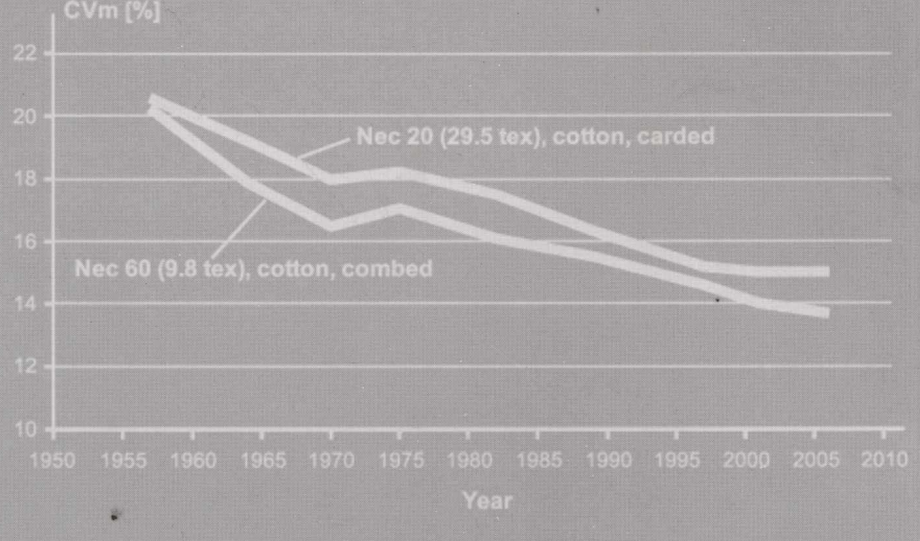
纺织服装高等教育“十二五”部委级规划教材

Textile Measuring Technology and Quality Control

纺织测试技术与质量控制

理查德·福特 著　By Richard Furter



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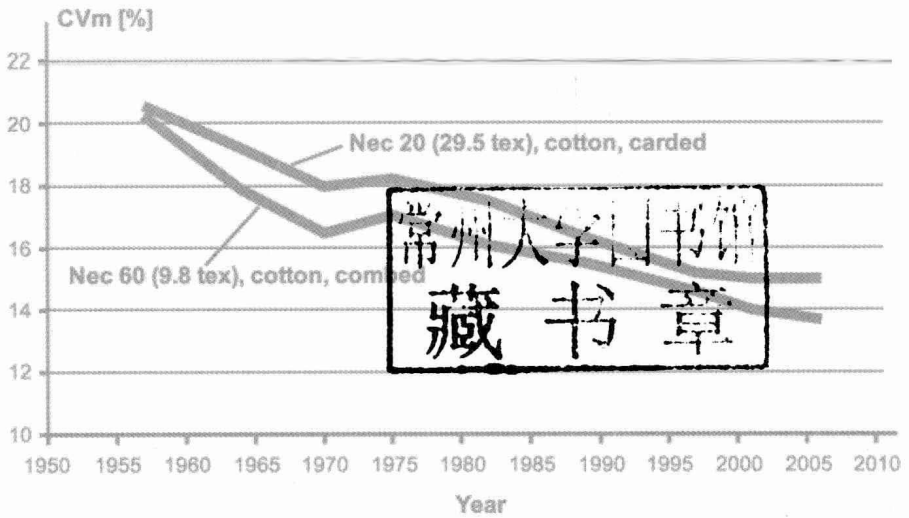

