CLOTHING PRODUCTION AND MATERIALS

Figure 5. Climbing Ben Nevis. (Seppälä 2009.; Photograph by Joe Nunn.)
4 CLOTHING PRODUCTION AND MATERIALS

4.1 Life cycle of outdoor clothing and importance of material choices

Materials and processes used for outdoor clothing have several potential environmental risks. When surveying environmental impacts of clothing, impacts can be divided into four main groups: manufacturing, delivery, consuming, and end of life (Fig. 17). Although materials are not the only aspect to affect the environmentally friendliness of outdoor clothing, correct choices of materials are extremely important. The textile manufacturing process includes stages of fiber manufacturing, yarn manufacturing, fabric weaving, dyeing, and several finishing. Fabric finishing is the final stage in fabric processing. It includes preparation of the fabric to be dyed and possibly printed. There may be also stages of washing or bleaching, before or after dyeing and printing itself. Finishing may entail any application of specialist fabric finishes, for example those giving water repellency and crease resistance. Fabric finishing is the chief cause of environmentally impacts in the production
phase, using significant quantities of water, energy and chemicals and producing substantial amounts of effluent.82

After the fabric manufacturing process, fabric is often sent to a garment manufacturer, who has also ordered accessories such as buttons, zippers and all the other materials needed. After pattern making the fabric is cut and sewn into an outdoor garment. Garments are transported to retailers and from central warehouses to final retail shops. Material and energy are also put into marketing. An end-user uses the garment, but also washes it and sometimes repairs and customizes it. If a garment functions properly the end-user may use it until the end of life, when it is no longer usable.

End of life solutions vary from transferring the garment to some less important use, to giving it to somebody else, or to charity, or to throwing it away to a garbage landfill. Each stage of this process can have adverse effects on people and on the natural environment. Generally, industrial processes cause pollution of the air, watercourses and ground. Fossil fuels burned to produce electrical energy produce further pollution, and electricity production also gives rise to greenhouse gas, carbon dioxide, a major contributor to climate change processes.83

The environmental impact of a textile product differs depending on the fiber material. The manufacturing process of natural fibers is different for the process of synthetic materials. Natural fibers are renewable, but they need to be grown. Growing and harvesting may need large amounts of fertilizers, pesticides and defoliants and they take growth area from food plants. Another problem with grown material is that unwanted impurities have to be separated from fiber. Chemicals are used for this cleaning process and toxic fumes can cause lung disease. Synthetic fibers are manufactured from refined oil which is not a renewable resource.

Spinning and weaving processes can be very noisy. Sometimes oils are used to help the spinning process. These are washed out later in the subsequent processes and will pollute waste water and kill fish. Sizing agents may be used in yarn weaving to reinforce the longitudinal yarns so that they can survive the weaving process, but those agents may end up in waste water. If fabric is knitted instead of woven, needle oils can cause environmental problems, because they do not break down easily. All the wet treatment processes such as desizing, prewashing, bleaching, mercering, dying, printing and after treatment have different types of impacts on the environment. The large consumption of water is a big problem, but

83 Timmins 2008, handouts and personal communication.
substances such as chlorine and dyes containing heavy metal are also dangerous to the environment and health.\textsuperscript{84}

Transport and sales demand transporting from one part of the world to another, which leads to heavy consumption of fossil fuels and natural fibers need different finishing, for example to avoid moulds to withstand transportation. Packaging also uses resources and energy. Even sold clothes often contain residuals from chemicals used in the process that may irritate the consumer and washing them leads chemicals to the water supply. The laundry process is actually also very harmful for the environment. It has been proven that a textile product only needs to be washed a few times for more energy to have been used for this process than for the production of the product itself. Disposal of clothes is one more problem and they can affect for a long time after they are already dumped in landfill. One of the difficult issues in the manufacturing process is afflicted to social right as work conditions, which can be dangerous and also toxic chemicals such as formaldehyde.\textsuperscript{85}

Outdoor brands also play an important role in environmentally sound textile manufacturing, because there is made the final choices of materials used. In most cases outdoor brands manufacturers do not make materials. They purchase materials from different fabric suppliers. Often designers and product managers are in a key position to make the choice of materials. The materials are one of the most important factors when considering the ecological footprint. Correct material choice can also make a garment more sustainable, because of durability, care and washing characteristics. One of the biggest problems of material choice is to get correct and objective information. A material manufacturer’s commercial material information may be one-sided or conceal side effects.

The real life cycle idea concretizes when all the parts of the garment are long lasting, recyclable, not produced in environmentally dangerous ways and disposal and recycling is not more harmful to the environment than original waste. Because of these facts fabric and accessories, manufacturers are in a key position. I think that designers should know how environmentally safe different fabrics and accessories are and what ways and options there are to increase the length of their life-cycle or recycle them.

According to Fletcher materials play in important role in our current understanding of what makes clothes sustainable.\textsuperscript{86} Materials are often the starting point for designers and the

\begin{itemize}
\item \textsuperscript{84} Breds, Hjort & Krüge 2002, 36-39.
\item \textsuperscript{85} Fletcher 2008, 46-47, 83-91.
\item \textsuperscript{86} Fletcher 2008, 3.
\end{itemize}
industry to make greener products. Fletcher states that materials diversity promotes the long-term health, resilience and effectiveness of the fashion and textile industry. Today’s fashion and textile industry is dominated by a large number of similar, ready-made products in a limited range of fiber types. Fletcher states that sustainability-driven strategy of materials does not require discontinuing production of the big two fibers. According to her, we should concentrate on alternative fibers. She proposes that replacing some conventional cotton production with alternatives such as organic or low-chemical cotton, flax, hemp and lyocell could bring benefits by reducing pesticides and water use. A shift away from polyester to renewable and biodegradable fibers such as wool and corn starch would reduce our dependency on oil.87

“In sustainability, there is no such thing as a single-frame approach. Issues dealt with in single frames will almost by definition lead to unwanted and unforeseen effects elsewhere. To avoid these effects we have to be aware about the impacts of our fiber choices on whole interrelated product lifecycles, which include cultivation, production, manufacturing, distribution, consumer laundering, reuse and final disposal.”88

It is difficult to name the most environmentally friendly material. All of them have their good and bad sides. A designer has to choose if animal rights should take priority over pollution, for example. The key rule is that textiles treated with strong chemical should be avoided. Harmful chemicals include chlorine, synthetic dyes, resin, formaldehyde, nickel and fluorine.

4.2 Basic concepts of textiles and the process of textile production

The major components of textiles are fiber, yarn and fabric. The basic unit of a textile is a fiber, which can be formed of yarns. Yarns can be woven from warp and weft yarns, knitted by interloping one or more sets of yarns or bonded to non-wovens. The textile properties desired in each functional outdoor clothing layer are different. The chemical, physical and biological properties of a product differentiate it from another. Therefore each decision can change an outdoor garment’s properties. Knowledge of the fibers is highly important because the properties of a fiber determine how it can be used. With the correct fiber choice a garment is more likely to meet the demands placed on it.89

87 Fletcher 2008, 3-16.
88 Fletcher 2008, 3-5.
According to Shishoo the evolution of fiber developments has gone through three phases. The first phase was the phase of conventional fibers. After that came highly functional fibers and the latest innovations in this century can be called high-performance fibers. He suggests that polyester is the single most common fiber used for sportswear and active wear. He mentions that other common fibers in active wear are polyamide, polypropylene, acrylics and elastanes. He suggests that wool and cotton fibers mostly find applications in leisurewear. Although new manufacturing methods of natural fibers give them properties for use in active wear.

The major properties of active wear are moisture transfer, thermal insulation, water resistance and stretch with full recovery. Fiber should transfer moisture away from the skin to avoid overheating and stickiness without overcooling the body. Thermal insulation should retain warmth without extra weight of the garment in winter. Water resistance is an important factor in outdoor clothing. Fabric should allow body moisture to escape, but repel rain water. Stretch in the fabric allows unrestricted movement and retains a sleek appearance of the garment. Important factors in outdoor clothing are also fit, wind and ultraviolet ray resistance.

