

# CHALMERS



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## Rethinking the Integrated Child Seat

*Designing experiences for future users and usage of  
Volvo Cars*

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

MOA NYBACKA

ANDREA SLAATTELIA LARSSON



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SUPERVISOR: Anna-Lisa Osvalder

EXAMINER: Anna-Lista Osvalder



# Abstract

"The automotive industry will change more in the next five years than prior 50", says General Motors' president in June 2016. This depends on fast technology development and may be due to the fact that the world is facing a new demanding, technology-raised demographic cohort who now reach their adulthood – the Millennials. It is important for manufacturers and product developers to understand the Millennials' needs because when this generation fully enters into the car-buying-market, their expectations for the experience will be quite different than that of previous generations. This Master Thesis, conducted by two Industrial Design Engineering students at Chalmers University of Technology, has during the spring of 2017 (20 weeks, 30ECTS) been produced in cooperation with Volvo Cars. Volvo Cars vision for 2020 is that no one should be killed or seriously injured in a new Volvo car. Within the important words *no one*, the focus for this thesis has been the offspring of Millennials. The mission was to investigate and further develop Volvo's integrated booster cushion and develop a concept for the rear seat that includes an inflatable material intended for the future in order to increase the usage and improve child safety in cars.

In order to get a better understanding on the subject, a literature study was conducted where different reports, research papers and internet articles were examined and compiled. It was found that right attitude, handling and safety approach in the use of an integrated booster cushion has a positive impact on child safety in cars. In order to improve the integrated booster cushion it should be adapted for children, for the audience and for future travelling. An empirical study was performed to investigate the users and usage and around 150 persons were participating in speed interviews, an online survey, observations and various focus groups consisting of parents, children and young adults. The users were divided into four different user groups with individual needs. This formed the basis for the idea generation which was done in collaboration with different focus groups. 130 ideas were generated and later evaluated, refined, merged, combined and finally one concept remained – the Integrated Child Seat Concept (ICSC). This concept was considered the most suitable one for solving the problems found.

The ICSC is a dynamic seat intended for the outer rear seats in future Volvo cars and is designed for the four target groups. The construction includes drop stitch inflatable material and is adjustable in order to be adopted for children's (approx. 4-10 years old) anthropometry and to obtain a good belt geometry for them. In addition there is a portable foot support to adopt it further. The seat has got side supports and can be tilted for more comfortable postures. The seat is visually similar to an original seat, which hopefully leads to the children having a more positive attitude towards the product and using it to a greater extent and as long as recommended. The solution is technology driven and the installation takes place automatically, in only one right way, which means that it will be liked, trusted and attractive for the technology raised cohort. Furthermore, there is less room for discussion between children and adults about whether or not to use a boosting solution.

The ICSC is adopted for the future since it is flexible and can be used by a diversity of passengers. It is easy to use and it can be used in the Volvo car's all application areas. The seat will not affect the regular seat and thus not the side users but rather adds something extra by the add-ons. These adds additional luxury value to all users which makes the solution more popular and liked in a long term perspective and hopefully some people choose the solution

even if there is no explicit need for it. *Share* will be the new *own* for the future and services such as car pools will understand the importance and benefits of this solution and consequently it will be more available and hopefully NO ONE will be killed or seriously injured in a new Volvo car in the future.

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Anna-Lisa Osvalder, Thesis supervisor and examiner, Prof. in Human Machine Systems, Senior lecturer in Ergonomics, Ph.D. in traffic safety (biomechanics and injury prevention), Chalmers University of Technology

Nathan Nuzzo, Thesis supervisor, Innovation Concept Leader, Volvo Cars

Clarence Campbell, Concept Design Engineer, Volvo Cars

Lotta Jakobsson, Adj Prof, PhD, Senior Technical Leader, Volvo Cars

Bhagyesh Ashtekar, SA Rear Seats, Volvo Cars

Helena Wallin, System Responsible Child Safety, Volvo Cars

Gert Aldeborg, Concept Designer Seatbelts, Volvo Cars

Markus Karlsson, Design Engineer Front Seat, Volvo Cars

Marcus Agnedal, Lead Engineer, Volvo Cars

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Tove Fredriksson, Master Thesis student, Volvo Cars

Felicia Rånge, Thesis Opponent

Sara Westerlund

Maria Andreasson

Elin Skoog

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# 1. Introduction

Generation Y, The Me Me Me generation or Millennials... The world has begun to follow this new demanding, technology and media oriented demographic cohort who reached adulthood around the turn into the 21st century.

Different environments affect the individuals in the generation of Millennials and generate broad tendencies even though there is, of course, a great deal of variation from one individual to another within the cohort. People in the Millennial generation have been raised under the mantra "follow your dreams" and have been told they were special. They tend to be confident as well as optimistic, which is something that follows them into adulthood and might mean unrealistic expectations. This can lead to disillusion, which in turn, in combination with their consciousness makes the Millennials a demanding audience to satisfy for product developers.

It is not just the mentality that has changed, the whole world has changed rapidly in recent years, perhaps also because of this generation, which welcomes changes. "The automotive industry will change more in the next five years than prior 50", says General Motors' president in June 2016. The world has experienced new fuels and new ways of travelling through services such as car sharing, car pools and that we travel more and more.

Millennials deeply value brands and are willing to pay more for products that are consistent with their image. When this generation fully enters into the car-buying market, their expectations for the experience will be quite different than that of previous generations. Style and features, especially technology, are critically important to millennials. It is therefore important for manufacturers to understand those brand perceptions and invest in brand-building now.

The millennials are a conscious generation and value environment, lifestyle and parenthood highly. Something that fits well with Volvo Cars' core values: safety, quality and environment. Volvo Cars is a leader in child safety, and thus already responds well to the demands of the new generation. However, today's products need to be developed since there will be greater demands on flexibility. So what is needed for Volvo Cars' already safe products to fit the new world and meet the needs of new generations?

This master thesis by the Industrial Design Engineering students Moa Nybacka and Andrea Slaattelia Larsson from Chalmers University of Technology has been carried out in cooperation with Volvo Cars in order to investigate this area.

## 1.1 Background

Volvo Cars is a strong brand that is known to produce luxury family cars and Volvo Cars has always put safety first. Volvo Cars has been considered to produce some of the safest cars on the market and their Vision 2020 is that no one should be seriously injured in a new Volvo car. Volvo Cars is innovative and leading in child safety and there are different solutions to meet the requirements for children's seats, among others an integrated booster cushion (IBC) for children from 3-4 years and older that Volvo Cars introduced as early as 1990 [1][2]. An invention from 2013 is an inflatable rearward facing infant child seat, which is mobile, light weighted and compact and therefore adapted to a more flexible use [3]. As Volvo Cars produces both the car's seats and the child seats they have the opportunity and intention to investigate how the seats interact with each other in order to ensure the safety of children on board. Therefore, Volvo Cars has the potential to develop a safe integrated child seat that utilizes the aforementioned inflatable material.

Another vision for 2020 is to offer cars that the customers desire. The world has changed, demands have developed and so the need for new products. The needs and requirements on cars are changing in line with the change of generations and the development of new technology. One important point is, inter alia, to meet the children's and their parents' needs and requirements. All parents want to protect their children as best they can and the use of child safety seats is therefore a matter of course for most people. But there are problems regarding, among others, both parents' and children's attitude towards the use and handling of child seats. An assumption is that products that have desired features are used more and to a greater extent. Therefore it is important to design a child seat that satisfies the desires of future car users and users of child seats, which are the Millennials and their offspring, the Alphas. They desire products that are attractive, flexible, compact and on demand.

The rapid development and impact on the environment have imposed demands on the dimensions of modern products. Volvo Cars now has a wish to further develop the integrated child seat as a potential to examine the possibility to implement the new hard wearing high pressure inflatable material in their future solutions and to meet the new imposed demands.

This project should investigate the issues mentioned above and look for other areas of improvement before developing a solution to some of or all the areas.

## 1.2 Purpose

The purpose is to design a forward facing child restraint solution, intended for children from the age of 4 years, to increase the usage of child restraint systems (CRS) in future cars and for future CRS users. The solution should facilitate the use so that the usage period is as long as the regulations recommend, while offering a flexible use of the rear seat for a diversity of passengers. All this to enhance the safety and comfort of children.

The future cars will have less space and are required to be more environmentally friendly, therefore a more compact and lightweight solution than the one used today is desired. The solution should nurture Volvo Cars' brand and keep portraying Volvo Cars as the safest car

brand on the market that, at the same time, develops innovative ground-breaking products for the users.

It is important to investigate the next generations' customers and consumers, "Millennials" and "Alphas", to get an understanding of their needs and desires. Volvo Cars is after all "Made by people" – for people.

For this project, a problem analysis is more important than the implementation and feasibility of a new concept. It is important to make a good conclusion so that the next investigator can easily take advantage of the discoveries made in the project.

### 1.3 Aim

The aim is to develop principles for a new integrated child seat for the rear seats of future Volvo Cars and at the same time investigate future users, everyday usage and the needs for child seats. The solution is primarily aimed for children between 95 and 135cm (approximately 4-10 years old) and is desired to contain both foot and side supports. Another aim is to develop a solution that does not inhibit the Volvo car's many application areas. Rather should the solution increase the seat's flexibility and provide comfort for a diversity of passengers by being easy to install and remove and increase the usage of a safe CRS by motivating different users and making a solution that is accessible all the time.

Central in the project is a relatively new, inflatable material, which is to be implemented in the future solution. The project will utilize the benefits of the inflating technology developed and used by Volvo Cars in existing solutions. Additionally, the focus for this project lies more on daily life requirements than legal requirements.

The number of steps in the sequence of use should be looked at in the new solution to minimize the risks of misuse. From a safety perspective, it is desirable that there will only be one possible way to use the product. The solution should, to as far an extent as possible, be developed with Universal design taken into consideration, meaning that as many people as possible should be able to use and understand the product correctly. When developing this kind of product it is important to, in addition to the safety aspect, make sure that the child's comfort (functional, physical and cognitive) and ergonomics is considered as well as the users' attitudes and handling of the product.

### 1.4 Report structure and used methods

The methods used in the project are aimed to find a final concept through an iterative and exploratory design process in six steps, see Figure 1, with the customer's preference and the users' needs in focus. The work is of a sequential character, which means that each moment ends before the next one begins. Possibly parallel if the opportunity exists.

**Explore:** An exploration of the scope will be conducted to get an as broad view on the subject and the solutions today as possible. This includes a massive gathering of information through

literature, papers, reports and internet articles using key words as common accidents, car safety, Millennials, future trends, car trends, child seat, child restraints, integrated child seats, drop stich material a.s.o. This also involves an investigation and analysis of the existing solution and its context, by looking at the functions and measurements in order to define areas that could be improved. The gathered information is compiled in Chapter 2.

**Pre-study:** A literature study as well as an empirical study will be conducted. The literature study, see Chapter 3, includes gathering of relevant facts and information through reports, papers and literature from leading researchers within the subject area and making relevant internet searches.

The empirical study, see Chapter 4, on the other hand includes an online survey, speed interviews, different focus groups and observations. The online survey together with different focus groups are performed to gather information on the publics' knowledge and perception of, as well as attitudes towards the IBC and child restraints in general. Through the speed interviews information is gathered on how cars are used, who the users are and to what purposes the cars are used. Observations together with a dialog with sales personnel at retail stores is made to get a view on how the IBC is marketed today.

**Define:** Through a function analysis of today's IBC and from the results of the pre-study, an analysis of the IBC is compiled and an ecotype, users and usage are identified in Chapter 5. The areas of improvements are defined and divided into two different groups of priority by using a KJ-analysis and a pick-chart, see Chapter 6. Thereafter a requirement list is produced presented in Chapter 7.

**Generation:** The ideation phase, see Chapter 8, is conducted in two phases. Phase one includes ideation with three groups. The methods used are a creativity boost, black box, brain writing, personas and scenarios. The goal is to get as many ideas as possible. Phase two is then conducted mostly by the project owners but includes dialogs with expertise at Volvo cars. Methods used are morphological chart, brainstorm and design by drawing. The goal is to combine different solutions with each other to find a valid construction to further develop.

**Evaluation:** The evaluation is divided into two main phases, where phase one only addresses construction issues and phase two issues concerning experience. Methods used during the first evaluation in Chapter 9.1 and 9.2 are PNI (Positive, Negative and Interesting), a realism and goal achievement chart, set based concurrent engineering, a criteria matrix, weighted concept selection matrix and evaluation discussion with expertise. In the second phase, Chapter 10, development and evaluation is made by drawing and modulating in Catia V5 as well as mind mapping.

