TexWIN - Textile Work Intelligence by Closed-Loop Control of Product and Process Quality in the Textile Industry

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Introduction TexWIN

PROJECT BACKGROUND

TexWIN, a European Research Project, aims at increasing the productivity and reducing down-times of machines in workshop factories, both for the textile and plastic industry. This will be achieved via a reduction of stop times, set-up times and waiting times, increased flexibility and reliability of processes, and via a reduced sampling effort. The consortium, coordinated by the "Deutsche Institute für Textil- und Faserforschung" in Denkendorf, Germany. It comprises machine builders, software developers, five textile and plastic mills, universities and research centres. The partners are stemming from different European countries: Germany, Italy, Switzerland, Spain and Belgium. Milliken Europe

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bvba, who is producing both technical textiles and master batches for the plastic industry, BMS bvba BarcoVision a leading supplier of Manufacturing Execution Systems with focus on the textile, plastics and pharmaceutical industry and Centexbel are the Belgian partners. The project will run for three years, starting from March 2010.

PROJECT RATIONALE

Manufacturing of textiles is a complex and distributed process. The products require highest quality for a wide range of variants (e.g. in medical or technical textiles); they often have a very short life-cycle (e.g. in fashion), and are based on natural materials. Production will be done in complex assembling processes (e.g. weaving), in batch processes (dyeing) or in continuous processes. The major production stages are spinning, weaving, knitting and finishing (which includes dyeing).
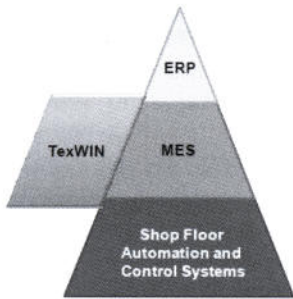

Figure 1 :
position of TexWIN in the automation pyramid
(MES = Manufacturing Execution Systems, ERP = Enterprise Resource Planning).

In order to better streamline and optimise these complex processes, TexWIN will rely on case-based reasoning. This basically means to solve new problems (i.e. to find new optimal machine settings for e.g. a dyeing or weaving process) based on the solutions of similar problems that occurred in the past. This optimisation process will be formalised in algorithms so that it can be done via artificial intelligence.

The TexWIN-System integrates a factory controller for the improvement of the process schedule and event-based coordination of factory (inter-)operations and an adaptive CBR-based production unit controller for identification of best process recipes/machine settings concerning product quality and production process set-up and execution efficiency. The various production unit modules will be integrated into a common communication framework, which will enable flexible interfacing and ontology-based information transformation. The TexWIN-Processes are adapted factory business processes which allow maximising the efficiency and quality effects and seamless integration into existing factories.

TexWIN is best suited for industries dealing basically with make-to-order production, small batches, high-quality product variants, workshop production, complex processes and non-homogeneous and/or natural materials.

MAIN OBJECTIVE

The breakthrough in this project is to exploit existing knowledge available in various factory internal and factory external sources by combining and evaluating process state information as well as product and material characteristics in order to derive best production instructions. In particular, existing

production knowledge and experiences from production operators will be preserved and made available by a CBR (Case-Based Reasoning) module.
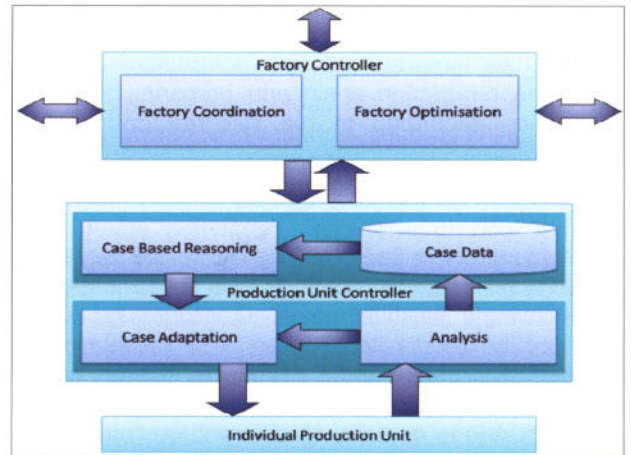

Figure 2: the TexWIN control hierarchy comprises three different levels: the individual production unit or machine level, the production unit level and the factory level.

