



# Functional Wool Clothing for the Active Child

Master of Science Thesis in Master Degree Program, Industrial Design Engineering

EMELIE DYMLING FRIDA WERME

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## Abstract

This master thesis documents the development of a product that facilitates outdoor activities for families with young children. The project aimed to develop better children's wool clothing in a functional outdoor context. An extensive user study of young children and guardians was conducted where requirements and need descriptions were collected and presented.

This was followed by a concept development phase, focused on areas with ability for development. These areas were growth, regulation of warmth and easy dressing.

The final concept incorporates a set of middle layer pants and sweater jacket with various features such as: growth regulation drawstring canals, warmth regulation removable collar, larger centre zipper, thumbhole cuffs and knee/elbow reinforcements. The sweater can also be transformed into a vest. The product was deemed helpful to and attractive for the user group. In short, a well-developed concept to fulfil the needs of a user group that often lack satisfying options in the outdoors clothing market.

Keywords: Children, children's wear, outdoor activities for children, outdoor wear, wool, wool outdoor wear, product development, textile industry

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# 1 Introduction

This chapter will give an introduction to the project, including background, scope, purpose and objective.

## 1.1 Background

Outdoor activities are central to people in Scandinavia. The outdoor market today is offering a broad range of products that provide better comfort and support for outdoor activities. Also, the interest of families with young children in regards to the subject is growing, for example there is a growing interest in outdoor day care centres. However, products supporting this target group are scarce and as such there is a need to investigate further to find new solutions to help them take part in outdoor life.

Current functional clothing for children is heavily inspired by adult wear even though the demands differ between young children and adults. Furthermore, products that are more similar to traditional children's wear in design are more popular, indicating that the gap should be larger between children and adult functional clothing.

Aclima is a Norwegian company offering a range of textile wool products with focus on outdoor life. Aclima has recently launched a small range of clothing for children since there exists a high demand from their current customers to expand in this direction. Norwegian day care centres require all children to bring wool underwear for outdoor use, further pushing the need to develop children's winter clothing.

## 1.2 Scope and Purpose

The project was intended to study families with young children and their desire as well as ability to take part in outdoor activities. In this context, young children means children between infants and pre-schoolers, i.e. ages 2-5 years. As Aclima's vision is to let all enjoy nature, the goal was to develop a concept that enhances their ability to fullfil the needs of this newly found market. The project aimed to investigate all the steps in the process from getting dressed to getting inside again. Also, child physiology was investigated, covering topics such as freedom of movement, comfort, and body temperature.

## **Research** questions

- What type of problems do families with young children of ages 2-5 years old encounter in the whole process of initiating, performing and completing outdoor activities?
- What are the differences in needs between adults and children in outdoor winter clothing?
- How can wool clothes be developed to facilitate outdoor activities for families with young children in the ages of 2-5 years old?

## Limitations

The project intended to study families with children in the ages of 2-5 years old, as opposed to infants. Children of other ages and disabled children were not investigated.

Materials used were those available from Aclima, new materials were not to be developed. The concept was developed primarily for the Scandinavian market and is intended to be used in autumn or winter. The end result was a concept, so final adjustment for optimal manufacturing (such as pattern cutting layout) were left outside the scope of this project.

## 1.3 Objective

The aim of the project was to develop a product that facilitates outdoor activities for young children at one or several steps in the process. The expected result was firstly guidelines of how to improve products for the target group. Secondly, a final textile product concept, suitable for Aclima. The concept would after the end of the project be adaptable to become a finalized garment produced for the autumn/winter collection. Functionality is deemed to be the most important property. It is important that the product will stand up to the demands required by the customers during use. The product must also be feasible and economical for the company to produce. Additionally, product enhancing properties, such as aesthetics, are other interesting aspects as they would add customer value and satisfaction. Furthermore, innovation is not a goal in itself, but could benefit both functionality and customer value rendering it as a property not to be discarded.

# 2 Methodology

This chapter presents all the used methods and the specific ways they were conducted.

## 2.1 Planning

## 2.1.1 Gantt chart

A Gantt chart is a visualisation of a project's activities and phases marked against time, both in duration and date (Johannesson et al, 2004). A Gantt chart was made in the planning phase.

## 2.1.2 Flow chart

A flow chart showcases how the phases of a project connect to each other, in what order activities are conducted and where there are iterations (Johannesson et al, 2004). The flow chart for this project can be viewed in fig 1.

## 2.1.3 ABCD method

The ABCD method is a framework, consisting of four steps, which can be used in the product development process to guide towards sustainability. The four steps are awareness (gaining knowledge of sound sustainable principles), baseline (expressing knowledge in a common language or guides), creative solutions (unobstructed idea generation), and decide on priorities (the most beneficial opportunity for better sustainability is chosen to be implemented) (The Natural Step, 2011). During the project a holistic perspective was taken with regard to sustainability. Economic, environmental, and social views were taken into consideration. The previous framework was a part of this but was not exclusive.

## 2.2 Data collection and verification - Theoretical study

## 2.2.1 Literature studies

A literature study was carried out in order to research and gain knowledge about different areas relevant for the project. These areas were:

- Textile fabrics and wool, fabric manufacturing, and clothing care
- Clothing physiology, sport and outdoor clothing
- Child development, children's physical and cognitive abilities
- Child motor development
- Child ergonomics
- Children in outdoor environment
- Children's play
- Inspiration books of family activities



Fig 1: Flow Chart

## 2.2.2 Material and manufacturing study

A material and manufacturing study was conducted, where information was gathered from Aclima and other sources about industrial sewing as specified by the machines and factories used. Also, properties of the available material were studied.

## 2.2.3 Market analysis

A market analysis is an analysis of the conditions of a product's existing market, the needs and requirements of the market and its stakeholders. This includes competitors, customer relationships, and the internal organisation of the company (Johannesson et al, 2004). A market analysis was carried out in the beginning of the project by looking at existing functional clothing for children and adults.

## 2.3 Data collection and verification - Empirical study

Interviews, observations, surveys and focus groups were conducted with outdoor day care centres, the outdoor association Friluftsfrämjandet, and parents with (or experience of) small children, interested in outdoor activities. To complement the existing knowledge in data collection, Eva Eriksson, Lecturer at Interaction Design Chalmers and responsible for the course Interaction Design and Children CIU235, was contacted and interviewed about researching needs of children.

## 2.3.1 Interviews

Interviews are a research method that can be conducted with different degrees of rigidity. In this project, semi-structured interviews were used. In a semi-structured interview, an interview guide with predetermined questions or topics are used, but the interviewer may deviate from the guide or change the order of the questions etc. (Berg, 2009). The questions were open, i.e. "would you like to elaborate on this topic" rather than leading questions that could have influenced the interviewee. In order to attain a deep understanding of the topic, further probing questions were asked. Also, in this project, interviews via video link were conducted with people that couldn't meet face to face. Some of the interviews were conducted with children present and some without. The interviewees were recruited from social networks of personal contacts, outdoor blogs and the outdoor association Friluftsfrämjandet. Most of them lived in Sweden in the area around Gothenburg. In all, 16 interviews were conducted with parents with small children (four via video link), and one interview was conducted with a pedagogue at an outdoor day care centre. Most of the interviews took approximately one hour and one of the interviewers took notes during the whole interview. Furthermore, a family group of six families were observed and interviewed individually during an outdoor family activity organized by Friluftsfrämjandet. See Appendix 1 for specific questions asked.

## 2.3.2 Survey

To get a wider perspective and reach more people outside Gothenburg, a survey was sent out through three different channels as a complement to the interviews: social media, a blog dealing with outdoor activities and children and the outdoor association Friluftsfrämjandet. The questions were qualitative, rather than quantitative and some of the questions were similar to those in the interviews. Some general information was collected, such as the age of the interviewee's children and their regular outdoor activities. In all, 16 persons answered the survey. See Appendix 1 for specific questions asked.

## 2.3.3 Observations

Observations are a research method used to collect data about how people behave in different situations. The purpose of an observation study is to gain knowledge about the real use of a product. As some behaviour is hard to convey during an interview, observations is a good method to use as a complement to interviews (Bohgard et al, 2008). In this project, observations were carried out at playgrounds, a day care centre, an outdoor family group activity and during some of the interviews. The observations were conducted in order to gain knowledge about how children play and how they act, and what happens in situations when children are about to get dressed to go outdoors.

## 2.3.4 Focus group interviews

Focus group interviews are a research method designed for interviewing small groups of individuals simultaneously. During a focus group interview, participants are collected together and asked to discuss a topic. A moderator is present for probing and keeping the conversation on track. Focus group interviews are very good means for collecting data from children because of the informal structure, which intends for the subjects to speak freely (Berg, 2009).

Two focus group interviews were conducted with children in the ages of four to five years old with three children in each group. The children discussed different topics decided by the moderator (how to dress in winter, what they liked and disliked about their clothing, favourite clothing, what was hard with clothing, how their parents dresses). A pedagogue from the day care centre was present during the focus group and participated by asking probing questions.

## 2.4 Analysis

## 2.4.1 KJ analysis

In a KJ analysis, collected information from a study is divided into separate parts of information and sorted according to chosen categories based on the collected data (Bligård, 2011). A KJ analysis was carried out in order to categorize and analyse the data collected in the interviews, observations, focus group, and survey.

## 2.4.2 Function analysis

A function analysis is a solution independent list of all the functions the product are to perform, dividing the functions into groups of importance i.e. main function, part function etc. (Johannesson et al, 2004). A function analysis was made to be used when generating ideas in the ideation phase. The function analysis was based on the result from the KJ analysis.

## 2.4.3 Requirement specification

In a requirement specification, all the measured requirements of the product are specified in a clear, orderly and precise manner (Johannesson et al, 2004). The requirement specification was based on the result from the KJ analysis.

## 2.5 Ideation

## 2.5.1 Brainstorming

Brainstorming is a method used by a group who together will come up with as many ideas as possible (Johannesson et al, 2004). No negative feedback is given during the session, instead all the ideas are saved to be analysed later on. This method was used continuously in the idea generation phase.

## 2.5.2 Negative idea generation

Negative idea generation utilizes a requirement specification (or in this case the function analysis) and changes the polarity to negative requirements (e.g. the product should not...) (Rawlinson, 1981). Then, questions are posed of how to fulfil these negative demands. The resulting ideas will aim to do so.

## 2.5.3 Rotation sketching

When using the method rotation sketching, a group of persons will sketch ideas separately for a set time, then sending the sketch to another person who will continue sketching on this sketch for another iteration. The rotation continues for as long as it is decided upon before the session. The different sketches can have stated problems to solve or just start out blank for the first person to fill. Rotation sketching was used early on in the ideation phase when generating ideas. This method was used to kick-start ideation during slow periods.

## 2.5.4 Morphological analysis and matrix

When using a morfological analysis or morphological matrix, a table is drawn where all the partial functions or requirements are listed vertically. All the possible partial solutions to one part function/requirement are given in the table on its row. In the next step these partial solutions are combined differently to whole solutions (Johannesson et al, 2004). The difference between morphological analysis and matrix are minor, where the first takes the requirement specification as input and the second the function analysis.

When this method was used, all solutions were sorted into a matrix according to which problems/focus areas they solved. From this matrix full concepts were created with a wide representation in mind so as to catch every solution in at least one concept.

## 2.6 Visualisation

## 2.6.1 Sketching

Sketching can be used as a visualisation tool to illustrate more or less rough ideas. Sketching was used when generating ideas and developing concepts to clarify and explain ideas. It was also used when visualizing the final concept.

## 2.6.2 Mock-up

A mock-up is a smaller, simpler or partial manifestation of a concept in physical form. The purpose of mock-ups is to test functionality (Johannesson et al, 2004). Mockups were created using fabrics supplied by Aclima and used when developing concepts to test and evaluate part solutions.

## 2.6.3 Function Prototype

As opposed to a final prototype a function prototype is not a perfect replica of the final product. Instead, the purpose of it is to showcase and test a concept in physical form. Nevertheless, a function prototype can be very similar to the final product. Function prototypes were sewn with a regular sewing machine using the fabric supplied by Aclima. The function prototypes were used in the user test.

## 2.6.4 Expression association web

In an expression association web the expressions that a product should express are summarized (Wikström, 2010). A central expression is determined, which is then defined and further developed using synonyms. Several expressions were discussed and in the end a few were chosen to catch the whole aura of the desired product.

## 2.6.5 Expression board

In an expression board, the expressions from the expression association web are compiled using inspiring and expressive pictures (Wikström, 2010). The pictures should be figurative, not abstract, and without humans or text. An expression board can include colours and forms for further development. Images that matched the chosen words in the expression boards were created, one with the aim of expressing Aclima and one more centred on the project's goal product (fitting Aclima with a child focus). The boards were used as support when sketching ideas.

# 2.7 Evaluation and verification

## 2.7.1 Pros and cons list

A simple pros and cons list of partial solutions were implemented in order to attain a general overview of the solutions' feasibility in manufacturing and functionality.

## 2.7.2 Pugh matrix

A Pugh matrix is a method for "concept screening" (Johannesson et al, 2004). The method is used to systematically rank concepts by giving them partial ranking of how well they fulfil single requirements. Then, these rankings are summed to a main ranking, making it possible to compare the concepts against each other. The requirements can also be weighted in importance to affect the ranking. Partial solutions from the morphological matrix were combined into concepts. Care was taken so that all partial solutions would be represented. The concepts were evaluated against a baseline concept (representative of today's product) in regards to the requirement specification. The base concept got a middle score of three in every aspects, the other where scaled in a range of one to five (where five was best). The scores were multiplied with the weight of the requirement and summed, giving a value of the concept's worth.

## 2.7.3 User/usage testing

User testing is an experimental method where real users interact with a product (this might be an existing one or a mock-up/prototype in development) (Bohgard et al, 2008). The goal is generally to test usability with a group of users that is as close as possible to the intended target group. However, the same method can be used to test other properties, such as durability. A function prototype of the final concept was tested and discussed with four children at an outdoor day care centre. The children were asked to dress themselves in both pants and jacket while being observed. They were encouraged to move in the clothing. Comfort was evaluated by asking questions to the children. The adult pedagogues were also invited to give feedback.

Furthermore, usage testing was conducted on sample bits of fabric by testing how the material would handle stress by sandpaper. Two thicknesses of chosen wool fabric (terry, 230 g/m and 400 g/m) were given the same amount of strokes by sandpaper. A stain test was also carried out using sour milk and soil to see how well the fabric resisted stains.

## 2.7.4 Validation against company stakeholders

In order to evaluate and validate the partial solutions further against the stakeholders, a meeting was held with Aclima where the partial solutions were presented and discussed. Topics were focus areas confirmation, manufacturing possibilities and the developed product's place within the children's clothing range.

## 2.7.5 Simplified Life Cycle Assessment (SLCA)

An SLCA is a screening method where product life cycle stages (design/development, material harvesting, production, packaging, distribution/ sales, usage, end of life) are evaluated in terms of general ecological and social sustainability guidelines (material harvesting/production, degradation of nature, meeting needs of people) in a matrix and ranked by colour (from red to green) (Nyström, 2011).

# 3 Results from literature and empirical study

This chapter describes abilities of children in the age group two to five and how they preferably should be clothed during the winter by their parents and themselves, as well as why.