**Solution:** The final solution is presented in Chapter 11.

**Communication:** Concludes the findings and gives recommendations for further investigations and development of the solution. Thoughts about the project and the outcome of it is presented in Chapter 12.

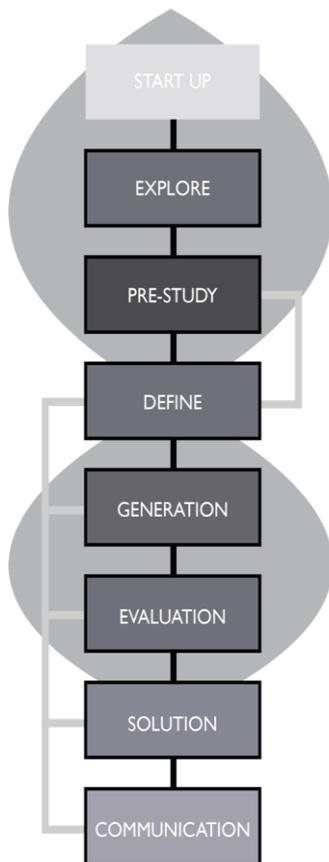


Figure 1. The design process.

## 1.5 Limitations

The project is limited on a number of points. Aspects and areas that will primarily not be taken into account are:

- legal requirements, such as measurements, loads and standards
- solutions for other seating positions than the outer seats in the rear seat
- solutions for other anatomy than for children from 15-36kg, 4-10 years, 95-135cm
- solutions for rearward facing child seats
- solutions that are mobile
- cover/surface material for the solution
- investigation of other inflating devices than Volvo Cars' already existing solution
- fabrication drawings
- virtual connection possibilities such as application interfaces
- technical specifications of inflatable material and/or inflating devices

Laws and regulations concerning child safety equipment differ a lot worldwide. This project will therefore focus mostly on European regulations and in particular Swedish law, regulations and recommendations.

## 2. Exploration of the scope

One reason for the exploration of the scope is that car trends are changing. How will cars be used in the future and how does that affect people's requirements and needs concerning the car itself and child restraint systems (CRS) in particular. Questions that need to be answered are: which advantages and disadvantages can be seen today in the way children are placed in cars, which are the most common accidents and what types of CRS are required? How does the existing solutions function and how can injuries be better avoided? Lastly, an investigation of Volvo Cars' IBC will be conducted to get knowledge about its features and functions in view of comfort, safety, accessibility and impact of possible misuse and whether the future trends in cars have an impact on it.

### 2.1 Future travelling

To satisfy customers, engineers must be aware of the features afforded by new technology and "The automotive industry will change more in the next five years than prior 50", says General Motors' president in June 2016 [4]. Hundred years ago, the car was a new invention. Then, there were not many cars on the road. Better personal finance and the fact that, today, half of the world's population lives in urban areas [5][6] has resulted in that, now there are millions of cars worldwide. The large percentage of cars have made it crowded in our cities and our planet requires that we travel more environmentally friendly, which has resulted in the development of alternative fuels, new customer behaviours and new travelling systems such as Uber and Sunfleet. This is justified since researchers say the population in urban areas will have increase by 70% in 2050 [5][6]. Meanwhile, humans have created new needs as a result of new technologies such as smart devices. Car companies have recently been telling us what the car of 2020 will be like: autonomous is one word used, electric is another, and it will be connected to the internet too.

Humans of the future will increasingly value flexibility and availability, and what is expected today of a smartphone will also be expected of a car in the future. In the same manner as mobile technology has made it possible for us to make instantaneous decisions anytime and anywhere, we will enjoy the same freedoms when it comes to cars and travel, and many car companies are working to integrate the virtual personal assistants in the car to help us with routes, traffic information and with planning our day. Our vehicles will be fully integrated in the digital lifestyle by 2050 according to researchers [7].

Personal mobility will become more of a service, something that companies such as Google, Uber and Lyft have recognised and they have been strongly involved in the creation of automated vehicles or platforms aimed for it [7]. Self-driving cars (SDC) that include driver control are expected to hit highways around the globe before 2025 and self-driving "only" cars are anticipated around 2030 according to an emerging technologies study on Autonomous Cars from IHS Automotive, driven by Polk [8]. Uber and Volvo Cars signed an agreement in August 2016 for a joint project to develop fully autonomous driverless cars. The cars were first tested, with an Uber technician on board to supervise the car's operation, on the streets of Pittsburgh, Pennsylvania in September 2016 [9].

Human needs and a new way of transportation/mobility will make demands on development, engineering, technology and design of the vehicles. “Share” is the new “own” and future mobility will have a “personal mobility portfolio” in order to meet the personalized need. The car that will only be a part of the portfolio, will need to be able to adapt to personal usage [7]. One, not completely strange future scenario, is that people basically could tell an app where they want to travel, and the system will, based on our preferences, propose a number of optimized transport modes, similar to the different ways that a GPS navigation system proposes to us today. Or, the human of the future could hail a self-driving shared vehicle, jump into the car of a social-media friend, who just happens to be driving by and going in the same direction. Or, they could take the public transport if it is the best alternative. Vehicles will be fully integrated into a larger network. This new way of travel together with people's demands on technology requires new thinking also concerning the design of cars.

The requirements on child restraints change because the technology evolves so quickly. The solutions are desired to be easier to handle, more convenient, compact and lightweight since we live in a time where we travel more and in other ways than just by our own cars. This quick development has given a boost to the market for unconventional solutions for child seats in order to please the customers. Real world performance of new technology is however always questionable, and experts claim that the tools used might not be able to reflect this [10]. The study [10] showed that the inflatable restraint system allowed the crash test dummy to move beyond the protective boundary of the seat since the inflatable restraint system does not include a carrying structure that prevents the air from deforming and moving forward, see left picture in figure 2. It is not wrong, per se, to expose air filled parts to high loads. The parts' tendency to easily change shape under load, especially with shear stirring, makes the part unreliable. Therefore, it is necessary that there is a hindrance for the pelvis to move forward, to avoid submarining. The right hand picture in figure 2 shows how a standard booster reacts under high loads in a crash test in an SUV FFRB. What can be seen is that the standard booster can stand against the force without deforming and thus holding the crash test dummy in place [10].

INFLATABLE

STANDARD

Tested in an SUV FFRB crash test at 56 km/h

TESTED IN AN SUV FFRB CRASH TEST AT 48 KM/H



Figure 2. A crash test made in an SUV FFRB (not rig) with the same crash test dummy (Q6) but with two different boosters. To the left an inflatable booster and to the right a standard booster [10].

## 2.2 Multi-Generations and their demands

Generations are not alike, therefore they should not be treated by marketers in the same way. Multi-generational marketing is the practice of appealing to the unique needs and behaviours of individuals within more than one specific generational group, with a generation being a group of individuals born and living about the same time [11]. This classification is primarily used by marketers, but can be successfully used in product development so the principle is the same: to detect the needs and approaches of the different generations.

The division originates from the American population but can also be projected on the rest of the western world. A generation is a group of people who experience similar events at a similar age and share a common social, political, historical, and economic environment. There is some inconsistency with regards to detail in the division but six generations can be distinguished:

- Pre-Depression (before 1930)
- Depression (1930-1945)
- Baby Boom boomers (1946-1964)
- Generation X (1965-1977)
- Generation Y - Millennials (1977-1994)
- Generation Z (1994-2010)
- Generation  $\alpha$  - Alphas (2010- ) [11].

The rapid technological progress has also made an impression on the generations. In the next ten years, 40% of all new vehicles will be sold to the Generation Y and they will be buying cars for the rest of the 21st century [11]. Generation Z is thus the users of the coming solution on an integrated child seat. It is therefore necessary to examine these important groups' needs and demands on the next generation of cars.

### 2.2.1 Generation Y – The Millennials

Generation Y (1977-1994), also called the Millennials are the most diverse, educated, socially conscious and tech-savvy group the world has ever known and the generation will prove to be the most influential, distracted and finicky demographic group in history when it comes to technology use. The “digital natives”, the children of this generation become consumers of online content at an unfathomably young age, most likely before they can type or read, and possibly even before they can remember [12]. In addition, the Millennials belong to a generation that have educated their older generation, something the world has never experienced before. Growing up with access to information at their fingertips has caused some demands on society and technology and Millennials have become accustomed to an on-demand lifestyle. Providing Millennials with slick user experiences is a matter of appeasing them. Millennials are impatient and prefer to have control and solve their own problems, which means that interactive technologies, from smartphones to websites to mobile apps need to provide the most usable, self-guided, hiccup-free, efficient user experiences in history [13].

Millennials are predicted to be a strong economic generation that is, in addition, very individualistic since 40% want to show off their taste and style [11]. Nearly half (46%) are

willing to pay more for products that are consistent with their image versus 20% of the "Boomers" (1946-1964) [11]. There is a perception that cars are not important to Millennials, but that is not the case [14]. Millennials are simply not buying cars right now because of their current situation and not due to the lack of interest. Millennials are mostly purchasing a car out of need, rather than desire, and they are more likely to do so than older generations because of a lifestyle change such as getting married, having children, buying a home, graduating from college or getting a job. Another reason is that the way of travelling has quickly changed in recent years and car pools and car sharing has become more common, and warmly welcomed by this change positive generation [14]. When this generation fully enters into the car-buying market, their expectations of the experience will be quite different than that of previous generations. Millennials approach the research process cautiously and pragmatically. They spend over 17 hours researching their vehicle before purchase, and 71% say they need to be aware of all possible vehicle choices because 32% like to impress people with their lifestyle vs. Boomers 6% [11]. As children, only about six-in-ten Millennials [15] were raised by both parents, Millennials might place parenthood and marriage far above career and financial success [15]. They place high value on good parenting and are somewhat more likely than other generations to say that being a parent is extremely important for their identity.

### 2.2.2 Millennials' offspring – Generation Alpha

Many analysts have quantified the importance of the millennial generation, few have examined the effect of their diverse offspring, generation Alpha. Children have influenced their parent's behaviours for decades but it appears that never before has there been such a passionate, intense and borderline obsessive relationship between two generations as the one between Millennials and Alphas. For many Millennials, their offspring, Generation Alpha, will literally be their only gift to our world, as families with one child have increased. About four-in-ten Millennials can admit they consider themselves a parent who sometimes praises their generation Alpha child too much [15].

Alphas are still in their formative years and still it is not completely known how they will be shaped. The thing we do know is, that it is the Millennials who will raise them. As the Millennials are more frequently career-changing, materially endowed, technologically supplied and likely to outsource aspects of parenting such as childcare, this will leave an imprint on the Alphas. However, demographics will give some forecasts. Alphas' parents will be older and the families will be smaller. They will be more culturally mixed, a little bit wealthier and they are expected to live longer.

Unlike previous generations, which have simply used technology, Alphas will spend the bulk of their formative years completely immersed in it. Alphas will also interact for the first time with these techniques at much younger ages than any other generation. They will grow up with tablet computers in their hands and will never live without a smartphone. Alphas also have the ability to transfer media and thoughts online in seconds. These massive technological changes, among others, make Generation Alpha the most transformative generation ever. We can only imagine what the Alphas will or will not own, carry or do because of their connection to technology in the future. They do not think of technical equipment's as tools, they integrate them singularly in their lives as pacifiers, entertainers and educational aids.

## 2.3 Branding and product design

A brand is what people feel about a company or an organization and/or the products or the service they provide [16]. Branding is how products and services are dressed and presented to the market and a brand is the difference between “a car” and “a Volvo Car”. Why is branding important in product development? Marketers often find designers wanting to make things in ways that do not reflect the brand’s position and heritage. Designers on the other hand wish to push the boundaries, shape markets and take the brand to new places. Ultimately both functions are partially right, but both need one another to ensure new product success. According to Ph.D. Monika Hestad [17], researcher in the interaction between industrial design and brand building, branding is a way to make the product unique and add more value to the product. It is not always the best, most beautiful and most innovative product that is the most important variable for success and that result in an economical profit for a company. The most important is, that there is a coherence with the brand. Thus, it is important for designers and product developers to find a symbiosis between branding and product design [17].

To qualify as a brand, the same story needs to be recognized by a group of people. If this is fulfilled in a generalized manner, this is one of the foundations for a strong brand [17]. A strong brand is a coherent brand. This can be seen, for example, in how well the product story and brand story match. This is important to keep in mind when developing products for a brand.

