

European Research in the Textiles and Clothing Sector

Common Strategy Paper

March 2002



Table of Contents

1 Executive Summary.....3

2 The Situation of the Industry4

3 The Challenges of the Future6

3.1 Challenge # 1: International Trade.....6

3.2 Challenge #2: Consumers and Markets7

3.3 Challenge #3: Human and Intellectual Resources.....8

3.4 Challenge #4: Technology10

4 Key Fields for Research & Development11

4.1 New Materials, Processing Technologies, Products & Product-Services....11

**4.2 Concepts & Technologies for Higher Efficiency in Product Development,
 Manufacturing and Distribution throughout the Textile/Clothing/Retail
 Chain.....14**

**4.3 Ecologic Materials, Sustainable Processes & Technologies and Human
 Safety in Manufacturing of Textiles and Clothing17**

**5 Preserving and Developing the Skill and Knowledge Base: Appropriate
 Structures for Research and Education20**

6 Conclusions21

1 Executive Summary

We stand at the threshold of a new industrial era with revolutionary changes taking place on a scale comparable to the industrial revolution in the 19th century. Entirely new ways of organising production and distribution as well as new types of products characterised by customisation, functionality, intelligence or miniaturisation are about to emerge, thanks to scientific breakthroughs in fields like electronics, informatics, biotechnologies or materials research. These changes affect all industrial sectors and create tremendous opportunities for those at the forefront of the new developments, but also potentially fatal threats to those who fail to use them.

In addition to this technological revolution, important changes in international trade, consumer behaviour, environmental and social legislation are set to reshape the industrial landscape in Europe and world-wide.

The European Textiles and Clothing industry has a longstanding tradition of being in a leadership role in terms of innovation, and despite increasingly fierce global competition and continued relocation of manufacturing to low-wage countries, it still represents one of Europe's major industrial sectors with an annual turnover of 198 billion Euro and a total workforce of 2.2 million in 2000. It remains one of the main players in world trade, the first in textile exports and the third in clothing. With a total number of more than 110,000 companies in the EU, of which about 95 % are SMEs, the sector is in great need of coordination and joint activities in many areas, particularly in research and development.

Automation, innovation, flexible re-organisation have been the main instruments of the European Textile/Clothing industry in preserving its leading edge in the global market place. The liberalisation of industrial nations' markets through the complete removal of import quotas by 2005 will further increase the pressure on the industry to differentiate itself and compete through the quality, functionality, environmental friendliness and consumer appeal of its products and the flexibility and quick response of its services, rather than on price only.

This can only be achieved by a large-scale industrial deployment of leading-edge research results, a highly efficient process organisation and chain management, and a highly qualified workforce. Prerequisite for the achievement of this goal is an industrial awareness of the latest developments in a research field that is very broad and multidisciplinary, which further complicates the matter, especially for the smaller companies.

However, awareness of available knowledge and expertise and information on critical issues will foster a range of applications with considerable impact on industry and society. The impact will be measured in improved industrial competitiveness as well as higher added-value for consumers, ranging from entirely new functionalities to better quality and safety, health care at all levels, to greater environmental friendliness.

In this sense the textile and clothing industry, which always represented a prominent feature of the European industrial landscape, has still a lot to offer to society as a whole and consequently all political efforts should be made to ensure that this industry finds all necessary conditions to succeed. An important part of this will be an adequate research policy that fully takes into account the needs and the characteristics of this industry, which is distinctly different in structure and functioning from other major European industrial sectors.

2 The Situation of the Industry

Notwithstanding increasingly fierce global competition and some relocation of manufacturing to lower-wage countries, the industry still constitutes one of Europe's major industrial sectors with an annual turnover of Euro 198 billion and a total workforce of nearly 2.2 million in 2000.

From 1999 to 2000 productivity grew by 8.0%, the best result since 1995. The nearly 114.000 companies invested last year more than Euro 6.9 billions, a 4.7% year over year growth.