Sometimes aerodynamic shape and safety components can make a huge difference or even save the wearer’s life. Outdoor clothing requirements vary from comfort to protection against dangerous environments. In mountaineering protection against harsh weather is required for survival. Comfort can be an important factor when full attention is needed to action itself. Fibers which make users feel better in action can be called comfort fibers. For example, DuPont’s shaped four-channel polyester fiber CoolMax® can dissipate body heat, keeping a constant body temperature.

Fiber characteristics depend on the construction of the fibers. Differences in fiber construction affect the dyeing and washing result. The basic unit of fiber is a polymer or long-chain molecule, which means that fibers are built up from molecules organized as molecule chains. A long-chain molecule can be called macromolecule. Several textile fiber characteristics depend on the mass of the molecules and molecules’ gravitation between each other. The molecular structure and thickness of a fiber have an effect on abrasion and tear strength, which matters when thinking of life span and the properties of the fabric. The structure of the fiber also affects moisture absorbency and thermal properties. If fibers have similar chemical structure, they react in a similar way to chemical substances like acid dyes.

90 Shishoo 2005, 2.
91 Blair 2007, 60; Hudson et al. 1993, 369.
4.3 Fiber classification

Textile fibers can be divided in two ways. They can be divided either by origin to natural and manufactured fibers or they can be classified by chemical structure as organic and non-organic fibers. Chemical classification is needed when their chemical reaction needs to be known. For example, when fibers are dyed, finished or washed, their sensitivity may vary. Chemical substances that may affect different fibers in different ways are acids, bases, oxidizing agents and solvents.\(^{93}\)

Natural fibers

Natural fibers come straight from nature, which means that they occur in fiber form in nature. We only collect, divide and clean them for our own use. They can be subdivided by their origin in the three main groups, vegetable, animal and mineral fibers, which means that they are either cellulose-, protein- or mineral-based. Natural fibers have been used by humans for thousands of years.\(^{94}\)

Vegetable fibers, also known as plant fibers, are obtained from plants. Vegetable fibers can be also called cellulosic fibers, because cellulose is their main constituent material. Cellulose is the most common compound existing in the vegetable kingdom. Natural cellulosic fibers are classified according to the part of the plant from which they come. They can be subdivided into seed, stem, leaf and fruit fibers. Seed fibers are from a hair produced by the seedpod. The purpose of seed fibers was originally to transport seeds to a new habitat. Stem fibers come from the bast layer of the plant. Leaf fibers are from the plant’s leaf and fruit fibers are from the shell of the fruit.\(^{95}\)

Cotton and other natural fibers are renewable and can also be grown in organic ways. Natural fibers are decomposable and recyclable and new techniques are low on emissions. On the other hand natural fibers require large areas under cultivation. Growing cotton requires a huge amount of artificial watering, fertilizers and pesticide, some other natural fibers slightly less. Other downsides of cotton are chlorine bleaching and dyeing chemicals. Because cotton represents 50% of all clothing fibers, it has attracted most attention in the ecological discussion. Hand-picked cotton is grown in mountain areas, which are not accessible by machines.

\(^{93}\) Boncamber 2004, 14-17; Elsasser 2005, 29.
Animal wool, hair, fur and certain filaments produced by insects, like silk, are called protein fibers. Proteins are complex, high-molecular-weight compounds containing amino acids, which creates their unique properties. Bird's down and feather are also classified as protein fibers when they are used in textiles. Animal fur is also classified as protein fiber. Wool and fur fibers contain keratin, which is the same protein as in human hair. Silk is produced by silk worms and contains the protein fibroin. Animals' hair is divided by its fineness into wool, hair and bristle.96

Wool is biodegradable, recyclable and renewable raw material. Wool production may be naturalistic and sheep can browse in areas where cultivation is impossible. On the other hand sheep can over browse land and cause erosion. In larger scale wool production sheep are often treated in unethical ways. Transportation and chemical treatments to avoid insects cause pain to sheep. Wool production also causes waste water and effluents from dyeing.97

Leather and fur are rarely used anymore in outdoor clothing, although leather is very common in outdoor shoes. Leather is a controversial material. It is renewable and it is naturally decomposable, but tannage does not decompose because of strong chemicals. Leather can be seen as a side product of animal husbandry or on the other hand leather production supports the meat industry. The environmentally disadvantages of animal husbandry are huge and treatment of animals may be cruel.

Fur fiber and fur can be separated. Fur fiber means animal’s hair without skin for example, Angora rabbit’s hair.98 Fur can be cut without killing the animal. Fur means animal hair when it is attached to the skin. Fur is possibly to most controversial material in the textile industry. It is renewable, long lasting and decomposable. Fur has same problems as leather, because the skin under the fur has to be treated with strong chemicals. Ammonia and nitrate emissions to the air, ground and water system are huge problems.99 There are also drawbacks like animals’ cage breeding and wild animals’ hunting.

Mineral fibers are fibrous crystals obtained from minerals, which can be spun. Asbestos is a common name for a group of silicate minerals. Minerals crystallize into fiber form under great pressure and heat when mountain chains move. Asbestos has been used as textile fiber

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98 Boncambor 2004, 189.
99 Boncambor 2004, 149, 179.
because of its incombustibility and good chemical stability. Asbestos is now seldom used, because it has been found to be carcinogenic.\textsuperscript{100}

\textbf{Manufactured fibers}

Manufactured fibers can be also subdivided in three categories, namely manufactured cellulose, synthetics and inorganic fibers. According to Elsasser manufactured fibers can be divided into generations. First-generation manufactured fibers are regenerated from natural materials. Second-generation manufactured fibers are synthesized from petroleum products. During the last 20 years third-generation manufactured fibers have been generated, which can be called high-performance or high-technology fibers, such as microfibers.\textsuperscript{101}

Regenerated fibers can be also subdivided by their origin into regenerated cellulose, regenerated protein, alginate fibers and rubber. Manufactured cellulosic fibers can be divided into two categories, which are both made from nature based ingredients such as wood pulp or cotton linters that cannot be used as fibers naturally. The molecular structure of manufactured cellulosic fibers is not in fiber form in nature. It has to be changed in some way. Molecule mass that is suitable for fiber is collected and cleaned. Suitable fiber molecules for textile use have to be enough long to be taken into fiber production at a reasonable cost.\textsuperscript{102}

Regenerated cellulosic fibers are pure cellulose fibers and have many of the same properties as natural cellulosic fibers. Derivative cellulosic fibers are chemically changed during production so that they become esters and their properties differ from natural cellulosic fibers. The development of manufactured cellulosic fibers has been a major factor in inventing manufactured fibers.\textsuperscript{103} The casein of milk can be refined to casein fiber, which is mainly used blended with wool. One fiber kilogram needs hundred kilograms of skimmed milk.

Vegetable based regenerated fibers can be produced from corn starch, soya beans and peanuts. Leather, silk and wool waste can be also wet-spun into protein regenerated fibers.\textsuperscript{104} Other regenerated fibers are natural rubber made from rubber tree gum and alginate fibers, which

\textsuperscript{100} Boncamber 2004, 328.; Blair 2007, 61.
\textsuperscript{102} Elsasser 2005, 64; Markula 1999, 84.
\textsuperscript{103} Elsasser 2005, 64; Markula 1999, 84.
\textsuperscript{104} Markula 1999, 103.
are made from salt in seaweed. Rubber has proven to be allergenic, but alginate fibers have sanitized properties.105

Synthetic fibers can be made in several different ways. Fiber spinning techniques in melt spinning, wet spinning, dry spinning and microfiber spinning can be improved to have unique performance characteristics. Synthetic fibers can be modified during manufacture, for example, fibers can be produced to be hollow or irregular cross-section. Synthetic fibers can be improved with better UV resistance or they can be given anti-microbial properties, which are widely commercially available already in outdoor clothing. Micro capsules in microfibers can contain anti-mosquito substances or deodorants.106 Synthetic fibers have generally good washing characteristics; they do not shrink or wrinkle easily if they are correctly handled. Synthetic materials moreover keep their shape better than natural fibers and withstand molds and bacteria better.