It is important to nurture the brand to keep it strong. This can be done by designing and further developing products in the company's line and on the basis of the company's brand and product story. Nurturing a brand can be done in three ways:

- Be different. Make sure that your brand stands out.
- Be vigilant. Don't allow your brand to do something that it shouldn't.
- Be relevant. The marketplace changes constantly, make sure you brand keeps up. [18]

## 2.4 Rear seat (Placement of occupants in cars)

World Health Organization (WHO) [19] states that over 3 400 people die on the world's roads every day and tens of millions of people are injured or disabled every year. The most vulnerable are children, pedestrians, cyclists and elderly people. According to a report issued by The Children's Hospital of Philadelphia Research Institute [20], 70 percent of rear-seated occupants are children younger than 14 years of age. Data from 2000 to 2006 show that approximately 13 percent of motor vehicle occupants rode in the rear seat. This represents 39 billion person-trips per year [20]. WHO states in their Global Status Report on Road Safety [21] that it is safer for children to travel in the rear seat. According to WHO [21], 84 countries out of 194 have enacted a law that prohibits children from sitting in the front seat. The laws vary slightly by country but the main content is, that children must either be of a certain age (10-12 years) or height (135-150cm) to be allowed to sit in the front seat. In Sweden it is recommended in most cars to disable the front passenger airbag if children under 140cm are sitting in the front seat [22].

## 2.5 Common accidents

The three most common car accidents are collisions hitting the front, side and back. Head-on collisions are the most common of these three, as 60% of all accidents are frontal [23]. When sitting forward facing, during frontal impact, the upper body is thrown forward until the seat belt stops it and at the same time the head continues forward at the same speed as the car had before the impact. To stop the head's movement forward, a great deal of forces are put on the neck. This increases the risk of skull and neck injuries, especially for children. Children's necks are much more fragile, which will be described in chapter 2.6. That is why young children should travel rearward facing as long as possible. In the event of a collision, a small dislocation of the body is normal, but if the belt is used improperly, the dislocation will be much greater and that can result in abdominal and spinal injuries [24][25] as well as increase the risk of head injury due to contact with the vehicle interior [25].

During a collision hitting the side, the person sitting closest to the side of impact will be slightly pushed towards the middle of the car. The head on the other hand, cannot keep up and will move in the opposite direction, towards the colliding car. Severe head injuries often occur as a result of this type of crash when the head hits the car's interior or the colliding car's front. Cars with side airbags and inflatable curtains have almost halved the risk of head injuries when adults are concerned.

When it comes to rear-end impacts, most accidents occur at relatively low speeds and therefore it is rare that children get injured. Whiplash is the most common injury amongst adults, but it is rare amongst children [26].

### 2.5.1 Rescue work in case of car accidents

In case of a collision, it is important that a patient with suspected neck or spinal injury is immobilized as soon as possible in order not to worsen the damage. Immobilizing can be done by the ambulance personnel, with help of two types of products, spine boards or vacuum mattresses [27]. This will preferably be conducted in the car but it is unfortunately common that the injured, if possible, exit the car before the rescue team arrives. After severe accidents, the roof of the car is cut to get hold of adults, since the spine should be kept as stable as possible. When it comes to children seated on high back booster (hbB), paramedics often remove the entire hbB to keep children stable [28]. Integrated boosters do not offer this possibility and children would then be treated the same way as adults.

## 2.6 Children's need for restraint systems in cars

Children's anthropometry and anatomy differs significantly from that of adults [29]. It is principally the head's size, weight and proportion in relation to the rest of the body that matters, see figure 3. Hips and the length of the legs are body parts that requires an adapted CRS. The chest and ribs are smaller, leaving the abdomen more exposed and are therefore less able to protect the child's internal organs in case of an accident. The older the children get, the more developed the anatomy, and at four years of age, the development of the muscles

in and shape of the children's neck give sufficient support in order for them to travel forward-facing [23].

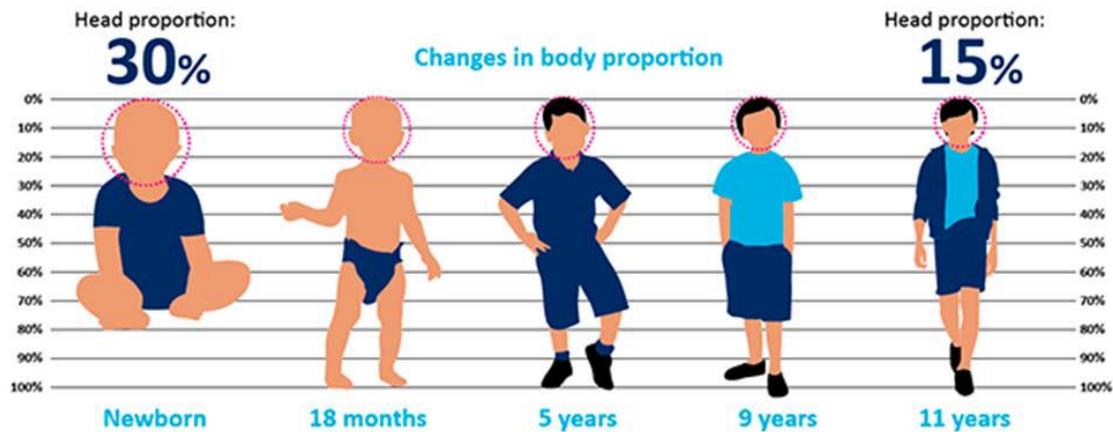


Figure 3. Showing the head proportion [30].

Children up to 12 years of age should use some type of special adopted restraints system since the geometry and the development of the pelvis and its iliac wings are not fully developed in children until puberty [23]. The use of boosters raises the child to obtain a good seat belt positioning, described in chapter 2.8.1.2. If the belt is poorly fitted, the child can glide under the belt and it can then penetrate the abdomen and thereby cause severe internal injuries or even dislocate or fracture the lumbar spinal column in case of an accident [23]. Another reason for the belt ending up above the iliac wings is the length of the thigh bone. Children have shorter thigh length than adults and since car seats are designed to fit adults, children cannot bend their legs around it comfortably without slouching forward, while rotating their pelvis. This increases the risk of the child gliding under the seat belt, so called submarining. This is one reason for children needing different CRS depending on the child's age, weight and height. The different types will be explained in more detail in chapter 2.8.

### 2.6.1 Children's anthropometry

All CRS solutions are dependent on children's anthropometry in order to make them both safe and comfortable. Children's anthropometry varies greatly between the age of four and twelve and the design of a CRS should meet all different measurements to avoid the problems described above. The following measurements have been regarded as important to consider when designing a seat, see figure 4. The table shows measurements from a Dutch study [31] and gives the 90 percentile measures of both boys and girls aged 4, 6, 10 and 12 years.

<b>DINED Antropometric database</b>				
(mm) 90 Percentile				
dutch m+f				
data collected 1993				
	Children 4y	Children 6y	Children 10y	Children 12y
Head breadth (23)	143	146	150	153
Head depth (28)	190	194	199	199
Hip breadth, sitting (25)	233	252	310	332
Buttock-popliteal depth (32)	315	365	455	487
Shoulder height, sitting (15)	389	432	513	550
Eye height, sitting (16)	530	587	693	740
Popliteal height, sitting (14)	302	352	439	474
Sitting height (17)	636	699	804	851
Breadth over the elbows (21)	308	319	379	396
Hip breadth, standing (24)	215	232	288	306
Foot length (41)	179	202	241	257

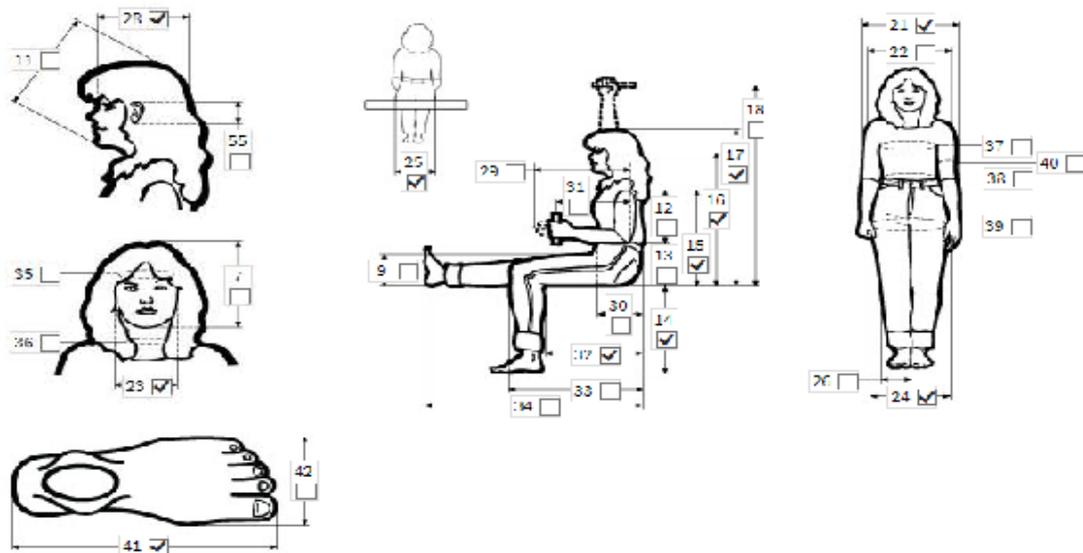


Figure 4. Anthropometry of children aged 4-12 years [31].

## 2.7 Designing for children

Children are not small adults, and this applies not only anatomically but also mentally. Developing products for children may be more difficult than developing adult products when it comes to anthropometric values, due to children's constant physical and mental development and the greater percentage variation in age groups among children compared with adults [32]. Children develops quickly, are fickle and anxious to see and try new things and they will click on anything that is in front of them on a screen. The children of today is a challenging audience to design for. The experiences they have with technology now will shape their expectations for using technology as adults.

As always when designing with any user experience (UX) consideration it is important to understand the users and it can be tempting to lump all children as anyone under the age of 12. Usability for adults is not as dependent on age differences as it is for children, which means that it is necessary to break down the category of “children” into smaller age segments. There is a big difference in children's cognitive, physical and social development from year to year.

A four-year old's basic reading ability and motor skills will require another design compared with an eight-year-old's.

Designers must account for varying physical, social, and cognitive abilities within each age group. A designer can affect a child's development through the experiences they and their product provide. Not getting the appropriate experiences can result in the child not developing normally since there are critical times during which particular environment input is necessary for a child to move into his or her next stage of development [33]. Understanding key differences between how children and adults interact with products helps to design for those children with success.

When developing products for children, consideration must also be given to the unexpected use of the product. With their imagination they can use products in a completely different way [33]. This, in combination with the fact that children take risks, test their skills and often lack judgment can lead to danger and therefore this is important to keep in mind in product development [33].

## 2.8 Restraint systems on the market

Volvo Cars introduced the first rearward facing child seat in 1972 followed by the first booster cushion in 1978 [1][34]. There are principally four types of child restraint systems (CRS) on the market today; infant seat, rearward facing child seat, high back booster (hbB) and booster cushion (BC), see figure 5.



*Figure 5. Volvo's mobile child restraints. From the left, an infant seat, a rearward facing child seat, a high back booster and a high back booster with removable backrest (booster cushion) [35].*

### 2.8.1 Child seats

Most child seats on the market come from companies specializing in development and manufacture of child seats. Most seats are mobile. There are many operators on the market with a variety of models that have been tested on the basis of the legal requirements.

All CRSs sold in Europe must be tested and approved according to UN ECE R44/03, UN ECE R44/04 or UN ECE R129 (I-Size) [37][38]. WHO is working towards that the same legal requirements shall be applicable worldwide, but there are still differences. Australia, New Zealand and North America have their own CRS type approvals, respectively, which differ significantly from UN ECE [19].

### Rearward facing child seats

In Europe it is mandatory to use an infant seat as from when the baby is new-born to 15 months of age [39]. The baby is fastened with a five-point or three-point harness and the infant seat should be used rear-facing. When the child is around one year old, a rearward facing child seat with a five-point harness should be used according to Swedish recommendations. In Sweden it is recommended that children travel rearward facing until they are 4 years old or 105-110 cm tall [40] since the risk of getting seriously injured in case of an accident increases considerably for children under four years of age when travelling frontward facing [41].