The objective of the TexWIN project is to increase productivity by up to 20% and reduce down-times of machines by one third of workshop factories. A hierarchical control approach (controlling both factory and production unit) will reduce stop times, set-up times and waiting times, increase flexibility and reliability of processes, and reduce sampling effort. Enterprises applying TexWIN will be able to maximise process quality (capability and efficiency) and product quality (defined product characteristics) and enhance their responsiveness towards unforeseen events in previous production steps and the production of new products.
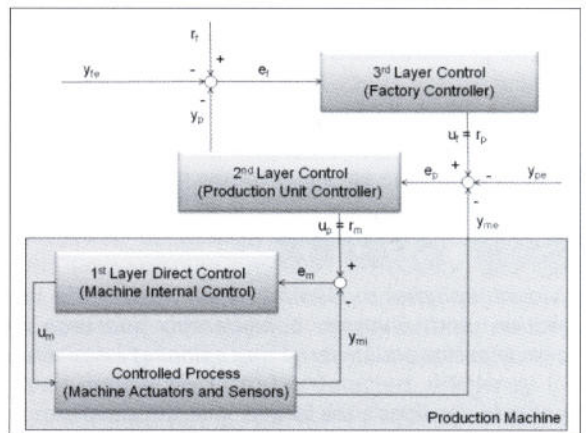
Implementation

Figure 3: outline of the control process for the hierarchical system

The approach is to exploit existing knowledge available in various factory internal and factory external sources by combining and evaluating process state information as well as product and material characteristics and deriving from this pool of information best-suited production instructions with a CBR approach combined with an adaptation system. CBR or "Case Based Reasoning" is the process of solving new problems based on the solutions of similar past problems. Additionally the existing production knowledge and experiences from operators will be preserved and made available within the TexWIN system.

The TexWIN system will be realised as a hierarchical control system. On **machine layer** a CBR system with a case adaptation system controls the individual production unit. On **factory layer** a coordination and optimisation instrument increases the productivity and reliability by integrating various information sources along the production chain and preparing them for scheduling according to the selected optimisation criteria.

Applications

Applications of the TexWIN system to textile processes will be done inside the consortium in the spinning and the weaving / finishing areas. Factories producing high quality diverse items in small or medium sized batches are concerned. They are using largely automated machinery with complex setting (blending, spinning) and / or sets of different machines with various possibilities to implement each principal function (weaving, finishing). At the single machine level, the TexWIN system will optimise the settings on the basis of past experience using CBR and at the factory level the TexWIN factory controller will assist the factory manager in setting up optimal processing chains according to the characteristics of the items to be produced and the available raw materials. As a concrete example in spinning, it is expected to adjust the speed of carding in order to limit stops during the spinning step, with constant flow production for a given quality and optimised production level.

Another example of application is colour master batch production. The chemical division of Milliken Europe plant in Ghent sells and provides technical support for plastics additives, colorants, anti-microbials, elastomers, and specialty chemicals. They also manufacture ClearTint® colorants, which are specifically designed for clarified PP. They are manufactured on demand as master batches of varying sizes. With respect to TexWIN, the focus has been on colour master batch production, which is most of the times characterized by short runs. The settings of this process correspond to the determination of a colour blend (components and proportions) which match a requested colour (as given by a type). The specific characteristics of the material used and of the specific tint of requested colour make this colour matching problem particularly difficult. The aim is to substantially reduce the number of trial and error steps required to find the right colour by use of a CBR-based approach. This would greatly increase the productivity. The CBR-based TexWIN approach will be implemented under a simple factory model, making the best exploitation of available recipes completed by a better knowledge of the peculiarities of the typical blends. It is the goal to transform the current implicit knowledge into explicit experimental / theoretical relationships. This process is currently under examination. It is introduced via "Case adaptation procedures", which is fully integrated into the TexWIN system.

Summary

Within TexWIN, the goal is to increase the productivity and reduce down-times of machines in workshop factories. This will be done be developing controllers based on Case Based Reasoning. This method will be applied to optimise complex manufacturing processes encountered in the plastics and textile industry.

More information can be found on the project web site: www.texwin.eu

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