A common raw material of synthetic fibers is crude oil. Synthetic fibers are produced as by-products of oil refining, so they do not need cultivated area. They do not need as many finishing chemicals or bleach as natural fibers. On the other hand synthetic fibers are not renewable or biodegradable and they have been hard to recycle. Their downside is also high energy consumption, emissions and poisonous chemicals. Oil refining also causes increases greenhouse effect.107

Raw materials of fibers can be divided by their chemical origin. Chemical classification is based on carbon compound, which means that fibers are divided into organic and inorganic. Natural cellulosic and protein fibers are organic as are manufactured cellulosic and synthetic fibers. Inorganic fibers can be also divided into natural and synthetic fibers. Mineral fibers and natural rubber are natural organic fibers. Inorganic synthetic fibers are made from glass, metal, ceramic substances or boron. These are mostly used for reinforcement in protective clothing. Chemical classification of fibers by origin is meaningful in understanding their reaction to finishes, dyeing and use. If fibers belong to the same chemical classification they have the same properties.108

107 Elsasser 2005, 75-78.
Blending of fibers has been maintained to increase good properties in textiles. Using different fibers can influence the appearance and feel of the material. A common reason to blend fibers is also to increase strength properties. The production method of blending depends on the result desired. Raw materials can already be mixed at the fiber stage or fiber blend can be spun in the yarn. This method is used for cotton polyester, wool polyester and wool viscose fabrics. The fibers are not the only contributors to materials characteristics. Spinning, structure of fabric and finishing processes also have a big impact, but fibers determine what kind of finishing processes can be used on each material type.109

4.4 Some fibers and accessories introduced to be eco-friendly

In this chapter I introduce some fibers that have been considered to be eco-friendly in outdoor companies’ web pages or in marketing. I have collected the information available and reviewed the possible environmental impacts.

The product development in technical fabrics is fast. In 1969, Bob Gore discovered that rapidly stretching polytetrafluoroethylene (PTFE) under the right conditions created a very strong, thin and lightweight microporous membrane, which has become the important component of performance fabrics. After that the use of lightweight, durable, energy-absorbing, moisture and heat-regulating materials are becoming more common in functional clothing.110

Functional clothing is getting more and more complicated. Technical outer wear can contain microfibers, breathable barrier fabrics, stretch materials, intelligent textiles, interactive materials for example phase-change materials, shape-memory polymers and wearable technology.111 Smart clothes and wearable technology products make safe recycling even more hard to accomplish.112 Synthetic fiber manufacturers have been interested in creating new solutions to make their fabrics more eco-friendly and decomposable. They have concentrated in creating recycling systems for man-made fibers. One of the systems is Libolon’s EcoFlying Plan (Fig. 18.).

112 Timmins 2009, 319-320.
Figure 18. Libolon’s EcoFlying Plan uses recycled yarn, recycled polyester, and nylon waste to create nylon plastic products, which can be repeatedly recycled. The final goal is to reach the concept of “Cradle to Cradle”. (Libolon 2009.)

One of the first of recycling systems, which gained much attention, was the system of recycling polyethylene terephthalate (PET) fibers from soda bottles to polyester (Fig. 19.). According to Braungart it was not a good solution for two reasons. Clothes made from PET bottles were not recyclable afterwards and PET bottles were not made to be wearable in the first place and it contains synthetic dyes, chemicals and other questionable substances.\(^\text{113}\)

Figure 19. RePET\(^\text{®}\) recycled yarns and recycled fabrics are made by recycling plastic bottles. Libolon promises that it’s recycled fabrics reduce emissions, lower water consumption and decrease the amount of chemicals involved in the production process. (Libolon 2009.)

\(^{113}\) McDonough & Braungart 2002, 106.
According to W. L. Gore & Associates there is no doubt that from an environmental point of view, the best solution of all is to pass a used garment along to someone else for future use. That way, its useful life can be extended. During the activity accidents may occur, resulting in a tear or puncture and that is why the expectations of their products are higher than ordinary fabrics due to the demands of the end-use. Gore helps extend their products lifespan by offering repair kits and other services. Gore repair patches prove useful in preserving the waterproof integrity of the garment. Wearers can either apply the patches themselves or have the garments mended professionally by one of Gore authorized Repair Centers. Many of their products feature a water and soil-repellent treatment, reducing the need for frequent cleaning. When garments do need to be cleaned, most can simply be washed in household washing machines. Both the water repellent treatment and easy care during the lifetime of the garment keep environmental impact to a minimum (Fig. 20.).

Recycling is another option. In order to recover the different material components of a garment, they need to be physically separated from each other. In 1993, they initiated the GORE™ BALANCE PROJECT™ program for high-quality recycling. They developed the technology to separate laminated fabrics into their components. Gore has the special label in garments which are designed to be recycle and Gore is committed to recycling these labeled products. If garments are worn out beyond repair, Gore promises that it is safe for consumers also dispose a garment along with ordinary household waste.¹¹⁴

Figure 20. Gore promises that even using recycled or renewable-based materials durability, final product weight and the manufacturing process are not compromised. For example rain shower tests, walking simulators for footwear and seam sealing tests are used to ensure performance and durability. (W. L. Gore & Associates, Inc. 2007.)

Gore-tex® laminates used in consumer products are manufactured to meet the criteria set forth in the Oeko-Tex® Standard 100, the most widely accepted standard for consumer safety in textiles globally. Their laminates are solvent free and Gore is committed to the EU REACH legislation. Since 1992, Gore Fabrics has committed to minimizing their ecological accounting system, with Life Cycle environmental impact through an active and Assessment (LCA) as a reference. When they design new products, they use an LCA methodology that takes into account all relevant aspects of the ecological footprint. Those aspects include resource and energy consumption, emissions to air, water, and land, and also health and ecosystems.\textsuperscript{115}

Teijin is a progressive Japanese fabric and chemical manufacturer which has founded a recycle system called Ecocircle for polyester garments (Fig. 21.). Teijin develops innovative, environment-friendly technologies and products and is a world known producer of re-cycled polyester for active sport, fashion, sleeping bags and work wear garments. Teijin works together with Patagonia and many other outdoor gear and apparel companies.

\textbf{Figure 21.} According to Teijin recycling polyester can play an important role in environmental sound garment manufacturing. Their endless recycling eliminates the need to use new petroleum and can also reduce the amount of waste. According to Teijin, over 40 % of textiles manufactured in the world are made from polyester and their system can be an important factor in forming a "recycle-based society" (Teijin Limited 2009.)

\textsuperscript{115} W. L. Gore & Associates, Inc. 2007.
Teijin’s and Patagonia’s common goal was to invent a closed-loop recycling system. Now used garments can be crushed into small pieces, which are changed into grains. These grains can be chemically treated into polyester raw material, which can be recreated into polyester fibers. Regenerated garments can be recycled again after use. Teijin has made a statement in their web pages about their environmental consciousness. Teijin wants to have responsibility which means duty as a manufacturer to reduce the environmental load of their production, sales activities and contribution.\textsuperscript{116}

Nextec Applications, Inc. founded in 1994, has a new process for creating performance fabrics. They make high performance fabrics for a broad range of markets including outdoor gear, performance apparel, industrial applications and protective products. They also want to protect and preserve the environment where their products are used.