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Acknowledgement

Five years ago, Mr. Richard Furter was invited to give a lecture on quality control and testing of fibers and yarns at the College of Textiles, Donghua University. His lecture was well received by all the students in the class. Since then, Mr. Furter has been giving such a lecture once a year and it has become a regular lecture for our students in the college. The reason that Mr. Furter's lecture is so welcomed by the students is because he has not only solid background in the theory of materials testing, statistics and quality control but also many years of real world experience in quality management in the textile industry. These are what students needs to know before their graduation. Therefore, we decided to invite Mr. Furter to give a course in textile quality control and management a year ago for this semester, knowing that he will be retired from his position of the technical vice president in Uster. Since then, he has spent substantial amount of time to prepare this textbook for teaching our students. The book discusses the global textile industry in general with the most updated information, measuring technology and quality control in a way that it combines the basic concept, and the new technology in off-line and online measurement of yarns and fibers. The strength of the book is that it discusses topics from an industrial and practical perspective which is often a weakness in most of our current textbooks. I am really impressed by the content of the book and excited that Mr. Furter will come to teach this course this coming fall semester. For students, taking this course, it will provide them a great opportunity of gaining real world experience in quality management in the textile industry, especially for fibers and yarns. For teachers, this book is an important supplement to their current textbook for its unique content and perspective. I believe that everyone who reads this book will enjoy the most updated information, the closeness of its content to the industry, as well as the way of thinking presented in the layout of the book.

Prof. Yiping Qiu
Dean
College of Textiles
Donghua University

November, 2011

Foreword

This book deals with various aspects of the textile measuring methods and was written for students who study textile technology.

There are still various quality challenges in the textile chain which can be conquered with a better understanding of the textile processes and with modern measuring tools.

In the past few decades significant progress was made in the area of the textile measuring technology, particularly in the domain of fiber and yarn measurement. In this book we will particularly direct our attention towards this area. The main part of the book deals with fibers and spun yarns, but one chapter is also dedicated to filament yarns.

Spinning mills had to manage many processes without testing instruments for quality control over many decades, because the technology was not available for sophisticated measuring systems. The first evenness tester for yarns was not developed until after the Second World War. This testing system contributed considerably to the improvement of the yarn quality. Although the speed of some textile machines such as cards and drawframes increased by 10 to 30 times between 1950 and the year 2010, the evenness of yarns improved dramatically during the same period. Surveys have shown that the evenness of knitting yarns made of combed cotton improved from CV_m = 20.2% in the year 1957 to CV_m = 13.8% in the year 2007. Without this improvement it would not be possible to process the yarns today on modern weaving and knitting machines (Fig. 1).