- At the age of two, children can generally run, jump, go up the stairs (sometimes with a bit of help), put on and take off some kinds of clothing, turn one page at a time in a book and stand on one leg for about a second (Misvaer, 2007). They can also turn on taps and open doors.
- Children at this age are becoming more and more independent, they want to do things on their own, without help, they express their own will, and test limits (Lidbeck et al., 2012). They can be defiant and their frustration level is low (Misvaer, 2007).
- A two year old might be able to cease with diapers during daytime. Two year olds sleep less than in their infant years and many stop sleeping during the day, yet they still might be in the need of a midday nap (Misvaer, 2007).
- At the age of three, children can eat and almost dress themselves without any help. They can also jump with their feet together, put their shoes on the right foot and walk on their tiptoes. (Misvaer, 2007).
- They are generally fearless, want to be in the centre of attention, have a vivid imagination and some have imaginary friends (Lidbeck et al., 2012). They can be defiant, but still also social and cooperative (Misvaer, 2007).
- Three year olds can categorize extremes, like high and low, but it's difficult for them not to group similar things into those extremes (e.g. quite low to low)(Taylor and Woods, 1998).
- Most children stop with diapers at this age (Misvaer, 2007).
- At the age of four, children can jump on one leg at least once, go down the stairs without holding on to something, and put large beads on a string. 80 % can button one or several buttons, and 89 % can get dressed and undressed by themselves (Misvaer, 2007). Most children at this age have the essential ingredients of advanced walk (Taylor and Woods, 1998) and they have good control of their movements.
- They reason from their own perspective but begin to develop a conscience and can more easily see another person's perspective (Lidbeck et al., 2012). Four year olds are better at communicating, sharing and taking turns.
- They are imaginative, enjoy dramatic play and develop friendship with one or two "best friends". Their play evolves from parallel play (playing by oneself besides another) to interactive. For the first time children begin to exhibit more interest in other children than in adults (Lueder and Rice, 2008).
- At the age of five, children can stand on one leg for about five seconds, run fast, kick a ball accurately, learn to swim, and ride a bike with two wheels (Misvaer, 2007). They have better general and fine motor skills and they walk better since their hips are straightened out.
- Five year olds start to understand collaboration and respect, are sensitive to moral issues and can take responsibility (Lidbeck et al., 2012).
- Five year olds become calmer and more independent. They can be precocious and are more vulnerable emotionally (Misvaer, 2007).

## 3.1 Physical development

The growth rate of children change with age. At the age of two to four, the growing rate is on average seven cm/year, and at the age of four to six it declines to six cm/year (Osnes et al, 2010). This illustrates the rapid growth of children at young age. There is however a great variation of size in same age group (Lueder and Rice, 2008). As such, it is rarely beneficial to regard a child's physiology in relation to age. Instead, total length is often used as a size measure, namely the centilong system. It can be noted that this measure system does disregard weight.

Physical differences between the genders are small before puberty, but girls generally have more subcutaneous fat than boys. (Osnes et al, 2010). In all, individual differences greatly overshadow differences between genders.

Child physiology differs from adults in regard to many factors. Firstly, it is obvious that there exists a difference in size. However, this difference is not proportional. For example, a child has a larger head in regards to stature.

Size

- There exists a great degree of variation between children.
- Children differ in size from adults in both stature and proportions.
- Children quickly grow in size.

Food

• Children have a higher metabolic rate and smaller food intakes (Taylor and Woods, 1998). Children have smaller glycogen stores (Osnes et al, 2010). On the other hand they are able to mobilize their aerobic system faster.

### Activity

- Given motivations they can be very active, though they are often active in intervals.
- Children use less effective movements that drain more energy (Taylor and Woods, 1998).
- Children sweat but not with the same odour as adults (Enander, 2012), and mostly in the same amount though in other areas than adults (less in armpits and crotch) (Garay, 2014).
- Children are weaker than adults (Osnes et al, 2010) though more agile and flexible (Taylor and Woods, 1998). Their hands are also weaker than adult's (Kroemer, 2006).

Oxygen transport

• Children normally have a higher pulse than adults to compensate for less efficient oxygen transportation (Taylor and Woods, 1998) and smaller heart and lung volumes (Osnes et al, 2010).

Heating and cooling

• Children have a relatively larger surface body area, which cools them off more quickly. Similarly, this process works for the larger head. Also, they do not have fully developed blood circulations in hands and feet (Janson, 2011) which gives the same effect on these body parts, but might also mean that they still are warm in the core body. See figure 2 for factors that heat or cool children in difference to adults.



Fig 2: Factors behind warmth regulation of children in comparison to adults.

## Implication for clothing

Sizing and proportions are different between adults and children. Clothing needs to accommodate this and larger head openings are especially necessary. Growth means that clothing will be hastily outgrown, especially in younger years.

As children are more agile and flexible they can stretch more extremely, implying that the clothes need to support a wider range of movement. Buttons and other hardware shouldn't require too much force as children are weaker in their hands. Undeveloped blood circulation in hands and feet means there'll be a more rapid cooling in these body parts. As figure 2 presents, different factors imply that either children heat up or cool down more quickly than adults, leaving a lack of consensus in how warm they actually are. The warmth of one individual could however be radically different from another meaning that there are a wider gap between individuals in the same age group rather than between children and adults. Even so, due to children's intervalbased activity there is a need for easy warmth regulation in clothing. Children need to regulate temperature in the same areas as adults, and moisture management is similar.

## 3.2 Cognitive development

Childhood is a time for rapid growth in a physical sense but also in cognitive development. For more information, see Appendix 2. To summarize, the behaviour described below is expected of children age two to five. Take note that this is a broad age group where cognition is rapidly evolving and therefore different between ages.

#### **Behaviour**

Children are impulsive. When there exists a personal interest children might be very attentive (Acuff, 1997). Children have a low threshold for frustration (Misvaer, 2007). They have different motivations, fears, and interests than adults (Lueder and Rice, 2008). Children have a great need for love and safety (Acuff, 1997), which impacts how they use their cognitive resources.

#### Sensing

At the age of five, children have two thirds of the visual acuity (i.e. sharpness) of an adult (Haywood and Getchell, 2005), but have a fully developed visual sense as the retina, cornea and optic nerve are completely developed (Acuff, 1997). Children can handle and identify unseen objects by touch at age four (Taylor and Woods, 1998).

## Problem solving

From around age two, children understand the meaning of symbols, i.e. that something can represent something else (Taylor and Woods, 1998). Children can internally represent experiences (play them out in the head) (Acuff, 1997), but are still mainly focused on physical exploration (Taylor and Woods, 1998).

Children need clear goals to solve problems and often use strategies to do so. Working memory capacity, inhibition and attention are generally poor (Bjorklund, 2012). Children have trouble coordinating two dimensions simultaneously (Taylor and Woods, 1998). Children can't reverse mental actions (Lueder and Rice, 2008), have not fully developed sequential thinking and need to use more of their mental capacity for cognitive processes (Bjorklund, 2012). As such, they have trouble with logic and have to behave more intuitively (Taylor and Woods, 1998).

Children learn different types of directions in order: up/down (early), front/back (of themselves by age three, of other things by age four), left/ right (four/five-ten) (Haywood and Getchell, 2005). Young children have troubles executing a task when crossing the midline of the body, e.g. fastening a strap on the left side with the right hand.

### Judgement

Children have a hard time seeing someone else's perspective (Bjorklund, 2012).

Children often see things as extremes, having trouble with "grey areas" (Acuff, 1997).

They judge based on prominent (Taylor and Woods, 1998), salient aspects and choose based on meaning, not function (Correia et al, 2012).

## Implications for clothing

It's important to remember that children do not understand everything that adults do, for example it may be more difficult for them to understand the procedure when dressing and undressing. It's therefore beneficial to make details clearly visible with strong colours and size.

Children might have trouble handling things they can't see and won't always identify direction, having problems with mapping appropriate garments to body side, e.g. left mitten to left hand.

## 3.3 Motor development

Motor development is the development of movement abilities (Haywood and Getchell, 2005). It is related to age and is a "continuous process of change in functional capacity". Motor skills are gradually developed by practicing and using the body, e.g. when children are learning to draw, they first use their whole arm and then they gradually develop more fine motor skills. (Osnes et al, 2010). Children learning to run also make unnecessary movements and therefore lose more energy than necessary. The ability to relocate limbs without looking improves between the age of five and eight. Until the age of six, children train upright stance of balance and coordination of lower and upper body (Taylor and Woods, 1998).

The development starts at the large joints near the body centre, such as the shoulder and the hip, and then continues outwards from the body centre. At the age of 15 months, babies can usually walk by themselves. There are three stages of motor learning that can be observed in many different skills (e.g. learning to walk or ski, which usually happens at different ages) (Sigmundsson and Pedersen, 2004):

- Excluding all the redundant degrees of freedom to get a controllable system, e.g. a beginner at skiing.
- 2. Gradually emancipating degrees of freedom to gain more flexibility, e.g. to bend the knees while skiing.
- 3. Using external forces to drain less energy for the same movement, e.g. use a carve turn instead of skidding when skiing.



## Implications for clothing

When designing clothes for children it's important to remember that their motor skills are not fully developed and as such they can't do everything that adults can. For example, finicky details or closing mechanisms that are hard to reach may be difficult. It would therefore be beneficial to design clothes with large, easily graspable details.

Children also move in a different style than adults, which suggest that clothing need to support both exploratory movements and crashes for when action fails.

## 3.4 Play and behaviour

Static anthropometry (measures and lengths of stature and body parts) and dynamic anthropometry (limits of movements) tell little about how children behave (Lueder and Rice, 2008). Therefore, it is hard to simply regard how children's bodies look when designing for them.

Children are intrinsically active. They are not passive or waiting to be stimulated. Thus they are active initiators and seekers of stimulation. This is a main motivation for development (Bjorklund, 2012). The youngest play physically and this play is very important for children. Intensity and frequency are raised prominently and reaches its peak during age three to five (Osnes et al, 2010). Between the ages of three to four, 20% of daily activities is skill play where the play is the goal, e.g. walking or climbing. Boys are somewhat more prone to wild playing, whereas girls similarly are more tuned to imaginary play. Children can forget time and space when they play. There exists a mode of flow which is the optimal mode between boredom and daring fear.

Children always explore their environment. Children use products and places in ways that may make absolutely no sense to an adult or a designer. Further, it is difficult for children to articulate needs and preferences. They lack language and often confuse needs with wants (Lueder and Rice, 2008). When studying children, observations are therefore important. As a designer, it's important to meet user preferences and comfort, while ensuring "productivity" and safety. Products should accommodate children of different chronological, physical and cognitive ages and support their current skill level while encouraging acquisition of new skills.



#### Implications for clothing

Since children are very active and sometimes forget time and space, their clothes are prone to wearing out quickly and children probably don't care too much about their clothing when playing. Therefore it's important to design clothes that are wear resistant and safe in order not to limit children in their play. Clothes need to support high physical activity, extreme poses and a high range of movements.

## 3.5 Comfort factors in wear

Comfort factors in clothing can be divided into four areas (Shishoo, 2005):

- Thermophysical wear comfort: heat and moisture transport/insulation
- Skin sensorial wear comfort: mechanical sensations
- Ergonomic wear: fit of clothing to wearer and function
- Psychological wear: the wearer's perception of the garment

The influence of clothing can thus be expressed by a fabric's properties. Firstly, clothing is generally used as temperature control, i.e. buffer against activity changes (Shishoo, 2005). This will be further discussed in next sub-chapter of 3.5.1.

Secondly, another thermophysical issue is moisture management, i.e. minimizing evaporation from the skin which results in rapid heat and energy loss as well as unpleasant feelings of wetness (Shishoo, 2005). Moisture control also affects friction between body and clothing. Moisture management is affected by the fabric's ability of waterproofness/absorbency (or wicking ability) and breathability, which in turn is an effect of fibre composition (i.e. if a fabric attracts or repels water being hygroscopic/non-hygroscopic). Furthermore, surface also affects moisture management as smooth textiles cling to wet skin making the wearer more uncomfortable.

Ergonomics in wear is affected by stretch and elasticity (Shishoo, 2005). Clothes with elasticity improve the freedom of movement since it imitates the elasticity of the skin. Simple body movements such as bending of knees or elbows stretches skin as much as 50%. Furthermore, ergonomic wear include light weight fabrics that reduce the energy consumption of the wearer. Lastly, clothes protect the wearer and thus fabrics with high strength and durability can be viewed as more ergonomic. Finishing of fabrics affects several areas of comfort but the most prominent one might be psychological wear and skin sensorial wear (Shishoo, 2005).

## 3.5.1 Cold temperatures

The major threat in cold weathers is cooling, which may be local skin cooling, extremity cooling or whole body cooling. There are some factors that influence the freezing impact of humans (Shishoo, 2005):

- Air temperature
- Mean radiant temperature (as expelled from a surface, e.g. outer garment)
- Air velocity (wind accelerates the heat loss from a warmer surface)
- Humidity (water accelerates the heat loss as seen during perspiration)

Generally, the warmth of the body can be described by a simple relation: amount of heat produced minus the heat loss (Shishoo, 2005). The metabolic rate, which most often is directly related to metabolic heat production, is in turn related to the physical work intensity. This varies greatly between winter sport activities. A lower metabolic rate (as affected by the physical work and the individual's ability) means that there is a greater need to minimise heat loss to keep a stable temperature, i.e. to insulate.

As air is a good insulator (Humphries, 2009) clothing that will trap air is beneficial. This is called the Air Trapping Principle. Therefore, fabrics with specially designed air spaces are good. This is affected by both fabric resiliency (i.e. springiness, since they maintain air spaces in fabric such as napped, piled or quilted ones) and thickness where a thicker material (given that it is closed in construction) will insulate more. However, microfibers can be very thin and still insulate well as they have a high surface area and thus will trap much air. Furthermore, fabric density is also critical when it comes to a garment's insulation, a fibre of low weight and high volume will be lofty and thus insulating. A higher air velocity comes from a higher speed or from wind (Shishoo, 2005). This induces movement of air that will transfer heated air away from garments. The smaller pores or holes are the more a fabric will shield from wind and keep heated air inside.

Waterproof or water repellent fabrics can be used to prevent wetting from the outside (this also affects such things as seams), but clothing can also get wet from sweat. To prevent this, the materials used also need to have breathability (gained from larger pores in the material) (Shishoo, 2005). As water conducts heat 24 times faster than air it is critical to be able to remove perspiration since this will cool the body rapidly (Humphries, 2009). During sport activities this is especially important, as the body will produce heat from the induced work. This heat will need to balance against stored warmth and thus need to be released. A heated body releases more moisture by perspiration. If the perspiration cannot be transferred away from the body by the garment it will leave the wearer cold and uncomfortable. This means that both heat and moisture should be released when needed in order not to overcompensate in either direction and in the end cool down the wearer.

Moreover, the body releases even more moisture as condensation of breath. The body releases water that heats and moisturizes the air breathed in to minimize airway cooling (Shishoo, 2005). In the higher range, airway cooling stands for 15-20% of total heat exchange and can be hindered by covering the mouth area. In cold climates condensation can be left on fabric around the mouth area in the form of ice (Humphries, 2009).

Different surface treatments and finising are used to give textiles different properties (for example water permeation) (Shishoo, 2005). These will gradually disappear because of wear and washing and must therefore be reapplied.



## 3.6 Clothing for winter outdoor activities

This sub-chapter presents findings from the user study.



## 3.6.1 Being outdoors

The families interviewed perform many different activities in widely different time spans, ranging from an hour to several days. Regardless of activity or timespan, high demands are put on the clothes since they need to withstand a lot of wear. Children are constantly moving around and they don't show caution with regard to their clothes. During their play the clothes sometimes limit children's movement. Some parents want more children's clothing adapted to specific activities, such as running or climbing, while other like the clothing to be versatile. Further, being outdoors with children requires a lot of planning and logistics. Extra packing includes foods, snacks as well as extra clothing, protection and logistic solutions such as prams or baby slings.

#### Day care centres

In a normal Swedish day care centre, the children are generally outdoors for about two hours per day given that the weather is not too bad. In outdoor day care centres, the children are outdoors for about four hours per day in nonextreme weather. In one Norwegian outdoor day care centre, they go on daytrips three days a week and in a Swedish one the older children go on daytrips once a week. Outdoor day care centres give recommendations and rules about what clothes the children should wear. Many have either rules or a culture of using wool undergarments.