The rearward facing child seats can be mounted in the car in two ways. One way is by ISOfix and the other by using the car's seat belt. The seat usually has a support leg to the floor, in addition to straps to be connected to the floor or an anti-rotation bar against the seat backrest.

### *ISOfix and i-size*

ISOfix implies that the car has got two metal loops integrated between the seat and backrest. Child seats equipped with ISOfix have got two metal brackets that are attached firmly in the loops in the car. ISOfix is an international standard for all manufacturers of cars and child seats. It was developed to reduce the misuse of child restraints and make them more effective [21]. In 2013 further progress was made due to the adoption of a new EU Regulation on "i-size" child restraints [42]. The intention for introducing i-size was to further simplify the usage of child restraints and at the same time increase the safety [21]. I-size is a standard that promotes the use of ISOfix. I-size has improved the protection against higher forces occurring when involved in both side and front collisions and through the "i-size" regulation a length classification has been introduced in order to make it easier to choose the right child restraints. The i-size regulation has also made it mandatory for children up to 15 months old to travel rearward facing when using an i-size type approved seat.

### Belt positioning boosters

When the child is between 105 and 110cm tall, it is time to change the rearward facing child seat to a frontward facing child seat, so called belt positioning boosters. An hbB includes side and back support as well as neck support. The side support on some hbBs guide the child to sit in the right position but does not give enough support to keep the child in place in case of a side collision [43]. One law in Sweden states that all children under 12 years of age or under 135cm must be using some kind of CRS [44]. Using a belt positioning booster reduces the risk of injury by 80% compared to only using the car's own belt [30] [21].

There are also integrated boosters (figure 6) that can be folded out from the car's own rear seat, but since they are the basis for further development they will be described in more detail in chapter 2.9. Most boosters are mobile. These are secured to the car with the ordinary 3-point seat belt together with the child. The mobile boosters have guiding loops to hold the booster cushion in place and to help the users to route, hence position the seat belt correctly. The position of the belt is further described in chapter below, *Belt positioning*. There are also some booster models that are attached to the car's ISOfix anchorages. The primary purpose is to hold the booster in place, when no child is using it.



Figure 6. The integrated booster cushion in the middle rear seat in an XC90 [36].

## 2.8.2 Seat belts

The three-point safety belt was invented and introduced by Volvo Cars in 1959 and in 1986 the seat belt was installed for all seats in all Volvo car models [1]. The belt has evolved since then by including force limiters and belt tensioners. Load limiters release the belt under controlled manners during a crash and thereby reduces the load on the body, especially the neck. Belt tensioners, on the other hand, tighten the belt in the case of a collision in order to remove the belt slack that is common and thereby reduce the body's movement forward [20] [41].

The three point safety belt is the best and safest one on the market for all passengers travelling forward-facing, also for children (4-12 years) positioned in boosters [45].

### Belt positioning

According to Reed et al. [25], the three point belt should be placed on skeletal structures that can bear relatively high loads without injury. The shoulder belt should go across the collarbone as close as possible to the passenger's centreline. The upper belt anchorage must be at or above shoulder height to avoid excessive downward load on the shoulder and spine in case of a collision [25]. The optimal position of the belt in the lap is below or in front of the anterior-superior iliac spines (ASIS) of the pelvis, approximately at the junction of thigh and abdomen but it should lie predominantly on the thighs [25]. A good sitting posture is recommended to obtain a good positioning of the belt. According to Bohman [24], a proper sitting posture should be upright with the butt all the way into the back of the seat, the shoulders against the seat back and both legs parallel to the direction of travel [46].

## 2.9 Integrated booster cushion

Volvo Cars introduced the first integrated booster cushion (IBC) in 1990 [1][2] and some automotive companies have since then implemented it in some of their models. The IBC was developed to facilitate the use of child restraints in cars. In the beginning it was placed in the middle seat in the rear seat of Volvo 850 and 900 and replaced the centre armrest. In 1995 Volvo Cars introduced the IBC in the outer seats of the rear seat of the S40. The IBC of today with two different height positions was launched in 2007 in the V70 and XC70 along with the pre-existing belt pretensioners and seat belt force limiters adapted for children [47].

The idea behind the IBC was to integrate the booster and lift the child to a position that enabled an effective usage of the existing three point seat belt. The goal was to reduce the need for add-on child restraints and increase comfort for older children. A clear advantage of IBC is that it is always available and that the misuse of child restraints decreases, which will be discussed in chapter 3. However, there are very few car makers who offer IBCs for children to this day [48]. In a press release [48], Lotta Jakobsson, Senior Technical Leader at Volvo Cars Safety Centre, mentions that the benefits of the IBC are that it is developed as a part of the seat and that the seat belt is in more direct contact with the child's body. This removes the possibility of 'slack' in the belt that could occur when using other mobile CRSs.

A study shows that the IBC is better than other boosters [24] mainly because of the ease of use. The insurance company Folksam [41] recommends the IBC over other boosters since studies have shown that misuse decreased. In an IBC you just buckle up without thoughts on mishandling, unlike in mobile restraints systems where problems with belt routing through guiding loops and displacement of the booster can occur. If the belt routing is done incorrectly or the mobile child seat is displaced, the seat belt may be placed incorrectly over the body and the child can be injured in case of a collision due to submarining.

### 2.9.1 Design, construction and function

The solution used in Volvo Cars today is provided by Autoliv. The IBC is situated in the rear seat's outer and middle seats. The IBC in the outer seats can be adjusted in two heights depending on the child's height and weight, whereas the IBC in the middle seat only can be adjusted in one height. The first position is on a height of 50mm and the second (top) position on a height of 86mm. The top position is intended for younger passengers who are 95-120 cm tall and weigh 15-25 kg. The first position is meant for a bit older passengers who are 115-140 cm and weigh 22-36 kg [49]. The approximate measurements of the IBC are 330mm x 270mm x 85/45mm (WDH), see figure 7. The construction is self-supporting, meaning that it does not have to get any support to be stable, and consists of thick galvanized sheet metal and some small plastic details [49].



Figure 7. Measurements of an integrated booster cushion.

In the development of IBC, the car's own seat is divided into two parts. A folding mechanism is installed in the front part of the cushion enabling it to be "folded out", see figure 8 [49]. A handle is positioned on the front part and by pulling it, a lock is released and the front half of the seat cushion can be moved on top of the other and locked in the lower position, and thus creating an IBC. To adjust the IBC to the top position, a button, placed above the handle, is pushed and then the IBC can be moved up and locked. To fold away the IBC, the handle is pulled to release the lock and then the cushion is pushed down into the car seat by hand pressure until locked in [49][50]. Besides the cushion's different positions and size, IBC looks just like the car's own seat with the same material. No extra side or back support is included. The way customers use the IBC is through a small number of steps. They fold it out as explained above, step into the car, buckle up and enjoy the ride. When they have reached their destination they unbuckle, step out of the car and fold away the booster (as described above). Since the steps are so easy, it opens up to a range of opportunities to meet the desires and requirements of a variety of passengers.



Figure 8. Folding mechanism of the integrated booster cushion [49].

### 2.9.3 Advantages of the IBC

There are advantages both usage and experience wise with an IBC versus other solutions. It contributes to improved safety as it reduces the misuse (see chapter 3.3.2) and ensures that a BC actually is being used [51]. Users of an IBC feel safe with the solution, since it can only be folded and unfolded in one way. This function also offers the convenience of simply folding out a child seat and/or stowing it away when needed. This in addition to the fact that the IBC occupies less space, it enables an easy use of the rear seat for a diversity of passengers [28][51] as well as an alternative usage, like the possibility to transport large items. IBC is also a great option if you find yourself without a CRS. Relatives, grandparents especially, can have a CRS available without the fuss of installation. An installation of an IBC also offers safe transportation even to the child's friends [24][28].

### 2.9.4 Packaging, sales and pricing

IBC is packaged and sold as an option, Family Pack, within Europe. Volvo Cars' sales statistics for the IBC is approximately 7% of the total car sales during the last five years. The trend is that more cars are being sold, but the option take rate has declined over the past five years with approximately 4 % units according to information from Volvo Cars. Last year, 2016, Volvo Cars sold approximately 534 000 cars [52] of which only 5,56% had included IBC in their option. According to The News Wheel [28], cars that offer integrated booster seats have declined in the past few years, as concerns arise with the safety of integrated child seats versus mobile boosters. Studies have shown [51][53][54] that IBC is as safe, if not safer than mobile solutions. Therefore, one can question why it is not sold to a larger extent.

The retail price for customers for the IBC is 2900 SEK. As an additional option, there is also a comfort upholstery for 1550 SEK, which includes side and neck support to increase the comfort of sleeping children.

## 2.10 Inflatable material

Essential to the project is a new hard wearing inflatable material, drop-stitch fabric (figure 9). According to Jakobsson et al [3] the history of this material began in the 1950's, when NASA and UN Air Force conducted a research to use it for aerospace applications. The first boats were developed in 1970's by among others the US Navy. Volvo Cars introduced the material in a child seat concept 2013 and are continuously trying to find new areas of usage.

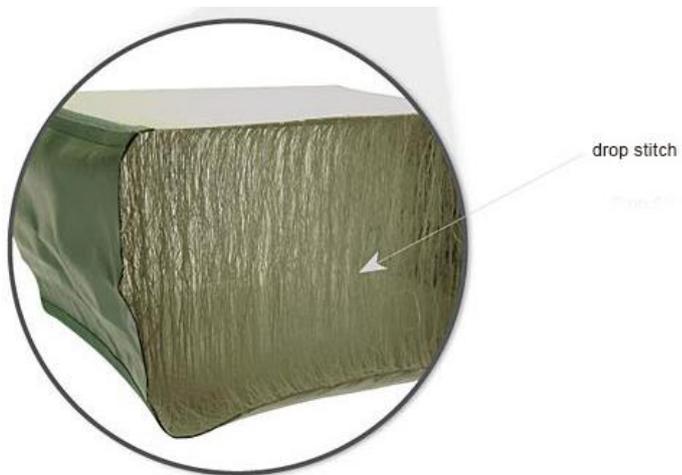


Figure 9. The drop stitch material [55].

The material is built out of two pieces of polyester woven support fabric with tens of thousands of fine polyester thread lengths in between. The polyester threads lock the two pieces of fabric together to an incredibly strong unit. It has an air-tight coating applied to the outer surfaces. The sidewall material is also made of polyester based fabric that is coated on both sides. The polyester thread is strong, durable and has very little stretch. The sidewalls and the drop-stitch material is glued together and a wide seam tape cover each lap seam creating a super strong, light weighted, air-tight product [55].

According to Zebec [56], a supplier of the drop stitch material, it can be inflated to pressures up to 15psi. The material comes in given thicknesses of 36mm, 51mm, 80mm, 100mm, 120mm, 150mm and 200mm. The weight per m<sup>2</sup> depends on thickness of the material but varies from 2,1kg to 2,6kg.

## 2.11 Summary

The automotive industry will change more in the next five years than in the prior 50 due to new technology, among others. Today half of the world's population live in urban areas and researchers say that this will increase to 70% in the near future. The population will increase as well. This together with pollution and new technologies in the society has led to new customer behaviours regarding transportation and more environmental friendly alternatives have emerged. In 2050 cars will most probably be autonomous, electric and connected to the internet. "Share" will be the new "own" for the human of tomorrow and travelling will be more of a service. The new technology has changed behaviours of an entire generation called the Millennials and their offspring Alphas, who have more demands and needs concerning future solutions. The millennials are an impatient, on-demand generation who prefer to have control and solve their own problems knowing that the answers usually are a googling away. They are predicted to be a strong economical generation as well as very individualistic, aware, exhibitionistic and lifestyle-oriented, which makes them likely to pay more for something that suits them.

Fast development, new ways of travelling together with people's demands has however a downside. Solutions are desired to be easier to handle, more convenient, compact and light

weighted. This has given a boost to the market for alternative solutions for cars and restraints systems that meet human needs. These have however not been properly evaluated regarding the safety aspect.

Children have special needs in cars. Children's anthropometry and anatomy differs significantly from that of adults and require special restraints systems when travelling in cars. Their bodies are underdeveloped and soft and have thus less ability to protect them in an eventual crash. The most common accidents are frontal, side and rear-end collisions, which all have various consequences for the involved passengers and the most critical part of the body is the head. Different child restraints are being used depending on the child's age, weight and height and there are principally four types of restraint systems on the market today; two rearward facing solutions; infant seat and rearward-facing car seat (0-4 years), and two belt-positioning solutions; high back booster (hbB) and booster cushion (BC) (4+ years).

