4 weeks. This has become increasingly important once European footwear industry has focused on the manufacturing of small series of differentiated and fashion products.

STATE-OF-THE-ART

During the last decades, footwear manufacturing companies have promoted and adopted innovative beyond state-of-the-art technologies and automated solutions on their manufacturing and distribution processes, targeting increased flexibility as a way to promptly respond and face the market challenges.

As a first step, the Portuguese footwear industry committed itself to radically renew the cutting processes, by replacing the manual and mechanical cutting of the leather. In

parallel, the industry also made a commitment to radically renew the internal distribution processes of the work-in-progress items (materials, components, and products), by replacing the manual distribution or distribution based on mechanical conveyors with dynamic and automated distribution systems (internal logistic systems) capable of transporting the work-in-progress items between the manufacturing operations within each independent production unit.

In this context, the Portuguese footwear industry is now a worldwide highly competitive industry whose success is closely based on this continuous capacity of innovating the manufacturing and distribution processes, along with a strong strategy of internationalization, own brands and technological innovation in the footwear product itself. This has been and intends to remain the strategy to respond and to anticipate the needs of the market thus guaranteeing the competitive positioning in the worldwide market.

It is in this context of a mature industry in terms of technological processes and management of own footwear brands that was developed the Research and Technological Development project, with acronym HighSpeedShoeFactory, led by KYAIA as footwear manufacturer and with the active involvement of CEI by ZIPOR as cutting and automated solutions developer and provider, CREATIVE SYSTEMS as expert in RFID, FLOWMAT and SILVA FERREIRA as logistic systems providers, INESCTEC as R&D in logistics and software, FEUP faculty as expert in engineering and CTCP as R&D expert in footwear and project management. This project resulted in a new footwear production model and state-of-the-art prototype solutions and systems for the footwear industry, installed at the main KYAIA's manufacturing unit.

NEW FACTORY MODEL, TECHOLOGIES AND SYSTEMS

HighSpeedShoeFactory is a new footwear factory model for 24/48 hours of agile response in order to satisfy:

- multiple distribution channels, including sales over the Internet;
- the production of customized and very small orders;
- the rapid replenishment of the product in stores;
- the development and production of new shoe models, new collections and footwear samples;
- the simultaneous production of different footwear products with different constructive methods;
- a meaningful reduction of work-in-progress stocks;
- and to reduce human intervention in routine repetitive works and increase their versatility and empowerment in the production system.

To develop this model, different conceptual approaches were considered and the respective implementation solutions considered. The solution finally developed is consumer centered and supported by an innovative production concept based in integrating in a "single productive phase" the cutting, stitching, assembly and finishing that are traditionally performed by separate independent production units or departments. To implement the model several solutions were developed, namely: on-line interactive virtual shopping application, new cutting system and new logistic systems.

Interactive Online Shopping Tool

The tool was designed to facilitate and enhance the consumers shopping experience (Fig. 1) by embedding a range of customized products and the possibility to do some products personalization (aesthetic details enabled by the cutting system).

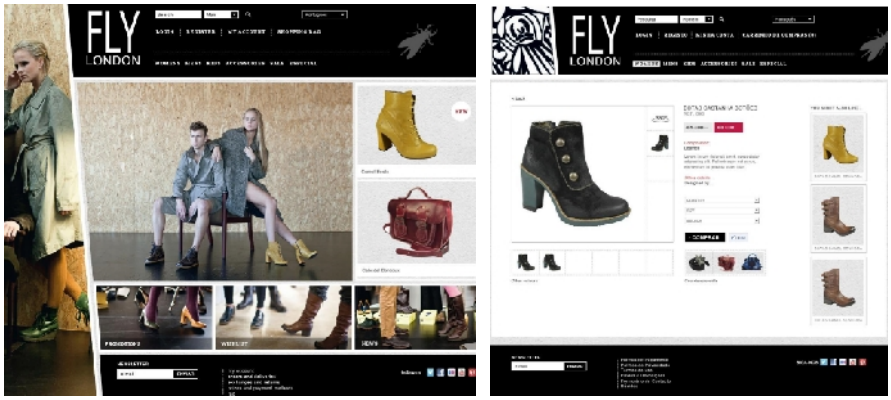

Figure 1. Interactive online shopping tool featuring products catalogue, suggestions and personalization options

Online interactivity gives insights about the consumer profile and feeds relevant characteristics to the suggestion system. Suggestion algorithms propose alternative shoes and complementary accessories. The tool is integrated with several information systems, namely the ERPs. CAD and production systems.