In day care centres, the clothes are dried in drying cabinets at high temperature, but far from all clothes can tolerate this. This affects what clothes children wear when going to day care centres. The staff wants clothes that are quick and easy to take on and off, preferably as a whole package as the pressure on the staff to quickly handle a mass of children is high. It is also difficult for the staff to know which (unmarked) clothes belong to whom. Clothes that the children can put on by themselves and clothes that can tolerate drying cabinets are considered beneficial. It's often easier for children to put on their clothes by themselves at day care centres since they do not get as much attention as they do at home and because of peer pressure.





## Important comfort factors for children in winter wear

Children need clothing to be comfortable as their threshold for discomfort is low. Furthermore, behaviour of play connotes that freedom of movement must be satisfying. In part, this implicates a good fit neither too large or too small in length and width. Narrow necklines are a special pet peeve that often is mentioned. Children's heads are proportionally larger than adults and often this is not adequately accounted for in pattern making. Not only is this phenomenon uncomfortable during wear as it presses on the child's neck but it's also complicates dressing.

Gaps let the elements in, with freezing or wetness as consequences. Gaps are created by bad fit or sliding during wear caused by friction between garment pieces, especially stiff cuffs (e.g. on the waist). Moreover, stiff clothes restrict children's movement and could inflict friction on their skin. Hard and scratchy labels, washing tags or other hard details are abrasive and can lead to irritated skin.

Clothes that can't be opened up offer no ability to regulate temperature and are unfitting for the active play of children. Children find clothes of synthetic materials and clothes that don't breathe uncomfortable. While different children prefer different levels of warmth a garment that cannot be opened up will make the child sweaty leading to freezing. Similarly, some clothes are unfit for longer outdoor stays as they fulfil several of the mentioned aspects subsequently leading to discomfort.

## 3.6.2 Weather and wear

## Choosing warmth of clothing

Most parents dress their children in layers, primarily those doing longer outdoor activities or having children in outdoor day care centres. Parents check the weather before dressing their children and if the weather is varying the process of choosing adequate clothing becomes more difficult. It is most difficult when the temperature is around 0°C as it is often then both cold and wet. Parents refer to themselves and ask: "What would I wear myself?". Because of this, women generally put more clothes on children than men do. Some take into account how active the child is going to be. Parents state that it is important to bring extra clothes, as clothes can get wet or dirty, and that the weather or the child's activity can change.



Regulating hotness and coolness

Parents want the possibility to regulate temperature, but it's hard for the children to do this by themselves and they don't always sense when to. Many parents point out that all children are different, some get cold easily and some don't. Some children tell their parents right away when they are freezing and some wait a bit or don't say anything at all (this may be somewhat related to age). When children are freezing, they get passive, get tense, whine and stop playing. Further, if a child is too cold he/she might get pale and keep still (Janson, 2011). It's important to pay extra attention to small children since the blood circulation in their hands and feet is not fully developed and they will get cold faster than adults (ibid.). Parents feel the children's hands to see if they are cold, while on infants and toddlers they feel the neck. Damp clothes will make the child even colder so it is important to change clothes if something gets wet.

When children get too hot, they usually take off their mittens and their cap (Villumsen, 2010). This is a natural reaction to get rid of the excess heat. Parents in the study noted that this is one of the first reactions of the children themselves. If it gets too hot, the cap can be taken off or the clothes can be opened around the neck or at the wrists (User's Guide, 2009). A good sweater has a zipper in front to make it possible to easily regulate the excess heat (Janson, 2011). Several parents used the strategy to open front zippers, especially when alternating between outdoors and indoors. There further exist several garments that have openings on vital places (such as the armpits) where warm air can escape (Humphries, 2009). Parents feel guilty when their children are not dressed properly or get cold especially and as such too much warmth is somewhat of lower priority than coldness. However, during activities with temperature swings (such as alternating environment) the need is great to be able to regulate clothing.

When children are playing outdoors in the cold they need to go inside every so often heat up (Villumsen, 2010). When alternating between outdoor and indoor environments where the temperature is changing suddenly it is beneficial to loosen up the clothes when inside. Otherwise the child may get cold when going outside again.

#### Wetness

Children get wet from weather or when playing. Especially inclined are mittens and other areas where the child interacts more with their surroundings. In comparison to adults children are more prone to sit or lie down on the ground, which makes their clothing wet in different areas such as the rear. This is very prominent at all times but of course happens more frequently when it is wet outside. The deduction is that it is important that the surface of outer garments is water proof. Lined rain gear (pvc-coated) is popular as it gives much protection against wetness while the lining keeps the child warm during colder seasons. However, this type of garment doesn't breathe which is a negative. Further, water can be absorbed into the garments from openings, such as unprotected cuffs. Some garments have "water barriers" (non-absorbent fabric e.g. inside the cuff) that serve as an obstacle for absorbed liquid. Still, a garment that doesn't breaths will lead to wetness inside itself as the child sweats just like adults. For example, pvccoated mittens without lining are prone to this.

Children are sometimes unaware of their wetness, especially when they are playing intensely. However, wet children result in uncomfortable and cold children, which in turn will make many children fussy and in a bad mood.

#### Wear

Children wear out their clothes faster and in different ways and areas than adults do. Children's clothing is worn mostly on knees and rear. Elbows, necklines (since they are too narrow to truly accommodate a child's relatively large head) and elastic seams in elastic garments are areas that also are prone to wear. Further, fastenings and details such as zippers, velcro and loops (especially under the shoes) get worn. Also, dirt sticks easily in detailing such as velcro. There is a great need for sturdy fabrics and fastenings in children's clothing! The quantity and type of wear differ between ages since activity is different. Infants and toddlers like to chew on their clothes, for example cuffs (sleeves and collar) and straps. The clothes for all children that move around on their own get worn faster when there is no snow. Quality garments and some inner layers (especially in younger ages) don't get as worn and are instead inherited. With that in mind, there is of course outerwear that is durable enough to be used by more than one child. Some even claim the only garments they have discarded because of wear issues are waterproof plastic-coated pants.





## 3.6.3 Layer principle of dressing

Layering is the most common way of dressing for outdoor activities (User's Guide, 2009). Several thin layers are more insulating than a single thick one as they will trap more air (especially elastic layers). A light long-sleeved sweater has been estimated to add 1 degree Celsius of temperature, while a heavy one will add 2 degree Celsius and two light ones even 2.5-3 degrees Celsius (Humphries, 2009). Yet, too stretchy and tight fabrics should not be put over insulating layers as the stretchy layer flattens the one underneath and presses out the air. Areas with thin skin (head, neck, wrists, armpits, lumbar, crotch, ankles) should be well protected (Villumsen, 2010).

The parents stated that the layering principle was mostly used during longer durations of outdoor time, such as when a family would do outdoor activities. When simply walking to the day care centre or being outdoors for shorter play the layering principle often was discarded. The attitudes between families with strong interest in outdoor activities and those who don't also diverge on the layering principle where those interested would emphasise harder on it.

To prevent direct skin cooling with consequent discomfort from low skin temperatures and local cooling there is a need for a minimal level of insulation that must be in place even when the body is very active (Shishoo, 2005). Closest to the body, there should be a moisture wicking or absorbent layer, then one or several middle layers with material and thickness based on the temperature outside, and finally a wind and water repellent layer that preferably breathes. Additionally, the Air Trapping Principle means that the escape of warmed air must be hindered. When air warmed by the body rises in a garment it can escape from openings such as at the neck. Also, the phenomenon of warm air rising means that a person that lies down loses even more heat (Humphries, 2009). It is also important that blood circulation is not compromised as blood carries warmth through the body.

## Inner layer

Closest to the body there should be tight clothes in polyester, polypropylene (wicking) or wool (absorbent) (Villumsen, 2010). Cotton socks are no good since they lose their insulation ability if wet. Similarly, a cotton shirt next to the skin will suffer the same effect (Janson, 2011). For small children who remain immobile for longer periods, wool is the best alternative. If the child is sensitive to wool or has atopic eczema wool terry, fleece or polyester can be worn closest to the skin (Villumsen, 2010).



The layer closest to the body should be tight to make it possible for the moisture to travel away from the body and not stay on the inside of the garment. Also, it's important not to wear too much clothes, as this would hinder the ability to push the heated moisture through all layers (User's Guide, 2009) (Janson, 2011).

Wool was mentioned by several interviewees as being a good material of choice in clothing. They were very satisfied if their children had previously used wool as an under layer, given that the garments were not scratchy. For children in outdoor day care centres, wool underlayering was used almost exclusively and used as regular clothing indoors. When being outdoors for a shorter period of time, many other children used their regular clothing under the outer layer. However, these regular clothes were mainly made of cotton. On the other hand, when planning a longer outdoor visit, greater care was taken not to have cotton as the inner layer even if not all interviewees owned wool underlayering. Most of the interviewees that spontaneously mentioned wool thought it would become more popular in the future.

## Middle layer(s)

The middle layer should insulate and be adjustable, preferably made of wool, micro fleece, or polar fleece. The air in between the layers of clothes insulate a lot. Active children should not be wearing too much clothes, instead it is better to bring extra clothes to wear when sitting still. What type of clothing that is needed depends on the age of the child, ability of movement, and activity (Villumsen, 2010).

The most common middle layer used by the interviewees was fleece clothing. However, some of the interviewees used outer layers with insulation and therefore did not use middle layers at all. On the other hand, one can view regular everyday clothing as either under or middle layering depending on its thickness. As such, when using regular clothing under an outer layer, either an under or middle layer is excluded. Thus, some used only middle layers, such as everyday cotton clothing, and no inner layer underneath an insulated outer layer.

## Outer layer

The last layer keeps the warmth intact, protects against wind and water and ventilates the excess heat (Janson, 2011). Overalls in nylon can be problematic when children become too hot because it's not possible to regulate the temperature enough. It is better to choose an outer layer with little or no insulation to make it possible to regulate the temperature better. However, overalls are practical when used on young children. It is good if the overall is easy to put on and take off, and it has to be big enough for the child to have full freedom of movement. If the overall has a removable lining, it can be used for more than one season. Other functional details are pvc-coated strengthening and retro reflectors. The cuffs should be in a material that doesn't absorb moisture. For older children, cover outerwear trousers and a jacket proves more beneficial than using an overall (ibid.). It is good to choose clothes with snow gaiters at the waist and at the legs, and strengthening at the knees and the rear. Other good details are outwear pants with braces, stems at cuffs, protective pieces by the chin and removable hoods on tops.

It was gathered from the interviews that many parents think overalls are practical in dressing as they are easy to put on. Furthermore, this type of garment lacks gaps where weather and matter can invade. Regular day care centres prefer overalls since the personnel has responsibility for many children and would not have time for complicated dressing of individuals.

In comparison, jacket and pants have better movement. It is further easier to replace a separate garment if it has gotten wet. Also, jackets and pants do accomodate growth better. The different pieces of clothing will slowly shift vertically in comparison to each other when the child grows. Furthermore, jackets can be worn longer than pants by a growing child. Also,



pants will show more wear and as the outer garments are separated they can be replaced when worn out while the jacket can get a longer life. It should also be noted that even if a child wears jackets and pants rather than a whole overall, there might still exist a need to undress more fully e.g. when going to the toilet as pants often have suspenders.

Young children generally become absorbed in play and will not be cautious about their clothing. It is therefore important that the garment is well-functioning and durable. As children grow older, they care more about their social surrounding and peer pressure increases. Children will compare their own clothing to what is popular. If overalls are common in a group of six year olds one child won't feel exposed, but if overalls are uncommon the child won't care to use them.

There is also an option of choice between lined and unlined outer garment. An unlined garment, both overalls and jackets/pants, will be more versatile as it can be used in slightly warmer weather. A lining that can be removed can be used in such a way and will also be both easier to dry and wash. However, if such an option is used, fastening mechanisms need to be well functioning as it will otherwise irritate the users (both children and parents). Furthermore, the users need to pay attention when to remove the lining in a warmer season to make full use of the option.



Many find jackets and pants more versatile. Both pieces and especially the jacket can be combined with other clothes to better fit with changing weather and seasons. In short, jackets and pants can be used more often and during longer time periods as they both fit growth and weather changes while offering functionality, such as easier toilet visits and better movement. However, overalls shows many benefits, such as easier dressing, more security in openings and a lower risk of the child getting stuck while playing. Jackets and pants therefore fit longer outdoor stays better. Parents that take the children on longer outdoor visits often chose jackets and pants. However, the popularity of overalls is still undisputed as it offers practicality during regular everyday living and shorter outdoor visits. Note that well prepared layering under a regular overall is not bad for longer stays either but will add time to the dressing process.

## 3.6.4 Accessories

#### Caps

Head protection is vital (Humphries, 2009). A thin wool cap is good when the child is active, but when sitting motionless, a thicker fleece cap can be used. Children have large heads in comparison to their bodies and therefore lose

a lot of heat through the head (Janson, 2011). A windproof cap is a necessity when windy (User's Guide, 2009). Parents prefer caps that are shaped like a helmet since this will hinder the cap from sliding down over the child's eyes. Nevertheless, it is usual that regular caps and hoods have this tendency.

## Mittens

All parents mention mittens as a huge problem area in children's

clothing. On the next page, some general problems with mittens are presented.

### Dressing

During the interviews, many stated that it is hard for children to put on mittens themselves. One of the observed three year olds could put on gauntlets without help, but often this task proves hard even for four years olds. Still, the step of tucking the mitten over or under the sleeve proved hard even if the child could put on the mittens by themselves. It's considered good if the mittens have a wide opening during dressing since it makes them easier to put on (Janson, 2011). Some found it practical if it was possible to open the mittens down to the thumb for easy dressing, but a zipper can get stiff. Parents think that mittens should be in one layer, several layers of mittens don't work well with children. However, multiple children used mittens under water-proof gloves for better performance. Obviously, mittens were easier to dress in than gloves. However, it was still difficult for many (especially younger children) to get the thumb in place. Nevertheless, mittens are more common than gloves as these are easier to put on and offer more warmth.

There is no consensus whether or not the mittens go over or under the sleeve, people have different preferences. It is hard to re-dress a mitten that is worn under the jacket. It would be beneficial if the cuffs could be put inside the sleeve but still be easy to put on again when taken off outdoors.

#### Sizing

Many mittens have a bad fit. Sizing is irregular and it is often hard to guess actual size based on sizing. An important length is between the fingertips and the wrist where the mittens need to be tight in order to stay put. If this is mismatched the mitten won't fit well. Of course, the growth of the child is troublesome as the measurement change over time.

## Bulkiness and discarded mittens

Mittens are often taken off outdoors as they are in the way when the children want to pick up and grip things. This is because many winter mittens are too bulky as they need to be well insulated and warm. The child might not understand the consequences (i.e. freezing) of going without mittens and thus this threat wouldn't hinder them to take them off. Furthermore, mittens are taken off when eating outdoors, otherwise it's impossible to grip the food. Discarded mittens are often lost. There exists some solutions to get the mittens to stick to the jacket sleeve. Many of them are unreliable, easily broken and uncomfortable. One of the most praised is to have a ribbon sewn on the sleeve where the mittens can be attached. This does however demand that mittens and sleeves to be compatible.

### Water

Water repellent mittens are practical and it's good to bring an extra pair as mittens have a strong tendency to get wet (Janson, 2011). Waterproof mittens with rubber reinforcements in the palm are efficient when children play in the snow. Mittens are troublesome when they are not waterproof since children have a huge tendency to play with water and otherwise get wet. Pvc-coated mittens are not well-liked (poor grip, sweaty, no insulation) but used by many since they offer this property. Some mittens also absorb water at the cuff which makes the water travel into the clothing. It is important that the lining of mittens can be pulled out to dry, at least in pvc-coated mittens where drying time otherwise would be very long. Young children often chew on their mittens which also leads to wetness, and furthermore inflicts wear.