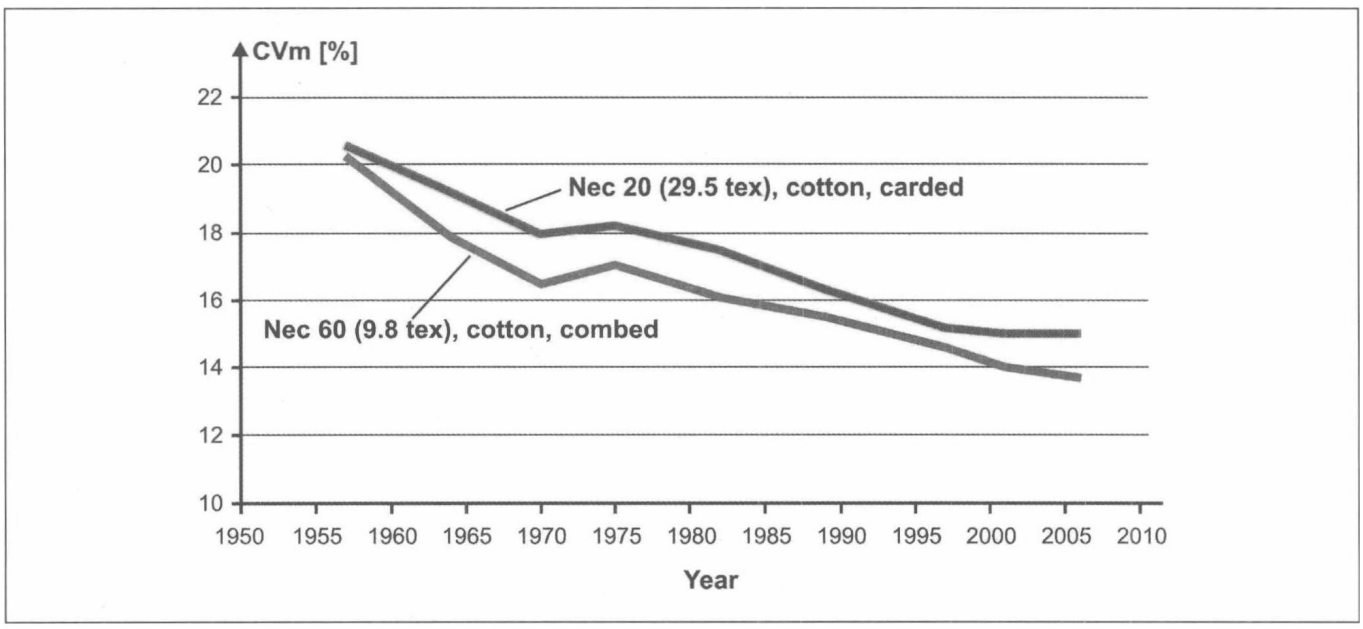

Fig. 1 *Improvement in yarn evenness between 1957 – 2007 (50% values of the USTER® STATISTICS)* *Source: Uster Technologies [1]*

The most important quality characteristics for spun yarns are the evenness, the imperfections, the strength, the elongation, the hairiness, the twist, the friction, the disturbing thick places, thin places and foreign fibers.

The most significant costs in spun yarn manufacturing are the raw material costs. Therefore, it is of utmost interest to also determine the quality characteristics of fibers.

In the textile industry benchmarks play an important role to compare the quality of a mill with the world production. For this purpose benchmarks are submitted after each chapter because quality characteristics only make sense if the results can be compared with previous results or with international benchmarks.

The USTER® *STATISTICS* represent benchmarks and are first and foremost a practical guide to 'good textile practices' in the field of fiber production and yarn manufacturing. The evidence of specific defects or shortcomings in overall yarn quality, which may become apparent through using the STATISTICS as a comparative standard, can be translated into immediate corrective action in the manufacturing process. Reliable cause/effect relationships have been established over the years and documented in the application literature. Legions of textile technologists and instrument users in mills around the world put that experience into action in their daily routine.

November, 2011

Richard Furter
Uster Technologies AG
Uster / Switzerland

Table of content

1 Textile industry overview

1.1 Introduction

The textile industry is the third largest industry worldwide. It also belongs to the first industries. The first textile machines were invented in England in the 18th century. James Hargreaves invented the "Spinning Jenny" in 1767 and Samuel Crompton invented the Spinning Mule between 1775 and 1779.

The Spinning Mule was used till 1900, particularly the self-acting mule, also called the selfactor machine. The next generation was the ring spinning machine. This machine was already invented in 1828, particularly for coarse yarns, by John Thorp in the USA.

The textile industry has conquered the European continent and the USA in a very short time and also some parts of Asia in the 20th century, particularly Japan.

England had more than 60 million spindles in 1920. England at that time was also perceived as the tailor of the world. The years after the Second World War have seen a permanent shift of the textile industry to low-cost countries, particularly to Asian countries (Fig. 1-1, ring spindles only).