The use of boosters reduces the risk of injury by 80% as compared to unrestrained. To travel safely, it is important to use the correct restraints and to grant a correct posture for the child. The use of boosters raises the child to obtain a good seat belt positioning. When an older child is sitting properly (4+), they sit upright with both shoulders and buttocks against the backrest and both legs parallel to the direction of travel. The belt should be positioned over the lap, not the abdomen and across the collarbone.

In Sweden children under 135 cm must be using some kind of CRS. In 1990, Volvo Cars introduced the first IBC and some automotive companies have since then implemented it in some of their models. The idea behind the IBC was integrate the booster and lift the child to a position that enabled an effective usage of the existing three-point seat belt. The goal was to reduce the need for add-on child restraints and get increased comfort for older children. The IBC is situated in the rear seats, produced in the same material as the car's own seat. The design of it divides the seats into two and a mechanism underneath enables it to be boosted and adjusted in two heights and removed in one movement, which can be carried out by the child.

### 3. Literature study

Solutions like IBC, for safe travelling for children, could be optimal for the future when "share" is predicted to be a key concept. The future is soon here, and the needs and requirements of the IBC will look different. This chapter examines improvement opportunities for a new solution with the same main function as Volvo Cars' existing IBC including improved safety. In addition, there are indications that the IBC is marketed poorly, which also should be further investigated.

This exploration will be conducted in order to obtain an as broad view on the problem as possible. The literature study provides an overview of articles from researchers in the field of study, together with additional data from statistics and online publications, which are collected and compiled.

#### 3.1 Comfort

In order to travel safely, it is important to use the right restraints and to grant a correct posture for the child. Often the comfort aspect comes as a secondary priority even if it is found to be a preliminary reason for an unsafe sitting posture. Therefore, children's comfort experiences in cars is one important area to examine.

##### 3.1.1 Children's comfort experiences in car

###### SUBJECTIVE ASSESSMENT

In a study, six children's (7-9 years old) subjective assessments in terms of comfort showed that when seated on the IBC, few children felt discomfort compared when using an hbB [54]. The children marked their overall comfort experience in a time lapse of 20 minutes, see figure 10 [54]. They also marked which areas they experienced as uncomfortable, see figure 11. Areas they felt discomfort in using an IBC were at the front and the back of the neck or at their bottoms. One child marked discomfort on the calves' muscles in the last assessment of the IBC [54]. No other areas were marked. When seated on the hbB, several children marked the entire back and neck, the front shoulder and neck as well as the arms [54].

TABLE III  
 RESULT FROM TASK 1, WHERE 1 CORRESPONDS TO  
 THE HAPPIEST FACIAL EXPRESSION AND 6 TO THE  
 MOST SAD EXPRESSION. THE CHILDREN WHO STARTED  
 TO TEST THE IBC ARE INDICATED WITH GREY.

Elapsed time	IBC			hbB		
	20 min	40 min	60 min	20 min	40 min	60 min
Child 1	1	1	1	3	1	4
Child 2	1	2	1	1	2	2
Child 3	1	1	1	2	2	2
Child 4	1	1	1	3	6	6
Child 5	2	2	2	3	3	3
Child 6	1	1	1	3	3	3

Figure 10. The overall comfort experience after 20, 40 and 60 minutes ride, graded by the children when riding an IBC and an hbB respectively [54].

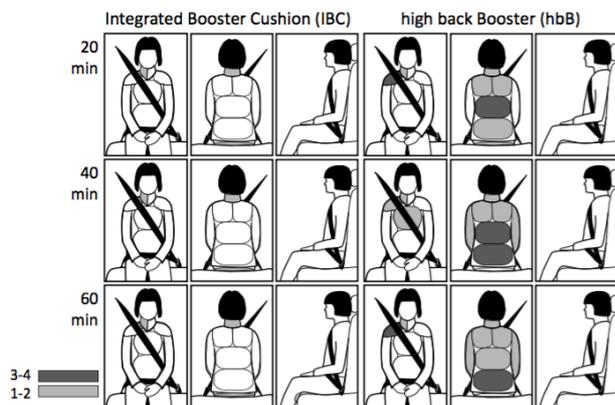


Fig. 7. The children's markings of inconvenience when seated on the IBC and the hbB respectively. Light grey colour represents that 1 to 2 children marked the area. Dark grey represents that 3 or 4 children marked the area.

Figure 11. The areas that were marked by the children as uncomfortable [54].

The children were also to conduct a word association session in order to investigate what percentages of the children selected the positive words for the IBC and the hbB, respectively [54]. In general more positive words were selected when the children were seated in an IBC, both in assessing the experience of interaction with the booster and the interaction with the seat belt (figure 12).

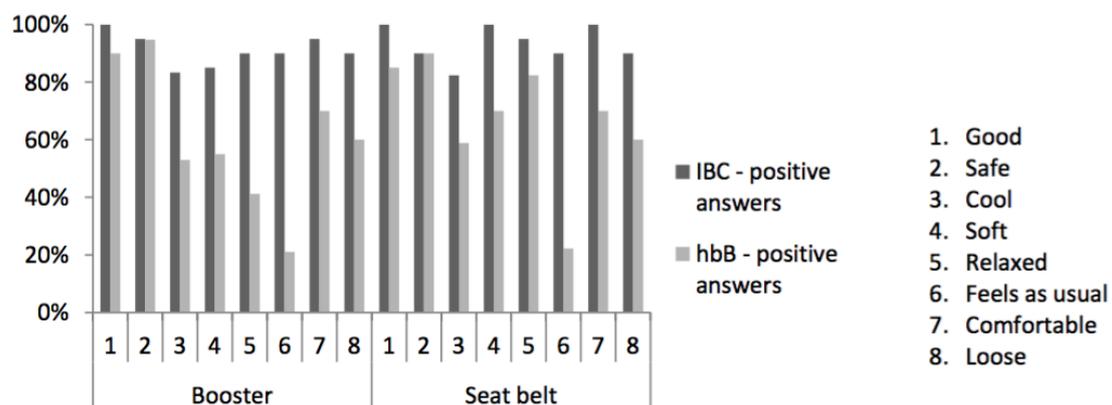


Figure 12. Children's word association when using an IBC and an hbB [54].

## OBJECTIVE ASSESSMENT

It is required that children sit still in their CRS in order to ensure that it is safe, something that they do not do. Children are moving influenced by their comfort experience as well as the child's personality and age. There are limited research on sitting postures of older children, but a study of six children aged 8-13 years (138-150cm) made by five Swedish leading researchers in traffic safety shows that the children spent most of their time in a sagittal sitting position with their upper back and shoulders in contact with the backrest (figure 13) and spent limited time in an extensive forward leaning position (3% of the time), whether they used a booster or not [53]. The children that had this extensive forward leaning position appeared to be the youngest and most restless children and the reason why these children sat in a position other than sagittal was because they wanted to reach for something, were moving to the

music, pulled the seat belt, talked intensively with the driver (which was their parent in this study) or were investigating the surrounding environment [53]. When the children just tilted to a forward leaning position the shoulder belt remained in position and resulted in the belt “grasping” the shoulder and staying on the shoulder, unless the child deliberately made a movement with the shoulder in order to let the belt slip off the shoulder, which however seldom occurred [53].



Figure 13. Sagittal sitting posture [53].

Another study of six 7-9 year old children (131-145 cm) that compared sitting postures on an IBC versus an hbB, showed that children seated on an IBC also had a sagittal sitting position, including the head upright most of the time during a one hour test. This can be compared with the children seated on an hbB where the shoulders seldom had contact with the backrest [54]. The individual variation among the children when seated on the hbB was greater than when seated on the IBC but the sitting postures also varied a lot individually, one child had for example his head in a leaning forward position as a result of using a tablet [54].

The most frequent lateral sitting posture both for using boosters and not using boosters was an upright position with the seat belt in contact with the neck or mid-shoulder [53][54]. The use of boosters has proven results in better shoulder belt fit than for children restrained by a seat belt only. The latter more often had seat belt contact with their neck, which causes discomfort (figure 14) [53]. It is important that the belt is not positioned too far out on the shoulder as it may slide off during a collision. It is however no danger, from a safety perspective, if the seat belt is too close to the neck in a collision [24]. This discomfort resulted in that the children changed position [53]. Either they sat leaned inward in the vehicle, rotated their legs towards the door and their pelvis inboard resulting in a lateral movement inboard of the torso, or they manually removed or moved the belt from the neck [53].



Figure 14. Child riding without booster, seat belt end up on the neck [53].

A Spanish study of 30 sleeping children aged 7-14 travelling on either an hbB, a BC or just using the car's seat belt, showed that poor belt positions occurred 78% of the time without booster, 61% with BC and only 17% with an hbB, which is a similar result as for daytime travelling children [57]. This, despite that the children in this study were not randomized by size, but booster seats were assigned based on the height and weight of the children. The most remarkable exception in the study was the occurrence of incorrect belt positioning [57]. In a booster, children tend to lean inward in the vehicle to a greater extent than seated without booster, which results in that the belt falls off the shoulder [57]. However, the belt tends to, to a greater extent, be pressed into the neck of the children who sat without booster versus those who sat on a booster since these tend to lean against the car window [57]. The hbB group showed statistically significant decreases in proportion sequences with poor belt fit and major side movement of the sleeping child [57]. This can be compared with a daytime observation study by Andersson et al. [43] that showed that the presence of large lateral head support on an hbB resulted in the children moving their heads outside the volume of the booster seat to get a better view out of the window or over the interior of the vehicle. In another daytime study within the same target group the children's subjective assessment was that they disliked the side wings on the hbB. The reason was that they felt restrained and locked in and the wings prevented them from looking out through the side window. As proven, one child imagined that the wings were good to lean against if sleeping [54]. In addition, an hbB was maintaining a greater initial distance between the head and the door, and the presence of the head support wings may potentially mitigate the consequences of a side impact [43]. According to Swedish National Association for Road Safety Promotion (NTF) [58] an IBC is a good solution as long as the children are sitting straight up and not sleeping. If the children are likely to fall asleep, especially on longer trips, an hbB might be good to consider to ensure the child's upright position.

Moderate and extreme forward and lateral postures occurred occasionally when using IBC or an hbB [54], see figure 15. The most common lateral posture of the torso when seated on an IBC was categorised as upright and the second most common posture varied among the children [54]. This can be compared to children being seated in an hbB, where the most

common lateral posture of the torso among the children was between the side supports, followed by slight or substantial inboard tilting, while outboard tilting was uncommon (2%). However, children tend to rotate the body more while seated in an IBC versus seated in an hbB. The children adapted a slightly rotated posture when relaxing, or in order to increase the space around the arms, while for example playing or writing [54]. Five of the six children seated in the IBC sometimes leaned the lower arm, elbow and/or the head towards the door panel, which sometimes resulted in a slight or substantial outboard tilting of the torso [54]. One child in the test leaned the arm towards the door panel while seated on the hbB. He was the only child that did not lean the arm towards the door panel on the IBC [54].



Figure 15. Lateral postures occasionally occurring when using an IBC [54].

When the children wanted to look forward, when not using an hbB, they often leaned inboard the vehicle (figure 16) in order to see between the two front seats, which was a reason for the shoulder belt getting further out on the shoulder [53]. The seat belt was however not under the arm or behind the back [53]. In observational studies it has been seen that children sometimes keep the shoulder belt behind their back or under their arm [59][60][51]. In this case, the belt does not provide the same safety because it does not capture the entire torso and there is a risk that the head hits the interior [24].



Figure 16. Child leaning inboards to be able to see out of front window [53].