## Coverage

The mittens must offer coverage. Unprotected wrists are undesirable and a higher glove gives protection against wetness. One child even wanted the shafts to go as far as to the shoulders. Good coverage is apparently a difficult riddle to solve as the gloves must offer freedom of movement and stay put even when in use. They can also glide down which makes them both less waterproof and more bulky. A padded lining made of fleece or wool will make the mittens warmer (Janson, 2011). During windy conditions, wool mittens inside a windproof layer are beneficial (User's Guide, 2009).

#### Conclusion on mittens

When children eat outdoors, they take off their gloves or mittens since it makes it easier for them to grip things and use fine motor skills. This is also true when children want to touch something when playing or exploring. Parents don't want the mittens to get lost. Furthermore mittens should have good fit and stay on the hands except for when the children want to take them off, offer no gaps and be waterproof, warm, easy to put on even when dressed, and not limit the children's use of fine motor skills in a too restrictive way. All in all, the tendency to lose half or a whole pair as well as the growth and general unreliability of mittens means that very expensive mittens are not sound to buy for the consumer.

#### 3.6.5 Activities

#### Dressing

Dressing children are troublesome. Generally, children manage better when they are at the day care centre than when they are at home since they can demand the parent's attention as well as there being a shortage of time. How well they cooperate with their parents depends on their mood. Four to five year olds can do most things by themselves. Children that have practiced a lot are of course more skilled at getting dressed by themselves. However, most children know roughly in what order the clothes should be put on. Getting dressed takes longer time when children do it themselves.

Children have difficulties with finicky things or things that require much force. Examples are:

- Zippers (putting them together, pull in the right direction)
- Buttons (fincky) and push buttons (if stolid)
- Mittens (get the fingers right, pull up zippers on the back of the hand)
- Pull pants over shoes and cuff or sleeves over the mittens

Sometimes shoes are put on the wrong foot and clothes put on hind foremost. If there are clear markings or clues (such as prints or marks) this is minimized. Clothes that contain many elements are even more difficult for children. Some stated that they found it complicated to pull the inner sweater sleeve down when they put on a layer on top of it. It's important to remove any gaps in the clothing, which can be hard for the children to do by themselves. However, specific care needs to be taken to not limit the ability to move in the clothes. During use some details could glide up or break - such as snow gaiters or cuffs. This is of course negative.

Zippers all the way down to the foot makes pants and overalls easier to step into. Fasteners for cold-weather clothing should not be made of metal or should else covered up if they are close to the skin (Humphries, 2009). Also, zippers should be large enough for clumsy cold (sometimes mitt covered) fingers. If a jacket is very long, a two-way zipper is good to enable the user to sit or bend down without the jacket riding up. A two-way zipper also offers easy regulation without the need to fully un-zipp a sweater.



Zippers and velcro make it easier for children to get dressed on their own (Misvaer, 2007). For security reasons, children's clothing should not have cords or drawstrings, especially by the neck. Hoods that are sewn onto clothing are also dangerous and should be avoided. For further security reasons, decorations that children can put in their mouths should also be avoided (Konsumentverket, 2012).

#### Toilet/diapering

Most parents try to make their children visit the toilet before going outdoors. Urinating outdoors is complicated but as the parents have no choice, they claim that "you just have to do it". Children can get stressed if they need to pee while wearing a lot of clothes since it will take time to undress. Therefore, and for convenience, it is good if the clothes are quick and easy to put on and off. It is beneficial if all clothes won't have to be taken off when needing to pee, especially when outdoors. It's still important that the garment's functions is maintained even if the clothes show improvements in respect to quick dressing.

When wearing overalls, children have to take off the whole garment, which makes them cold and lower their morale. Outerwear pants with suspenders are also complicated as these are locked in by a covering jacket. When children pee outdoors there is a risk for splattering, especially if they need to be standing up. Sometimes children pee in their overalls as they don't always tell their parents early enough that they need to pee (especially if it's hard to go to the toilet) but wait until they really have to go. Furthermore, when accidents happen it's easier to regain status quo by just switching some garments, i.e. pants, rather than a whole overall. Diapers are not as critical, then it's possible to wait a bit longer before changing. However, diapers are complicated to change if they are hard to reach and especially if the child needs to be fully undressed. Thus a special crotch opening is beneficial for diaper changes. Most parents bring an underlay for changing diapers or do it in the stroller. Thus changing diapers is more easily done wherever, as long as it's not windy and that the cold can be managed.

### Laundry

Children's clothes become dirty quite fast from food, sand and daubs. Small children often spill when eating, which makes their clothes dirty, especially around the neckline. If the garment is waterproof, cleaning is fairly easy. However, food spill is a main contributor to laundry needs. Some children wear a "dirt t-shirt" on top of the inner layer of clothing to keep them clean when inside.

It's highly desirable that the clothes can withstand handling from washing machine and dryer as they probably will be washed often. Some parents also prefer if the clothes are washed many times so they can be sure that any chemicals from manufacturing are gone. Many parents try to wash as infrequently as possible, especially outerwear when the dirt can be brushed off. These clothes also get dirty very fast after washing and many parents don't see the point. Beyong washing machines, tumble and cabinet dryers are used as well. Lined waterproof garments are difficult to dry if it's not possible to remove the lining.

Note that there exists a conflict between laundry/dryer needs and owning a few well-fitting garment pieces at a time. This means that a garment that take a long time to dry cannot be used during this time, which creates a need for owning and carrying extra clothes. As a child quickly discards clothes because of growing, this creates a huge demand for ownership and consumption of clothing - something that is unwanted because it creates economical, ecological and labour concerns.



### 3.6.6 Consumerism

#### **Buying clothes**

Quality, function and comfort are important factors that affect what parents buy. Many parents also like the concept of organic and nontoxic clothes. Second hand clothes and inherited clothes are common among families with small children. When deciding upon what to buy, many listen to other people's experiences. Parents are reluctant to try new things that they aren't sure of beforehand. Many want to buy the same brands for their children as they wear themselves, even though some complainthat companies make children's clothing that are miniatures of clothes for adults instead of looking at what children need. Many also gain loyalty to brands they have had good experiences with previously. Parents generally buy clothing in smaller batches over time or in order to prepare for a seasons. Sets are common, but parents don't buy all clothing from a single store. Most often they have a hard time finding suitable clothing and as such will take every opportunity to buy what good clothing they can find.



Price and economy also affect what clothes parents buy. Most parents think that quality is reflected by the price, especially when it comes to wool clothing, although some point out that cheap clothes also can perform well. Most parents find it easier to buy quality clothes if they are sure they will serve at least one season. They also think that it would be positive if the size was adjustable. Some parents emphasize that children have their own tastes and preferences and thus think that it's important that the child likes the clothes. If the child doesn't like the clothes, they will not be used.

#### Colours and prints

Colours and prints are very important when buying clothes for children. Generally, parents like to dress their children in strong colours. Furthermore, dark colours on outerwear might be popular among young males but decreases the visibility of the child which in turn decrease their degree of traffic safety. Parents dislike colours and prints that are too gender-stereotyped. Several parents mentioned the options of "princess clothing", i.e. pink, lilac and glitter, against "combat clothes", i.e. dark, black and blue with prints of e.g. cars or skulls. Depending on what clothes children wear, they are treated differently. Also, if clothes are to be inherited by younger children it is again deterimental if the garments are too gender-stereotyped. Some parents further mention other stereotypical factors in children's clothing they don't like, such as tighter and less reinforced clothing for girls.

There is also a care aspect of clothes. Those that often get very dirty (such as outerwear pants) should preferably be in darker colours. Wool clothes should not be dyed in too light colours as these will look tawdry after a while. However, bright colours are beneficial when being outdoors since they are clearly visible.

## 3.6.7 Summary of attitudes

#### Children

Children are not cautious about their clothes and can get extremely focused on their play, not noticing that they get cold or wet, or even that time is passing. Younger children won't notice that they get cold, instead complaing when it starts to hurt (which generally is too late). Furthermore, children can't "bite the bullet" in the same way as adults, nor are they as durable as adults when uninterested in an activity. Children often don't have a problem getting dressed by themselves at day care centres, but at home they demand help from their parents. They can adapt to their clothes, for instance engaing in calmer play when their clothes restricts their freedom of movement. However, they can also get frustrated and change their clothing, e.g. taking off their mittens.

Children's preferences are quite different from those of adults. When asked, they think more about details (such as fun pockets or prints) than function, for example prefering things that are pretty or fun. When observing children and talking to their parents, it's obvious that comfort and function are also very important qualitues for children, since they appear very bothered by uncomfortable or non-functional clothing. However, they appear to have a hard time expressing this. Children seem to be more sensitive than adults and have high demands on the comfort and fit of the clothing. For example, children are bothered by small things such as knobbly clothes or too narrow necklines. But when buying clothes with their parents they don't express that they care that much about function and practicality even if they demand that the garment is comfortable. In fact, if they don't find the garment comfortable, they will not wear it. From about four years of age, children start to care more about what they wear (as they become more affected by their environment). As they age, the more they care about peer pressure and which clothes they wear.

#### Adults

Some adults find it important that the clothes are easy to take care of and that they are easy to put on and take off. Others think it's more important that the clothes are functional and that it's alright if dressing and undressing takes some time. Some actions, such as going to the toilet and putting on clothes, are troublesome according to most parents, but they "have to be done". Parents dress their children according to how warm they are themselves. Mothers generally put on more clothes than fathers. It's very important for parents that their children don't get cold, but they are not as conscious of and responsive to if they get too hot. They think of themselves as bad parents and feel guilty when their children get cold. Safety is also an important factor (retro reflectors etc.) even though parents don't always know why clothes are designed the way they are, for example why hoods are removable.

Most parents claim that shopping clothes is tiresome. They often impulse shop if they find something at a good price, but also shop by season. They find it difficult to find clothes that fit well and they often settle for "good enough" as there seldom is enough time to search through everything. On the other hand, parents also like shopping for children's clothes: "I like to shop, it can be fun to buy things for the children, especially smaller versions of things I own". Many grow loyal to brands they have had good experiences with previously. Parents are prepared to pay a certain price for clothing but they become dissatisfied if the clothes are too expensive or simpler than the price would suggest. If expensive clothes break after only a short period of time, they get even more dissatisfied.



Parents are generally happy with wool clothes, which are pricier but functional. The high price and the functionality make parents care for the clothes. It's positive when clothing last for a long time, without breaking or being grown out of. Parents think that expensive clothing especially should last for a longer time. Most parents are very happy with clothes they own that can be enlarged. When buying clothes for children, most parents buy larger sizes than necessary so that their children can grow in them. They want the clothes to last for one whole season when buying season specific clothes.

Colour and prints are very important for parents, both from a gender perspective but also to make it easier to pass down clothes between children with different genders. Parents generally like when clothes have a lot of colour and find it more important that the clothes are fun than that the colour fit their child. Many find the contrast pink/purple and blue/black very boring. They want to influence what their children wear while they can as parents find that children have their own willpower.

Parents want their children to wear toxic-free and organic clothes and they want to know that the clothes were manufactured under good circumstances and working conditions. Even so, it's more important to them that the clothes are good for their kids than how they affect world ecology.

Long underwear is sometimes not considered suitable indoor-wear since some parents see them more as underwear than everyday clothing and appear to consider them to be unrepresentative to wear. Long underwear is frequently used on skiing trips. In these situations, it seems to be more socially accepted that both children and adults wear long underwear indoors.

Parents don't like to wash clothes if it's not necessary. Outer garments don't get washed very often. Inner layers get dirty fast and need to be washed regularly. Some parents think it's just easier to wash everything than to evaluate whether or not something need to be washed.

## 3.6.8 Total summary

Children and adults have different needs when it comes to winter clothing. For example, children have different proportions compared to adults. Their cognitive skills and their gross and fine motor skills are not fully developed, meaning they can not always perform the same task and activities as adults. Children also have different preferences, basing much of their judgement on notable features while having a un-pronounced high base requirement on comfort. Lastly, they have a greater emotional need and are very focused on their activity meaning that their clothing need to withstand wear and extreme movements.

When being outdoors with children one must make greater preparations for breaks when not able to go indoors, which requires more planning and logistics. The nature of children and their behaviour means that they run a greater risk of getting dirty, hot/cold, tired, wet or hungry. This affects their mood even if they are unable to always sense in time why they are uncomfortable or lack physical ability necessary to fix the problem themselves. Furthermore, it is hard for children to dress themselves and be dressed. Outdoor wear is not optimal in terms of dressing as it takes a long time to apply. This also creates problems during toilet visits. Also, both children and parents have difficulties choosing the correct degree of warmth when dressing.

Parents have difficulties finding satisfying clothing on the market, especially as children quickly grow out of garments. Parents try to counterbalance this by buying clothes to grow into, resulting in big sizing. Moreover, as children have a tendency to become dirty, laundry needs are high and thus parents want easy to care for clothing.

In order for winter clothing to be comfortable it needs to offer heat and moisture transport and insulation (thermophysical wear), pleasant mechanical sensations (skin sensorial wear comfort), fit the wearer and function (ergonomic wear) and apply to the wearer's perception of the garment (psychological wear).

# 4 Material study and sustainability

This chapter describes properties of wool and knits as well as sustainability issues relating to wool clothing.

## 4.1 Merino wool

The main material used in the project is merino wool from New Zealand. Regular wool is hair from domesticated sheep (Humphries, 2009) and made up 2% (of a total of 66.9 tons) of total fabric production in 2005. The main production of merino wool (also of fine merino wool which makes up 90% of its produce) is Australia (33%), followed by New Zealand in second (14%) and China in third place (11%). The rest of the world's sheep wool output comes from many other places all over the world. Most domesticated sheep must be sheared by humans, in comparison to wild sheep that shed their hair naturally. For more specific information about the wool fibre, see Appendix 3.

Merino wool is a niche market combining commercial interest of wool growers producing very fine wool and manufacturers with a reputation of creating high quality wool (Simpson and Crawshaw, 2002). The wool comes from the merino sheep (the oldest and most numerous sheep breed) and is a soft, fine wool. This type of sheep is the finest wool producer as it has no kempy wool (brittle fibres sometimes mixed with normal fibres) in its fleece and a high annual yield of (pre-degreasing) up to 4.4 kg of wool. (Humphries, 2009). New Zealand is generally known for its meat and wool producer crossbreeds of merino and other types of sheep. Even if the merino breed is mainly a wool producer it is especially resilient and can be raised in areas that are too extreme for other types of sheep (The New Zealand Merino Company Limited, 2014) which suits the Southern New Zeeland well as they are the only breed that can be kept there. There were about 2 million of merino sheep in New Zealand in 2003 (Sheepworld, 2003).

Wool quality is linked to fineness which is expressed as the diameter of the fibres in microns ( $\mu$ ) which denotes millionths of a meter. The finest wool has the highest quality. The wool grade of merino wool is graded as fine (18-24 $\mu$ ) or superfine (12-18 $\mu$ ) (Humphries, 2009) and is as such the sheep variety with the finest wool. A finer wool gives a finer yarn (Humphries, 2009). The sheep produce soft and luxurious fabrics that are highly suitable for next-to-skin wear (Russell, 2009). Merino wool doesn't itch. It has all the qualities ranked as best for fine fabrics and the scales on the fibre surface are tightly packed giving a soft feeling with much crimp (12-18 $\mu$ ).
#### Properties of wool

Positive properties	Comments
Comfort	High comfort overall
Absorbency	Because of the fibre structure. Most absorbent
	of all fibres, can absorb up to ½ of their weight.
Hydroscopic (feels dry even after moisture ab-	Because of fibre surface and interior cells.
sorption)	
Collect little static	Absorbent fabrics collect less static.
Soft	
Warm	Loftiness gives good insulation, even when wet.
Appearance	
Beautiful texture	
Pleasing hand (feeling when touching fabric)	
Wear and care	
Good elastic recovery	
Not prone to wrinkling	
Water- dirt- and stain repellent	
Good abrasion resistance	Looks good after a long life.
Low tenacity	Pills easily removed.
Moldable	Because of fibre surface.
Natural flame resistance	Burns slowly and the flame has a tendency to
	go out.
Negative properties	
Comfort	
Can irritate the skin	If the hair is coarse (which merino is not). Very
	seldom caused by allergies. Causes itching and
	redness.
Weaker when wet	Not as long as it feels dry against the skin.
Wear and care	
Felts (when warm and moist) if un-treated with	
anti-felting treatments	Because of fibre surface.
Can be eaten by insect larvae	
Manufacturing	
Exists in a limited supply	
Hazards of agriculture	E.g. pests.