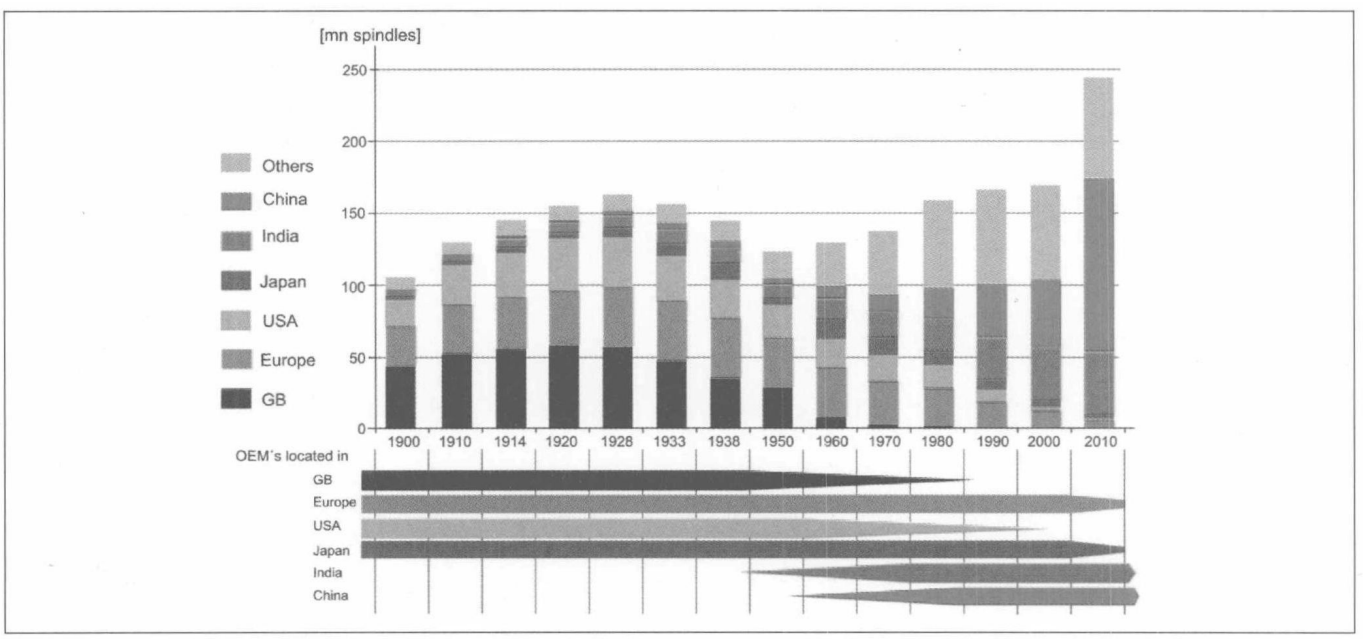

Fig. 1-1 *Production of textile machines and installed spindles worldwide. Grey bars: Rest of world.* *Source: Gherzi/ITMF/UT [2]*

The history of the textile industry is a history of migration to the countries with the lowermost labor costs. China does not have the lowermost labor costs anymore. Therefore, it is also a challenge for China to remain an important textile country in the future.

Fig. 1-1 shows that the spinning mills have nearly disappeared in Europe, USA and Japan, and China is now the country with the biggest yarn producing industry.

Fig. 1-1 also shows that Great Britain and the USA have ceased to be a country of textile machinery manufacturers. Europe and Japan have lost market share to machinery manufacturers in India and China or had to establish production centers in these territories.

OEM's: Original Equipment Manufacturers (in this case textile machinery companies).

The perspective from the point of view of South Asia, Asia Pacific and Japan with respect to textile machinery manufacturers looks different. Fig. 1-2 shows that the number of textile machinery manufacturers has increased with the number of spindles installed in Asia. The blue bars represent the installed ring spindles in Asia (Turkey not included).

