Processes of Manufacturing in the Textile Industry

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ABSTRACT: The textile industry is characterized by an economic enterprise aimed at the production of fibres, yarns, garments, clothes and decorative products for home and decoration, as well as for technological and industrial purposes. In the industrial industry, the garment industry is one of the largest and most diverse industries, with a vast number of sub-sectors spanning the whole growth chain, from raw materials and intermediate goods to the manufacture of finished products. The operations of the textile industry have various subdivisions, each with its own characteristics. The length of the textile industry and the diversity of its technological processes contribute to the coexistence of various sub-sectors in terms of their market development and incorporation. The garment industry is designing technologies for expert systems to maximize efficiency, boost quality and reduce costs. The study of textile designs or systems requires the use of mathematical equations to simulate the behaviour of textile systems (yarns, fabrics and knitting). The Finite Element Method (FEM) has significantly encouraged the estimation of the behaviour of the textile structure under mechanical loads. In the case of classification problems, the Artificial Neural Networks (ANNs) have proven to be a very powerful method as a fast and accurate solution. The Case-Based Reasoning (CBR) approach suggested in this thesis complements the effects of finite element analysis, statistical modelling and neural networking approaches.

KEYWORD: Case Based Reasoning, Expert Systems, Industry 4.0, Textile Industry.

INTRODUCTION

Textile and textile practices have various subdivisions, each with its own characteristics. The duration of the textile cycle and the diversity of its technological processes contribute to the co-existence (within the fashion and apparel sector) of various sub-sectors in terms of their market structure and incorporation[1], [2]. Described by its diversity and heterogeneity, the textile industry comprises primarily small and medium-sized businesses, some of which are highly specialized in unique processes. The high quantity of raw materials used in the manufacture of fabrics (cotton, wool, synthetic materials, etc.) and the variety of manufacturing methods required to produce them must be illustrated among the causes of its sophistication. In fact, the textile industry can be categorized in a variety of ways, based on the manufacturing cycle, the finished goods obtained, etc. In the particular case of textile fabrics, the cycle starts with the processing of natural fibres or the development of artificial or synthetic materials[3], [4]. Then, after spinning (if necessary), start processing into flat textile structures, fabrics or cloths, in the form of woven fabrics, knitted or mesh, nonwovens, etc. Fabrics or textiles are usually handled in finishing processes, like dyeing or painting, curing, rolling or mechanical finishing processes, which provide new properties to the fabric until the next step: the clothing stage[5], [6]. Development preparation is a dynamic environment for any production activity. Planning is difficult in textiles because there are various types of fabrics, yams, spinning processes, preparing methods and final goods. Both of these considerations, combined with the customer's demands for orders accurately filled and quick turnaround periods, render the project planning process more difficult[7], [8]. In addition, successful production preparation in the textile industry has become highly important as strong international competition has had an impact on the sector. Fabric development practices are largely focused on statistical models aimed at predicting the properties and efficiency of the fabrics under consideration. Specific analytical methods have been used to represent the fabrics in a numerical context and to estimate their final properties[9], [10]. Among other issues, the FEM study primarily assisted the prediction of the behaviour of complex textile systems under mechanical loads. In the case of classification problems, ANNs have been found to be a very effective method for a simple and precise solution. The garment industry is slowly designing expert systems technologies to maximize efficiency, boost quality and reduce costs. These devices work in a number of locations in the garment manufacturing process. This critical decision-making scenario in the textile industry produces a series of production planning decisions required for the development of a particular form of end product. This series starts with the decision to manufacture a certain class of end product. Every decision in the series depends on the combination of the decisions made at the preceding points. The summary for this paper is as follows. Section 2 will describe the textile processing processes in the textile supply chain, beginning with the fibre and yarn production processes up to the general principles. The segment starts with the fundamentals of garment manufacturing techniques and concludes with the apparel finishing and clothing industry. The Case Based Reasoning Approach for the textile industry is defined in Section 3.