#### 4.2 Knits

Knitting, a construction technique where yarn is formed into connecting loops, can be divided into two general types (see fig 3): weft and warp (Humphries, 2009). During weft knitting, yarn is fed from the side. Loops are formed horizontally and connected to the neighbour vertically. Warp knitting uses a separate needle for each yarn and feeds the yarn from the end. The loops are formed vertically.



Fig 3: Warp (above) and weft (below) knitting

Fully fashioned (the garment piece is made during one single step of knitting), flat knitting (producing rectangular pieces of knitting), circular knitting (producing a tube of material) and warp knitting (e.g. laces, tricots) are common techniques (Simpson and Crawshaw, 2002). Wool is mostly produced by fully fashioned and flat knitting. Circular knitting is limited to certain markets and warp knitting is seldom used for wool. Terry (see fig 4) is a fabric that is woven or knitted with loose loops of yarn on one side of the fabric (Humphries, 2009). The knitted version is manufactured using a special circular plain stitch machine with weft knitting. Extra yarn is knitted through the back of the inlay and pulled out to form loops. The loops provide an insulating loftiness and the extra yarn has the ability to absorb more moisture.



Fig 4: Wool terry

Properties of knits	
Positive properties	
Comfort	
Comfort stretch, more give than woven fabrics.	Comments
Extensibility (ability to grow).	Overall high comfort
	Depends on type of yarn, knit stitch, type of
	machine and needle. Does stretch in specific di-
Shape retention	rections subject to the material and manufactur-
	ing process, often one-way.
Warm	Depends on type of yarn, knit stitch, type of
	machine and needle.
	Insulates well as it is porous and holds much air.
Good vapor transport	Furthermore it has an uneven surface that cre-
Wear and care	ates less contact with skin
Recovery (recovering its shape after extension)	Because of the open structure.
Easier cleaned than woven fabrics	Depends on type of yarn, knit stitch, type of
	machine or needle.
Negative properties	
Comfort	
Not windproof	
Wear and care	
Not as durable as a woven fabrics	Because of the open structure.
Tendency to sag and bag in wear	,
Prone to distortion	
Prone to shrinkage after washing	

#### 4.3 Sustainability of wool

Sustainability is defined as the ability for the people of today to live well and fulfill their goals, while ensuring that future generations can do the same (Berlin and Adams, 2014). Three tracks have been developed to map out this abstract definition of sustainable development:

- Economic: Profitability, business growth, meeting market demands
- Environmental: Planet, environmental resources, natural heritage
- Social: People, social justice, equity, equal opportunities

Globally, there is a large consumption of textiles. A growing world population not only increases textile consumption, but the amount of textiles consumed per person is also increasing (Russell, 2009). This means that the textile industry has a huge impact on all three areas of sustainability. Mainly the environmental issues, such as toxic emissions and pesticides, have been brought up in the media. But social issues, such as low wage jobs and globalism, have also been en vogue in the mainstream debate. Of course, much is at stake economically with such a large global industry.

It is difficult to assess practices used during manufacturing due to the often scattered supply chain of clothes and textiles (Russell, 2009). Even if many consumers now demand well conducted production, much data is lost during the stages and handover of goods between manufacturers. Furthermore, this means that claims may lack accuracy, verifiability and context. This, in turn, makes information about sustainability inaccessible even if that information is desired further up in the supply chain. Wool has an even longer supply chain than many other fibres and ownership may change several times during this course. See Appendix 4 for a screening of the environmental impact in different stages of the lifecycle.

#### 4.3.1 Wool farming

As previously mentioned, the wool used in the project is produced in New Zealand.

As wool is a naturally produced protein it is renewable (Russell, 2009). Unlike synthetic products, it also has a yearly cycle of production as well as being limited in supply. Wool products are constrained by competition against other crops and by environmental aspects in sheep grazing and wool processing (Simpson, 2002).

The holding of livestock has an impact on nature. Grazing has both beneficial and deterimental impacts. Firstly, herbivores keep a landscape open and could help maintain its character. However, over-grazing can lead to erosion as the vegetation keeping soil in place is removed (Brown, 2009). Several areas in the world see environmental consequences of growing herds of sheep or goats that live in areas unfit for other purposes (this is roughly two fifths). These areas are mainly located in Africa, the Middle East, Central Asia, and northwest China. Furthermore, there is no guarantee that areas without consequences are managed well.

A growing concern in sheep farming is the practice of mulesing, where some wool-bearing skin around the anal area is removed to decrease the risk of pest infection (Sneddon and Rollin, 2009). This has been claimed to harm the sheep and cause unnecessary suffering. However, the wool for the material used in the project comes from mulesing-free farms. Further, other aspects of animal welfare and neglect are relevant when discussing sheep farming.

Wool is most commonly harvested using hand clippers. To keep the final product free from unwanted residues, the woolgrower is responsible for using approved pesticides, drenches and agricultural sprays. However, the use of such chemicals also adds to the environmental impact (Simpson, 2009). Wool is packaged and compressed before transport. The compression puts high demands on the packaging. For example, it has been discovered that polypropylene packaging shatters fibres, contaminating fine wool, which leads to visible faults in the finished fabric. Another problem with compression is that wool that has been compressed for a long time is difficult to break up into a manageble form (Simpson, 2009). Furthermore, sheep are bred all over the world. The transport of wool to different locations for further processing also has an environmental impact.

#### 4.3.2 Textile production

At Aclima, both the manufacturing of the actual material (i.e. knits) and the finished clothing are conducted in-house with the knitting plant in Denmark and the sewing plant in Estonia.

The textile industry was among the first to start the industrial revolution and later to adopt globalisation (Russell, 2009). As late as in the 1990s, a mass of industries moved from developed countries with traditional production to less developed ones in order to take advantage of lower wage range, progressive assistance packages and less stringent or monitored environmental standards. This concentration and lack of care in the new production areas has led to a high degree of pollution in these areas. Fortunately, many of these countries seem to be trending toward stricter controls. However, there is still a need to evolve to create good sustainability principles.

Even today, many countries see the need to reclaim local industries as future wealth demands export and high value products (Berlin and Adams, 2014). This has led to many re-industrialisation initiatives. The implications are greater proximity between production and headquarters or product development as well as closeness to the market where the goods often are sold (as is the case of e.g. Europe). This would create benefits from simplified logistics and communication, but also helps an area to be self-supporting economically. Economical wealth tends to spill over into the the social sphere when it affects employment ratios. Further, local production means that it is often easier to have a transparent production line, which is beneficial for the consumer, company and society. Thus, local production is a more sustainable production.

Environmental impact is usually evaluated by determining the energy requirements as well as water and resource usage (Russell, 2009). Further, toxic waste from the laboursome production steps of textile production also affects the environmental impact of fabric production. Fibres differ between how much energy, water, chemicals etc. that are required in order to produce the end product of combed and aligned fibres. However, the difference between textile mills is probably greater than the differences between fibres. Older mills might use more resources while modern mills use efficient state of the art low liquor-ratio equipment (ibid.).

#### 4.3.3 User phase

Since clothing has an active user phase, with continuous handling and washing, it is also important to regard the impact during this life phase. In one example, the washing and handling of polyester trousers and cotton briefs consumed between 76-80% of the energy use (when washing, drying and ironing) during the garment's whole life cycle (Russell, 2009). Furthermore, the use phase accounts for the greatest water consumption.

Wool is a more hygienic fabric than many others, requiring less washing as it is often sufficient to simply air the cloth instead (Russell, 2009). Most consumers also are intimidated when it comes to wool, and are not willing to hot wash or tumble dry it even if the wool has been treated to withstand this type of handling. Still, hand washing (a method sometimes used for sensitive wool garments) would nonetheless inflict a lower degree of wear on the garment, increasing its lifespan. On another note, wool clothing is best washed with laundry detergent free of enzymes. It is unknown to the authors whether this is better or worse in regards to environmental aspects, but it does still require the consumer to purchase a secondary detergent.

#### 4.3.4 Disposing of clothing

Most textile garments finish their life in landfills, which are becoming less common in most developed countries (Russell, 2009). Thus much waste is transported away to countries that keep landfills. In anaerobic landfills, natural based fibres (such as wool, rayon or cotton) decay quickly while synthetics decay slowly. As wool is a naturally produced protein it is biodegradable. However, all fibres potentially produce methane, a potent greenhouse gas, that will add to the greenhouse effect if not collected.

There exists a higher demand for both reusing and recycling wool clothing, as the fibre is relatively expensive (Russell, 2009). At specialist fibre reclamation firms the garment might be shredded to return it to fibre form after a sorting by colour to minimise redyeing. The resultant fibre is called shoddy. Sometimes shoddy is blended by carding with other fibres before a spinning step. The finalized products might be garments, felt or blankets.

# 5 Requirement specification

This chapter describes the requirements specification that was formed with data from the user and literature study.

Туре	Requirement	Request	Ranking	Value	Comment
Comfort	Accommodate good comfort		5		
	Keep user warm		5	<ul> <li>Keep normal body temperature</li> </ul>	• • • • •
	Keep user dry	Accomodate water resistance	-		
	Allow removal or absorbation of perspiration		5		
	Accommodate possibility to regu- late temperature		4		
	Minimize gaps		3		
		Minimize bulk- iness	2		
	Maximize free- dom of movement		5	Arms up, around. Lift knees up.	
	Accomodate good fit		5	User measurements must correspond to	Neither too small
Customer Value       Maximize user value         Fit well in Aclima's collection       Fit well in Aclima's collection         Accommodate reasonable price       Accommodate cer- Fit ain user growth do structure	Maximize user value		3	the measurements on the garments with some margin	nor big so that it doesn't limit free- dom of movement
	Fit well in Aclima's collection		4	of error.	
	Accommodate reasonable price		4	Max 900 sek/ garment	Not more expen- sive than similar
	Fit a certain user during one whole season	4	Fit three sizes (90, 100, 110)	market Age 2-5	
		Minimize losing pieces of garments	2		
Ergonomics	Accommodate er- gonomic support		4		
	Simplify dressing and undressing		4		Doesn't neccesarily need to be measured in time. Instead, that the user wouldn't need to take shortcuts and has a happy feeling afterwards.

Туре	Request	Requirement	Ranking	Value	Comment
	Maximize chil- dren's capability to dress and undress on their own		4		The amount of times the child needs help
on their own Maximize und standing of dra ing procedure Accommodate of fine motor s Accommodate safety Simplify bodil waste eliminat	Maximize under- standing of dress-		4		If there is a direction in the garment, it should be clear
	ing procedure	Simplify dressing children right	3		Show clearly what layer the garment is supposed to be
	Accommodate use of fine motor skills		3	•:	To a certain degree
	Accommodate safety		5		Retroreflectors, no fixed hood, follow laws
	Simplify bodily waste elimination		4	•:	Can't take too much time
<b>D</b> 144 1	xx7/2 1 1 1	Clarify functional details	3	•:	For example removable hood
Durability and- care	Withstand han- dling of users		4		(why is it remov- able?)
	Maximize durabil- ity during use		4	Higher demands than an adult's. Measure over time.	
	Accommodate quick drying		4	•: Overnight	•
	Endure washing in washing machine		5		-
	Minimize risk of soiling		2	Whole or parts of garment	Minimise expo- sure to dirt or make the garment
	Endure drying in drying cabinet	F. J J	4	* 40°	dirt repellant
Aesthetics	Appeal to users	tumble dryer	2		
Астального Ар	Accomodate		4		
	colourfulness	Accomodate fun details	3		
	Accommodate gender neutrality		4		
Sustainability	Minimize sus- tainability impact		4		
	Minimize toxins		4	•	To a certain limit
		Maximize organic materials	3	•	Difficult to affect
		Foster sustainable behaviour among	4		
		users			

#### 5.1 Trade-offs in the requirement specification

When regarding the requirement specification, some challenges and trade-offs were identified:



A waterproof fabric hinders water to be transferred through it, while a breathable garment encourages this effect. Thus a more waterproof fabric is less breathable. Today this is done by using water repellent coating applied by spray or membrane layers that let smaller water particles through. Even when disregarding other properties such as price, wear resistance and sustainability, neither of these solutions are waterproof but rather water repellant.



A warmer garment has more insulation and restricts air escape. This means that the garment will bundle the wearer fully and tightly (and especially so in certain areas) with the drawback that it will be more cumbersome to dress in.



An uncomplicated garment is both easier to produce and also offers fewer distractions that can break or affect the user's understanding and safety. However, when disregarding functional details, functionality itself can also be reduced, such as when opportunities of regulation are removed if a front zipper not is included.



Different functionality (e.g. ease of understanding, dressing, regulating temperature or allowing for growth) could certainly oppose each other when applied in a specific way. However, this is solution dependent.



Safety in children's clothing is especially critical, and added functionality such as drawstrings or tight buttons may add risks of strangulation or other safety issues. However, this is not completely exclusive, as added functionality can enhance safety, e.g. a removable hood is safer than a fixed one. Reflectors are also an example of a safety element.



Since a child is constantly growing, the perfect fit for the child is ever changing. The size of a garment is more or less static (more elasticity gives room for more size variations) and does not as such account for growing. Further, a good fit gives the best ease of movement (both too large and too small garments affect ease of movement) and this will be reduced by a change in fit. A garment's function (e.g. warmth, wear resistance, ease of dressing) is also affected by fit.



Gaps created by the interfacing of different garments offer a wide range of opportunities in dressing, such as regulation of temperature (e.g. jacket and pants provide more regulation possibilities than overalls), ease of movement (clothing pieces that are not sewn together will not hinder movements) and possibilities for growth/ fit (when layers overlap, the overlap can shrink when the child grows while still being highly functional). However, gaps will always produce risks of exposing under layers or skin leading to a loss of coverage or warmth.

## 5.2 Important functionality to retain

The following are important functionality to retain, regardless of the final solution.

- Possibility to make toilet visits without any major issues
- Possibility to get dressed without any major hindrances
- Freedom of movement
- General functionality (e.g. warmth)
- Safety
- Washability

See Appendix 6, for full requested functionality.

# 6 Concept development

This chapter describes the concept development phase from the requirement specification to the evaluation of the solutions.

#### 6.1 Focus areas

Since the project is restricted to using wool as the main material and doesn't consider outer garments, some requirements were disregarded, such as waterproofness and garment options such as mittens. In the chosen context of inner garments, three areas with great opportunity for improvements were chosen as a main focus when developing concepts:

- Possibility to grow in (use for a longer period of time)
- Regulation of temperature
- Facilitation of dressing

These three areas emerged frequently during the empirical study and were deemed suitable to work with considering the given conditions, such as the available material. Also, the market was identified to lack good solutions to these difficulties. Therefore an opportunity exists to fill this market gap with a well designed product.

#### 6.1.1 Allow growth

Children grow quickly and don't have time to wear their clothes out before the clothes become too small. Parents regard many clothes as being too expensive considering the short period during which they are used. Many parents buy too large clothes and let the child grow into them, sacrificing fit. Later, clothes are also used to an extent where they are too small. Except for a bad fit this also leads to less wear resistance as the material is stretched thin. Reviewing sewing patterns for children in the age group (age 2-5, generally size 90-110 centilong), one can see that space widthwise changes little (circa 5 cm) while space lengthwise changes more (circa 1015 cm). Even if children have different shapes and grow differently, one can use these sewing patterns as guidelines and focus more on added length in solutions. Furthermore, an elastic material can withstand an added (small) amount of stretch widthwise as the material will elongate in this direction.