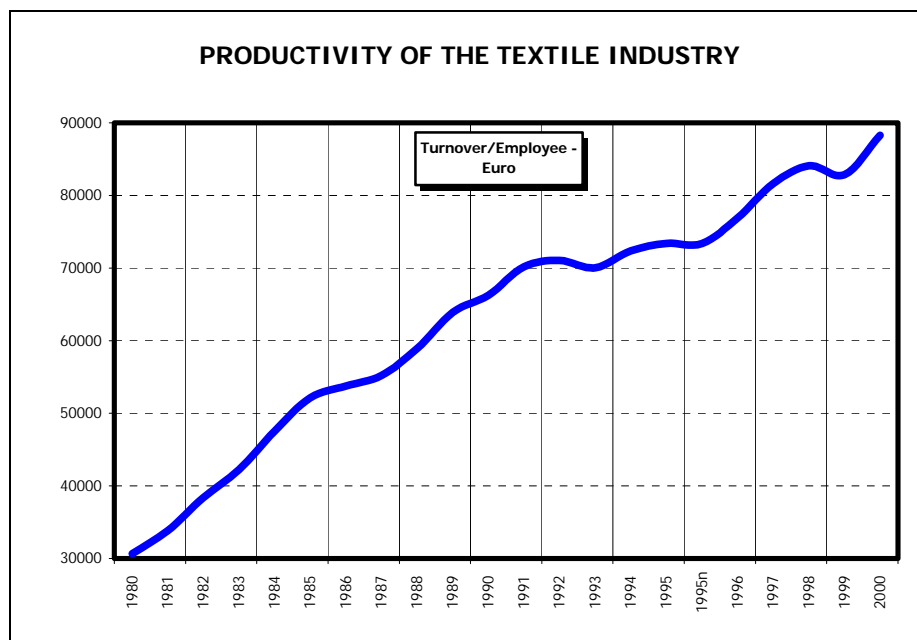


Fig.1: Development of productivity (turnover/employee) in the textile industry
 1980-1994 : EU-12 (1980-85: reconstructed data for Greece, Spain and Portugal)
 1995-2000 : EU-15
 Source : EURATEX on National data

The industry in Europe is structured in 3 main sub-sectors; manmade fibres, textiles and clothing which represent 6%, 55% and 39% respectively. The textile part of the chain is composed of spinning (16%), weaving (21%), finishing (12%), made-up & household products (11%), other textiles incl. carpets & technical textiles (22%) and knitting (18%).¹

¹ All percentages represent a weighted average including figures for turnover, added value and employment (evenly weighted) and are based on Euratex estimates for the year 2000.

EU-15 is the major player in world trade, the first in textile exports (20% - Intra-EU trade excluded) and the third in clothing (10.3% - Intra-EU trade excluded²) and has a substantial balance of payments surplus with all developed nations.

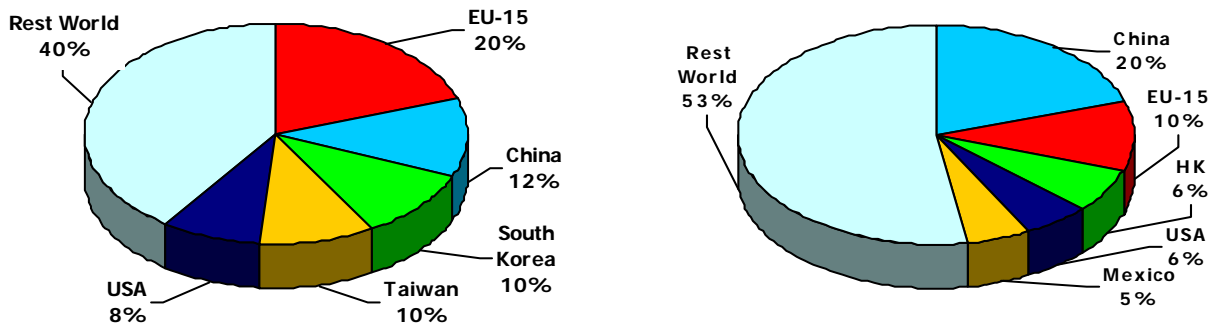


Fig.2 Main players in world exports of textiles (left) and clothing (right)

Even if import surges have further aggravated our trade balance, whose deficit is of Euro – 29,5 billions (+17.9%), the year 2000 has to be qualified as very positive: [a] for textiles products which improved strongly their trade surplus to Euro 4,2 billions (+11.5%); and [b] on the overall export side because EU companies as a whole improved spectacularly their performances in markets outside the Pan-Euro Mediterranean area which are either [1] relatively open to imports such as South Korea, Japan, US, Canada, Mexico, South Africa, etc...or [2] less open markets like the ASEAN countries. The Euro/US Dollar exchange rate has certainly been of help, but nevertheless this shows that European companies are more competitive than ever at world level

The above information confirms that this industry continues to constitute a key industrial sector in the EU in terms of international trade and as a creator of value and employment. This will be even more so with the accession to the EU of the newly associated states in Central and Eastern Europe in most of which the textile and clothing industry contributes a considerable part of the GDP.

Success stories throughout all sub-sectors, countries and regions confirm that competitive EU companies will be able to gain market share worldwide. However, this will not be easy and will need a response to four main challenges or minimal requirements in an ongoing process that will impact on trade, environment, social and technological fields.

² On total textile and clothing, EU-15 is second worldwide exporter with 14.3% while China leads with 16.4% and Hong-Kong, China is third with 13.2%

3 The Challenges of the Future

3.1 Challenge # 1: International Trade

One central element is needed to solve the chief future challenges: international trade development. In this context three paradigms will impact on the future medium to long-term trade scene and will also impact heavily on the response from and to the other main challenges.

- *The Concentration Paradigm:*

- 2005 will see the end of import restraints under the ATC³. Although more than 50% of 1990 trade volumes will already have been liberalised well in advance, growth in and the removal of all quotas will undoubtedly lead to increased imports, particularly in the apparel pipeline with loss of production and employment in the EU as a result.
- The end of restraints could well squeeze some exporter countries out of the market. We will see China, India, and one or two others as the major beneficiaries of liberalisation while prospects for smaller country suppliers in a post MFA⁴ world seem rather bleak, particularly for the least developed ones.
- One can foresee growing trade resulting from the acceleration of concentration processes in production and retailing. The latter will be particularly sensitive to price deflation for imported products, so as to better fit the expected polarization of garment price segments, particularly in the more prosperous mature markets.