1. *The Textile Fabrication Technologies and Processes*

The garment and clothing industry involves practices such as the manufacturing of raw materials, i.e. the storage or production of different garment fibres, and/or the manufacture of yarns by spinning (making of 'natural' fibres and 'man-made' fibres). Certain actions within the garment and apparel industry include the development of knitted and woven materials (i.e. spinning and weaving); the finishing operations aimed at providing garments the optical, tactile and aesthetic properties that customers need (bleaching, painting, dyeing, impregnating, grinding, plasticizing, etc.); and, ultimately, the turning of these materials into items such as garments, woven, carpets. The processing of fibres is the first step in the textile process chain. The field of fibre materials is split into natural and man-made fibres. Regulation (EU) No 1007/2011 of the European Parliament and of the Council of 27 September 2011 on textile fibre names and associated naming and marking of the fibre content of textile goods harmonizes the legislation of all European Union countries, safeguards consumer rights and decreases the possibility of fraud. This Legislation shall extend to textile products made available on the Union market and to apparel goods. Within the field of natural fibre products, they can be categorized by source, such as cellulose (from plants), protein (from animals) and mineral. Plant fibbers can be seed hair, such as cotton; bast (stem) fibres, such as linen; leaf fibres, such as sisal; and husk fibres, such as coconut coir. Animal fabrics include skin, feathers, fur, and secretions, such as silk. The most widely used natural fibre fabrics are cotton and wool. Asbestos is the only essential mineral material, but it has little economic implications today due to its related health problems. The first step in the process is to isolate the fibres from the seeds and other materials such as capsule fragments, leaves, twigs and soil. In the carding unit, the fibres are combed by a set of revolving drums and the moving carding bars are filled with metal combing teeth. As a result, a smooth, uniform fibre band is created. In the fibre band called the sliver, the fibres lie parallel to each other. The sliver is kept together by friction between parallel fibres, which provides just enough stability for subsequent development steps. The transformation from a loose fibre bundle to the real yarn takes place during the spinning cycle. The bundle of parallel fibres is twisted, giving the yarn its durability. The prevalent spinning technologies developed in the industry are ring spinning, open-end spinning and air jet spinning. Rayon is the common name for fibre (and the resulting yarn which fabric) and was the first regenerated cellulose fibre to be developed that is not synthetic. Man-made fibres are classified into two types: viscose and related cellulose-based fibres; and synthetic fibres such as polyester, nylon and acrylic fibres. In their initial state, the fibre-forming polymers are solids and thus must first be transformed to a liquid state for extrusion. The fibre forming material is formed by a transient fluid extruded through a spinneret and then returned to a solid state (by solidifying) in the shape of a fibre. There are three primary forms of spinning: melt spinning, wet spinning and dry spinning. Textile fabrics are most usually woven, but they may also be created by weaving, felting, lace making, netting, unwoven process and tufting or by mixing these methods. Two yarn structures, warp and weft thread, are used in the weaving process, which are interlaced and lie at right angles to each other. The threads that run along the length of the fabrics (in the direction of production) are known as warp ends, whereas the threads of weft threads are opposite to the direction of production. There are many techniques for integrating the weft thread into the cloth, the most common of which is the cutter, rapier and air jet technology. The pattern or style of the cloth is the way the warp and the weft are interlaced. The pattern or repetition is the smallest unit of the weaving that, when replicated, creates the design needed in the cloth. The number of wave structures that can be generated is almost infinite. The most popular basic weave patterns are simple, twill and atlas weave patterns.

2. *CBR and the Textile Industry*

Many academic articles concentrate on the effectiveness of machine assisted design methods in the textile industry. This productivity can be measured by the reduction of the manufacturing time of the same set in comparison to the conventional method; the reduction of the actual sample tests; the reliability; the flexibility; the imagination: the accentuation of the potential to manifest the innovation of the creators, linked to the principle of unevenness, the divergence of ideas in the process of creation; and the management process. Quality assurance from the outset of the whole process. More necessary and important than simulations is to link this simulation with the production processes because:

- It is known that computer simulation processes are not capable of making accurate decisions as to what the end result will be.
- The production of a sample is also important for selling, as simulations are not embraced in the existing consumer culture.