Based on the study, where an IBC and an hbB were compared, the children perceived it, to a greater extent, easier to move freely seated in an IBC versus an hbB. The soft seat cushion, the simplicity of the design and the absence of torso supports contributed to this, versus the hbB, which was perceived as hard, created a locked- in feeling and felt unpleasant when moving and changing postures [54]. As improvements for the hbB, the children desired a softer

BC and backrest as well as a wider backrest. The short seat cushion of the boosters created some inconvenience and one of the children in the study suggested a longer seat as an improvement [54]. Previous research showed that the median rear seat cushion length of 455 mm was longer than the thigh length of 24 percent of adults and 83 percent of children [20]. Huang and Reed [61] compared child body dimensions with rear seat geometry of 56 vehicles and found that most of the second-row vehicle seats are longer than the thighs of children less than 12 years of age. As a result, an occupant will be forced to slide forward on the seat so the knees can bend comfortably at the seat cushion edge. This allows a comfortable leg position in opposite to having an upright position that puts pressure on the back of the legs. When doing this, the lap belt raises high on the abdomen and often places the shoulder belt in an uncomfortable position [20]. One advantage of boosters is that they effectively shorten the cushion length. But in a study of children's sitting postures, a slouched position was occurring even on boosters [53]. In total, four of the children assumed a slouched posture during a ride on the IBC, 12% of the time, and five children on the hbB, 29% of the time [54]. This slouched posture occurred mainly among the youngest and shortest children (138cm) who sat in this position 90% of the time [53]. Sitting in a booster enables the knees to bend around the edge of the booster, but the shins may end up in an uncomfortable angle resulting in that the child slouches [54][53]. When the IBC is folded out, a small "pocket" is created in the front that sometimes is interpreted as a foot support. In some cases the children put their feet on the "foot support" which caused an uncomfortable angle, especially for taller children, see figure 17.



Figure 17. Uncomfortable leg position [54].

### 3.2 Children's activities in cars

Children's activities during travel have shown large variations in both extent and content. During one study, an one hour ride with six children aged 7-9 years, it was found that commonly occurring activities were playing on a smartphone, looking at videos or photos on an electronic device, taking pictures, sorting small toys or things and using a Sticker Book [54]. Examples of other activities not including a device or toy were fixing the hair, talking to the driver, playing with the grab handle above the door or playing with the seat belt [54]. During this test, children were also asked to fill out a questionnaire about their subjective assessment of perceived discomfort and their attitude towards the boosters and then they often used their thighs as writing support, which resulted in a bent forward posture [54].

### 3.3 The users' approach to IBC

The users' attitude and safety approach as well as how the users handle the different CRS solutions will be investigated in order to understand the different situations and problems the users are faced with.

#### 3.3.1 Attitude and safety approach

Right attitude, handling and safety approach in the use of an IBC together with the belt pretensioning and load limited belt has a positive impact on child safety in cars [51]. The combination reduces injuries, increases the appropriate use, maintains the small normal displacement forward and might save lives [51]. Several studies have been carried out to determine the reasons for using or not using BCs, for example Bingham et al. [62] that performed a survey with 350 parents of 4 to 8 year olds. Although it is required by law in Sweden, that all children under 12 years of age or under 135cm must be using a CRS, see chapter 2.8.1.2, and the majority (93%) understood that BCs reduced the risk of injury, still 37% of the parents said they would not use the BC for short trips. The most common reasons for part-time non-usage were that the child rode with others, was in a hurry, and was too big or just refused to use a CRS.

It has also been demonstrated, in studies, that children stop using the booster earlier than recommended [51]. Adult's answers to why children, prematurely, stopped using the BC were mostly related to inconvenience in combination with children's unwillingness to use it because they wanted to feel older, and to the adult's poor knowledge about child safety [51]. Based on subjective assessments of six children, 8-13 years old, after an observation with and without IBC, only two children said that they preferred to use the IBC. The other four children preferred using only seat belts because they were "used to it" [53]. In the same study, the children who felt that the booster was too hard, preferred to ride without a booster because it was more comfortable [53]. This, even though the child during the test constantly adjusted his posture to prevent the seat belt from being in contact with the neck [53]. In another study, sixteen 7-8 years old children were studied/interviewed in order to examine the attitude towards the use of BCs and identify reasons for use and non-use [51]. From a children's perspective, the most common reasons for not using a BC were [51]:

- the BC was perceived as childish. In a study of 7-9 years old children, 80% of the children's markings in a word association session were set on the negative alternative when asked about how they felt to travel seated on the booster [54].
- it felt too crowded with three (or more) passengers in the back seat
- their friends were not using the BC
- if the family only had one booster seat, the youngest child was using it

From an adult's perspective, the most common reasons for not using a BC were:

- inconvenience with the storage and transportation of the booster
- lack of space with three passengers in the back seat
- child negatively influenced by friends. Adults often expressed thoughts that the children wanted to feel older. Not using a BC seemed to be a sign of getting older [51]

The most common reasons for using a BC according to the adults were safety and comfort, including both proper belt fit and the ability to see out of the car [51]. From the child's perspective, the most common reasons for using a BC were: easier to see out, better seat belt comfort (particularly for the shoulder belt), safety and that "parents told them to" [51]. When selecting between the words 'feeling safe or insecure' in a word association session 90 % of the children associated both an IBC and an hbB with safety [54].

### 3.3.2 Handling of the product

As mentioned earlier, correct handling of boosters have a positive impact on safety [51]. For the question "What would make booster seat use easier?" several test participants in a study answered; "built-in seat", "required by law", "everyone using it" and "the child likes it" [51]. Many of these proposals are already developed. IBC is a built-in seat and it is required by law to use some kind of CRS until 135 cm which implies that everyone should use it. The high rate of non-usage may be due to the handling of CRS that complicates the usage.

A 2011 EU study found that the average rate of misuse of child restraints was about 65%, confirming that many children are still incorrectly secured in cars [21]. Four leading Swedish researchers recently conducted a handling study with seven consistent BC users (aged 7-8 years) together with their parents. The aim was to investigate the difference in the handling of an IBC and a Britax mobile BC (figure 18). In the study, the children were asked to position the BC, sit on it, buckle up, unbuckle, leave the car and remove the BC. The parents were then asked to position the BC, buckle up the child, unbuckle and then remove the BC [51].



Figure 18. A Britax booster cushion [51].

#### Timing of the handling sequence

The average time to perform each action in handling sequences for the two boosters are shown in the figure 19, below.

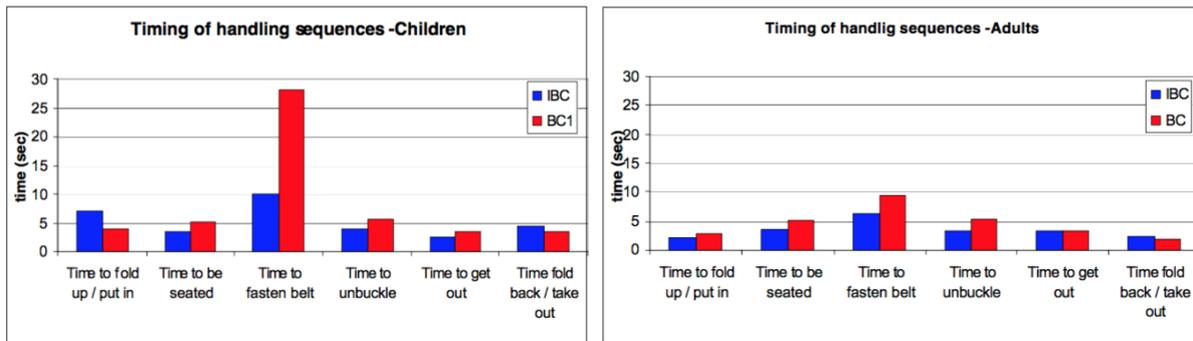


Figure 19. The blue marks the result for IBC and the red marks the result of Britax BC. To the left the children's handling sequences and to the right the handling sequences of adults [51].

The IBC got better results time wise than other boosters for both children and parents, except in one action: to fold out and fold away the IBC versus to put the BC in and take it out. However, it was only a difference of a few seconds. It was the first time the children and the adults used an IBC and the average time to fold it out was 19 seconds for children and 6 seconds for adults. When asked to repeat the handling sequence a second time, the time was reduced to 7 seconds (-12s) for children and 3 seconds (-3s) for adults. The time of folding away the IBC for the children was reduced from 13 seconds to 4 seconds (-9s), when repeated a second time. For the adults, the folding time was unchanged, three seconds, and this time was also much faster than the time it took to take out the BC.

Studies have shown that the use of an IBC minimizes the risk of wrong installation and positioning in relation to the airbag compared with the use of mobile boosters [51]. The car and the child seat should not therefore be seen as two separate entities, but they must work together as an IBC does and therefore this is a safer alternative. The IBC is especially safe when installed in a Volvo car since they are considered as one of the safest cars on the market [63]. Moreover, it is easier for children to enter and leave an integrated solution because it does not displace itself. This also facilitates to buckle up [51]. The European CHILD project [59] showed a misuse rate of 67% among boosters. Belt routing over the guiding loops was the main problem (25%) followed by belt twisting (20%) and belt placed behind the back (16%) [51].

### Buckle-up

The IBC is designed without guiding loops since it does not have an extra backrest and is attached to the vehicle's own rear seat. The anchorage points of the belt are designed to maintain a good belt geometry for booster seated children as well as other passengers. In a study, parents appreciated that the risk of incorrect belt routing was small when using the IBC. Although the time for buckling up with an IBC, was slightly longer for children versus adults, it was significantly shorter than for mobile boosters [51]. In a study of CRS by NHTSA, Swedish Road Administration in 2004 [64], problems with the seat belt was found to be the most common misuse of boosters (did not fit on the shoulder 21%, too loose 16%, did not fit the lap 10% and wrong age / length 9%).

It was easier and faster to buckle up the child on the IBC since no belt routing around guiding loops was necessary. Another reason was that the IBC allowed easy access to the buckle,

whereas mobile solutions required the adult and child to lean further forward in order to be able to see and access the buckle, since it is partly hidden by the guiding loops. Another positive outcome of IBC having no guiding loops is, that in only one of the seven cases a misuse was detected when buckling up, comparing with 5 of 7 for the mobile solutions. The problems that arose with mobile solutions was, that both children and adults led the lap belt wrongly, the belt was loose, misplaced over the shoulder or they failed to put the shoulder belt under the guiding loops. The problem that arose when buckling up on an IBC was that a child had twisted the belt. This was classified as minor misuse.

## 3.4 The Volvo Cars' brand

A product is something that is made in a factory, whereas a brand is something that is bought by the consumer. Competitors might copy products and the products might be obsolete but a brand is unique and a successful brand could last forever [17]. "It is, for the public, hard to describe what a brand is" [17]. All commonly held perspectives are all good explanations of what a brand is about [17]. Those perspectives are important as not the brand manager or the Vice President marketing own a brand, but people. Brand researcher Monika Hestad [17] talks about three important factors in the definition of a brand: The brand story, the mediator and the interpreter.

### 3.4.1 The brand story

There needs to be a desire to develop a certain meaning, a philosophy or a vision. This could involve, for example, a story that the company or the public decides to communicate and that differentiates the brand from others [17].

Volvo Cars has clearly embraced this thinking and is a company that many marketing lecturers use as an example of a success story concerning "brand building". Volvo Cars managed to describe its philosophy and become synonymous with only one word: "safety". In 2014 Håkan Samuelsson, President and CEO of Volvo Cars stated that Volvo Cars' vision is that "by 2020 no one should be killed or seriously injured in a new Volvo car" [65]. Volvo Car Group is often regarded as a role model for traffic safety, which distinguishes the brand from others.

Volvo Cars' core value is not only safety, even if this is the most significant one. There are two other values, together with *safety*, that define the Volvo Cars brand: *quality* and *environmental care* [66]. The second core value, quality, expresses Volvo Cars' objective to provide products and services that meet people's needs. "For Volvo everything starts with people. We understand people and how to make people's lives easier, safer and better. This is something that comes naturally to us", it is "The Volvo way". Volvo protects what is important to people and wants to make people feel special and innovate to make people's lives better and less complicated. The idea is to give users an experience of care and to simplify their lives. This is why Volvo Cars are "designed around you" [66].

Volvo Cars also has an environmental approach based on respect and care for human beings, society and nature. Volvo Cars is driven by protecting the things that are important, making people feel privileged and engaging people in helping the world to be a better place for all [66].

Volvo Cars wants to create smart and responsible products and services for customers and the world at the same time, they want to build industry-leading expertise in the focus areas; Needs, Requirements and Environmental data. "People's health, energy efficiency and resource efficiency drives our focus on the environment. We will continue to design our products to be a natural part of a sustainable future and to be a natural part of people's lives, as we strive towards uncompromised mobility" [66].

### 3.4.2 The mediator

There needs to be something that represents the story, something that makes people think about the brand story. This could involve, for example the product itself, the name of the product, the logotype or promotion activities [17].

Volvo Cars' primary product is cars and Volvo Cars has a reputation of being the world's safest car with a high quality. Volvo Cars are well-known for what in Swedish is called *framkomlighet* (accessibility) - the ability to go wherever you want - regardless of the weather conditions. This is something that is an important part of the Scandinavian heritage for Volvo Cars and a clear reflection of who Volvo Cars are and where they come from [66]. Volvo Cars is proud of its origins and cares for its heritage and Swedish nature.