- *The Globalisation Paradigm:*

- In view of the increasing degree of liberalisation on the EU market, the opening up of export markets is of crucial importance to the European industry. Companies will need to be more offensive in their search for markets abroad and particularly in emerging (middle income) countries because consumer demand will develop substantially both in volume and value.
- However, it is not clear today how many potential export markets will be opened as a result of the market access strategy pursued at political level; nor is it clear whether the outcome of the Doha Development Agenda will prove helpful in this context.

Nonetheless, the “social and environmental dimension” of international trade can be expected to come more to the fore, and the importance of NGOs cannot be forgotten.

- Only the achievement of a true level playing field, with no trade barriers (low tariffs and abolition of non tariff barriers) and trade facilitation to ease trade flows, will enable the European industry to compete on global market and force the TC industry abroad to envisage more production oriented towards local markets instead of exports.

³ ATC – Agreement on Textiles and Clothing (Defines the gradual phase-out of the multi fibre agreement MFA until 1 January 2005)

⁴ MFA – Multi Fibre Agreement (Regulating exports of textile and clothing products from developing to industrialised countries)

- *The Regionalisation Paradigm:*

- Today, there is an evident move towards the creation of a number of very large trading blocs: the build-up of blocs of influence is a successful example of how trade can foster development, enhance competitiveness and strengthen relations between countries belonging to it, formally or not. Some examples: EU-Turkey, NAFTA, ASEAN, SAARC and the future EU-Mercosur or FTAA's.
- A crucial element for Europe is the role played by the future Pan-Euro-Mediterranean area covering the Newly Associated States in Central and Eastern Europe, Turkey, Mediterranean and EFTA countries.
- The future role of this zone is no longer an issue, but speedily resolve the slowness of its implementation remains a serious concern. This 700 million consumer area must function effectively and in particular the *cumulation*⁵ question and the preferences linked to this.
- Nevertheless, the growing importance of the Pan-Euro-Mediterranean area tends to confirm the fact that in the future being located close to the market will become more important as mass-individualisation will require small batch production, short lead times and proximity to the final consumer.

3.2 *Challenge #2: Consumers and Markets*

Already today, many companies in the textile and clothing industry have for some time no longer fitted the classical mould. They may have become importers or distributors as well as manufacturers; they may too have extended their activities vertically or indeed horizontally by merger, acquisition or subcontracting in what has become an increasingly multi-fibre industry.

All this aims at better monitoring the emergence of new markets that are influenced by the interaction of the following four factors: consumer structure and behaviour, market development, management and education/training

- *The Consumer Factor*

- In the following years the industry will face five key trends:
 - [a] The change in the age structure in mature markets with an ageing population and rising income levels;
 - [b] The growth of single households versus the classical family households model in mature markets
 - [c] Fast improvements in the living standards for a new middle class in the fast growing markets of the most advanced of the developing countries;
 - [d] The growing importance of the “intangible sphere” in consumer behaviour that will favour “ethical consumption” in a world dominated by “urban life”
 - [e] To those changes one should add the fact that there would be rising media coverage & consumer awareness of environmental, health and social issues. It is

⁵ Origin cumulation: custom provisions allowing duty free movement of goods between 2 or more partners if origin provisions (double transformation) for products are respected

already evident that even if the magnitude of this phenomenon is hard to assess, the authorities and the consumer may have to choose in certain areas between human health and safety as such and the environment as a whole, imposing new and costly technical standards to EU industry. (e.g. fireproofing)

- *The Market Development Factor*

On a global scale one can speak of a three-tier market development:

- In developed (high income) countries, consumer demand is likely to grow, however at lower rates than spending at large, and growth in value will be stronger than in volume.
 - There is no doubt that consumers will require prompt responses from producers and distributors as market segmentation will increase strongly and be accompanied by new ways of consuming.
 - On the whole, EU consumption is unlikely to increase significantly overall, although there will be areas of substantial growth; including technical and “intelligent” textiles.
 - There would be a rising demand for high value functional, healthy, environmental friendly and personalised textile products requiring from companies the ability to work with smaller batches, greater flexibility and quick response (mass customisation and industrial made to measure)
- In emerging (middle income) countries consumer demand will develop substantially both in volume and value. Consumption will tend to grow increasingly in the middle range of the market.
 - On the whole consumption growth in those countries will create pressure on availability of fibres. This is likely to create upward pressure on prices for materials.
- In developing (low income) countries consumption growth will be small and informal forms of distribution will prevail.

All the above applies mainly to clothing and interior textiles for private consumption, which to date represent the lion’s share of textile production. With more and more textile products destined for commercial use (industrial and service sectors) market trends will also follow the patterns of industrial cycles and global development of industry and service activity.

3.3 Challenge #3: Human and Intellectual Resources

- *The Management Factor*

- As in other consumer goods industries, companies that produce textiles and clothing have to ensure that the consumer rather than the product is the centre of gravity from which all company functions have to be directed. Only the company that can guarantee the right service at the right time and place at acceptable cost and quality to its final consumer will stay in the market. For this managers have to control the flow of material, information and know how that is influenced by a multitude of factors.
- The rising complexity and acceleration of business makes it necessary for the majority of small to medium-size companies in the sector to develop and efficiently manage

cooperation and networking structures across company boundaries, that include subcontracting, outsourcing of non-core tasks or concurrent engineering. A clear enterprise strategy supported by appropriate structures and extensive use of information and communication technologies will be indispensable.