Possible general solutions could be:

- Tucks, folds or pleats (sewn or open): fold up hems on sleeves/legs and shirts, tuck in fabric in well chosen places (for example at available seams), a design of pleats or sewed folds.
- The possibility to add length by an adding a piece of fabric.
- Having a silhouette that looks good when both "too small" and "too large".

### 6.1.2 Facilitate regulation of temperature

Children don't have the same understanding as adults for the layering principle. Also, they don't always evaluate their physical status consciously. They take off their cap and mittens first if they get hot, which often leads to freezing in sensitive areas. Therefore simple regulation around other parts of the body (for example around the neck) is helpful. Children are not very patient, which means that regulating the temperature needs to be easy and take a minimal amount of time. Furthermore, it's hard for children to reach distant parts of their body and they lack the hand strength of an adult. Possible general solutions could be:

- Take away or add parts of the outfit, e.g. sleeves, collars, middle layers.
- Open up: Fold down or open up around the neck or collar, fold up sleeves, openings in warm areas that are easy to see and reach.

#### 6.1.3 Facilitate dressing

Dressing children often takes time and creates conflicts. Many parents want their children to learn how to dress themselves but some components, like inert buttons or finicky details, are too difficult for them due to physical and cognitive limitations. Children sometimes fail to dress properly under the outer layer, forgetting middle layers of warmth. Also, they have a harder time understanding how much clothing that is to be used given the weather conditions. Understanding how much clothing to use is also hard for the parents. Moreover, children want to learn to dress themselves but might at times also be reluctant to be dressed at all.

Possible general solutions could be:

- Better grip and accessibility: large buttons and zippers, velcro (a solution that however lacks wear resistance), well chosen openings that are easy to see and reach.
- Simplify body parts placing: large openings for head and limbs, make sure that sleeves in underlayers won't bulge up during dressing.
- Clarity in design: accent colours for clarity, clearly show front/back or up/down (with e.g. colour or print) and openings that in general are easy to see.

### 6.1.4 Other development possibilities

To increase customer value and desirability, it is beneficial that the clothes are designed to look like everyday nice-looking clothes. If a garment primarily used for sports is made to look nice, the chance that it will be used in everyday life and thus more often is higher. As such, a consumer could view the garment as more useful. Further, an everyday garment is more desirable than single use clothing and thus more purchasable. From the perspective of the user a nicer everyday-looking and well liked garment would make the child more compliant to wear it, which may ease dressing and increase the amount of use events.

To make stains less visible it is preferable to use darker colours. The use of dark colours in these areas will also make them seem more wear resistant. Gender separated clothing is both fun and restricting, and contributes to stigmatization of certain elements. The study showed that it is preferable that the colouring of the clothes is gender neutral, even though the present market is quite segregated into gender based divisions. This means that it's easier to buy gender based clothing even if the parents are reluctant to do so. Furthermore, children can easily assess where "they belong", and given their preference to belong they often like to be placed in "their division" (i.e. boys/girls). As such, both the market and children in general do press adults to buy gender based things. However, a clear benefit of gender neutral colours, besides helping both society and parents to neutralize colours, is that such clothing is easier to pass down between children of different genders.

In children's wear, gender neutral permits a broader range than adult wear, as colours preferred for children have different tones and saturations. Furthermore, many prefer children's clothing to be in strong colours. Thus a more intensely coloured garment is viewed as being more fitting for children. Certainly, parent's do think it's fun to buy cuter or more colourful clothing for their young. Also, some parts of the clothes could preferably be in bright colours to make the children more visible when outdoors. This is especially important for outer garments. Furthermore, children sizes and sewing patterns are unisex as there's no difference sizewise between genders. When assessing general gender neutrality (such as details, patterns or silhouette) this is important to keep in mind.

Still, there are elements and silhouettes that are considered to be gender specific. A garment can play with these elements (some may argue that they should) but to cross over too much in either direction would turn away a large group of consumers as they would feel that the garment is unfitting for their child (either by being too much or not enough gender-stereotypical).

#### 6.2 Expression

These two boards show a descriptive visualization of Aclima (left one) and the desired expression of the developed concept (right one). The boards were used as inspiration for concept development.



Fig 5: Expression Boards

#### 6.3 Solutions

During concept development, existing solutions found in the market analysis were used as inspiration, see Appendix 6 for style gallery of openings. Below, specific solutions to solve the challenges given in the focus areas are presented.

Solutions for regulation of growth (see fig 6)

- Regulate length by tucking in fabric, by stitching with zig zag seam or cross stitches.
- Regulate length by tucking in fabric with the help of snaps or other fastening solutions.
- Gathering fabrics with the help of a string in a canal.



Fig 6: Growth Solutions

Solutions for regulation of warmth

(see fig 7)

- Possibility to remove parts of a garment e.g. sleeves to make a vest out of a sweater.
- Collar solutions where the collar can • be folded down and the neck area opened up. Several options.
- A regular zipper opening (an easy • area to open up.)
- Thumbhole cuffs warm the back of • hands but are also easy to fold up.

Solutions for simpilifying dressing

#### (see fig 8)

- Two-coloured. A two coloured pant (legs have different colours) helps the child to place the leg in the right pant legs.
- Zippers with clear design and easy grasping possibilities.
- Thumbhole cuffs help the child grasp the end of the sweater as another layer is applied.
- Envelope neckline. Common neck-• line in infant clothing. Back and front pieces overlap in shoulder area and are stitched closed in sleeve seam. Allows for a larger neck opening during dressing.











Fig 7: Regulation Solutions

Various mixed solutions

- Nice looking clothes for everyday use creates a higher appeal, as the garment is beautiful while flexible in use.
- Many-in-one. A garment that can easily be altered to become other types of garments, e.g. jacket to vest, overall to separates.
- Aesthetic details that will appeal to the user group.
- Aesthetic details/print that grow with the user.

The part solutions from the idea generation were compiled in a morphological matrix (see fig 9).



Fig 9: Morphological matrix

#### 6.4 Evaluation of solutions

The table below shows a summary of the results from the Pugh matrix. Four concepts, put together by combining part solutions from the morphological matrix, were evaluated against the requirement specification. The numbers in the table come from the Pugh matrix evaluation, where the bold numbers (to the right) are scores weighted by requirement importance and the thin numbers (to the left) are the unweighted scores.

Concept 0	Concept 1	Concept 2	Concept 3	Concept 4
Regular middle opening, cuff fold- ing	Fold in, reinforce- ment, envelope neck- line	"Canal" in side seam. Collar solu- tion.	Armhole, snaps, take of arms, several in one, large long zipper	Fold in, hem/straight piece, two colored, short clear zipper
114 <b>411</b>	119 <b>429</b>	120 <b>438</b>	121 439	123 444

See Appendix 7

The formal evaluation shows that the difference between the best and the worst concept is not very large, with a difference of 8% between the best and worst. However, the Pugh evaluation clearly shows that the highest score derives from allowing growth as this requirement has been ranked highly. After validation with the company stakeholders, manufacturing possibilities for all concepts were discussed and all of them proved valid. However, the final concept was chosen in order to minimize effort in production. Due to manufacturing constraints in machinery and process the canal concept would be easier to manufacture. The canal solution will also offer best support of continuous growing. Furthermore, as few solutions are exclusive, several of them can be chosen together. However, in regards to usability it is beneficial that not too many and complicated solutions co-exist in the final product. As such, the final concept is a collection of the part solutions that helped the concepts to score, e.g. a clear zipper. Fun aspects that are hard to evaluate in numbers but offer value to the user are also a part of the final concept, such as collars and the ability to make a vest.

# 7 Final concept

The final concept, which can be seen in fig 10, incorporates a middle layer sweater jacket and pant set with special features. Today, Aclima's children collection mostly offers under layers and therefore a middle layer garment would widen their range. Further, the market today offers a vast amount of under layers for children. Middle layers are more rare, and as the lower price market yet has to catch up it would be easier to sell high quality garments in this sector. Moreover, a middle layer fabric is thicker and will offer more support for hardware and technical solutions, which is beneficial for a function dense concept.

Separates are chosen, as these can be used during a longer period of growth. Furthermore, pants and sweater can be used separately and will thus offer more possibilities of warmth degree and styling. Lastly, it is important that both garment pieces look good and could be incorporated in several use cases, thus increasing the user value.

The final concept has functionality that makes it possible to enlarge the garments and it can therefore be worn over several sizes (for children age two to five this is size 90-110). Hence, the garments can be used for a longer period of time. The longer use phase increases the chance of the garment being worn out instead of grown out of. The concept also looks more like everyday clothing, which further increases the amount of possible uses. This means that fewer different garments are needed, which saves both time, money and is more sustainable.



#### 7.1 Fit

The garments have a wider fit (especially in the waist area) than an under layer since this was deemed more suitable after testing prototypes on children. The waistband on the pants has a 20 mm elastic drawstring inside. This can be tightened or loosened through a buckle to make it possible to adjust the width of the waistband as this measurement varied greatly between children (see fig 11).



Fig 11: Waist band

#### 7.2 Fabric Choice

Merino wool is an excellent material in regards to the comfort wear factors discussed in chapter 3.5. It is absorbent, warm and has a nice surface as stated in sub-chapter 4.1. As benefits a middle layer winter garment a thicker wool fabric was chosen: Aclima's merino wool terry 400 g/m3 (see fig 15). Terry is woven with loops of threads on one side of the fabric. This gives a loftiness that traps air and thus insulates well. Even if the other choice, 230 g/m3, variant would be warm enough for a middle layer, the chosen material has a nicer hand that more clearly signals that it is made of wool. As a result it looks more expensive. Furthermore, a set where the garment pieces can be used separately and where the pieces themselves have regulating features is easy enough to regulate temperature-wise. The surface is also cozier and the inside even more so. It also offers a soft feeling against the wearer's skin which is beneficial if the wearer has sensitive skin. During the user testing the coziness was one of the first properties mentioned by the children.

The merino wool terry chosen for the concept does contains polyamide. From a sustainability perspective this makes recycling harder but including polyamide makes the fabric stronger which is beneficial in children's clothing. Except for the strong comfort factors of terry wool the features of pleasure, durability and quality suggest that the material choice is sound.

A test was made where sand paper was dragged against the fabric repeatedly to determine if the fabric was wear resistant enough (see fig 12). This showed that the fabrics wear similar on both sides and between themselves. Thus the difference between the fabric would be small in terms of wear resistance.

Furthermore, another test was conducted to determine dirt (sour milk and soil) resistancy (see fig 13 and 14). The fabric swatches were not washed with water, instead the dirt was brushed off with or without paper.



Fig 12: Wear resistance test, front and back



Fig 13: Dirt resistance test, with sour milk



Fig 14: Dirt resistance test, with soil



Fig 15: Close up of the material surface (right side)

# 7.3 Lengthwise tunnels with drawstrings on sleeves and legs

On sleeves and legs, the garments have lengthwise canals with 5-6 mm flat elastic drawstrings (see fig 16). This makes it possible to wrinkle the garments along the tunnels making the sleeves and legs shorter (see fig 18). The garments can be used in three different sizes (e.g. 90, 100, and 110) instead of just one. In order to achieve this, it is possible for the sleeves to be shortened 70 mm and legs 110 mm, which is the difference in length in the 90-110 pattern sizes. Using elastic drawstrings instead of inelastic ones maximizes the wearer's freedom of movement. The canals end in the hem of the pants and at the cuffs of the sleeves. In order to minimize bulk, the drawstring is sewn together (rather than having hardware) in regular intervals and these seams are placed in these end locations of the canals (see fig 17). The seams can be unpicked one by one when a longer length is desired.







Fig 17: Drawstring solution



Fig 18: Wrinkled sleeves and legs



#### 7.4 Jacket middle zipper, fold-down hem with snap button

Having a middle front zipper makes regulation of temperature easy for both the child and an adult helper. Furthermore, a zippered opening makes the neck opening more comfortable and the sweater easier to put on since children's heads are proportionately larger than adults'. The front zipper is a 6 mm (the largest zipper that still is relatively light, fitting user and material) splittable coil zipper (the strongest variant of zipper) with a cover in the top position to prevent the zipper from lying directly against the wearer's skin. The zipper is extra strong in the bottom seam and has reinforcement film to withstand wear. The slider is relatively large, visible and graspable to make it as easy as possible for children with small hands and limited fine motor skills to pull the zipper up and down by themselves. An extra grab attachment could be used to improve this (see fig 19).

The hem of the jacket is finished with a band interfacing to not add bulk. Furthermore, this hem will at the time of purchase be folded up by 100 mm. There is a seam that can be unpicked after the child has grown, in order to add length to the jacket. The zipper interfacing continues below the zipper and merges the gap between the garment sides. The folded down fabric can be closed with a riveted snap button (with a diameter of 10-12 mm) that does not demand that much force (see fig 20). It is essential that the snap button is effortless for a child to open.

It was observed in the user test that children that wish to close a zipper reach for a zipper start by grabbing the hem and searching upwards. When the zipper is missing at that point they will have to make a larger effort to find it. Therefore it is beneficial that the zipper starts as close to the hem as possible when they first obtain the jacket - at which point it will likely be in it shortest mode. Children are fast learners and it's easy for them to perform actions once they have larned them, given that the actions is within their physical limitions. Later, when the hem has been unfolded, the children will both have experience with the garment and be older. Then a zipper that starts higher up won't be as hard to notice and get hold of.



Fig 19: Zipper



Fig 20: Snap button by the hem

#### 7.5 Collar

The final concept incorporates a foldable collar that can cross in the middle, connected by means of an openings on one side, and become a small scarf (see fig 21). The collar is fastened to the sweater with three riveted snap buttons placced on the neckline (10-12 mm diameter) in order to safely come loose if there's a risk of strangulation (see fig 22). The snap buttons are hidden on the inside as not to rest against the skin of the wearer.





Fig 22: Snap buttons by the collar



Fig 21: Collar

The scarf expands 60 mm from the connection point in order to not be at risk of being caught by the ends during playing. Furthermore, a removable collar opens up the opportunity to swap between collars of different colours. The collar can be folded down or used as a scarf and can therefore be used to easily regulate temperature. It was observed during the user test that children could dress themselves in the collar as long as they had ability to put down their whole hand in the opening. This means that the size of the opening should be approximately 60 mm. The opening is placed on the left side of the collar, as most people are right handed.

### 7.6 Zip-off removable sleeves

The sleeves can be removed to allow the sweater to be used as a vest (see fig 24 and 25). This expands the seasonal use duration, increasing user value. The sleeves are fastened with zippers (4-6 mm splittable coil zippers) that also can be partically opened to regulate warmth under the arms (see fig 23). A zipper is denser than buttons and would prevent gaps from forming.





Fig 23: Zipper at arm hole

Fig 24: Sweater with sleeves



Fig 25: Sweater turned into vest

#### 7.7 Additional features

The garments have reinforcements on knees and elbows, for durability (see fig 26). As the chosen fabric is very thick, the reinforcements only cover the knees and elbows in order to avoid bulk and be comforable temperature-wise.





The cuffs have thumbholes, for easy dressing when using jackets over the sweater and also help warm the back of the hand (see fig 27).



Fig 27: Thumb hole

The pants have pockets, to increase the perception of a dressed garment and to allow interaction between the child and the garment (see fig 28).





#### 7.8 Colour and aesthetics

Darker colours help hide stains. Intense colours fit children. Thus a highly saturated and rather dark colour would fit a child garment, especially on areas with high exposure to dirt such as reinforcements on knees and elbows. Colour proposals can be viewed in fig 28. The opportunity for fun details is larger in children's wear and as such strong accent colours on stitching, smaller pattern pieces and hardware are is used. Colours and aesthetics offer a unique opportunity to speak to the child and offer something special that will appeal to them. The use of a patterned zipper adds another colour element to the clothing, offer even more clues for interaction, and include an opportunity for decoration. Graphics that grow with the garment can offer an additional fun factor to letting the garment out (see fig 28). Printed graphics in general are easy for a child to notice and respond to, especially if the print is depicting something that children like.