With the line "Made by people" Volvo Cars wants to show who they are and which values they stand for [67]. They arrange different events to attract a wide range of customers and to get the possibility to meet customers and personnel as well as the general public in events like Volvo World Golf Challenge and Volvo Ocean Race. They also sponsor several big events and federations that stand in line with one or several of Volvo Cars' core values (safety, quality and environmental care) such as Gothenburg Horse Show, Swedish football association and Childhood[68].

Volvo Cars also sells a variety of accessories of premium quality to strengthen the bond between customers and the brand. Volvo wants their customers "to breathe" Volvo. Ever since Volvo started their production of cars in 1927, the focus has laid on safety and "people first". Not only the cars have to be safe, the users need to feel safe with their purchase. This has resulted in a range of products and services such as Volvo Cars' own service and repair, road assistance and child seats. "Cars are driven by people. The guiding principle behind everything we make at Volvo Cars is therefore – and must remain – safety" said by Assar Gabrielsson and Gustaf Larsson, founders of Volvo [69].

### 3.4.3 The interpreter

There needs to be someone who interprets the mediator to represent the brand story. A brand is not a fixed entity and a story of a brand depends on what people feel and think about the brand. It is not necessarily "the meaning" intended by the company [17]. The commonly held perspective 5-20 years back in time was that Volvo Car owners were strongly associated with senior citizens and hillbilly hick types of characters. The perspective has changed due to changes in society and changes in the brand strategy in the early 2010. Nowadays the commonly held perspective is that a Volvo Car is owned by luxury oriented middle class, well-

educated family-people. Volvo Cars defines themselves and their target group as; “Volvo is a human-centred luxury car brand. Everything we do starts with people. We are not like all other premium car brands, we are different. Buying a Volvo Car is a statement and an active decision. To create genuine desirability for the Volvo brand, we need to address and cater for a certain mind-set and aspirational target audience that shares our values. These people are the future of the Volvo brand”.

## Brand archetype

"Archetypes" is a concept originally conceived by the famous Swiss psychologist, Carl Jung. In marketing, a brand archetype is a symbol, character or category which is assigned to a brand or a business [70]. Every brand and business entity has an individual personality and unique story to tell. If the story is good, there is always a main character who is pivotal to the narrative and storyline. This character is subjective and becomes the heart of the story and over time develops into a person that the audience can relate to and identify with. The idea behind using brand archetypes is to anchor the brand against something iconic – something already embedded within the conscious and subconscious of humanity. People connect with people, not products or services. Clients want to know there is a shared sense of purpose and meaning. A defined and coherent brand archetype will better connect with the target audience and illuminate the driving force of the business.

Although the number of archetypes is unlimited, a researcher named Dr. Carol S. Pearson has bent, developed and adopted Jung's theory and created a system of 12 archetypes in three different categories. Each individual archetype has its own set of values, mission statement and personality traits. A strong and well established brand usually identifies with one dominating archetype. Volvo Cars' archetype is, according to researchers, *a caregiver* [70].

### *Volvo Cars' brand archetype – a caregiver*

A caregiver's motto is “Love your neighbour as yourself” [71]. The goal of a caregiver's businesses is to help others and offer protection, safety, care for others and support to their customers. Volvo Cars embraces this in an outstanding way through their market-leading safe products. A caregiver's strategy is to do things for others. Volvo Cars has announced through the release of the latest car, Volvo XC60 that they want that the user through the new technology should feel: “life feels easy”, “pleasure while drive” and “custom design”. Volvo Cars has the strategy of giving some added value to the user.

## 4. Empirical study

The perception, based on the literature study is that the IBC is more flexible and convenient than a mobile CRS since the IBC is always available. The new trend that *share is the new own*, demands that the next generation cars will be as flexible as possible and facilitate for as many different users and areas of usage as possible. This means that the new solution of the IBC must be flexible and not affect neither the design nor the comfort of the rear seat. This is why the users and usage must be investigated and mapped.

Since the literature study showed that few users use the child seat long enough, the reasons for this will be examined by looking at the users' attitude and approach towards different CRS. In connection to this, today's users' needs as well as the needs of future users will be examined.

In the exploration of the scope it was found that the share of IBCs sold has decreased by about 4%-units since 2012 through 2016. One opinion is that the IBC is poorly marketed and/or that the customers need to choose between IBC and other features that they find more desired e. g. seat heating. This will be examined more closely though a check with retailers.

Another master thesis is conducting a study on the comfort of the IBC for children aged 4-10 years. A discussion were held to see if the findings from their study could be implemented into this project.

### 4.1 Method

The methods selected for this study give a broad perspective, as both quantitative and qualitative data have been collected. Firstly, quantitative data were collected through speed interviews and surveys and secondly qualitative data were gathered through focus groups and interviews. Around 150 persons have been included in this study in the ages from 3 to 80 years.

#### 4.1.1 Speed interviews

In addition to the facts that emerged from the previous literature study, around fifty random speed interviews were conducted on the streets of Gothenburg. This to collect basic information about users and the usage of passenger cars. In order to reach an as wide range of interviewees as possible, the speed interviews took place on three different occasions. Persons and groups of all ages were asked and to get a connection to children aged 4-12 years in some way, the place for the interviews were strategically chosen to, the entrance of the science centre Universeum, Bergakungens cinema and the training centre Angereds Arena.

It was desirable not to lead the interviewees but to let them think about their eventual usage of cars, therefore the questions were asked in a way that directed the interview over to more of a dialogue. Five questions were asked and discussed, see Appendix 1.

- Do you have a car or access to a car?

- What do you use your car for?
- What does your family situation look like?
- Do you normally or sometimes transport children in your car or in a borrowed car?
- How do you do with the child's seat?

#### 4.1.2 Focus group children

The target group of this project is children between 95 and 135cm that according to anthropometric data are children aged approximately 4-10 years. Children develop rapidly, not only in a measurable way, but also their mental ability including their perception and values [33]. In addition to the information that emerged through the speed interviews, deeper conversations were conducted with two different focus groups, one class of twenty-one 10 year olds and one with two siblings aged 4 and 6 years. Since these children are included in the target group for the new concept, it was important to get an as united opinion as possible on their attitude towards, and the aesthetics of CRS, especially boosting solutions and activities in cars.

Similar questions were investigated in the different focus groups but for the ten-year-olds the focus laid more on attitude and stigmatization and whether they use and/or are willing to use a boosting solution. For the siblings, the focus was more on their relationship to each other together with an observation on how they and their parents used their boosters. Other areas that were examined were daily activities and requests on activities in the car when it comes to both shorter and longer trips. The interviews in the school classes were done in groups of four to minimize the risk that the children would be influenced too much of each other. The interview with the siblings were held by their mother (being one of the project owners) in order to make them comfortable.

#### 4.1.3 Focus group adults

The project aims to adapt the new concept to children between 95 and 135cm tall but they do not make the purchase themselves. That is why it is important to investigate who the buyers are. This was investigated through conversations in two focus groups, one consisting of four parents with children aged 3-10 years and one consisting of seven young adults aged 20-25 years without children. The purpose was to investigate today's parents' and future parents' view and requests on CRS, purchase and usage. One out of the four parents had an IBC and the other had mobile CRS. The questions asked and discussed with the parents can be found in Appendix 2 and the question discussed with the young adults were: What are your thoughts and demands on solutions for travelling by car with children aged 4-10 years old.

#### 4.1.4 Online survey

The online survey was sent out on an internet forum with the aim to investigate parents' views and needs as well as thoughts about purchase and usage of different CRS. The survey got 71 responds. The survey can be found in Appendix 3.

### 4.1.5 Interviews

Interviews were made at retailers of Volvo cars in Gothenburg, Bilia in Sisjön and Brabil on Hisingen. This was made to investigate how many Volvo cars that had an IBC and how the retailers marketed IBC to customers.

### 4.1.6 Group discussion

A discussion was held with another group of thesis workers from Linköping University of Technology, Sofia Boberg and Tove Fredrikson, conducting studies on the IBC's comfort for the same age span (4-10 y/o) at Volvo Cars. The purpose with this discussion was to gain information about their findings and if it corresponded to what was found both in the literature study and the empirical study about people's perception about the comfort of the IBC.

## 4.2 Variants in car usage

The speed interview's introductory question was if the interviewees had a car or access to a car in some way. Most of the respondents owned their car themselves or borrowed the car from parents or workplace. Only a few rented or shared a car for special occasions. Four of the respondents did not have a driving licence but had a partner, relative or friend who would help if a situation arose that required a car.

The second question involved the usage of the car, what do they use the car for. The primary daily area of usage was to get to and back from work in combination with taking the children to preschool, school or leisure activities. Other activities, done on a weekly or monthly basis, were grocery shopping, going to larger shopping centres or visiting relatives. Around half of the interviewed used their car for longer trips, e.g. skiing trips, camping or travel abroad by car, see Appendix 1.

The third question regarded their family situation. Here, the answers varied a lot. Some families included two parents and two children aged between 4 and 10 years, while others had a bigger, more complex family constellation with bonus siblings, shared custody of children between 4 to 10 years but also teenagers and/or grown up children on their way to move out. Some grandparents lived next door while others lived far away and some had pets, mostly cats and dogs.

The fourth question was who tends to drive and/or pick up the child or children from for example activities, school or friends' houses. If the parents themselves could not drive or pick up their child/children, most respondents had help from grandparents, neighbours, friends' parents, relatives or friends.

The fifth question regarded how they handle the situation with the child seat if the child is travelling with different cars. A normal scenario is that grandparents have an extra seat or that they move the seat from one car to another. Some drive without, since they feel that it is easier handling while others have an extra booster in the trunk of the car. Just a few interviewees

said that they rather did not help out picking up grandchildren since they do not have an extra booster.

## 4.3 Children's assessments about car travelling

The results from the focus group with school children, the interview with the siblings as well as some of the results of the online survey were compiled. The children's view on car travelling is described in the following chapter.

### 4.3.1 Attitude and stigmatization (10 year olds)

The online survey showed that children outside the city centre get driven more often by car than children living in the city centre. Mostly back and forth to school and/or different activities but also to most of the places the adults go to, for example purchases at large construction companies. When the children were to answer where they were seated in the car there was no one who mentioned that they used a booster solution, although later in the interview it turned out that one third still used boosters. However, it was important for the children to mention that they used a seat belt. The distribution between the different CRS solutions was uneven. The most used CRS solution was, if only with a small margin, a regular mobile booster cushion. The use of only the seat belt came in second place and the solutions that were the least used were the IBC (2 cases) and the IBC with comfort upholstery (1 case).

A subjective assessment shows that it was the girls and the shortest children in the class who had a more positive attitude towards booster solutions. The children were having trouble figuring out what was making a certain solution good, *when it is fine, it is fine*. However, there was a girl who thought her high-back booster was comfortable to sleep in. Another opinion came from a group of four children, all of whom used mobile boosters. They agreed that it was good that the booster occupied their place, *when my booster is there, it means it is my place because no one is bothered to move it*. The two who used the IBC thought it was better, as they could easily change place with their younger siblings. On the other hand, they complained that they were uncomfortable when they went on longer trips as they had no place to put their feet. One of them had recently been on a trip to Sälen ski resort and during the trip he had put a bag under his feet. The girl with the comfort upholstery liked that you could lean against something when looking out the window but that it was uncomfortable for the arms as they did not really fit "inside the chair". Those who only used a belt thought it was awesome and they perceived themselves as cool as their older siblings.

It was easier for the children to express what they disliked with their boosters. The negative aspects of this study mainly concerned stigmatization, comfort experiences and children's conflicts with their parents. See Appendix 4 for more complete answers.

The majority of children were seated on the outer seats of the rear seat. It was also found that the rear seat was used by a variety of constellations of rear seat passengers. Most common constellation was to be seated in the rear seat with a sibling. Almost all children thought it was boring to travel with the exception of special circumstances such as travelling with classmates. However, this only involved shorter distances. The children experienced that they, during

shorter trips, only look out of the window or talk to fellow travellers. During longer trips they usually use some kind of multimedia device to entertain themselves e.g. phone or tablet. One problem with that was that there was no natural place for storing the device and that the cord was too short to charge the device during usage.

When asked about what the ultimate booster cushion should look like, the children thought that it would be ultimate not to have to use one or that you could choose different themes for it to follow on a day-to-day basis, for example favourite movie one day and favourite artist the next. Other suggestions were that it should be artificial, anthropomorphic and interactive, be able to talk or be like a game.