- In addition, vertical integration of companies will further develop, especially in the clothing business. The move towards the integration of retailing to better monitor changes and increase margins will be normal practice, particularly in the middle range market, in order to compete with large retailers and distributors who will play an increasing role, in particular in those countries where to date they have been less active.
- However difficult it might be for EU SME's facing tough competition, brand development and brand image is and will be a growing asset while exporting overseas and particularly to emerging markets where purchasing power is increasing rapidly and where the status symbol plays a central role in the wealthier classes of consumers able to afford EU products. Managing products and brands in foreign markets with a variety of consumption patterns and cultural backgrounds as well as different technical standards or legal provisions, will be a further challenge.

- *The Education and Training Factor*

- Tomorrow, more than today, the EU textile and clothing industry but also manufacturing industry as a whole could face a general shortage of qualified, high-tech personnel. This phenomenon could be amplified by a deteriorating textile knowledge base in Europe due to a decline in employment as well as of the lesser attractiveness of the sector to high-potential youngsters mainly due to a traditional image and somewhat lower wages.
- This is of some concern since the preservation and development of know-how and skills through effective education and training will be key to sustained competitiveness, as the importance of knowledge-intensive tasks and flexible skills in companies rises.
- As companies' strategies increasingly focus [a] on design and product development and [b] on retailing, gradual delocalisation of production may increase all over Europe. This phenomenon of de-industrialisation would need careful monitoring, in particular on the cost management and training side, as it is clear that there will be a need to provide young industry starters with critical skills and knowledge as well as to re-skill, on a large scale, current textile and clothing workers and managers (see chapter 5).

- *Creativity and the Protection of Intellectual Property*

- Creativity in fashion and design is seen as a major asset for the future control of markets. Design, creation, flair will remain concentrated in the EU even if their predominance will not go unchallenged with US and Asian companies catching up in this European stronghold.
- We will see more and more the emergence of a marketing driven creativity based on cross-fertilization between various disciplines with fashion and design becoming increasingly influenced by ethics, innovation and technology.

- However, the piracy of designs and models, fraud and counterfeiting will continue to pose a major threat in this field. In spite of substantial efforts made in the recent past, more needs to be done on a political and operational level to halt their progression.
- The enforcement of rights related to trademarks, industrial designs and origin rules as well as, increasingly, the application of patents to protect scientific and technological inventions would be a further key to enable the European textile and clothing industry to reap the full benefit of the creativity and inventiveness of its human resources.

3.4 Challenge #4: Technology

It is already clear from today's practice that in the near future, managers will need to control and guide innovation and communication processes through technological tools that develop at an extremely rapid pace.

- The Innovation Factor

- Already today, fibre innovation is seeking to rebalance the power of fashion and creativity and interact with it in order to increase the technological content of final products as well as the increasing diversification of their end-uses, to be in line with the consumer's future needs.
- Starting at fibre level, relentless product and process innovation has to cover the entire chain. It is vital that companies increasingly agree to work together, to concentrate their efforts in the innovation field. (See chapter 4.1)
- In addition, environmental issues will continue to pose a major challenge particularly to the textile industry. Legislation will impose more stringent requirements in terms of emissions to air, soil and water. Costs will increase as limited water resources and limits to the availability of certain fibres push prices upwards; waste management and packaging issues will grow in importance. Here too industry will need integrated approaches to innovate and make best use of R & D. (see chapter 4.3)

- The e-Factor

- Ongoing concentration at both ends of the chain (fibres, retail) demanding forward and backward IT integration will play a major role in supply chain management and can help to alleviate the particular challenge posed to industry because of the numbers of SMEs in textiles and clothing.
- The investment in and deployment of information and communication technologies (ICT) can lead to everything from enormous efficiency gains thanks to streamlining of all company functions to a complete breakdown of operations due to an interruption of traditional information flows. Managers therefore need to understand not only the capabilities and functionalities of the technology in question but also its repercussions on existing company structures and processes. To develop appropriate concepts and methods and adapt ICT to the sectors needs will be a major source of sustained competitiveness (see chapter 4.2)

4 Key Fields for Research & Development

All these present and future challenges for the industry described in the preceding chapter call for a wide variety of research and development activities that should lead to intelligent innovative solutions at all stages of the chain and for all types of companies.

Such activities may be structured in the following three key categories:

1. Research for new materials, processing technologies, products and product-services
2. Research in new concepts and technologies for higher efficiency in product development, manufacturing and distribution throughout the textile/clothing/retail chain
3. Research in processes and technologies for improved resource efficiency, environmental friendliness and human safety in the manufacturing of textiles and clothing

In the following sections each category is described in more detail and specific current bottlenecks and research needs are named and potential consequences of successful innovation are outlined.

4.1 New Materials, Processing Technologies, Products & Product-Services

Relentless product innovation based on new or improved (fibrous) materials, new combinations or processing of existing materials, continuous creation of new styles and designs or the application of textile materials to more and more consumer and industrial uses has been the main driver of the industry for the last decades and proved to be a particular strength of European companies. This is believed to continue to be so in the future with all the above areas still providing enormous scope for innovation and improved competitiveness on the global market.