Innovative Cutting System

The innovative cutting system features 2 independent working areas and 2 heads that may work in the same or different areas. Each head integrates up to 12 tools, namely, several types of punches, pens, oscillating cutting knife and laser engraving possibility. These tools allow materials cutting and aesthetic personalization and customization to reply to costumers and client's desires or demands.

Figure 2. Multi tool cutting system development and final prototype

New integrated digitalization and refined nesting algorithms result in improved leather use. Proprietary software and controls allow fast replies to models changes, flexibility to cut different materials and integration with some factory processes.

Logistic Systems

The integration into a single production phase is supported by a new internal logistic system that ensures the automatic transport of items in the whole manufacturing process, assigning and controlling the work flow along the different production workstations. This solution is managed at the top level by the company ERP system and at the factory level by the logistic software integrating three different software-based systems that automate the flow of work-in-progress and do their assignment to the working posts in the cutting, stitching and assembly manufacturing phases.

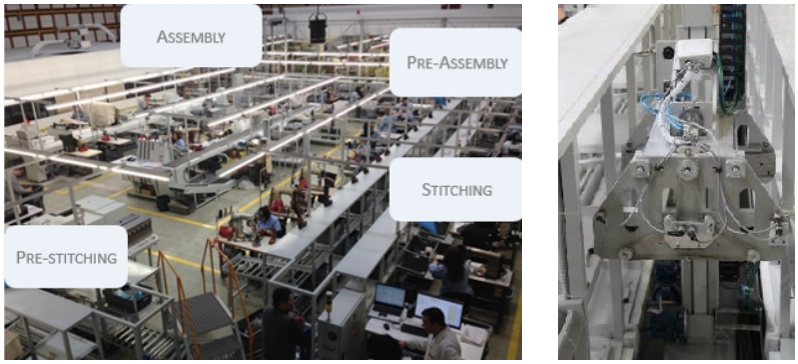

Figure 3. Internal logistic system general view and robotic manipulator details

To implement the concept new stitching and assembling logistic systems were developed. The first comprises 3 independent sub-systems, pre-stitching, stitching and pre-assembly, featuring each a robotic manipulator (developed) that moves the materials in boxes between the working posts (WP). Each WP includes 1 working location/cell, 1 waiting cell and 2 store locations. During the tests the system was able to manage simultaneously up to 70 models and do 1215 movements per day (8 hours).

The assembling system comprises 1 external internal through which the pallet trays containing the upper and components flow from WP to WP, 1 high speed internal ring and transference points to move the pallets between the rings. The systems was conceived to facilitate the simultaneous production of several shoe models of different construction systems (e.g. Glued, Pratik, Goodyear).

CONCLUSIONS AND FUTURE WORK

These solutions aim the sustainable and agile production of small series (European footwear producers important target), facilitating the production and commercialization of customized or personalized shoes, supported by innovative cutting and logistic solutions that contribute to eliminate a relevant level of stock of intermediate work-in-progress, dramatically reducing the product lead time from 3/4 weeks to 1/2 days, while

simultaneously allowing the effective production of several shoe models of different construction systems.

The model will continue to be developed and improved at European and National level. In the frame of the HORIZON 2020 EU Innovation Action aiming CPS-oriented Future Internet-based machine-factory-cloud service platform *CPPS-isation* and Experimentation, Ref. 680633, BEinCPPS project, lead by POLIMI and in which KYAIA, INESCTEC and CTCP participate a Cyber Physical System-based automation approach will be implemented so that the logistic High Speed Shoe Factory systems will become connected and cooperative elements.

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