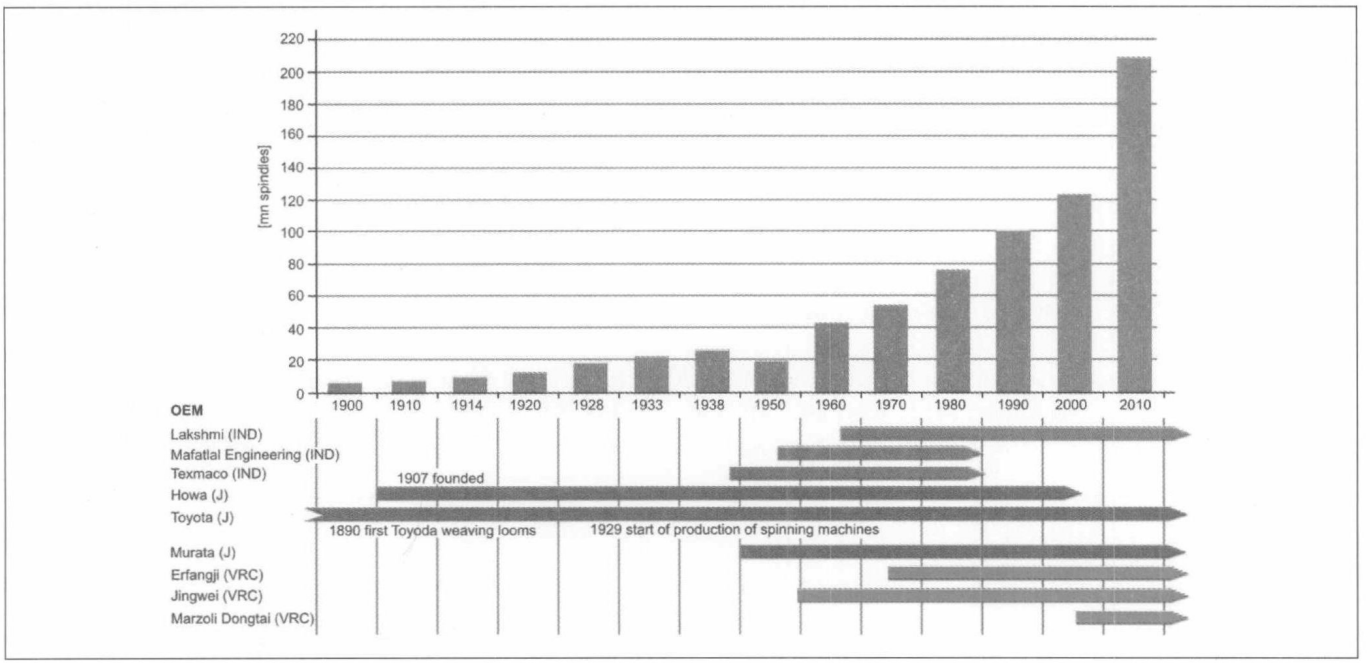

Fig. 1-2 The rise of Asian textile machinery manufacturers *Source:Gherzi/ITMF/UT [2]*

1.2 Textile machines and productivity

Fig. 1-3 shows the development of the productivity in spinning and weaving mills in the past 250 years.