- New and improved fibres, textile & composite materials

Property improvements at the fibre level significantly influence both processing options at subsequent stages of the chain as well as properties and functions of the final product.

Fibres that respond in a “smart” way to external influences like temperature changes, humidity, chemicals and bacteria, light and radiation, fire, electric discharge or mechanical use will enable the production of functional or smart clothing for sports and leisure wear as well as work wear and protective clothing, which all represent growing markets.

Fibres and textiles that conduct electric current or light, accumulate energy, store information or receive and transfer radio waves will open up a whole new market for intelligent garments containing sensors and actuators and advance the vision of wearable technology that can control, alert, inform, relax or entertain the wearer.



Fig. 3 textile keyboard (© ElekTex)



Fig. 4 Wearable electronics (© Philips)

Fibres and textiles with improved characteristics in strength, weight, chemical resistance, flame retardance, isolation, filtering or noise reduction properties as well as biodegradability will find wide use in a variety of industrial sectors like construction and interiors, automotive, aeronautics and machinery, environmental and geo-technologies as well as agriculture.

Such high added value products that draw from traditional European strengths like engineering and industrial design skills can give the industry tremendous opportunities to be competitive on markets worldwide.



Fig. 5 3-dimensional technical textile products from glass and carbon fibres

Last but not least, textiles with medical and hygienic properties will find a multitude of applications in the healthcare sector, be it in the form of biocompatible implants and tissues, antibacterial wound treatment material or anti-allergic clothing or home textiles for infants, children or skin-sensitive persons.



Fig. 6 : Medical applications of textiles (sources IFTH, Tissupor, ITV-Denkendorf)

The enormous diversity of textile applications make it obvious that research work in most cases has to be multidisciplinary, carried out by research teams that combine scientific backgrounds as diverse as physics and material sciences, biology and (bio)chemistry, informatics and electronics to medicine and socio-sciences.

- *Innovation in processing technology*

New textile and composite materials will require adapted or entirely new machinery and processing methods. But also existing materials can yield new properties and functions if processed and engineered in innovative ways. Recent breakthroughs in bio-chemistry and biotechnology as well as plasma, laser and nano-technologies will allow novel yarn forming, coating or laminating processes that will give new and traditional fibrous and textile materials highly desirable properties both in terms of subsequent processability and final product characteristics.

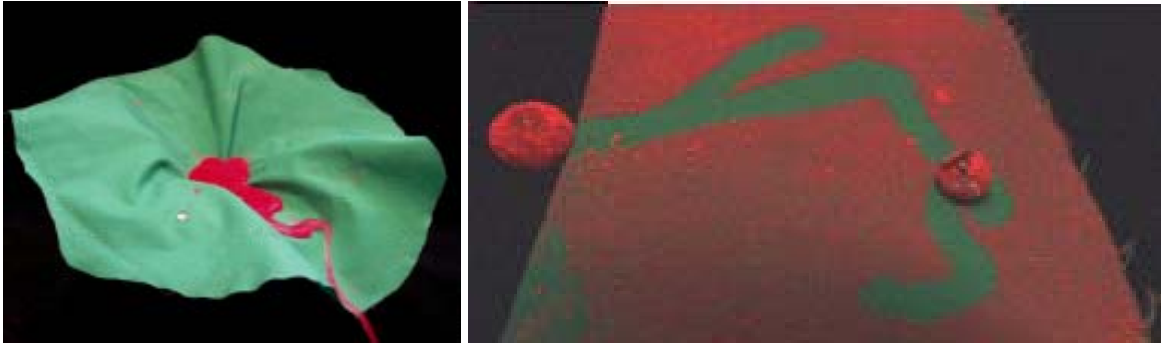


Fig. 7 Textiles with Lotus-Effect®

But also traditional textiles processes can still offer enormous scope for innovative solutions that improve manufacturing speed, quality automation or flexibility – all factors that greatly affect the competitiveness of the European industry whose future lies in highly flexible capital intensive production of high quality specialty products for sophisticated uses rather than labour intensive low cost standard products for the mass market.

The artificial separation of skill and technology, intensive design and product development functions for clothing, which will remain firmly rooted in Europe, and labour intensive manufacturing (the make-up of garments), which moves increasingly towards low-cost countries, highlights the difference that existence or non-existence of fully automated processes can make. A resolute effort to tackle all problems that prevent the garment manufacturing industry from becoming the truly high-tech industry that all other parts of the textile chain already are, will, if successful, not only reverse the relocation trend but also stop the erosion of the industrial skill base in Europe and provide the whole industry with a more modern image that is sorely needed to attract high-potential young people and to create a more favourable climate for local investment.