Epic\textsuperscript{®} by Nextec’s patented encapsulation technology places a silicone barrier inside the fabric by using precise polymer placement and special chemistry. Epic\textsuperscript{®} technology encapsulates the actual woven fibers, not only the surface like the older conventional methods of laminating or coating (Fig. 22.). The silicone barrier decreases a fabric’s absorption, while increasing its weather resistance and aerobic breathability performance. Epic\textsuperscript{®} offers rain and wind protection combined with breathability and it is also durable up to 200 washes even when washed at high temperature. It can be applied on almost any substrate for example polyester, nylon, cotton denim and wool. Epic\textsuperscript{®} is Oeko-Tex\textsuperscript{®} certified and has also been certified according to ISO 14001 and ISO 9001 standards.\textsuperscript{117}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{image.png}
\caption{The Nextec\textsuperscript{®} encapsulation process does not use solvents or other substances, hazardous to the environment or to workplace health and safety. They use only 100\% solid materials, which create no hazardous wastes. (Nextec Applications Inc. 2009.)}
\end{figure}

\textsuperscript{116} Teijin Limited 2009.
\textsuperscript{117} Trendence Production Ab 2009.; Nextec Applications Inc. 2009.
Biomimetic materials are inspired by nature and implemented into new fiber and fabric technologies. Biology has always been a rich source of visual and aesthetic inspiration for the design of clothing in the history. There are countless examples of motifs such as flowers, insects and various animals, incorporated into design of textiles either through structural patterning, print or embroidery.\textsuperscript{118}

Nature has also become major source of innovation in functional textiles and clothes. Plants and animals can set an example for new constructions of models. According to Bramel, Schoeller has got inspiration it’s water-repellent and easy-care finish called NanoSphere from the lotus leaf concept.\textsuperscript{119} This means that the leaves of certain plants always stay clean, because of their surfaces and is easily washed off by rain. A biomimetic approach to the production of composites including plant fibers represents a possibility for addressing the problem of obtaining a more sustainable material, with more acceptable LCA profile.\textsuperscript{120}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{NanoSphere.png}
\caption{NanoSphere® is an ecologically clean textile finish. According to Schoeller it is developed in accordance with the bluesign® standard, which guarantees the highest possible exclusion of substances which are harmful to humans or the environment. (Schoeller Technologies AG, 2009.)}
\end{figure}

Accessories manufacturers have also paid attention to eco-friendliness. When looking at the footprint of outdoor garments and the possibility to recycle them, accessories play a prominent role.

\begin{thebibliography}{99}
\bibitem{118} Kapsali 2008, 117.
\bibitem{120} Kapsali & Dunamore 2008, 107.
\end{thebibliography}
Unitex wants to meet the functional requirements of the outdoor industry while achieving their environmental goals to minimize the burden on the earth. They want to find new ways to protect the environment from product design to manufacturing, and eventually to the final disposal of their parts. Products made from standard plastic materials are non-biodegradable. Unitex can recycle and regrind their own materials such as Acetal and Nylona to conserve the limited resources of raw plastic material which mainly comes from petroleum. The materials they are using hold the official OK compost certificate.

YKK, the zipper company also admits that plastic products have made living more convenient, but when they are no longer needed they become waste products. If the plastic products are burned, they emit dioxins and contribute to global warming. Zippers may not be the greatest threat to the planet, but as YKK says on its website: "Little Parts Big Difference Every little bit adds up." YKK is a zipper company that believes if they make perfect products, they will enhance the clothing in which they function as an integral part. The higher the quality of the clothing, the better they will perform and last.

YKK is working to develop products that contribute to solving these types of environmental problems. NATULON® fasteners are made of recycled polyester material. They are suitable for recycling after use and can be reused in a sustainable resource cycle system and comply with the Green Procurement Law. ReEarth™ is a biodegradable fastener comprised of corn and other plant materials. After use, natural microorganisms break zipper down into water and carbon dioxide.

YKK advocates protecting the environment at every phase of their operation. YKK established the Environmental Charter in September, 1994. Group companies are united attempt to effectively address in the environmental issues. YKK promotes environmentally friendly measures in all their activities, from product design to manufacturing, use, disposal, collection, and recycling.

Bemis makes thermoplastic tapes and heat adhesives for waterproof garments that provide solutions often complexly solved technical challenges within a manufacturing process. Bemis admits that the term thermoplastic adhesive does not sound an environmentally safe product

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121 Duraflex, which was established in the United States, is the well-known plastic buckle and fastener brand for backpacks and other equipment. In 1999, Unitex International Button Accessories Ltd. became the licensed manufactured/supplier of Duraflex Group.


123 YKK claims to be the first environmentally sound zipper company.

or made in a responsible way, but they claim that their film and tape products feature one of the most environmentally friendly types of adhesive in the industry. Bemis is proud to distinguish themselves in this aspect from other adhesives such as epoxies, cements, or solvent based adhesives. They understand that manufacturing their products and managing their business has impact on the environment. They say that they are committed to minimizing any negative effects and they want to be a company that takes action to improve the environment and community.

Next pages I go through some vegetable based regenerated fibers which have been introduced to be eco friendly.
Bamboo

Bamboo is a fast growing grass. Bamboo reaches maturity quickly and is ready for harvesting in 2 to 4 years. Bamboo does not require replanting after harvesting because its vast root network continually sprouts new shoots. Bamboo grows without pesticides, herbicides and fertilizers. The extensive root system of bamboo holds soil together, prevents soil erosion, and retains water in the watershed. There are two ways to process bamboo to make the plant into a fabric: mechanically and chemically. The mechanical way is by crushing the woody parts of the bamboo plant and then using natural enzymes to break the bamboo walls into a mass so that the natural fibers can be mechanically combed out and spun into yarn. This is essentially the same eco-friendly manufacturing process used to produce linen fabric from flax or hemp. Bamboo fabric made from this process is sometimes called bamboo linen. Very little bamboo linen is manufactured for clothing because it is more labor intensive and costly. Chemically manufactured bamboo fiber is a regenerated cellulose fiber similar to rayon or modal.\textsuperscript{124}

Bamboo fiber has soft hand feel. It is antibacterial and wicking, quick drying, odor-inhibiting and it has UV blocking properties. Bamboo evaporates moisture and feels cool because it is a full oval cavity fiber. Bamboo clothing is naturally more wrinkle-resistant than cotton, and while it may still require ironing after washing, bamboo fabric can be ironed at lower temperatures than cotton. Shrinkage during washing and drying is minimal at warm temperatures. Bamboo fibers and fabrics absorb dyes faster and more thoroughly than cotton, modal and viscose with better color clarity.

Bamboo fabrics do not need to be mercerized to improve their luster and dyeability as cotton requires. Mechanically and chemically manufactured bamboo clothing can be completely decomposed in the soil. Bamboo plantations reduce greenhouse gases because of photosynthesis. Bamboo fabrics and clothing can be manufactured and produced without any chemical additives although eco-certification such as Oeko-Tex is necessary to ensure that the manufacturing and finishing processes are healthy. The growing of bamboo is

\textsuperscript{124} Bamboosa 2009.
environmentally friendly but the manufacturing of bamboo into fabric raises environmentally
and health concerns because of the strong chemical solvents used to cook the bamboo plant
into a viscose solution that is then reconstructed into cellulose fiber for weaving into yarn for
fabric. Chemically manufactured bamboo is sometimes called bamboo rayon because of the
many similarities in the way it is chemically manufactured and similarities in its hand feel.

Bamboo clothing marketers have introduced bamboo as the most eco-friendly and sustainable
fabric (Fig. 24.), but the chemicals used in manufacturing process can be hazardous to
workers. Most bamboo fabric is chemically manufactured by cooking the bamboo leaves and
woody shoots in strong chemical solvents such as sodium hydroxide and carbon disulphide in
a process also known as hydrolysis alkalization combined with bleaching. Breathing low
levels of carbon disulphide can cause tiredness, headache and nerve damage. Even low levels
of exposure to sodium hydroxide can cause irritation of the skin and eyes. Because of the
potential health risks and damage to the surrounding environment, such textile manufacturing
processes cannot be considered environmentally supportable, but it could change to be one, if
the process is made more ecological. Bamboo can also cause skin irritation, because of
chemicals added or used during the manufacturing and finishing processes of the clothing.125

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Figure 24. Premiere Fashion Corp. promises that bamboo clothing has various benefits. (Premiere Fashion Corp 2007.)
Coconut

Coir is a coarse fiber extracted from the fibrous outer shell of a coconut. Coir fibers are found between the husk and the outer shell of a coconut. The palm trees flower on a monthly basis and the coconuts take one year to ripen. The individual fiber cells are narrow and hollow. There are two varieties of coir. Brown coir is harvested from fully ripened coconuts. It is thick, strong and has high abrasion resistance. Coconut fiber is traditionally used in mats, brushes and sacking. White coir fibers are harvested from the coconuts before they are ripe. These fibers are white or light brown in color and are smoother and finer, but also weaker. They are generally spun to make yarn that is used in mats or rope. The coir fiber is relatively water-proof and is one of the few natural fibers resistant to damage by salt water. Fresh water is used to process brown coir, while sea water and fresh water are both used in the production of white coir. Coir fibers make up about 1/3 of the coconut pulp. The other 2/3 is called the pith or dust. It is biodegradable, but it takes 20 years to decompose. Once considered useless it is now being used as mulch, soil treatment and a hydroponic growth medium.126

Cocona® is a new concept of using a natural technology in order to give sports fabrics several new features without adding chemicals. The fabrics are made from the activated carbon of recycled coconut shells, which are leftovers from the air and water filtration industry and would have gone to landfills. The filtration industry obtains them as leftovers from the food industry. Activated coconut carbon is used to filter air, water and also to treat waste water. Cocona® fibers and yarns can be used in a wide range of knit and woven fabrics as well as non-wovens that provide effective evaporative cooling, odor adsorption and UV protection.