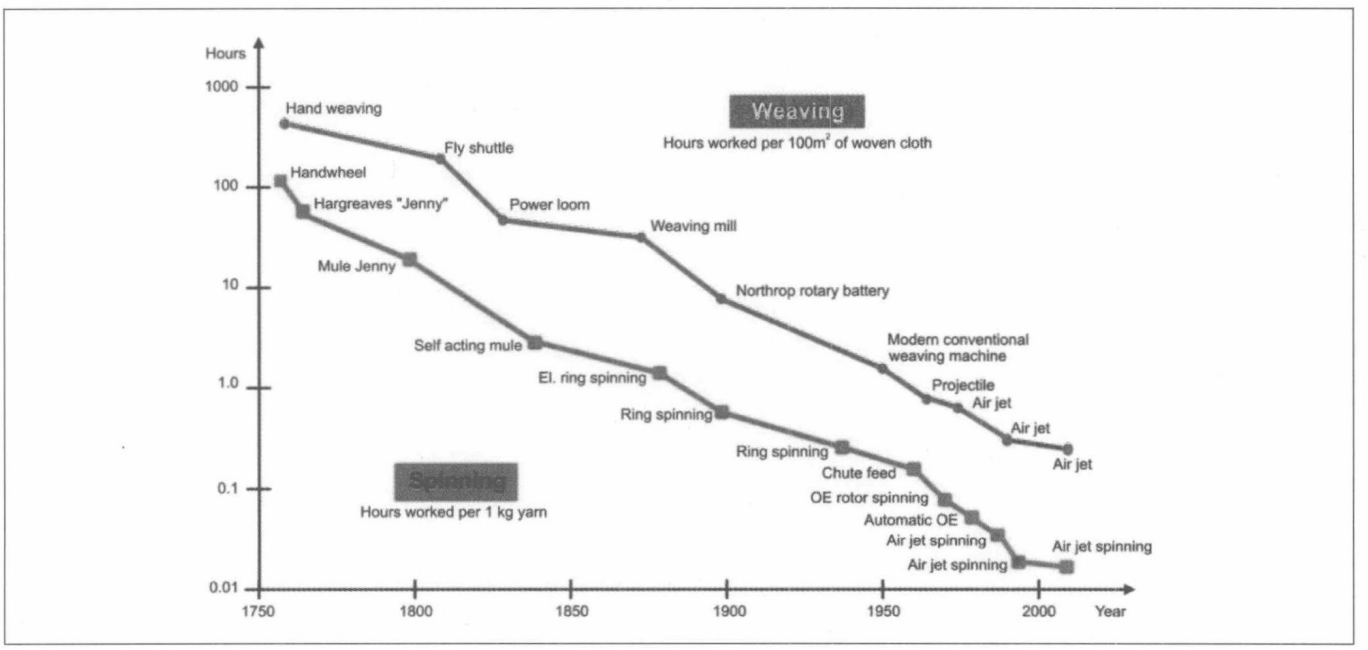

Fig. 1-3 Productivity in spinning and weaving / Territory: Western Europe *Source: ETH, Zürich / UT [3]*

Reading example: With the hand wheel a person required 100 hours to produce 1 kg of yarn. With the introduction of the electric ring spinning machine it only required 1 hour of an operator per kilogram of yarn to monitor the machines and to repair yarn breaks in the late 19th century.

A ring spinning mill of today with 30'000 spindles for medium count cotton yarns needs 50 operators per 8 hour shift to produce 12 metric tons of yarn per day or 500 kg per hour. Since they employ 50 people per shift (administration not included), the production per hour and per capita is 10 kg. In order to produce 1 kg of yarn it needs 0,1 hour of a person (Fig. 1-3, with automatic chute feed system).

1.3 Global fiber production

The most important textile materials are cotton and polyester. Polyester is available as staple fibers and filament yarns. Cotton is grown in more than 30 countries.

The natural raw materials consist of cotton, wool, hemp, ramie, sisal, flax, kapok, coir and silk. The synthetic raw materials consist of polyester, polyamide, acrylic, cellulosics, polypropylene, polyacrylic and polyurethane.

The textile raw material is also a measure of the growth of the textile industry. Fig. 1-4 shows the increase of the two groups of fibers, natural and manmade fibers, from 1960 to 2009.