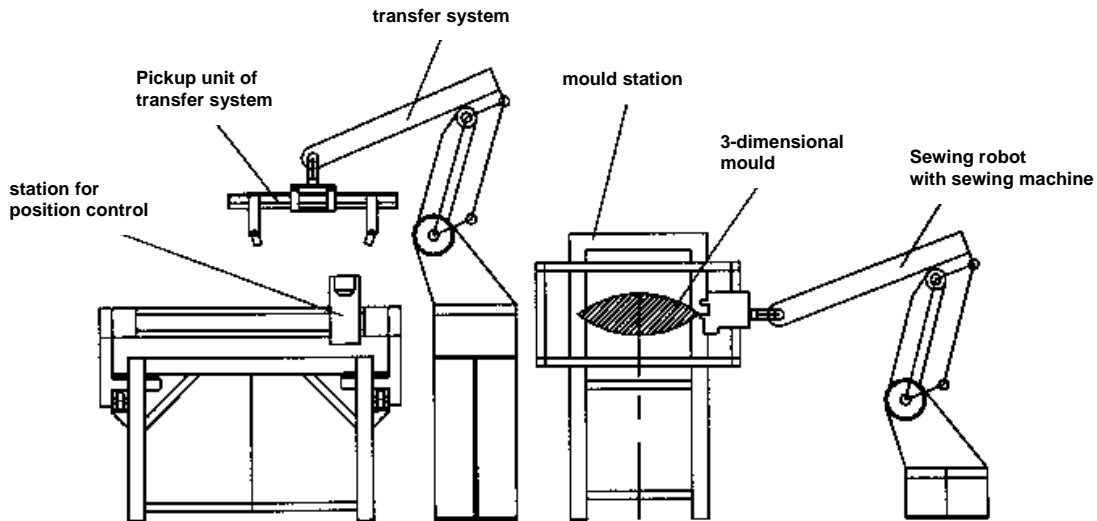


Fig. 8 principle layout of automatic 3-dimensional sewing system for garments (©Institut für Nähtechnik Aachen)

Such a programme seems all the more appropriate at a time when all consumer goods branches are experiencing a shift away from mass production of standard low-cost products towards mass customisation or industrial made-to-measure of personalised quality products. These new concepts can only be successfully realized if speed, flexibility and proximity to the final consumer are built into the system (see further 4.2.)

4.2 Concepts & Technologies for Higher Efficiency in Product Development, Manufacturing and Distribution throughout the Textile/Clothing/Retail Chain

All products and product-services that may result from innovations discussed in the previous chapter can only be successful on the market if they are produced exactly to customer specification, at competitive cost and delivered at the right time to the right place. In order to achieve this, a multitude of factors needs to be kept under control, which constitutes a great challenge to a single company, especially for the many specialised small and medium-sized enterprises in the textile clothing chain. Continued business acceleration and globalisation will increase dependence on suppliers, customers, technology providers, designers, testing & research centres and all kinds of business intermediaries often widely spread across Europe and the world, and makes efficient communication and information management indispensable for all enterprise functions from procurement, production, planning and organization to marketing sales, as well as research & product development. This concerns traditional hierarchically organised companies as well as value-adding networks (Virtually Extended Enterprises, Dynamically Networked Enterprises).

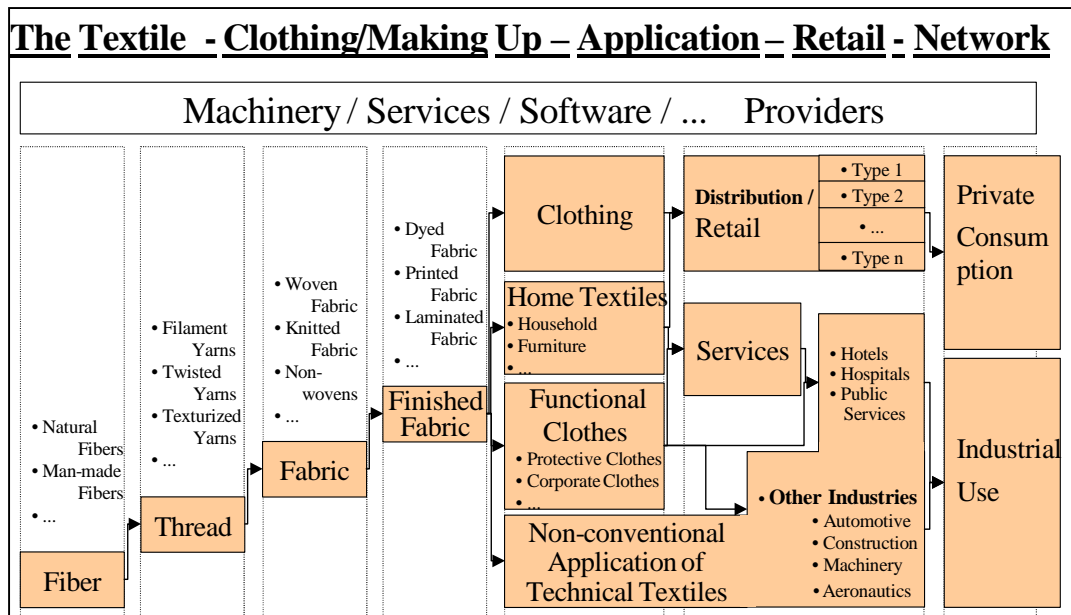


Fig. 9: Textile chain typology (© ITV Denkendorf)

Many new tools and concepts based on so-called information society technologies have been developed in recent years and some successful pilot projects have been realized in the sector. However, a lack of proven sector-specific concepts and appropriate applications as well as sufficiently interoperable, standardised solutions has hampered a broad deployment so far. A specific obstacle to a wide adoption of digital communications and information management in the textile/clothing/retail chain has been a lack of sector-specific description and messaging standards for data exchange via Internet based platforms. Looking at the different business functions, the following trends can be identified:

