

## EDITORS' PREFACE

In advanced countries as well as developing countries, the textile and garment industry still plays an important role in economy, in terms of production and employment. However, there exist many barriers in this industrial field that are pressing companies to face the following competitive challenges:

- Shorter product life cycles: distributors and consumers are looking for more variety and personalization.
- Lack of flexibility in the supply chain.
- Cost reduction: retailers do not want to lose their sales margins which generates a pressure to compete for cheaper prices on products.
- Homogeneity need: the lack of integration, the heterogeneity and the lack of standards is a chronic weakness of the textile and garment industry.
- Consumers demand more comfortable textile and apparel products as casualization becomes a global trend over the decades.
- Biofunctional performance of textile devices and apparel products becomes critical area of concerns as more and more consumers pay attention to making healthy lifestyles.

Under this challenging economic pressure, there is a strong need to develop new methods in order to optimize the quality of textile products and textile management. Information technology, especially computational techniques can play an important role in this optimization.

Since 1950's, computational techniques have been widely applied in textile industry and garment industry for process and materials' structure modeling, simulation and control, optimization of product quality, product design, textile market forecasting, and production management. The related computational techniques include classical methods such as statistics, differential equations, classical signal and image processing (time series analysis and frequency analysis) and statistical pattern recognition, and intelligent techniques such as soft computing and data mining. Classical methods are essentially based on formalization of physical laws and analysis of measured numerical data while intelligent methods often deal with uncertainty and imprecision related to human knowledge on products and

processes and linguistic data analysis. The selection of specific computational techniques is strongly related to the nature of the problem of interest. In general, an optimal solution to a complex textile problem can be found by combining several complementary techniques in a suitable way.

This edited book reports recent research results and provides a state-of-the-art on computational techniques in textile and garment applications. The main objective of this book is to gather a peer-reviewed collection of high quality contributions in the relevant topic areas. Textile engineers in companies and technical centres as well as applied researchers and research students working on different textile topics can benefit from this book. The contributions of this book are mainly extracted from the special sessions on textile of the 17<sup>th</sup> IMACS Congress (IMACS'2005), held in Paris in July 2005. The following criteria have been used in screening the chapters:

- Quality and originality in methodology,
- Application oriented papers exhibiting originality with reasonable theory involved,
- Relevance to computational techniques and textile industrial/engineering applications.

This book collects a number of representative applications of computational techniques in textile and garment industry. These applications cover the following issues:

- 1) Textile quality assessment by image analysis,
- 2) Modeling and simulation of textile structures,
- 3) Computer aided garment design,
- 4) Computerized textile management and textile Supply Chain,
- 5) Textile quality subjective and objective evaluation;
- 6) Computational thermal bioengineering of textiles and clothing;
- 7) Computational biomechanical engineering of textiles and clothing.

The volume starts with an introduction chapter, entitled "*From biological macromolecules to drape of clothing: 50 years of computing for textiles*" and written by Prof. J.W.S. Hearle of University of Manchester. In this chapter, the author presented an overview of computing techniques (software and hardware) in various textile applications, including modelling of fibre, yarn and textile structure, modelling of textile mechanics, modelling of fabric drape, and textile and garment CAD.

The other chapters are divided into six logical parts each corresponding one category of applications.

Part 1 on *Textile Quality Assessment by Image Analysis* contains two chapters that apply techniques of image processing and analysis for extracting relevant features of textile surfaces and characterising the quality of related materials. In Chapter 2, the authors propose a new method of frequency domain image analysis based on the two-dimensional discrete wavelet transform (2DDWT) to objectively measure the pilling intensity in sample images of knitted and nonwoven fabrics. Chapter 3 gives an objective evaluation method of seam pucker in textile samples compared to the existing references used by experts. This method is based on 3D image analysis, permitting to extract feature vectors from test samples and standards of seams using multi-scale wavelets analysis, spectral analysis, texture analysis and fractal analysis. The most relevant feature vectors are obtained using the criterion of sensitivity and conformity to expert knowledge on classification of seam specimens.