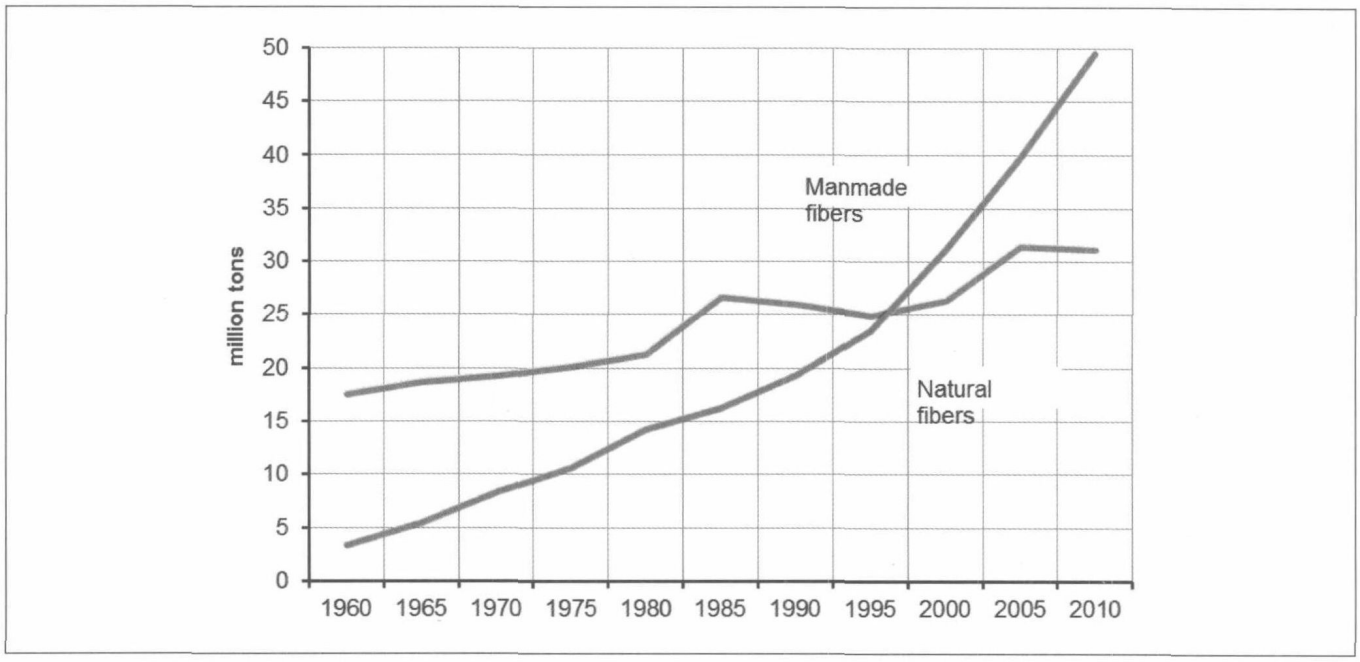

Fig. 1-4 Increase of textile raw material, figures in million metric tons. *Source: Oerlikon [4]*

1.4 Natural and synthetic fibers 2010

The textile industry has an enormous requirement of textile fibers. All figures in million metric tons.

Natural fibers	31.235*
Manmade fibers	49.568
Total	80.803

* Figure includes cotton, wool, flax, hemp, jute, ramie, abaca, agave, coir, kapok, sisal and silk

1.5 Natural fibers only 2010

Cotton is by far the most important natural fiber. All figures in million metric tons.

Cotton	25.000	
Wool	1.083	
Bast	3.835	Flax, hemp, jute, ramie and allied fibers
Others	1.317	Abaca, agave, coir, kapok, sisal and silk
Total	31.235	

1.6 Manmade fibers only 2010

Manmade fibers can be subdivided into cellulosics and synthetics. The raw material for cellulosics is wood, and the raw material for synthetics is crude oil. All figures in million metric tons.

Cellulosics	4.397	(Viscose, Modal, Micromodal, Tencel)
Synthetics	45.171	(Polyester, Polyamide, Acrylics, others)
Total, manmade fibers	49.568	

1.7 Global fiber consumption 2010

Nowadays cotton covers only 36% of the entire textile fibers. Without manmade fibers it would not be possible anymore to satisfy the fiber requirements of the textile industry (Fig. 1-5).

Total: 80.803 million metric tons. Market share in percent.

