1. Introduction

Technologies for the production of textiles are amongst the oldest technologies developed and used by mankind. Firstly, there are clothing textiles which protect against cold and heat, and have the largest share of the manufactured textile industry; then there is the increasing contribution of fabrics for home and technical use. But of course, the classical textiles represent just one part of a wide range of products and there has been an increasing growth in textile intermediary substances which include fibres, yarns and nonwovens, substances that are employed as reinforcing and/or filling elements in thermoplastic or duromeric composites, yarns. The textile yarn or fibre is the most important basic component of most textile final products; and in the past several years yarnless and more efficient alternative technologies, for instance those based on porous sheets, have been developed. But despite the fact that in certain fields they meet the requirements, there is no doubt among the experts that in the near future, no new technology can really substitute textile yarns as the basic component for the production of textile goods. Therefore, all efforts aimed at increasing efficiency and process rationalisation will be focused on the processes of fibre formation and processing; improvements which normally only result from a substantial scientific-analytic description of the essential cause-effect relations of the processes involved.

The fundamental goals and motives for such a process analysis, which within the scope of this book are limited to the dynamic aspects, can be summarised as follows:

1. A generally accepted rule says that a process can only be considered controllable if there exists a sophisticated model by which it can be described mathematically [1]. Only when the analytical work coupled with the development of a satisfactory mathematical model has reached this level, is the *know-how* finally complemented by the control of the *know-why*. The latter, which can never be obtained from any equipment supplier, leads to the path of stable and optimised process control. Furthermore it is then possible to estimate the limits of the process (that is the maximal speed or throughput) realistically.
2. Already on the level of planning and execution of the theoretical and experimental investigations on a process, the dynamic process analysis itself

can lead to a decisive gain of knowledge. The process analysis always accompanies an analytical way of thinking. Such theoretical considerations supply useful know-how for the future work with the technical equipment.

3. The development of different types of technological processes, especially those for fibre formation and processing, can be characterised by the integration of single process stages at simultaneously higher process speeds. Some typical examples are the several processes of melt spinning and texturing of endless yarns. Here, the drawing process, which had been a separate process in the past, was technologically and technically integrated into the spinning or texturing process. One of the consequences was the increasing need for automation, for instance by means of microprocessor control. It is well known that the efficiencies of all process stages have to be multiplied to get the total efficiency of the integrated process. Therefore, even a small disturbance can result in a high loss of production; and hence, planning of a process automation and rationalisation needs a thorough knowledge of the dynamic and steady behaviour of the process under consideration. Then, all the questions about the number, type and quantitative and qualitative effects of the appearing disturbances, as well as their influence on fundamental process and product qualities, can be answered. Furthermore, the meaningful choice of the measurement and control parameters, as well as stable and high quality production, can be guaranteed. Fig. 1.1 (after [2]) shows the various functional levels in automation. The analytic model of the technological process, at the zero level (that means the process level itself), must be seen as the base for all other levels.
4. To sum up, it can be said that the quality of the analytical model is directly related to the efficiency of the process and the quality of its final products.

According to the aims and motives discussed above, process analysis in general is a continuous task within the process maintenance.

This present monograph aims at a description of the dynamic cause-effect relations between a technological machine and its product, the fibre, at several fibre formation and fibre processing stages. Following the long-standing experiences of the authors, the main, but not exclusive focus of this book, is laid on the fibre formation and fibre processing stages of melt spun fibres. Firstly, the content is based on strongly revised parts of a former monograph in the German language [3] as well as on extensive and exhaustive investigations of the modelling of the fibre formation in melt spinning processes. These investigations, which are still in progress, have been carried out at the Leibniz-Institute of Polymer Research Dresden, Germany, over the last twenty five years.

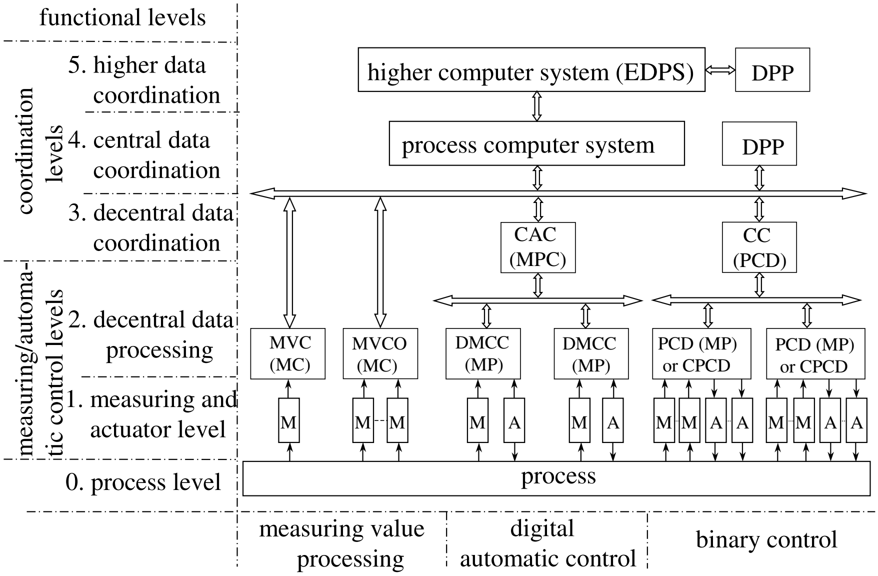

Fig. 1.1. Functional levels of a complex process automatic control system by use of a process computer according to [2]:
M measuring device, A actuator device, MVC measuring value computer, MC micro computer, MP micro processor, MPC micro processor controller, MVCO measuring value concentrator, DMCC digital multi channel controller, PCD programmable controller device, CPCD connection programmed controller device, CAC coordination automatic controller, CC coordination controller, DPP data processing peripherals, EDPS electronic data processing system

The Chap. "Steady State and Non-Steady State Technological Processes", deals with the fundamentals of modelling steady state technological processes on the one hand and non-steady state (dynamic) processes, on the other. The ideas are expounded for both the fibre formation and fibre processing process.

In the Chap. "Modelling of Steady State Fibre Formation Process in Melt Spinning" a model is developed which describes the fibre formation of thermoplastic polymers for different melt spinning processes, which include the monofilament, multifilament, staple fibre and spunbonded nonwoven processes.

The Chap. "Dynamics of Fibre Formation Processes", focuses on the effect of process disturbances on the essential fibre properties during the melt spinning process of polymers and glass, as well as during carding and drafting processes.

The Chap. "Dynamics of Fibre Processing Processes", presents dynamic models for the description of different fundamental fibre processing processes and demonstrates their potential for some exemplary processes.

In the Chap. "Dynamics of the Tensile Force and its Importance for the Process Stability", the measurement, signal evaluation and interpretation of the tensile force (which is an important dynamic product property in all fibre formation and processing processes) are considered.

The book is aimed at experts and students of technical subjects and should be useful for:

- understanding of process parameters,
- recognising the importance of occurrences in dynamic processes as the cause and effect of technological disturbances, and
- gaining strategies and knowledge of disturbance analysis in order to organise undisturbed production.

As is the case with most technological research, the current subject is highly specific and requires a union of various classical fields. As such, fundamentals from mathematics, physics, technical mechanics, automated control engineering, textile technology and textile testing were employed to develop the physical-analytic connections.