Cocona fiber can also be blended with merino wool. Cocona-merino fabrics retain the favorable qualities of pure merino, but its drying time is actually five times faster than pure merino wool when it is wet. Cocona® natural technology will not wash off or wear out, and it is not harmful to the body or the environment.127 Fabrics made from Cocona® fibers are

127 Millet 2009.
lightweight, comfortable and retain all of the conventional product features, such as stretch and washability (Fig. 26.). Because Cocona® natural technology™ uses activated carbon made from coconut shells (Fig. 25.) to outperform other fabrics and yarns, other fiber has to be taken into account when thinking overall footprint of material.

Figure 25. The stages of Cocona® thread manufacturing (Cocona, Inc. 2009.)

Figure 26. Cocona Inc.promises innovative, environmentally friendly material choice with evaporative cooling, UV protection and odor management. (Cocona, Inc. 2009.)

129 Cocona Inc.; Trendence Production Ab 2009.
Coffee

Most coffee grounds end up in landfills, which contribute to the overall solid waste management problem. It is possible to reuse these grounds in fabrics. There is a patented process that transforms the coffee grounds into yarn, which can then be produced into many styles of knitted and woven fabrics, as well as soft shell fabrics. Singtex promises that the clothes need to be washed only in cold water (Fig. 27.).

Singtex claims to be able to produce two shirts from the amount of grounds needed to make one medium cup of coffee. The fabric dries fast, absorbs sweat quickly and diffuses moisture efficiently. It is also said to be odor controlling and provides UVA and UVB protection with its ability to diffuse and refract UV radiation. Singtex claims that the process is also energy-efficient due to a lack of fuel-intensive high temperature carbonization. The success of S. Café will ultimately depend on how cost-efficient it is compared to other sustainable fabrics. If it turns out to be unreasonably expensive, coffee grounds still have other uses as fertilizer or coffee grounds can be composted and or used for biodiesel.

Figure 27. Singtex’ S. Café™ material uses fibers from coffee grounds to produce a fabric that is quick-drying, controls odors, and protects wearers from harmful UV rays. (Singtex Industrial Co. 2009.)

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Corn fiber has characteristics similar to those of polyester staple fiber and has the luster of silk. Its moisture regain surpasses polyester, so the fabric made from it is very comfortable. The corn fiber is produced by Poly Lactic Acid (PLA) which is fermented from the corn amylum. Amylum can also be called starch. Corn fiber is a renewable resource and not made of petrochemicals. It can be recycled into fertilizer and is decomposable. Its flexibility and curl recovery are very good so the fabric has good shape retention and anti-crease. It has excellent hand touch and drape, good dyeability and it can be dyed with dispersion dyes under normal pressure. The advantage of corn fiber is high melting point, high crystallization degree and good clarity. Corn fiber has the characteristics of silk and it has excellent hand touch and brightness. Tests show that corn knitted fabric does not irritate the skin. Corn fiber has good drape, moisture regain and air permeability, likewise good heat resistance and is unaffected by UV light. It has also good luster and elasticity. A disadvantage is that the corn fiber textiles are too rigid and frail (Fig 28.).

Figure 28. DuPont™ Sorona® is made from naturally occurring starch in the kernels of corn. PLA causes only low CO2 and CO emission from burning. (DuPont 2009.)

131 DuPont 2009.
Hemp fiber is one of the oldest fiber plants in the world. In China it has been grown for 4500 years.\textsuperscript{132} The use of hemp for fiber production has declined sharply over the last two centuries, but before the Industrial Revolution hemp was a popular fiber because it is strong and grows quickly. It produces more fiber than cotton or flax when grown on the same land. Hemp bast fibers are one of the longest natural soft fibers. They are longer, stronger, more absorbent and more insulate better than cotton. This means that hemp will keep the user warmer in winter and cooler in summer than cotton. Hemp is more effective at blocking the sun's harmful ultraviolet rays. The nature of hemp fibers makes them more absorbent to dyes, which, coupled with hemp's ability to better screen out ultraviolet rays, means that hemp material is less prone to fading than are cotton fabrics.\textsuperscript{133}

The original Levi Strauss jeans were made from lightweight hemp canvas. Hemp is the most durable of natural fibers. Hemp is also a very eco-friendly crop. It requires no pesticides and needs little water. It renews the soil with each growth cycle. Its long roots prevent erosion, help retain topsoil and it produces oxygen. Hemp grows readily in most temperate regions. Hemp has three times the tensile strength of cotton and is strong and durable. Natural organic hemp fiber breathes and is biodegradable. It is also weather, UV and mold-resistant. Hemp is therefore excellent for outdoor wear.\textsuperscript{134}

Hemp can be blended with other fibers for different qualities in the garment. Hemp blended with other fibers, such as cotton, linen, silk, or lycra and lyocell, easily incorporates the desirable qualities of both textiles. Hemp also produces more fiber per acre than trees, and can be renewed two to three times per year. Nothing is wasted in the production process. Seeds are used to make oil and food supplements, while the stalks are used for fiber. When compared to other bast fibers such as flax, ramie and jute, hemp ranks second in fiber length, ultimate fiber length, aspect ratio, tenacity, tensile strength, and breaking length, and third in

\textsuperscript{132} Sundquist 1983, 77.
\textsuperscript{133} Raw Organic and More 2009.; See also Härkäsalmi 2008.
\textsuperscript{134} Raw Organic and More 2009.; See also Härkäsalmi 2008.
cellulose content. Hemp fabric is naturally more suitable to people with chemical sensitivities than cotton. The producers in Europe have begun using cleaner biologically-based enzyme technology, while China uses chemical methods for processing hemp. Neither method produces fabric with the same whiteness and softness as cotton. Some hemp fiber manufacturers in China use modern physical-chemical methods which create a cotton-like short fiber. This creates short fiber hemp called "cottonized" hemp or "flock" hemp. But the quality of the resulting yarns still needs improvement, especially in the area of long-term wash-and-wear resistance. Traditional hemp processing of plants into yarn for fabrics relies on natural and mechanical processes to separate the long fibers from the plant for spinning into yarns. Naturally Advanced Technologies Inc. believes in sustainability and makes hemp pulp based technical fabrics which they claim to be environmentally friendly (Fig. 29.).

Figure 29. Crailar® is an enzyme process, which transforms raw hemp fiber into strong and soft apparel-quality fabric. NAT’s owner Mr. Barker hopes Crailar® to be next big apparel textile material such as Lycra and Gore-Tex, but plant-based and organic. Textile World announced Crailar® Quality Fabric of the Month in September 2009. (Naturally Advanced Technologies Inc. 2009.; HempNews 2009.; Textile World 2009.)