- *Procurement and industrial sales (B2B e-commerce)*

Various enabling tools and concepts have been developed and are now beginning to be used, ranging from company websites and e-catalogues to supplier-customer extranets and virtual marketplaces. Real value can be created through systems that facilitate the identification of suppliers and customers, that make crucial procurement/sales information available in real-time to all parties concerned, that automate standard transaction functions and allow the focus of all enterprise functions on the fulfilment of customer demands without compromising on cost and profitability parameters. However, intelligent concepts and technologies based on sector expertise are needed that permit both highly integrated, personalised systems for crucial supplies and key customers (via extranets, EDI systems etc.) and non-strategic activities like procurement of standard goods or sale of overcapacity, second quality product or waste (via Internet marketplaces or auctions).

- *Distribution and retail sales (B2C e-commerce)*

Take up of B2C e-commerce in textiles and clothing has been much slower compared to other, more standardized consumer goods (such as books, music and software) basically due to problems of product property description (notably fit, feel and touch, as well as colour) but also logistic and technological problems (like economies of inventory and

delivery, capacity and cost of consumer Internet connections). More sophisticated solutions to overcome such problems are under development and may help growth in B2C e-commerce in the sector, beyond the current success of big mail order companies, offering a promising additional channel for smaller manufacturers and retailers that can exploit their proximity advantage and existing consumer confidence. However, more technological development, integration and standardization work will be necessary to make full 3D visualization of garments or home textiles, realistic virtual try-on and system independent colour rendering technologies applicable and affordable to a wide range of companies and raise consumer interest and confidence in on-line shopping of apparel and home textiles.



Fig. 10: The virtual catwalk (© MIRALab)

- *Production and resource planning, flexible manufacturing systems*

Intelligent and highly flexible production planning and manufacturing systems based on affordable, user-friendly and compatible IT solutions that allow integration with business management systems (internal and external) are still not sufficiently available to the industry. Trends towards highly specialised industrial products as well as personalized consumer goods increase the need for systems that can efficiently handle small orders and production batches, reduce lead times or control quickly changing product parameters.

Enterprise resource management systems that fully cater to the *multi-step-processing* orientation of the industry, rather than the *assembly-of-parts* system of other branches, need to be developed further to achieve a wider deployment in companies of all sizes. Online inspection and quality control systems are to be further advanced in terms of functionality and user friendliness to enhance the reliability of production and planning and to save costly resources in reducing waste and erroneous production.

A major effort should be made to the garment making process through the development of fully automated handling and securing systems to finally make this part of the industry competitive in high labour cost countries and preserve this important stage of the chain within Europe. The general trend towards higher quality sewn industrial and consumer products will also raise the need to achieve the same degree of reliability (i.e. reproducibility) in this manufacturing process, that today is of the norm for virtually all manufactured goods and that can only be realised through full automation.

- *Research, product development, engineering and design functions*

The more and more complex and sophisticated nature of textile products combined with a higher frequency of product changes and shortened product life cycles, calls for an ability of companies to put highly specialised, multidisciplinary expertise and skills, often from external sources, to work in a very quick and effective way. This requires knowledge-based concurrent enterprising. Relevant knowledge has to be sourced and exchanged in (ad-hoc) expert networks, which can be done efficiently if the right IT tools and organization concepts are used and made available to the industry. Product development and design processes can be speeded up enormously by keeping as many steps as possible (such as design, sampling, testing etc) on a virtual level. To achieve this, sophisticated but easy-to-use systems are needed to simulate optical, mechanical or chemical properties of the product as well as parameters of further processability in a very realistic and reliable way. Security aspects, though important in all business areas, play a prominent role in research and product development supporting IT systems, since the future competitive advantage of the company is directly concerned.

In general new tools based on Internet technologies still need to be developed for many sector-specific expert tasks but always steered towards interoperability to allow seamless integration into value-adding solutions across the chain. Parallel to technical development, underlying concepts and methods are needed to ensure wise technology use that does not erode but sustain the competitive advantage of the company.

4.3 *Ecologic Materials, Sustainable Processes & Technologies and Human Safety in Manufacturing of Textiles and Clothing*

Manufacturing companies operating in Europe are not only faced with high labour costs, but in general with higher costs for the use of natural resources like energy in all forms, water or air as well as for health and safety provisions for human resources employed in the production process, as compared to competitors in other parts of the world. This is mainly due to strict environmental and social legislation, which constitute major objectives of European policy and which will not be compromised. In addition final products have to comply with high environmental and health standards that are imposed both by legislation and by consumer demand. Last but not least, total life cycle considerations are gaining more and more ground in Europe making companies responsible for their products during their entire life span from production through use to disposal, recycling or reuse.

The industry has therefore to come up with innovative solutions that can make up for these competitive disadvantages and thereby preserve production in Europe.

- *Renewable resources and bio-degradable materials*

Growing consumer demand for eco-products combined with legislative pressures for environmental excellence in all business functions have revived industrial efforts to make maximum use of renewable bio-materials. The well-known and widely used natural fibres cotton, wool and silk as well as increasingly also (rediscovered) flax, hemp and other plant-based fibres are back into research focus as their properties can be considerably enhanced by enzymatic and other advanced biotechnological processes. In addition immense world-

wide research effort with promising results is devoted to the production of high-quality fibres and textiles from cellulose and starch, which can be cheaply won from abundant natural resources or side products (otherwise waste) from agriculture, forestry and related industries.