Part 2 on *Modeling and Simulation of Textile Structures* collects three chapters that apply mathematical and computer modeling and simulation techniques for predicting functional properties of textile materials from their structural parameters. Chapter 4 describes a method for characterizing yarn unevenness using the mass variation curve (MVC). Some statistical features of MVC (stationarity, independence, linearity etc.) are studied in order to identify long-range and short-range dependencies. The techniques of Fast Fourier Transform and estimation of Hurst exponent have been used in this approach. Chapter 5 presents a method of computer simulation of woven fabric structures using images of yarns taken along their lengths. The related fabric simulations are confined to single fabrics of plain, matt and twill weaves. This method permits to mathematically model yarn curves in the fabric structure and obtain projections of yarn images in the perpendicular direction to fabric surface. Chapter 6 gives a method for computing permeability of textiles using numerical simulations of fluid flow. The permeability is a key feature in the manufacturing of composite materials with textile reinforcement. The related simulations are performed by solving two different flow equations, i.e., the finite difference Navier-Stokes/Brinkman equation and the lattice Boltzmann equation. The obtained results have been validated with theory and experimental data.

Part 3 on *Computer Aided Garment Design* includes three chapters that describe several typical problems in garment and furniture design and give related solutions using computational techniques. Chapter 7 deals with the problem of 3D human body scanning for garment design. The authors propose a distributed collocation method for taking geodesic body measurements, which have been proved more efficient than classical linear measurements.

The geodesic measurements are obtained by solving the geodesics equations using the bicubic tensor product Bezier patches. Chapter 8 deals with the problem of rapid measurement of human body surface shape. A concept of isomorphic mesh (mesh of human body surface shape) has been proposed. It is generated from original data of human body measurements by applying geometrical rules related to some characteristic points on human body surface. Chapter 9 presents an adaptive CAD system for flexible design and manufacturing of sofas. This system permits to model current design and manufacturing processes and then improve these partially manual processes without customer's feedback. The improved system is highly adaptive and adjustable, which integrates adaptive virtual prototyping techniques and realistic pictures of products to be designed.

Part 4 on *Computerized Textile Management and Textile Supply Chain* contains two chapters dealing with optimization of planning and organization structure in textile supply chain. Chapter 10 discusses the problem of optimal purchasing policy, currently encountered in textile supply chain. The authors give an analysis on the limitation of the standard hypothesis of the knowledge of the uncertain demand modeled using exact probability distribution. Scarf's method has been proposed to study the optimal decision obtained from the defined family of demand models. Chapter 11 provides a simulation model linking manufacturer, retailer and customer in an apparel supply chain. This model generates a portfolio that satisfies the apparel retailer-defined customer service level. Fuzzy logic is integrated into the simulation model so as to investigate the different forecasting error degree between the sales forecasting and the customer demand in the apparel supply chain.

Part 5 on computational thermal bioengineering of textiles contains 6 chapters that describe the concept, models and computational systems with case studies. Chapter 12 introduces the concept of computational textile bioengineering and outlines the framework. Chapter 13 reports the development of a software package for computing simulation of dynamics of the human thermoregulatory responses when wearing clothing. Chapter 14 reports a computational model to simulate the temperature regulating effects of multi-layer textile assembly incorporated with phase change material (PCM) microcapsules. Chapter 15 discusses the numerical simulation of the coupled heat and moisture transfer processes in intelligent clothing incorporated with heating elements and PCM microcapsules. Chapter 16 deals with the modeling of the coupled heat and moisture transfer processes in the wall incorporated with textile materials and PCM microcapsules for studying the potential of energy saving efficiency during air conditioning process. Chapter 17 describes an mathematical simulation of the human psychological perception of moisture sensations.

Part 6 on computational biomechanical engineering of textiles consists of 5 chapters. Chapter 18 reports a CAD system for biomechanical engineering design of textiles and apparel products. This system allows computational engineering design of textile products by selection of fibers, yarns and fabrics with specification of their structural and mechanical properties, as well as patterns and human body., with which the dynamic interactions between human body and textile materials can be simulated and the results are visualized in 3D to show the skin pressure and stress distributions and the resulting discomfort sensations. Chapter 19 describes an application of moving mesh technique in simulation of human body deformation and garment pressure distribution. Chapter 20 reports a numerical simulation for predicting the skin pressure when wearing graduated compression stocking. Chapter 21 deals with computational modeling of the biomechanical behavior at the foot-sole interface. Chapter 22 reports computational simulation of the dynamic pressure distributions when wearing socks.

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