Fig 29: Colour proposals and print

# 8 Discussion

In this chapter, the phases of the project and the final concept are discussed.

#### 8.1 Literature

The field literature concerning children is heavily divided into areas by occupations, for example books about pedagogy for teachers or medical books for doctors. Often, these books are not mainly intended to describe children, instead focusing on e.g. education or curing child disease. The areas overlap but sometimes use different terminology. Therefore researching literature provides a fragmented picture where one has to interpret and sift through information to capture how it relates to clothing and design.

There is a lack of literature about outdoor wear. There could be a correlation to the fact that most of the Scandinavian society is very inactive physically in daily activities. Further, the area of outdoor clothing, especially for children, might lack a flair of research credibility and this would be why it is not brought up by researchers.

Often children are mentioned in a vague terms as "young children". This is a very imprecise phrase and leaves the reader wondering which age that is really designated as children develop quickly between birth and preschool. However, children have an individual development rate and as such it's hard to point out from literature when development specifically occurs for any child. Hence the term "young children" is inclusive and could be the most descriptive choice of language. To compensate for the vagueness one might view the claims as describing the oldest children in the age group and lower the requirements to fit even younger children and thus design for the least developed child in as many aspects as possible. This works as long as the product itself is not designed to push development, such as a game. Most children have some weak points and a concept that's designed to accomodate many weak points would fit more children.

#### 8.2 Methods - in general

The design process and methods used in this project are not very common in the textile industry. Applying a novel way of working in this field was a new experience, which worked very well. It would be highly beneficial for Aclima and similar companies to continue to work in a similar way. Aclima's current way of working is to develop products which they then test on extreme users. In this project, the development instead started by identifying the needs of the users. The concept development process was also very structured. Applying this process on a new field was considered very successful.

#### 8.3 Sustainability

In a time-limited project like this, it is not obvious where to stop improving sustainability. However, a broad screening was conducted in order to catch the most critical issues where economic, environmental, and social issues were taken into account. Also, a lot of thought went into improving the most critical phase: the user phase.

#### 8.4 Interviews

Often it's hard to gain initial access to and attention of possible interview subjects, leading to a loss of possible candidates and their answers because of lack of interest. However, the project focused on designing a product for people interested in outdoor activities and this would be the people that participated in the survey and consented to being interviewed. Therefore the data from the interviews and the resulting implications were sound.

Surveys offer no possibility to ask further questions. This leads to a possible loss of information, as answers could be vague or only paint a small part of the picture. Nevertheless, a survey is a relatively easy method of data collection. As such is it better to have a survey than to not have one.

Children are very much affected by leading questions. They also focus on notable features and truly want to give the "correct" answer. Therefore, the process of interviewing children is difficult and one might question the benefit. However, interviews give good results as long as the interviewer has knowledge about how children usually answer (and thus can interpret their underlying needs) as well as including a person that knows the children well and can probe further into their answers. Furthermore, it is also important to gain a feeling for the nature of children and observe how they answer and behave. This is impossible without meeting children.

Most of the interviewees were well-paid people active in the field of technology. They went to the same university and are well educated. This definitely affected the study results as the interviewees differ from the general population in regards to preferences, prioritization and financial means. However, the target group for the final product would be similar to the interviewees and as such the study results do give an accurate indication to base a product on.

A big part of the discussion during interviews was focused on outer garments. This might have been because it's easy for parents to have opinions about these garments, since they are the main barrier against the environment as well as being most visible when outdoors. Furthermore, the study was conducted during winter when outer garments are necessary. This also affected what the child notices as children mostly focus on highly visual aspects when evaluating. They would make the topic of outerwear prominent, but did not disregard the importance or development potential of inner-layer garments.

## 8.5 Requirement specification

It's easy to measure certain requirements, such as maximum size for example. In contrast, some requirements are more subtle and more difficult to measure. During an evaluation they are harder to both assess and judge. Therefore they are more easily overlooked. This doesn't mean that they are less important - rather, it means that they feel less important because of their status as un-measurable via the difficulty to evaluate them.

#### 8.6 Idea generation

Since the aim of this project was to develop clothes and the authors are very interested in sewing, the knowledge about manufacturing techniques was high. This affected the idea generation process and made it possible to more quickly evaluate the feasibility of ideas. This knowledge can also be seen as limiting since it can be argued that such knowledge hinders innovation. However, in this project, it was seen as a big asset because of the aim to be able to manufacture and sell the garments early on after the project was finished.

The idea generation process started with very general ideas, which then became more specific. Some idea generation methods (like negative idea generation) were used more or less just to get started and didn't actually contribute that much to the ideas and solutions. The best ideas instead came from a relatively long and structured idea generation process.

#### 8.7 Concept development

The construction of mock-ups proved to be a good method as several design features could then more easily be evaluated and tweaked. Had mock-ups not been used, the final concept certainly would have been less developed.

#### 8.8 Evaluation

It's difficult to perform an evaluation that is completely objective even when using formal evaluation methods such as Pugh matrix. The scores are affected by the importance of each requirement, which is decided by the person making the evaluation. However, such an evaluation is a good tool to use in order to show which solutions are considered good and why.

#### 8.9 Final concept

Changing sport clothing to look more like everyday clothing can have different effects. It is possible that parents may not want to use the clothes for what they are primarily made for (sport) because they are too nice looking which therefore induces the opinion that they need to be handled more carefully. However, it is also possible that the clothes will be used both for what they are primarily made for and for everyday use, which increases both the utility of the clothes and the value to the customer. Further, the target group would need less clothing and would hopefully buy less, which promotes a more sustainable behaviour.

The garment would be produced in Estonia inside the European Union. European manufacturing keeps distribution close and jobs in the region. Further, labour issues of in-house production are easily evaluated and can therefore be more fair. This would be the most sustainable choice of production.

The use of a wool product means that washing is not as necessary. However, stains still occur. Even so, wool can be washed in a washing machine and can handle most stain repellants. It is necessary to emphasize this fact to customers as wool is believed to be hard to wash. However, overly highlighting the washability of the garment could lead to un-changed washing behaviour and hence no improvement in terms of environmental impact. Some requirements were disregarded in the start of the concept development phase. Thus, these have obviously not been addressed. Many other requirements are hard to measure. Long term durability of the concept has not been tested due to time restrictions. However, sticking to established construction methods should lead to a garment of sufficient durability. Of course, as the product will be able to grow with children, it will be used during a long time. Quality children's wear is often inherited and must endure a long use period. This means that the product would be durable in the same fashion. Subjective requirements, such as aesthetics, are hard to measure. Still, this doesn't mean that they have not been evaluated. Rather, by means of meetings with users, discussion and careful assessment, they have been considered and can be considered as met.

The study showed that children have a high threshold of comfort and relate well to fun details. During the test fitting, there was consensus regarding the coziness of the pantsuit, which would imply that the the comfort needs of the children have been fulfilled. Of course a final product which uses appealing colours and fun details such as pockets and decorations would charm even more. Such a product would be even more desirable to its users.

Another factor influencing the sale of the product is the fact that the primary users are not the ones making the final purchase decision; instead it is the parents who buy clothes for their children. What the users really want might not be considered. However, parents like cute details and the feeling of quality. These properties are not mutually exclusive with regard to the desires of children, and so both groups need to be kept in mind during the product development process. The challenge is to aesthetically appeal to both groups while not going out of bounds regarding important properties such as comfort or price. The product was constructed to conform to the requirements which were in turn based on both the insights gained during the user study as well as the needs of Aclima. Testing of the mockups validated the construction of the garment as well as its performance. Given an appropriate pricing and adequate marketing support, the product could certainly be successful. The price can be calculated based on existing products and how functionality was chosen to be manufactured. Hardware, another price factor, was carefully considered and kept to a minimum. As such, the cost would be carefully balanced against the added functionality. The functionality of the concept would lead to a longer user period, which means that the consumer would be more willing to pay the asking price. As such, the concept would be both sellable and appealing. In short, this is a well-developed concept to fulfil a need of a user group that often lack satisfying options in the outdoor clothing market.

# 9 Conclusions

Children and adults have different needs when it comes to winter clothing. For example, children do not conform to the same proportions as adults. Their cognitive, gross and fine motor skills are not fully developed, meaning that they cannot always perform the same activities or tasks as adults. Children also have different preferences, basing much of their judgement on readily apparent features while having a un-pronounced high base requirement of comfort. Lastly, they have a greater emotional need and are more focused on their activity meaning that clothing needs to withstand wear and extreme movements.

Through studying families with young children, some problems relating to outdoor activities were identified. In terms of clothing, these were difficulty when dressing and undressing (especially in stressed situations), difficulties to regulate temperature, bad fit of clothing, movement-limiting clothing and the risk that the child would become wet or cold.

In this project (limited to wool) the final concept, which included a sweater jacket and a pair of pants, solves problems regarding growth (fit), temperature regulation, and easy dressing by making it possible for the child to grow in the garments. The garments also have clear details that can easily be used by children, removable sleeves and a collar solution. This concept fits well into Aclima's current collection by means of aesthetic detailing as well as a focus on functionality and ease of use. The final concept met the discovered requirements on children's clothing and contains functionality in several focus areas that are not currently well-addressed in the market. The resulting product is useful, sellable and attractive to the users. Functional wool clothing for the active child.

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### Appendix 1: Interview Guide and Survey

#### Interview Guide

#### Generella frågor

Hur gamla är barnen? Hur länge är ni ute? Hur ofta är ni ute? Vilka aktiviteter gör ni ute? När kan plaggen begränsa barnens aktivitet? Skiljer det sig mellan väder? Vad kan avbryta en utomhusvistelse? Vad har barnen för kläder?

#### Endast dagis:

Vad ger ni för råd till föräldrarna om kläderna? Vad kräver ni att barnen har? Hur håller ni koll på vad som är vems?

#### Kan ni berätta om hur det går till vid påklädning?

Vart förvarar ni kläderna? Vad är svårt i påklädningen? Hur självständiga är barnen? Vad klarar de själva? När behöver ni hjälpa till? Med vad? Har de svårt för höger/vänster? Fram/bak? Hur lång tid tar det? Hur mycket kläder har barnen på sig vid olika temperaturer? Hur tänker ni som vuxna när ni väljer hur mycket kläder barnen ska ha på sig? Vilka kläder finns på plats på förskolan hela tiden och vad tar man med sig dagligen?

#### Hur fungerar det med mat och raster?

Äter ni ute? Tar ni inomhusraster? Får de andra saker att äta/dricka när vädret skiljer sig? Hur ofta äter ni? Blir det olika efter väder?

#### Hur gör ni vid toalettbesök och blöjbyte?

Har barnen blöjor? (Hur hanterar ni det?) Vad skiljer om de har blöjor eller inte? Vad klarar de själva? Måste man ta av allt? Hur lång tid tar det? Är det lika jobbigt att ta på sig igen?

#### Kan ni berätta lite om hur barnen leker?

Hur beter sig barnen? Vad leker de? Hur rör de sig när de är ute? Skiljer det sig mycket mellan vad de gör? Hur varma blir de? Behöver de ändra sin klädsel efter aktivitet? Är det jobbigt? Tappar barnen vantarna ofta? Vad ställer lekarna för krav på kläderna? Begränsar kläderna lekarna/rörelser på något sätt?

#### Hur är det med slitage? Klädskötsel?

Vart slits kläderna mest? Hur ofta tvättar ni? Skiljer det sig mellan olika typer av plagg/material? Vad har ni för krav på vad plaggen ska tåla? Viktigt att det är lättskött?

Vad har barnen för inställning till att vara ute? Tycker barnen om att vara ute? Klagar barnen?

#### Hur fungerar det när det är kallt ute? Sol?

När fryser barnen? När blir de för varma? Hur märker ni det? När är det för kallt för att vara ute? Snor etc, blir det jobbigt? Säger barnen till när de fryser? Om barnen blir för varma? Hur fungerar det när det är blött? Är ni ute här det är blött eller regn? Blir barnen blöta när de leker? Är de blöta länge när de är ute? Hur lång tid torkar ni plaggen? Använder ni torkskåp? Finns det kläder som inte tål det?

Hur går det till vid avklädning? Vad behöver barnen hjälp med? Hur lång tid tar det? Vad gör ni med kläderna sen?

Preferenser kan vänta till senare

Endast föräldrar Vad tycker ditt barn om i klädesväg? Favoritplagg? Varför? Vad kan bli bättre? Sämsta plagget? Vad brukar du välja för kläder till ditt barn? Mönster/färger? Material?

#### Survey

Hur gamla är ditt/dina barn?

#### Utbud

Vad tycker du är bra med de barnkläder som finns på marknaden idag?

Vad tycker du är dåligt/vad saknar du med de barnkläder som finns på marknaden idag?

Vad brukar du tänka på när du ska köpa kläder till dina barn?

#### Aktivitet Vad brukar ni göra när ni är ute på vintern?

När kan kläderna hindra/begränsa barnens aktivitet?

Vart slits barnens kläder mest?

#### Påklädning Hur tänker du när du klär dina barn för att vara ute på vintern?

Vad tycker du är jobbigt eller svårt när du klär på dina barn för att vara ute på vintern?

Vad klarar barnen själva när de ska klä på sig för att vara ute på vintern?

### Appendix 2: Full Cognitive Ergonomics

#### Cognitive development

During the first two years in life, myelination of the brain (isolation of neurons) takes place. Before this development is complete, data transfer in the brain is prone to "spill over" on unintendedly used neurons. However, the development of a human brain depends upon this progress in order to build its structure. The myelination then decreases gradually until puberty, when it is complete (Osnes et al, 2010,).

#### Mental processing abilities

During age two to seven the child goes through the preoperational stage (Piaget, 1929, from Bjorklund, 2012, pp. 165, 169-175) where experiences are being internally represented and can be played out in the child's head (Acuff, 1997). The child might have learned a concept of an object and is able to apply this concept on other things, e.g. calling all four legged animals dogs. Physical exploration is however still dominant (Taylor and Woods, 1998). Intelligence is symbolic (representational) and is expressed via language, imaginary, and other modes. Thought is intuitive rather than logical and there is a lack of logical characteristics of concrete operations. Children are greatly influenced by the appearance of things. They make judgements based on the most salient aspect of their perceptual fields and are thus centered. Also, they are unable to coordinate two dimensions simultaneously (e.g. valuing the same amount of liquid in different sized glasses). They are egocentric and as such assume others see the world as they do. (Bjorklund, 2012). This gives them an inability to estimate perspectives of others (Lueder and Rice, 2008).

As early as of 18th months a child begins to differentiate between "same" and "different". (Lueder and Rice, 2008). They tend to view the world as bipolar, i.e. in "black or white", where the scales in grey are missing (Acuff, 1997). Young children have difficulty integrating objects that form a whole (e.g. vase/faces image). Under age nine the child is seeing either in an object that is dual (Haywood and Getchell, 2005).

Memory capacity grows with development. Adults is recognitied to be able to hold five to nine units of informations simultaneously in working memory. Children of age two can hold two items, age five four items and age seven five items (Bjorklund, 2012). They have poor inhibition (removal of irrelevant information) which however increases with age (Bjorklund, 2012).

Selective attention is poor with young children. Attention ability also increases with age. However, this differs between tasks. Individual differences in attention are relatively domain specific (Bjorklund, 2012, p. 259). For example, a child could be focusing strongly on his or hers favourite tv-show. There are nothing that limits their attention span when they are able to naturally explore what is interesting to them (Acuff, 1997). In contrast, children's attention span is more variable and defocused in regards to abstract stimuli.