Soya

Soybean protein fiber is a new type of textile material. It has many of the merits of both natural and synthetic fibers: thinness, lightness, high strength, good resistance to acid and alkali, excellent moisture absorption and wet transference. Soybean protein fiber has the luster of silk and an great drape, which makes the fabric elegant. Soybean protein fiber not only has good optical effect but also has outstanding features in wear. Knitted fabric of soybean protein fiber is soft, smooth and light to handle, like fabrics made from silk blended with cashmere. 136

Soya fabric has the same moisture absorption and better moisture transmission than cotton, which makes it comfortable and sanitary. It has good dyeing properties. The original color of soybean protein fiber is light yellow just like that of tussah silk. It can be dyed with acid dyes and active dyes especially the latter, which gives the product fine color and luster, and good sunlight resistance and perspiration fastness as well.137

Figure 30. ExOfficio promises that Tofutech™ has natural odor and bacteria resistance, moisture wicking properties, comfort, wrinkle resistance and quick-dry convenience. (ExOfficio2009.)

137 Swicofil 2009.; ExOfficio 2009.
Unlike silk products, soybean protein fiber product resolves the contradiction between fine color and inferior color fastness. Moreover, fabric of soybean protein fiber has outstanding anti-crease, easy-wash and fast-dry properties. Soybean protein fiber has good affinity to human skin and is comfortable to wear (Fig. 30.).

Soybean protein fiber filled up a gap the vacancy in textile material development. It will inevitably stimulate the new product development in the field of cotton, wool and spun silk spinning. It is important that soya fiber can be a potential replacement for petrochemical-based synthetics generally and also for cashmere. Soya protein fiber is a by-product of tofu production, which otherwise ends up in landfills. It can also be blended with other fibers to increase strength in other fibers. Soya protein fiber has good physical properties. The breaking strength of the single soybean protein fiber is higher than that of wool, cotton and silk and only lower than that of polyester fiber. Soya fabric is very stable and shrinkage of fabric under natural washing conditions is not a problem.138

Figure 31. In sun shine top of Valais (Seppälä 2009; Photograph by Joe Nunn.)
5 STAKEHOLDERS IN OUTDOOR INDUSTRY

5.1 The challenges of green production

Consumers cannot buy eco friendly products if they are not available. Thus, outdoor brands are in key position to affect consumers’ choices. In past few years consumers, outdoor clothing retailers and shareholders have increasingly started to demand environmentally responsible products and services from outdoor companies. Companies should fulfill environmental standards and demonstrate their commitment to the environment in all day-to-day operations in their offices as well as in suppliers’ manufacturing facilities. Reduction of environmental impact is not incompatible with saving manufacturing costs or adding brand value. Actually, green design and manufacturing can strengthen the brand and save money. Reducing waste, usage of energy, water and other natural resources as well as using substitute materials instead of conventional materials in production lowers costs and makes more actual profit.

In the outdoor market, it is not possible to build a life style brand in the future without being ecofriendly. However, companies should avoid greenwashing. Customers have started increasingly to demand proof of commitment to nature. Joining environmental programs and getting eco standards is an opportunity for companies to show their sincere environmental beliefs and convince their customers that their manufacturing is sustainably responsible. Real environmentally friendly design is not only made by the purchasing department. Successful green manufacturing should also be cross-functional. Sustainable, responsible values should be taken into consideration in a design department, but also by engineering, research and development, production management, logistics, financial department and marketing. Quick-wins can be generated by the purchasing department alone if effort is made to convince stakeholders and customers of sustainable values over a short period of time. However, if only one department has these values this cannot be recommended in any way.140

There are many difficulties and economic realities in economically poor countries to reach ecological manufacturing in functional outdoor garments. Using suppliers in low income countries entails additional responsibilities for outdoor brands. Often the legislation is not as strict in economically poor countries as it is in western countries. Companies are mainly interested in profit and the people want to reach the same standard of living as those in western industrial countries before making any environmental efforts. Even nation politics in

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140 sourceit Gmbh 2008 ; See also www.sourceit.ie
low income countries demand the same standard of living before they are ready to pay attention to environmental aspects. An opinion of people in low income countries is that western countries have caused climate change and those countries must remedy the situation. Western outdoor companies often produce their products in Asia at low manufacturing costs, but at the same time they must be act responsibly towards the environment. They should demand their suppliers follow codes of conduct and help them to make environmentally friendly choices, even if the country’s legislation do not require it. It requires resources from the supplier to invest in more environmentally friendly manufacturing methods and facilities.\textsuperscript{141}

Manufacturing in low income countries implies numerous challenges. Distance from headquarters causes many difficulties. Communication is difficult because of time differences and possible language barriers. Production enforcement is more difficult and it is much harder to supervise and control production, its quality and environmental actions. Long distance incurs expense and higher carbon footprint, because goods must be shipped and visiting supplier’s production facilities necessitates more business travel. Using local third party agencies instead of the company’s own business travel reduces the carbon footprint. Local presence at the manufacturing location is a key success factor for enforcement. Bad quality problems are also environmental problems, because in the worst case scenario the quality of the clothing is so poor that they cannot be sold. If clothes are destroyed, they have only used raw material and energy sources. In a somewhat better situation they can be sold at discount, but then the company will lose profit and brand image may be impaired.\textsuperscript{142}

The suppliers in low income countries often use less environmentally friendly, old production technologies. It should therefore be western companies’ responsibility to support their suppliers in developing more efficient production technologies by offering fair pay for their services. A company should thus be a major buyer from their supplier in order to exert more influence. A long-term trust-building relationship is necessary for suppliers to be able to make the modifications. Supporting green manufacturing methods and buying more environmentally friendly material does increase a company’s expenses in the short term. They have to have capital to make these green changes in their production chain. Successful green manufacturing can be used as a marketing tool adding value to recuperate lost capital.\textsuperscript{143}

\textsuperscript{141} sourceit Gmbh 2008; See also www.sourceit.ie; Grundström, Haltsonen; Hausen, Mykkänen, Möttölä & Särkkä 2004.

\textsuperscript{142} sourceit Gmbh 2008; See also www.sourceit.ie; Grundström et al. 2004.

\textsuperscript{143} sourceit Gmbh 2008; See also www.sourceit.ie
5.2 Actions and actors in environmentally and social sustainability

There are stakeholders on different levels who affect sustainable development in the outdoor industry (Fig. 32.). Governmental stage, domestic and international legislation, standards, associations, organizations, textile manufacturers and outdoor clothing companies are not isolated from each other. Textile manufacturers and outdoor clothing companies belong to different types of associations and organizations, which try to influence legislation and standardization. Legislation has an effect on the standards which textile manufacturers and clothing brands apply.

**Figure 32.** Several actors on different levels affect the sustainability of outdoor clothing (Seppälä 2009.).
Legislation, Standards and Ecolabels

Legislation

All countries and continents have their own laws on ecological aspects in manufacturing and work conditions. The EU has a relatively new law called Registration, Evaluation and Authorization of Chemicals (REACH). This is a European Community Regulation on chemicals and their safe use (EC 1907/2006). Its two most important aims are to improve protection of human health and the environment from the risks of chemicals while enhancing the competitiveness of the EU chemical industry. It is also meant to increase transparency and integration with international efforts. The idea is that the industry itself should ensure that the chemicals it uses do not adversely affect human health or the environment. The industry should manage potential risks and have knowledge of the properties of its substances.

Environmentally laws are not as strict in low income countries as in the western world and harmful substances are not as strictly controlled. The textile companies have moved their production to eastern-Europe and Asia, where in the worst case scenarios textile industry exploits underpaid women and sometimes even children. Working conditions may be poor, for example dust, dampness, noise and emissions may cause health problems. A growing concern for the consumers and growing demand for ecological control of textile production has engendered international standards and wide selection of ecolabels. Standards, ecolabels and environmental organizations can be used for supervising ecology of production.

ISO Standards

Standards aim to ensure satisfactory characteristics of products and services. These are quality, environmental friendliness, safety, reliability, efficiency and interchangeability. Standards can be used as tools for the sharing of knowledge, technology and good practices supporting sustainable development. Standards help to promote good business practices and to foster technological innovations.