Fig. 11: Sources of renewable fibres

Novel raw materials will in turn require research and development efforts to adapt or innovate processing technologies on all subsequent stages of the extended textile chain. Success in these fields led by the European industry followed by world-wide take-up can be an enormous step towards more sustainability on global scale.

- *Environmental friendly and resource efficient processes, recycling and reuse*

Major concerns for the textile, and to a lesser extent the clothing industry, are an overall reduction in use of water, chemicals and energy, the identification and substitution of toxic chemicals and the reduction, recycling or reuse of liquid and solid waste. Water and chemicals are of main concern to the dyeing, finishing, printing and laundry companies whose processes are in addition energy intensive. The development of innovative processes that obtain the same or better results with less resource input can result in a substantial reduction of production costs.



Fig. 12: pilot system for textile dyeing with overcritical CO₂ (source: DTNW Krefeld)

As far as waste, solid or liquid, is concerned new developments should help to further improve effectiveness of treatment and recovery methods and technologies, but also make sure that solutions are made available that can be economically used by companies of all sizes.

Apart from the efficiency imperative, environmental together with health issues are also imposed on industry as a whole by changing consumer preferences towards “greener” and healthier products as well as negative business impact through increasing media coverage of real or potential environment or health risks of certain products. The main obstacle to take a more pro-active approach vis-à-vis such issues, is often the lack of reliable information on potential environmental impact of products throughout their whole life cycle, the toxicology of chemicals used, the availability and characteristics of potential substitutes or best available technologies. Highly valuable research efforts could therefore be devoted to total life cycles studies, chemicals testing and the provision of comprehensible and easily accessible environment and health related data.

- *Health and Safety at the Work Place*

Apart from health risk free use of textile products also health and safety of workers in the production process represents a high priority of the industry. Exposure to noise, heat, dust, chemicals or dangerous machine parts etc. has to be minimised and any negative health effect has to be prevented. The modern workplace has to be as ergonomic as possible. Research in methods and technologies that innovate in this respect can help, saving enormous cost both to the single company and the society as a whole.

5 Preserving and Developing the Skill and Knowledge Base: Appropriate Structures for Research and Education

The evolution of the textile and clothing sector towards a more and more capital intensive high-tech and knowledge driven manufacturing industry has greatly increased the need for qualified, i.e. highly educated and multi-skilled, personnel both in management and operations. Appropriate educational systems and new learning technologies must be available to prepare newcomers in world standard academic and vocational programmes as well as re-train or re-skill existing personnel at and outside the work place.

Existing education and research facilities of global reputation have to cater effectively to an industry whose products and processes become more and more sophisticated and based on multiple disciplines including chemistry and biotechnology, physics and material sciences as well as engineering.

Making maximum use of education programmes and research facilities is a specifically difficult challenge for thousands of small and medium companies, which constitute the European textile and clothing industry. The barriers are twofold; (a) financial - limited resources restrict tangible and intangible investments in R&D and education - and (b) human – extremely lean structures make education and skilling programmes difficult for work force and managers alike.

The most crucial need regarding factory workers is to increase multi-skilling to cope with the growing importance of sample-machinists and other flexible workers. They are necessary to translate the creative impulse given by designers and product developers into industry products and give manufacturing companies the needed flexibility in markets where demand changes rapidly.

A similarly important challenge concerns the improvement of strategic skills of management, be it by training existing executives or by allowing new blood to take command. An endemic problem is the small size of companies, which hardly allows European company executives to be more than overall managers and prevents them from hiring other necessary professionals. Tasks like motivation building, development of new skills in logistics, exports (international experience), human resources management, networking or partnership building have to be an integral part of modern management.

The textile knowledge base is still broad and deep in many parts of Europe, especially in traditional textile regions. However, without a great effort to attract and adequately educate young talent, this knowledge base will be at risk. The best way to attract fresh talent is the creation of truly European centres of excellence that combine world-class education and research with real industry experience. Only when scientific challenge and true industry career opportunities come together, can a sense of fascinating future prospects be created. In such an environment international mobility of scientific personnel and students must be the rule, not the exception.

6 Conclusions

Product and process innovation, new management concepts and business models all based on leading edge research and development and world-class higher education and vocational training will be the basis for sustainable competitiveness of the textile and clothing industry based in Europe. Those working in this industry believe in a future full of opportunities that can be turned into industrial successes provided all efforts are focussed on innovation. The more production and distribution become truly European as raw materials, unfinished and final products circulated frequently between business partners in the EU and its neighbouring countries, the more joint product development and process innovation must have an European dimension too. European research programmes should support this process by encouraging companies and research centres of all types and sizes to become engaged in cross-boarder research and development projects and disseminate research results European wide.

Only in being provided with a level playing field in research policies and its due share of attention and support from European programmes will the textile and clothing industry be able to contribute its part to the political goal (stated at the European Council in Lisbon in March 2000) of turning the European Union into **“the world’s most competitive and dynamic knowledge-based economy within the next ten years”**.