Young children need to use more of their capacity to execute cognitive processes (Bjorklund, 2012, p. 252). Young children cannot reverse mental actions (Lueder and Rice, 2008) and their sequential thinking is not fully developed (Acuff, 1997. Children need to focus on a specific
goal in order to solve problem (Bjorklund, 2012). When able to most children at the age of two is able to solve simple problems, evaluate their results and correct their solutions to fit better with the goal (the example here was to copy a house of blocks from a given solution) (Bjorklund, 2012).

Even very young children and infants use strategies to solve problems (Bjorklund, 2012). Often children are not aware (no metacognition) that they use a strategy (Bjorklund, 2012). Older children select more effective strategies which they also can be taught. (Bjorklund, 2012). Utilization deficiencies (in-effective strategies) are common, because of lack of mental resources and awareness to evaluate these strategies. Still, the un-effective strategies are important because of learning and strategy optimization (Bjorklund, 2012).

#### Perception

At the age of five the visual acuity is 67% and at ten fully developed (Haywood and Getchell, 2005). Even very young children do have depth vision (Haywood and Getchell, 2005) and rely more on depth and motion cues to perceive objects than on edges. Nevertheless, children may err in judging depth until near-adult level/early adolescence. However, vision is fully developed at age two and three (Acuff, 1997) where the myelination of the optic nerve is complete (Lueder and Rice, 2008) as well as the maturation of the retina and corneal thickness. This means that the visual sense is ripe during this early phase in life and that the difference between child and adult perception is dependent upon the interpretation of the visual stimuli.

At age four a child can handle objects purposeful and recognize unseen objects by touch (Taylor and Woods, 1998). This capacity is relatively mature by age five where most can explore objects major features. Even still their tactile localization are less accurate than those of age six to eight.

#### Spatial abilities

Children master the up/down of direction first, then the front/back (before age three) and last side laterality (age four to five). From age two and a half to three, children can place objects in front of or behind themselves, but have a harder time placing an object in front of or behind something else. At the age of four they can do that and also place objects on side of something. Left/right discriminations become better between four or five to ten. Young children have difficulty executing a task when a limb must cross the midline of the body (which improves between four and ten, where even a ten year old might have problem) (Haywood and Getchell, 2005). Sense of direction improves between ages five and eight. Two thirds of children age six can identify major body parts (and it's rare to not be able to after age nine) (Haywood and Getchell, 2005). At age eight most can use body references to indicate direction. (Haywood and Getchell, 2005).

#### Emotions

Children differ emotionally from adults. Motivations, interests, and fear are different (Lueder and Rice, 2008). Also, frustration is more easily aroused in a child (Misvaer, 2007). Children are impulsive (Acuff, 1997. Young children have a great need for love and safety while growing in their autonomy. Children like bright colors, organic shapes and sinuous, and smooth, shiny surfaces. They choose toys based on the meaning they provide and not only function (Correia et al, 2012).

## Appendix 3: The Wool Fibre

### The wool fibre

The wool polymer is made of keratin, a protein. Molecular chains of joined amino acid are stacked in single alpha-helix coils. These coils connect to each other in cystine cross-linkage (if there are sulfur in the amino acids) and salt bridge links between side chains (Humphries, 2009). As all protein fibres, wool is sensitive to alkali and chlorine bleach but not to acid.

The connected coils make up mikrofibrils, forming the spindle shaped cell in the main body called the cortex (Humphries, 2009). These cells are able to take up moisture, rendering wool very absorbent. When wool takes up water the swelling is radial, with small change in length (Wool science). The cells inside the wool fibre are of three types: ortho- (soft keratin), meso- and paracortex (hard keratin) (Marshall et al, 1991), where orthocortical cells predominate typically taking up over 50% of the fiber cross-section and volume. Mesocortex cell is generally disregarded when describing the cortex, and these cells are placed in the paracortex area. Thus the wool fibre is describes as bicomponent (Humphries, 2009). The ortho- and paracortex cell areas are twisted together along the length of the fibre and behave differently when wet fibre dries, resulting in a spiral crimp. When spinning the wool into yarn, this crimp hinders wool fibres to be put closely together and the yarn remains lofty and will trap air. Also, the crimp together with the alpha-keratin formation makes the wool fibre elastic with good resilience.

The outer layer of the wool fiber (the cuticle) has a surface of scales in three sub-layers. The outermost sub-layer is the thin and porous. The scales of the cuticle are all directed in the same direction, making the fibre smoother from top to bottom than the reverse. When fibres move the scales tangles the fibres together - a process called felting (Humphries, 2009). Furthermore, the outer layer is water-, dirt- and stain repellent which explains why it still feels dry even if the fibres have absorbed moisture (Russell, 2009). Some coarser wool have a center with air spaces that is called the medulla (Humphries, 2009).



Microstructure of a wool fibre

The cuticle

Different sizes of wool fibres

#### Properties of wool

General advantages to natural fibres are absorbency, texture, appearance, wear comfort, that they collect little static and have a pleasing hand. Natural fibres are also an annual and renewable resource (Humphries, 2009). Wool is in fact the most absorbent of all fibres as it can absorb up to one third of its own weight (Humpries, 2009). Also, it is soft, warm, moldable, lofty, have a dry hand and good elastic recovery (Humphries, 2009). The elasticity makes wool a material that is un-prone to wrinkling. Pilling is not a generally a problem with wool as the material has low tenacity (Humphries, 2009). However, wool has good abrasion resistance and does thus looks good even after a long life. Odor does not stick to the material like it does on synthetics as the outer layer of the wool fibre is water-, dirt- and stainrepellent (Russell, 2009). Furthermore, wool has a natural flame resistance. It will burn slowly and have a tendency to go out (Humphries, 2009). It is also anti-static (Russell, 2009).

On the other hand, wool also felts, is weaker when it are and feels wet (Russell, 2009), it can be eaten by insect larvae, exist in a limited supply, can irritate the skin and is not free from hazards of agricultures (such as lack of sheep nutrients and diseases) (Humphries, 2009). Coarser wool is more prickly and can cause itching and redness (Humphries, 2009). Sometimes this situation is belived to be an allergic reaction, but as wool is so similar to human hair this is rare. Still, most people don't react to finer wool in this way.

It is not the clothes in themselves that makes the body warm, but the air in between or in the layers (Villumsen, 2010) where the lofty wool is able to trap their air. As wool still regains its crimp and loft while absorbing moisture inside the fibres, the material is hygroscopic - taking up moisture without feeling wet. Wool will work as protection from changing temperatures in the environment and keep warm even when wet. When dampening, clothes made of cotton will cool down the body and should therefore be avoided. However, textiles that can absorb a lot of water gets heavy, thereby increasing the risk of the added weight pulling the fibre or fibres from each other. Water fills the voids between the polymers in the fibre and break hydrogen formations therebetween which eventually forces the polymers apart. Wool is especially vulnerable due to its high proportion of amorphous regions. Therefore the fibres lose strength when wet, just like hair. Water also cleaves salt linkages in the non-crystalline (amorphous) regions of the wool, which cooperates with the breaking of hydrogen bonds to make a less elastic and weaker textile.

## Appendix 4: SLCA

	Material from the earth	Material pro- duced by society	Degradation of nature	Meeting people's needs
Design and de- velopment	Paper, energy, oil, metal			Working conditions
Raw and manu- factured mate- rials	Merino wool, animal feed, water, energy	Chemicals, colours	grazing, pollution	Working conditions
Production	Energy	Polyester thread, print		Working conditions
Packaging	Energy, wood	Chemicals, colours	pollution	Working conditions
Distribution and sales	Energy, oil		Pollution	Working conditions
Usage	Water	Chemicals	pollution	Usability, safety, price, etc
End of life			Landfill	Working conditions

Good Good Good Good GK Bad Very bad No knowledge

## Appendix 5: Function Analysis

#### Comfort

Accomodate comfort Facilitate freedom of movement Faciliate finer motoristic movements Hinder bulkiness of fabric Accomodate safety Accomodate warmth Minimize gaps Allow easy regulation of warmth Facilitate warmth in wet conditions Hinder wetness from outside to reach inside Hinder feeling of wetness Allow sweat to be transported away from body

#### User value and usability

Facilitate growth Allow toilet visits, both indoors and outdoors Flacilitate easy dessing and undressing Facilitate easy understanding of how to dress in layers

#### Cleaning and wear

Minimize need of cleaning Facilitate cleaning procedures Allow easy care Minimize wear

# Appendix 6: Style Gallery

### Style Gallery Sweaters and Overalls

### **Methods**









Elastic None Zipper Two-way Zipper

Snap buttons

Hook and eye

Lacing

Velcro

Ties and ribbons

### Placement Sweaters



wide opening

No opening: deep opening

Over-lapped Envelope neckline overlap





Two to side

Long to side

Long two to side



Button

On shoulder On both shoulders

Longer On both shoulders

### Placement Overalls



Short middle All the way middle Around whole middle front/back

**Toilet openings** 





To side of leg To side middle leg Two side middle leg







Curved back

Back flap

Back flap with middle opening

Sides





## Appendix 7: Formal Evalution

Туре	Require- ment	Request	Ranking	Conce	ept O	Con	cept 1	Conc	ept 2	Con	cept 3	Con	cept 4
Comfort	Accommo- date good comfort		5	3	15	3	15	3	15	2	10	3	15
	Keep user warm		5	3	15	2	10	3	15	3	15	3	15
	Keep user dry	Accomodate water resis- tancy	5	3	9	4	12	4	12	4	12	4	12
	Allow removal or absorbation of persiration		4	3	15	3	15	3	15	3	15	3	15
	Accom- modate possibility to regulate temperature		3	3	12	3	12	4	16	5	20	2	8
		Minimize bulkiness		3	9	4	12	4	12	4	12	4	12
••••••	Minimize gaps		2	3	6	2	4	1	2	1	2	2	4
	Maximize free dom of movement		5	3	15	3	15	4	20	3	15	3	15
	Accomodate good fit		5	3	15	4	20	4	20	4	20	4	20
Customer Value	Maximize user value		3	2	9	5	15	5	15	5	15	5	15
	Fit well in Aclima's collection		4	3	12	3	12	4	1)	3	12	3	19.
	Accommo- date reason- able price		4	3	12	2	8	2	8	1	4	2	8
	Accommo- date for a certain user growth	Fit a certain user during one whole season	4	3	12	5	20	5	20	5	20	5	20
		Minimize loosing pieces of garments	2	3	6	3	6	2	4	2	4	3	6
Ergonomics	Accom- modate ergonomic support		4	3	12	4	16	3	12	4	16	4	16
	Simplify put- ting on and off clothing		4	3	12	4	16	3	12	4	16	4	16
	Maximize children's ca- pabilities to put on and off clothes by themselves		4	3	12	4	16	3	12	4	16	5	20
	Maximize under- standing of dressing procedure		4	3	9	3	9	3	9	3	9	3	9
		Simplify dressing chil- dren right	3	3	9	3	9	3	9	3	9	3	9
	Accommo date use of fine motor skills		3	3	15	3	15	3	15	3	15	3	15
	Accommo- date safety		5	3	12	2	12	3	12	3	12	3	12
		Clarify func- tional details	4	3	9	3	12	4	12	5	15	5	15
	Simplify bodily waste functioning		3	3	12	3	12	3	12	3	12	3	12

Durability andcare	Withstand- handling of users		4	3	12	2	8	3	12	3	12	3	12
	Maximize durability during use		4	3	12	2	8	2	8	2	8	2	8
	Accommo- date fast drying		4	3	15	3	15	3	15	3	15	3	15
	Endure washing in washing machine		5	3	0	3	0	3	0	3	0	3	0
	Minimize risk of soiling		2	3	12	3	12	3	12	3	12	3	12
	Endure dry- ing in drying cabinet		4	3	6	3	6	3	6	3	6	3	6
		Endure drying in tumble dryer	2	3	12	3	12	3	12	3	12	3	12
Aesthetics	Appeal to users		4	3	12	3	12	3	12	3	12	3	12
	Accomodate colourfulness		4	3	9	3	9	3	9	3	9	3	9
		Accomodate fun details	3	3	12	3	12	3	12	3	12	3	12
	Accommo date gender neutrality		4	3	0	3	0	3	0	3	0	3	0
Sustainabil- ity	Minimize sustainabili- ty impact		4	3	12	3	12	3	12	3	12	3	12
	Minimize toxins		4	3	12	3	12	3	12	3	12	3	12
		Maximize organic materials	3	3	9	3	9	3	9	3	9	3	9
		Foster sustainable behaviour among users	4	3	12	3	12	3	12	3	12	3	12
		• • • • • • • • • • • • • • •		114	411	119	429	120	438	121	439	123	444

Allow growth	Fold in	Fold cuff	Snaps/other	Canals/	***************************************
Pos	Do not disturb that much, low material costs, maintains	Easy to produce / perform, proven solu- tion, easy to control	Non-destructive, can be integrated with other details	Gathering May be more practi- cal to manufacture, difficult but possible	
	proportions, can be aesthetically pleasing, is not done by mistake	precisely		to restore, even short- ening, if drawstring: precise control, more spacious when short, can become aesthetic at the right location, non-obtrusive	
Neg	Manufacturing? Must be sewn last, takes time / risky to unpick, hard to recover, does not regulate precisely (requires in that case itterationer), can get stuck dependant on method, less aestheti- cally? style locked	Thick, prevents details on the cuff, folds up easily, slides, style locked, unaesthetic?	Complicated to manufacture / more expensive, can be buttoned up / con- fused by mistake, can become unaesthetic	Manufacturing, unevenly regulated at one side, loose strings, style locked	
Extendable areas Pos	Reinforcements Existing seam, not in the way, relatively invisible, can be made discreet, reinforced, freedom of move- ment, even regulation	Hem Existing solution? Can be discreet, easy to access,	Arm holes There is already a a seam / split, extend not by misstake	Side seam Manufacturing, range of motion, can be made safe, simple splitting / unbutton	Straight piece Even tucking in, abili- ty to make aesthetic detail
Neg	Fiddly manufacturing (size), thick, propor- tions	Thick, wet, hard to sew in shirts (or other small spaces)	Complicated reg- ulating the sleeves. Aesthetically? Finicky at design. Loose edge?	May become unbal- anced / uncomfort- able style locked, bulky, does it work as an under layer?	Too narrow for manufacturing? Style locked.
Temperature regulation <b>Pos</b>	Take of sleeves Multiple applications / multiple garment, longer duration of use, not exclusive, easier to pull over the head	Collar solutions Easy to access, some solutions easily but- toned, not exclusive, low cost solution, fits into the brand	Regular middle opening Established solution, easily produced, easily regulated, not exclusive	Thumb holes Easier to take on over layer, warms hand back, not exclusively, Can get wet	Several in one (overall/west) Multiple uses, longer duration of use, not exclusive, prevent gaps, may change with growing, fun
Neg	Harder than collar / front control, misplace pieces, a little more difficult manufacturing, risk that it is not regulated outdoors, style locked	Buttons hard? Safety (strangulation), is in your way / lumpy, style locked	Boring / no inno- vation, awkward to assemble the zipper by the user, awkward when small grip sur- faces, style locked	do not account for growing, fold up / regulate, hard to winkle out, heavy, extra manufacturing, tightness, light fabric -> messier	Complicated, difficult regulated, does not account for growing
Dressing	Two coloured	Large/clear	Thumb hole	Envelope neck- line	Big head open
Pos	Easier for the children to dress themselves How big is the effect?	Easier to see / grab, different levels of solution	Easier to take on over layer, warms hand back, not exclusively,	Easier to pull over your head, more fabric -> more heat	possibility Easier to put on, more comfortable?
Neg	Minimal difference in manufacturing, more colours needed, style locked	More expensive? Another variety has to be purchased / used, style locked	Can get wet, do not account for growing, fold up / regulate, hard to winkle out, heavy, extra manufac- turing, tightness, light fabric -> messier	Less durable? Compli- cated manufacturing? Can slide up, requires more space by outer layers. Style locked	More details, (large neckline -> less insu- lation), if tricky open- ing less used, more steps in dressing, style locked

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