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144 The new law entered into force on 1 June 2007.
145 The European Commission 2009.
146 The European Commission 2009.
147 International Organization for Standardization 2009.
The International Organization for Standardization (ISO) is a network of the national standards institutes of 162 countries, making it the world's largest developer and publisher of international standards. National institutes are often part of the governmental structure of their countries, or are mandated by their government. ISO makes it possible to reach a consensus between the needs of society and the requirements of business.\textsuperscript{149}

The ISO 14000 family is used globally and covers environmental aspects like environmental management, labeling, performance evaluation, life cycle analysis, communication and auditing. The ISO 14001 family provides assurance to management that it is in control of the organizational processes and activities having an impact on the environment. It also provides certainty for shareholders, customers, the community and regulatory agencies that the company is upholding ecological manufacturing principles. Standards also convince employees that they are working for an environmentally responsible organization.\textsuperscript{150}

\textbf{Verification, testing and certification organizations}

There are several organizations which offer testing services ensuring quality and reliability during production. Early detection of substandard materials and unreliable production avoids unexpected costs and delays and protects a company’s brand. Testing organizations have their own local testing laboratories, where products can be tested close to supplier’s manufacturing facilities. They offer a complete range of services including testing, product inspection, process assessment and technical assistance. Laboratory testing covers product safety and performance criteria. Testing proves that fabrics, yarn, components and finished products are in conformity with the contract and standards. They can also do safety testing such as flammability risks and ecotesting to detect prohibited, hazardous substances. Product inspection involves visual evaluation of statistically selected samples. Final random inspection covers product appearance, workmanship quality, size measurements, functions, assortment, accessories, labeling and packing. They can do several types of assessments.

Code of conduct covers social responsibility including, for example, labor rights, working conditions and hours and also fair payment. The organization can compel suppliers to follow a code of conduct. For example, SGS offer such services. It is a well known international organization in verification, testing and certification and offers services to multiple industries. SGS’s Consumer Testing Services (CTS) covers the total supply-chain with a wide range of

\textsuperscript{149} International Organization for Standardization 2009.

\textsuperscript{150} International Organization for Standardization 2009.
services in all the major production and retail countries for all consumer products and services. CTS can be obtained individually or combined according to the company’s needs. SGS’s Factory Quality Assessment allows a company to verify the capability of their supplier to meet contract conditions for safety, quality, performance, quantity and delivery terms. The organization can also give a company’s suppliers technical assistance to fulfill quality and environmentally demands.\textsuperscript{151}

Ecolabels and standards

Ecolabels can give consumers information and help them make more environmentally friendly choices, but a wide variety of them can also confuse a customer. There are domestic, European and international ecolabels, which makes it difficult to figure out their real content and to compare them with each other. Many countries have their own ecolabels, but only a few of them concern textile products. Ecolabels can be divided into three different groups (Fig. 33.). In the first group, individual garment manufacturers can have private ecolabels of their own. Therefore, they do not necessarily have any relevant meaning and may not be reliable. The second category is private and public ecolabels, which are supervised by an external evaluator. The third category includes ecolabels which are externally audited by an authorized party. Customers should prefer standard ecolabels to be sure about the benefits.\textsuperscript{152}

There are internationally used standards like Oeko-Tex\textsuperscript{®} Standard 100 and systems used in geographical regions.

\textbf{Figure 33.} EU Flower is used in the area of the European Union, the Nordic Swan label in Scandinavia and national systems like the Blue Angel ecolabel is used in Germany and Bra Miljöval (Good Environmentally Choice) in Sweden.

\textsuperscript{151} SGS 2009.

\textsuperscript{152} Talvenmaa 2002, 72.
Oeko-Tex®

Oeko-Tex® Standard 100 is a specific product safety ecolabel for textiles. It was established in 1992 by the Austrian Textile Research Institute. The Standard is a uniform, scientifically founded evaluation system to ensure the human ecological safety of textiles. There are several independent test institutes which are members of the International Oeko-Tex® Association. These institutes test for substances harmful to health according to Oeko-Tex® Standard 100.

The properties of modern textile products, such as bright colors, easy-care properties and long life span, cannot be achieved without the use of specific chemical substances. Functional properties are now demanded of textiles, for example technical mountaineering garments, because such properties are essential for their intended use. The list of potentially harmful substances that Oeko-Tex® Standard 100 checks for, and imposes a limit value on, are pH, formaldehyde, heavy metals (As, Pb, Cd, Cr, Co, Cu, Ni, Hg), pesticides, chlorinated phenols, dyes (specific classifications), chlorinated organic carriers, biocide finishes, flame retardant finishes, color fastness, odors and emission of volatiles.

A license for using the registered Oeko-Tex® Standard 100 label can be granted after successful testing of the pre-product, intermediate or final product. Oeko-Tex® Standard 100 is product-related. Oeko-Tex® Standard 1000 is a testing, auditing and certification system for production sites throughout the textile processing chain. This standard involves some participation in Oeko-Tex® 100 scheme, but it goes further by assessing the chemical usage and handling, water usage and disposal, exhaust air production, dust and noise generation, energy usage and general workplace conditions. To qualify for certification according to the Oeko-Tex® Standard 1000, companies must meet criteria in terms of their environmentally-friendly manufacturing processes and provide evidence that at least 30% of total production is already certified under Oeko-Tex® Standard 100.153

Fairtrade Labelling Organizations International (FLO)

Fairtrade Labelling Organizations International (FLO) is designed to support the sustainable development of small-scale producers and agricultural workers in the poorest countries in the world (Fig. 34.). FLO aims to set clear criteria to make sure that all conditions of production are socially and economically fair and environmentally responsible. FLO’s vision is that all producers can enjoy secure and sustainable livelihoods, fulfill their potential and decide their future for themselves.

Figure 34. *FLO especially wants to help producers who are disadvantaged by conventional trade so that they could combat poverty, strengthen their position and take more control over their lives (Fairtrade Labelling Organizations International 2009).*

Their mission is to connect consumers and producers via a label which promotes fair trading conditions. The key objectives of the FLO standards are to ensure that producers receive prices that cover their average costs of sustainable production and to provide an additional premium which can be invested in projects that enhance social, economic and environmentally development. FLO also enables pre-financing for producers who require it and helps facilitate long-term trading partnerships.154

154 Fairtrade Labelling Organizations International 2009.
bluesign®

bluesign® is an independent industry textile standard. The bluesign® standard was developed from a project initiative in 1997 (Fig. 35.). The standard can be applied to the entire production chain. It covers all the levels, from raw material and component suppliers who manufacture for example yarns, dyes and accessories, to clothing manufacturers, to retailer and brand companies, to consumers including productivity, consumer safety, air emission, water emission and occupational health and safety. Production processes that are designed around maximum resource productivity with a view to environmental protection, health and safety, represent an assurance for manufacturers and retailers that today's quality criteria are fulfilled in the best possible way and that applicable regulations and limits are in compliance.

bluesign technologies does not only provide a solution to Environment, Health & Safety (EHS) problems along the textile supply chain, but also functions as a role model and actively contributes to the conservation of our planet and the natural environment. For this reason, Bluesign Technologies is a member of various organizations, for example EOG Association for Conservation, which is an initiative from the European outdoor industry and B.A.U.M., the European business community's largest environmentally initiative founded in 1984. The standard does not override existing Restricted Substance Lists (RSL) or REACH requirements. bluesign® also offers tools such as bluefinder™, a database where the newest approved components can be found.¹⁵⁵

Figure 35. The company bluesign technologies ag was founded in 2000 and is organized as a global network. Its advisory board’s members are leading representatives from the scientific and political communities, trade and industry, and consumer and environmental organizations (bluesign technologies ag 2009.).

¹⁵⁵ bluesign technologies ag 2009.
Funding organizations, associations and working groups

1% for the Planet

1% for the Planet is a nonprofit organization funding environmental causes (Fig. 36.). Their mission is to build and support a business alliance financially committed to creating a healthy planet. Yvon Chouinard, founder of Patagonia, and Craig Mathews, owner of Blue Ribbon Flies, were passionate environmentalists and they understood it was good business to protect the natural resources that kept them in business. Based on their own business models, the two men designed a plan to encourage more businesses to donate 1% of sales to environmental groups.156

Figure 36. The members of 1% for the Planet decide the amount and recipient to receive the donated funds. The members get a 1% for the Planet logo to show their customers their sincere commitment to the environment (1% Percent For The Planet 2009.).