- The use of CAD devices does not prohibit the knitting of designs, but restricts their number and discards those that are not acceptable.
- The modelling of textures, raw materials, decorative structures are not precise enough. With respect to industrial processes and machine models, the current developments in the development of the software and the use of the CAD system are based on the guidance of the Artificial Intelligence (AI) program. Most precisely, the use of CBR involves the study or treatment of questions on the basis of previous cases.

According to the complicated configuration of the cloth and the complexities of the material used, it is not feasible to use precise models for the construction of the study. This textile engineering thus greatly depends on the use of numerical methods, the approximate models of which simulate the properties and behaviour of textile structures. Humans address several issues by arguing from previous cases: lawyers use the decision of previous cases in their arguments; clinicians search for examples of signs that classify medical pathologies from a series of previous cases; developers focus many of their latest ideas on approaches that have already been implemented; and professional programmers reuse more or less complex prevail schemes. Therefore, the concept of the CBR system is to use such AI approaches, which require the process parameters to be approached, to benefit from the experience of these systems. Build a database that will expand over time as more items are created. Growing industry produces different products and each product can have different related processes. Case Based Reasoning is a approach that uses various techniques to construct expert systems and can offer approaches in areas that are not well understood. In addition, it makes it easier to test solutions where there is no algorithmic process, to learn new cases and to explore new rules and generalizations. CBR is simpler than other methodologies, as it is easier to reuse a solution than to get a solution from scratch. CBS instances allow the reasoning to concentrate on the essential facets of the issue and to define the distinguishing features. Cases can also have 'negative information,' warning of potential failures (exceptions). Finally, this approach retains an information base, as users can introduce additional cases without expert assistance.

CBR addresses the issue by extending approaches already found to related problems. In addition, because the CBR memory retains a variety of problems with its solutions, the solution to a new problem is to restore memory-stored instances. A scenario thus includes a given problem and a solution to the problem. In this study, which focuses on textile manufacturing processes, the question arises when a customer decides to develop a new textile product and asks for an acceptable solution that meets his or her criteria for process parameters as much as possible. The aim, therefore, is to use some AI approach to estimate these process parameters, to learn from previous implementations of this sort of operation. All in all, an AI approach that supports gradual, non-dependent and predictive power properties is required. Incremental property is related to the fact that the algorithm needs to respond to new data over time. Based on each parameter, each question may include specific parameters, and the importance of these parameters can vary depending on the user's requirements. And ultimately, the AI system should be able to estimate more than one parameter. Such characteristics point to a robust approach such as Case Based Reasoning. Since the CBR is a lazy learning approach, it allows the algorithm not to be affected by some parameter and can be tailored to any new scenario giving more weight to certain parameters than others. In addition, the CBR specification should be flexible enough to allow more than one parameter to be expected. Furthermore, end users of textiles are not interested in a generic model that generalizes all the results, but in a particular approach offered for the unique question they are looking for. Another argument to be taken into consideration is that our program may accept more than one feature that is part of the problem being addressed, and this distinction of definition and solution can differ on demand. Few hybrid solutions have been found in CBR literature to cope with the reuse phase, but most of them are designed to solve only one solution attribute. Most of the plans use supervised learning methods and have only one feature to anticipate. This is the case with the method to estimate oceanographic temperatures. This program retrieves the most related cases and retracts a radial-based network with them to create a new approach. Another CBR method that addresses a solution of more than one attribute is the CBR completion case in depth, but the attributes are predefined to be part of the definition or part of the solution. This has more than one trait to solve, but they solve this step by step in this situation. Since they deal with domains that have predefined and well-known attribute dependencies, the order in the measures is extracted from those dependencies. The compromise-driven retrieval can be found in the suggested CBR literature. This definition allows the expansion of the application form, including the rules for numerical attributes: Less-is-Better and More-is-Better. The standard CBR method consists of four sequential phases that are triggered if a problem needs to be addressed. Figure 1 demonstrates the CBR extended to the textiles industry. The textile cycle includes the processing of the fibres by mechanical operation into the finished product, i.e. machinery and materials: raw material inlet and outlet tissue or fabric. These elements can be represented with parameters or attributes. As a consequence, the method can be represented as an attribute-list-value. In a project, the implementation of a rapid configuration method for textile processing machinery based on the physical behaviour simulation of the precision textile structures method can be found. This program was created to be a tool that helps to change process parameters and begins when a user needs to build a new product. The consumer will define some of the parameters needed to receive the correct drug. These parameters can belong to the raw material, to any system in the process or to the final product. Thus, with the AI system, it is possible to estimate the rest of the parameters that have been obtained from previous implementations of this sort of operation.