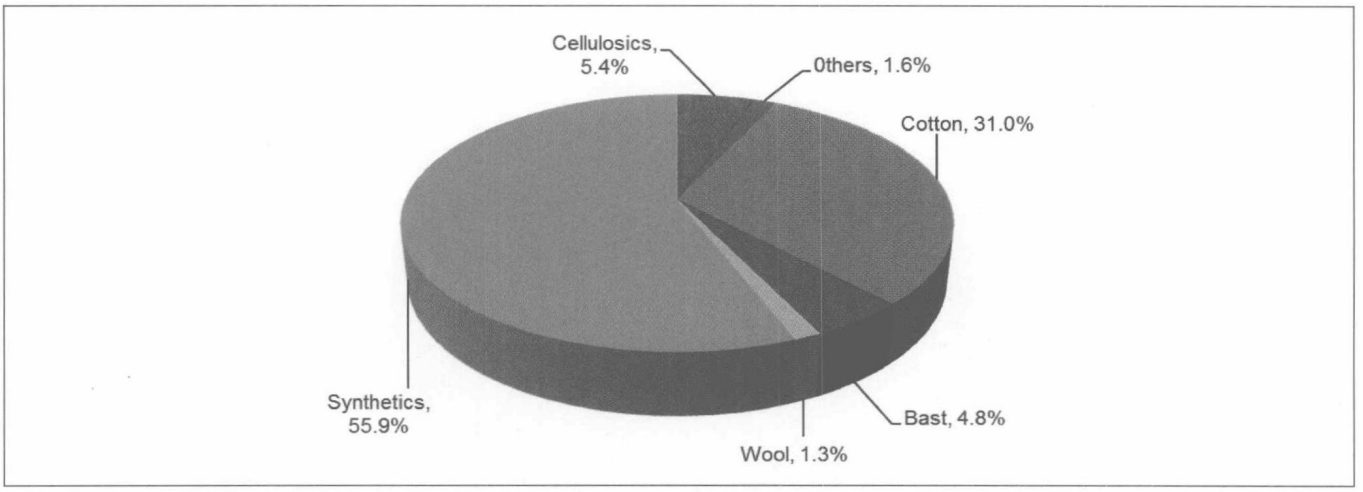

Fig. 1-5 Global fiber consumption, natural and manmade fibers in 2010 *Source: Oerlikon [4]*

1.8 World natural fiber market by fiber 2010

Among the natural fibers cotton dominates the market. The wool fiber sector could not grow in the last four decades. Among "Others" there are various fibers which all have a limited market (Abaca, agave, coir, kapok, ramie, sisal and silk).

Total: 31.235 million metric tons. Market share in percent.

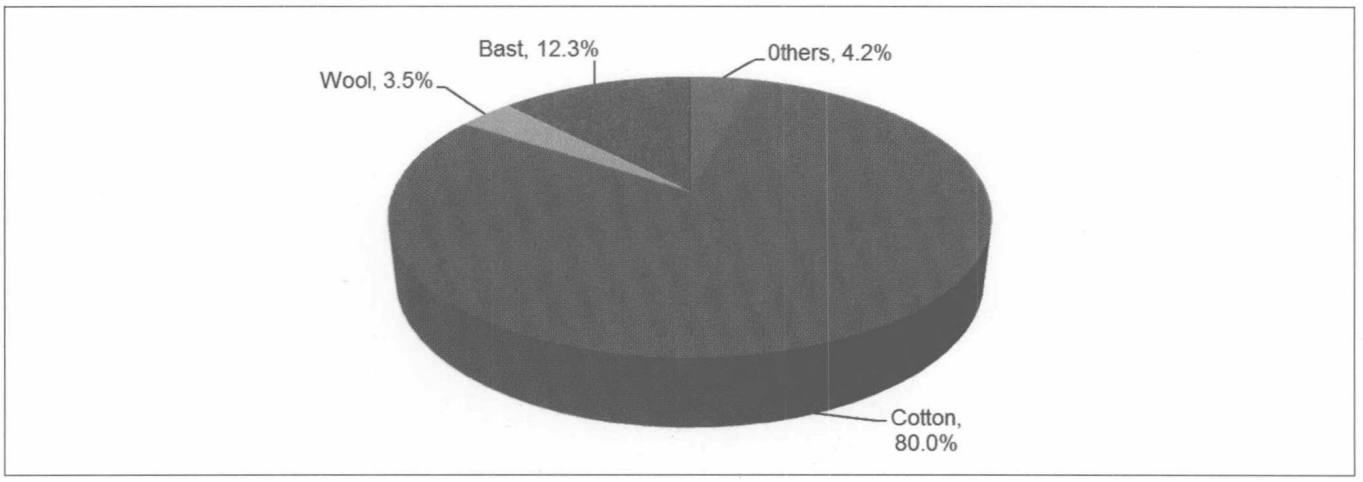

Fig. 1-6 World natural fiber market by fiber 2010 *Source: Oerlikon [4]*

Wool: Clean weight
Bast: Flax, hemp, jute, ramie and allied fibers
Others: Abaca, agave, coir, kapok, silk and sisal