The Outdoor Industry Association (OIA)

The Outdoor Industry Association (OIA) was founded in 1989 to ensure the growth and success of the outdoor industry in the United States (Fig.37.). It is the association for companies in the active outdoor recreation business. The OIA provides trade services for manufacturers, distributors, suppliers, sales representatives and retailers in the outdoor industry and seeks to ensure healthy and diverse specialty retail and supply chain based on quality, innovation and service. The OIA has several working groups. These groups bring competitors together to solve problems shared across the industry for example labor practices, manufacturing standards and the streamlining of data exchanged along the supply chain.

156 1% Percent For The Planet 2009.
The OIA works to raise the standards of the industry. It provides support services to improve member profitability, represents member interests in the legislative and regulatory process, and promotes research, training and education (Outdoor Industry Association 2009.).

The Eco Working Group (EWG)

The Eco Working Group (EWG) was formed by the OIA in 2007 to explore the issues of environmental sustainability as related to the outdoor industry (Fig. 38.). The OIA’s eco working group helps companies share best practices by developing an eco index for the outdoor industry.

The working group has an open membership, encouraging participation from all companies throughout the supply chain in outdoor business. In the Eco Index is an Outdoor Industry environmentally assessment tool for products with environmentally guidelines. The index helps companies to manage their supply chains toward their own environmental goals. The group has also released guidelines for measuring and reducing the environmental impact of packaging.157

Figure 38. The Outdoor Industry Association has established the Outdoor Foundation to inspire and encourage future generations to enjoy outdoor lifestyle and to be healthier (Outdoor Industry Association 2009.).

The Conservation Alliance

The Conservation Alliance’s mission is to engage businesses to fund and partner with organizations to protect wild places for their habitat and recreation values (Fig. 39.). The US based alliance was founded in 1989 by industry leaders REI, Patagonia, The North Face, and Kelty, who shared the goal of increasing outdoor industry support for conservation efforts. They also wanted to encourage other companies in the outdoor industry to give money to environmental organizations and to become more involved in environmental work. The Conservation Alliance directs its funding to community-based campaigns to protect threatened wild habitat.158

Figure 39. The Conservation Alliance grants have helped organizations in their work to protect land, remove dams, and preserved access to thousands of miles of rivers and several climbing areas in North America (The Conservation Alliance 2009.).

European Outdoor Group (EOG)

The European Outdoor Group (EOG) is an association set up to represent the common interests of the European outdoor industry (Fig. 40.). It was founded in 2003 by outdoor companies who recognized the need for a cohesive, across the border approach to represent the outdoor sector. The world has changed in such a way that legislation, environment, the media and trade have become multinational issues and overall internationalism has increased generally. EOG promotes best practices, conducts market surveys, holds industry workshops, and engages in collaboration with European trade shows and with national trade associations.

EOG’s aims are to provide a voice for the outdoor industries ensuring an effective interface between industry and consumers, the media and government and to liaise with the European Government on issues of legislation that affect the outdoor industry. EOG also wants to

158 The Conservation Alliance 2009.
generally promote participation in outdoor leisure activities. EOG has working groups for its members to solve specific issues concerning the industry. For example, the sleeping bag working group was set up in 2005 to resolve the confusing communication information and evaluate effects of the new standard in 2005 (the EN13537 norm).

Figure 40. EOG’s objectives are to facilitate networking among its members, to deliver relevant and cost effective services for them. For example, they worked with the two major organizers of European outdoor trade fairs to ensure that members have the most effective platform possible for their products (European Outdoor Group 2009.).

Sustainability Working Group (SWG)

The EOG founded its own Sustainability Working Group (SWG) in 2008 (Fig. 41.). This interest was given a boost by the founding in the USA of the Outdoor Industries Association Eco Working Group and an upsurge in consumer interest in the subject. During the OutDoor Trade Fair in Friedrichshafen in July 2008, the European Outdoor Group (EOG) held an open meeting to discuss what the European industry should be doing regarding the issue of sustainable business practice.

The key outcome of the meeting was a decision to set up a European Sustainability Working Group to provide a common voice for the industry. SWG’s vision is to promote and adopt the very best standards of sustainability and seek to improve business practices to the benefit of the environment, the work force and society as a whole. Its aims are to improve the ecological and environmental impact of the industry and also to ensure that the outdoor industry is up-to-date on relevant environmental, health and safety legislation.

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159 European Outdoor Group 2009.
160 European Outdoor Group 2009.
161 European Outdoor Group 2009.
Figure 41. SWG is in charge of maintaining dialogue with relevant stakeholders and facilitating facts-based communication of sustainability credentials, including review of certification and labeling schemes (European Sustainability Working Group 2009.).

EOG Association for Conservation

The EOG Association for Conservation was founded in 2006 (Fig. 42.). European outdoor industry uses the same model as the US Conservation Alliance. Membership of the association is open to any company able to demonstrate an active involvement in the outdoor industry, including suppliers, manufacturers, brands, publishers, sales organizations and service providers. Membership demonstrates commitment to protecting the outdoor environment when companies support environmental projects. Its key objectives are protecting natural and wild areas for future generations and the raising of awareness within the industry for the need to conserve and protect the environment. It raises money from subscriptions, donations and via fundraising at industry events. The projects focus on specific issues and root causes using community volunteers. Direct citizen action builds public involvement, consensus and support.162

Figure 42.  Any company involved in the outdoor sector, for example suppliers, manufacturers, brands, publishers, sales organizations and service providers, can join the EOG Association for Conservation. (EOG Association for Conservation 2009.).

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162 EOG Association for Conservation 2009.
Co-operation between OIA and EOG and the End of Life Options Committee

In fall 2009, the Outdoor Industry Association (OIA) based in the USA and the European Outdoor Group (EOG) formally agreed to work together to coordinate their sustainability projects (Fig. 43.). They have been working informally together since their inception, but a formal agreement brings clarity to the relationship. The aim of the cooperation is to produce complementary tools for the outdoor sectors, to help cross-adoption throughout the industry and optimize stakeholder engagement. They want to find ways to ensure a cohesive approach to sustainability for the whole industry by having various committees which can work together.163

![EOL-committee](image)

**Figure 43.** The Eo-Committee seeks an optimal end of life solution and hopes to offer opportunities for designers and manufacturers to make clothing more easily reused and recycled (Sustainability Working Group 2009.).

The crucial co-operation at the moment is to set up the first industry-wide end of life solution. So far there have been end of life programs on the company level, but the End of Life Options Committee (EoL-Committee), founded in 2009, wants to create a model for the whole outdoor industry to limit the environmental impact of products designed and produced by fashion and footwear firms (Fig. 44.).164,165

When the consumer no longer wants or needs clothing, the options currently available are re-selling them in second-hand shops or exporting them to countries such as Africa. Other options are recycling, incineration, composting and consignment to land-fill. If the impacts of

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163 In 2009 co-chair of the EOG’s Sustainability Working Group, Anne Girard from Petzl, and chair of the OIA Sustainability and Fair Labor Advisory Council, Jill Dumain from Patagonia, will lead the coordination efforts between the two groups.

164 Adrian Huber from the Mammut Sports Group is chair of the End of Life Options Committee (EoL Committee) and EOG member companies such as Adidas, Mammut Sports, Polartec and Helly Hansen are involved working in it.

165 Just-style 2009.
fibers and dyes are already considered in the designing stage, a product's lifecycle can be affected in a positive manner. The Committee wants to focus on identifying a sustainable business model. It needs to quantify economic, ecological, and social impacts and to present solutions that optimize economic value versus ecological footprint. Their goal is to have at least ten major brands committed to the End of Life business model by 2012. It is important that the model should work for companies of all sizes and all parts of the value chain.\textsuperscript{166}

\textbf{Figure 44.} The End of Life Committee co-operates with various stakeholders from legislation level to consumers (Sustainability Working Group 2009.).

\textsuperscript{166} Just-style 2009.; Sustainability Working Group 2009.