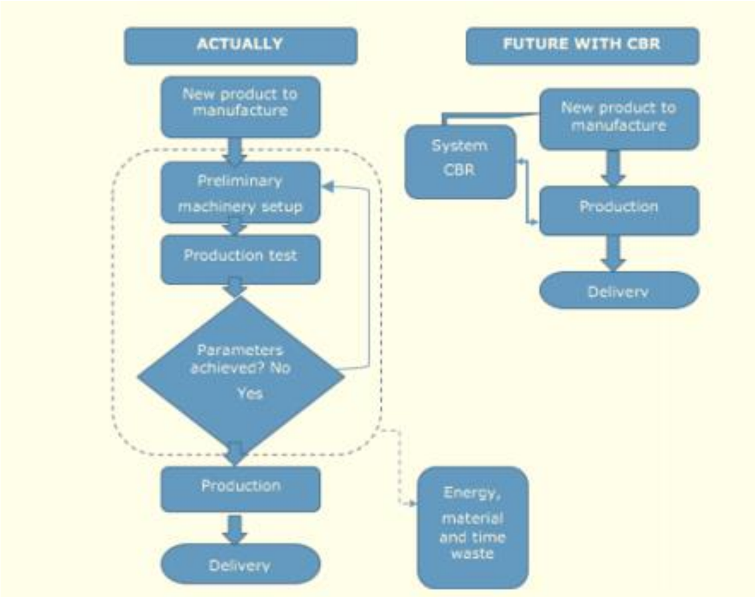

Fig.1: CBR Applied to Textile Industry

CONCLUSION

Expert systems, with implementations in the garment industry, are influenced by dynamic management paradigms arising from the device architecture of the hierarchical networks, their guided adaptively to unpredictable events, and the high changeability of the components. Decentralized management paradigms are not yet widely developed in the corporate sense. In the one hand, that is because, although the underlying theoretical models are ancient, functional ideas, proof, and architectures have been possible only since the emergence of high computational resources. At the same time, however, it is precisely the unified control systems that make way for new improvements in productivity by greater flexibility and adaptively. Their effect on production processes in textile industries may be outlined as follows:

- Identification of defects or other issues that might occur during the subsequent manufacturing process.
- Incorporating simulation results and parameters into textile machinery for the rapid setup of the system as well as the precision manufacturing of virtual textile structures built using this method. Conventional simulation and modelling techniques do not add value because they are of no use in the production of multifunctional technological textiles. Only traditional textile goods may be sold by a business that follows this template. The capacity to produce some type of multifunctional textiles has a huge effect on the potential of the company and its goods to deliver added value.
- Increasing the pace and versatility of the production of new innovative textile goods. Simplifying the manufacturing cycle for producing these goods raises the pace of new products and, at the same time, succeeds in seeking a target market that meets the emerging demands of society and offers fashion industries additional profit opportunities.

Future manufacturing technologies would need to be built at a rapid pace in order to achieve the agility demanded by modern enterprises. Typical industrial software engineering methods would need to be tailored to the modern model of distributed complex system computing, with a special focus on interactive and multi-layer system interactions that are difficult. In order to achieve so, any generalized specific features would need to be provided, likely by a centralized application network with similar functionalities, using a software-oriented design strategy.

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