#### 4.3.2 Siblings (4 and 6 years old)

The siblings are a boy aged 6 years and a girl aged 4 years. The girl always wants to do as her older brother. She is very stubborn and does not want to be left behind. The boy often sends his little sister to test different things before he tries himself in case it would be dangerous. They are very close in age, which is an advantage according to their parents because they always have someone to play with. It can however be difficult, since they often quarrel about little things.

Both children use the same type of booster, a high-back booster. The colour is the only thing that differs, the only colours available on the same model of booster. Earlier, when the girl still used a rearward facing solution, she always complained and said that she wanted the same solution as her older brother. Just before she turned four years she got the new seat and she was so proud to finally have become as "old" as her brother. Even now, if she goes alone in the car, she wants to sit in her brother's seat because she wants to be like him.

According to the observation the children often wanted to do everything themselves, especially the girl. To get in to the car was quite difficult and when in a hurry, it often resulted in one of the parents lifting the children up. The buckling up takes time since it is hard for the children to see where to buckle the seat belt. An extra check of the belt position is made by one of the parents. As soon as the children are seated, they start playing with the folding table, toys, sunglasses or other things available. The observation also showed that it is difficult for an adult to get to the middle seat of the back seat when the children are already seated.

### 4.4 Parents' assessment about car usage and boosting solutions

All participants in the focus group used some sort of booster solution for their children, one had an IBC and three used mobile solutions. According to the online survey, only one respondent out of 71 used an IBC while 50 used some sort of mobile frontward facing solution.

At first all participants in the focus group felt mostly positive about their booster since the child could see out of the window. It felt comforting and safe to use a booster. Then the participants using mobile solutions mentioned that the boosters take up too much space and that it is too

little space for an adult in the back seat when using two boosters. Another negative feature was the insufficient visibility of the buckle that made it difficult to buckle up the children, especially when the children were unwilling to help. The participant with IBC felt more satisfied with the booster than the others and praised it for its availability. The IBC user mentioned the absence of foot and side support as something they desired as well as chair heating and better comfort for other passengers than children.

Most respondents of the online survey felt that they had no problems with the CRS they are using today. The problems that were mentioned were the lack of space when having three boosters in a row in the back seat, the occupation of space of the mobile solution when not used, the instability of the mobile solution. Parents also felt unsafe when the child easily could loosen himself/herself and mentioned that it is difficult to clean if the child gets car sick.

When it came to purchasing CRS, the most important features, according to the focus group, was that the seat should be safe, comfortable, practical and easy to handle, install and clean. The aesthetics was not mentioned, but entertainment for children was of higher interest. The respondents of the online survey had similar requests when purchasing CRS and added size, fitting in car, comfort, removable upholstery and price. They also mentioned that they looked at tests, certifications, recommendations and brand.

When asked what features a CRS should have to express safety, most respondents of the online survey answered test results and recommendations. Some mentioned bright contrast colours, price, known brand and a robust, enduring, stable construction. Only one suggested that an integrated child seat express safety.

Pricing of a CRS should, according to the focus group, lay around 1500-2500SEK. Whereas, 30 out of 71 respondents of the online survey thought that a reasonable cost should be somewhere between 500 to 1500SEK and only ten considered that a cost over 3000SEK was reasonable. However, parents demand independent tests and reviews before buying and/or using CRS solutions.

From the online survey it emerged that 46 respondents (64,8%) had heard of the IBC before the survey, 19 of those had read about it and 18 had heard about it from friends and/or relatives. Whereas 25 respondents (35,2%) had not heard of it at all. 32 respondents had not used an IBC while 14 had tried it sometimes and out of those 14, twelve responded that they use it 1-2 times a month and only two respondents use it on a weekly basis. Eight had tried an IBC in a Volvo car. They all felt safe when using the IBC. The participants in the focus group that had mobile solutions had not used or tried an IBC, but found it to be a smart solution due to its availability. The only negative aspect was the cost of changing cars to get an IBC.

The respondents that had not heard about the IBC prior to the online survey were mostly very positive towards an integrated solution and made comments like, "should be standard in all cars", "practical", "functional", "smart", "easy" and "good looking". They also commented that it was a good secondary solution that all taxis should have them and that it makes it easier when hiring or borrowing cars. Another comment was that it is very seldom that you buy a new car and that other features like the car's energy consumption probably would rank higher if you had to choose between the two. Three comments were more negative towards the IBC. One person felt it more convenient with a mobile booster that you easily could move to other

cars, one felt that today's IBC should be further developed to something better and one felt it did not look optimal and that one should have made more effort in designing it.

The online survey's respondents that use or had used IBC were very positive towards the IBC, mostly for its availability and simplicity as well as the possibility to store it when not used. They had also some suggestions on how to make the IBC better, so as for example tilting of the seat, seat heating, side support, making the seat wider and improve the comfort and add more features that could be adjusted.

When asked if the IBC was perceived as safe or unsafe, 14 people responded that it looked unsafe due to the simplicity, and the lack of side support, that the cushion was too small and the seat did not have any details, that it looked as if it was carelessly produced. It was perceived as more safe when the respondents knew that it was placed in a Volvo car. 57 of the respondents considered it as safe due to the brand, availability, flexibility and usability. Comments were; *Volvo has high standards on quality and high requirements on safety, I trust Volvo, It looks like it cannot be installed incorrectly, It looks stable and cannot come loose, It is always there and then you use it, It is very flexible and can be easily stored away if not used.*

When the focus group was asked if their children liked their boosters, most of them answered positively. Some parents had experienced trouble during their children's "obstinate" age. The respondents of the online survey also answered predominantly positively about their booster. Some had had comments from their children that their booster was the wrong colour, that the side support obstructed the view, that it felt cramped and uncomfortable and that they wanted to sit as adults. Some thought it was awesome when they got a new chair, to be able to ride as adults or older siblings and felt pleased to be able to look out of the window.

The focus group was also asked about how much time they and their children spend in the car. Many children travel less than 15min/weekday in the car. During weekends and holidays they travel longer distances. One family travels every weekend to their grandparents, who live one and a half hour away and another family makes summer trips, driving up to 3000 kilometres. Yet another family goes on skiing holidays during the winter, around a six hour trip one way and visits their summer house during summer, a four hour drive.

Normal activities for the older children during longer trips were watching series or movies, drawing or playing games. The younger children often fell asleep at some point. Two children became easily car sick, which resulted in that the whole family listened to children stories on the car's audio system or played "I spy with my little eye something beginning with".

According to the focus group, the most common things the children want to bring with them when going on a car trip were their pillow, books, favourite toy at the moment (even if they will probably not play with it), multimedia device and/or something to draw on and crayons. These things are stored in the middle seat of these families' cars since the maximum amount of children were two.

When it comes to entertaining the children when travelling longer distances, the first suggestion was to let them watch a movie or series, if not travelling during night time when the children are sleeping or if a child easily gets car sick. Other suggestions were to play games that involve the whole family, listen to stories or music on the car's audio system.

Colouring books and sticker books are also a great way to pass the time. A suggestion that all agreed on was to take breaks regularly, to let the children run around for a while, which made it easier for them so sit still when driving.

## 4.5 Young adults' assessment about car usage and future trends

The young adults interviewed had a wish that a future CRS solution should be fast, exclusive, personal, user-friendly and automatic and have a slick design. A topic that was highly discussed was the effectiveness and accessibility of a CRS solution. The young adults believed that all people would have even more flexible lives and even less time in the future than they currently have. Time spent in cars would be longer due to the fact that more people travel by car as a result of city expansions. Therefore future CRS solutions have to be effective and always available for the young adult to "survive" the everyday life. In addition, it should not be boring for neither children nor adults to use the solution and preferably contain some kind of new technology that could give added value. According to the young adults, added value primarily meant something that gave users something back, preferably time. For instance, the added value could be to help the children with their homework.

## 4.6 Retailers' (lack of) information about IBC

From observing Volvo cars displays in retail stores one can state that Volvo Cars could do more in terms of conveying the child safety and integrated solutions. It was almost impossible to find a car at the retailers that had an IBC. Brabil could offer one of the staff's cars that was equipped with IBC for testing while Bilia could not tell if they had IBC in any of their used cars and did not have any new car with IBC installed in their showroom. Since they recommend IBC to customers with children over two years of age, it seems strange that they are not able to show the feature in store.

On Volvo Cars' website it is also difficult to find information about the IBC. There is a lot of information about child safety and different kinds of mobile child seats but very little about the IBC. Information about the built-in solution was not entirely obvious, when assembling a car for purchase on Volvo Cars' website or the app.

## 4.7 The perception of IBC's comfort

According to the literature study, see Chapter 3, the comfort of the IBC was perceived as disappointing by both the children and some of the respondents of the online survey. Participants in the empirical study confirmed this. Poor comfort experience reduces the safety for the passengers since the bad experience makes them change position, thus gives an incorrect belt position. This is why it was important to verify the findings with Sofia Boberg and Tove Fredrikson, examining the IBC's comfort. The conclusion of their study was that the IBC could be improved concerning the comfort and that the comfort upholstery makes the

perception of comfort somewhat better but could also be improved. However, due to the wide age range of the users it is difficult to satisfy all of them with one "static" product.

## 5. Problem analysis

It is important to analyse the product to be able to improve it. It is also important to identify where and how the product is used, what type of users there are and which needs they have and how to position it to get the best response. Through a number of analyses, target groups, brand archetype usage and usage areas are identified and the functions of today's IBC are analysed in order to identify which functions are to be preserved and improved or eliminated.

### 5.1 Positioning in the market

A strong brand is created from having a good idea, identity and ambition to make a positive impression in the minds of people. Volvo has a strong and coherent brand which is indicated in the symbiosis and consistency between the brand story, mediator and interpreter.

Every customer has different ambitions, possibilities and motivation that drive them to purchase new products. In order to build a relationship to a brand and become loyal, the customer requires more of the product than just satisfying basic needs. This is especially true for products that have similar performance and price within the market segment. In the development of "green products" it is important to define which "green profile" the target group will have. This relates to the so called ecotypes developed by two Swedish researchers, Persson and Hemberg [72]. Eco-types are six fictional types, based on archetypes and related to eco-branding that differentiates the customer's perceived quality and value of green products as well as what motivates them to purchase green alternatives.

#### 5.1.2 Analysis of ecotype

Good design and branding is about people's opinions. Therefore it is important to identify which "people" to brand and design for. The target group for the new solution is already defined and it is, in theory, easy to implement the new solution on the market. There are, however some problems concerning the attitude among the users of boosters and people owning a car that contains a boosting solution. Product design cannot change people's attitudes, mind-sets and behaviour but archetypes are "the software of mind" [72] and it could be that by analysing the ecotypes a common denominator can be found in what motivates them to consume products that have other features than the user intended to purchase. Then the product and the brand can be adapted so that users change their attitude unconsciously and instead consume products that add values to the user.

The idea of defining an ecotype (figure 20) for the project is to, through the Persson and Hembergs model [72], find properties that motivate consumers to consume products that not only, primarily, meet the consumer's wishes. One desire is that through identification of the ecotype, make Volvo Cars users wanting to own, rent or share a Volvo car with an integrated child seat, although the need is not fundamental.

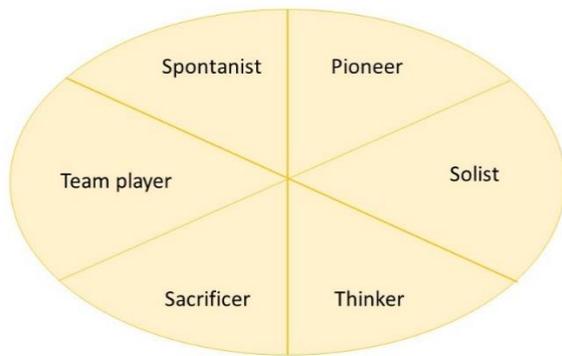


Figure 20. Ecotypes [72].

The model on which the researchers have applied ecotypes is called Needscope and is a model for describing basic personalities among marketers [72]. Needscope is in turn based on archetypes and Volvo Cars' brand archetype, *the caregiver*, is placed in the chart (figure 21) and is called "*the cautious*". According to the variables for the description of Needscope (extrovert or introvert and I or we-oriented), "*the cautious*" are described as we-oriented and mainly introverted, cautious and a little worried as well as showing great care about others. The ecotype that the researchers attach to this personality type is *the victim*.

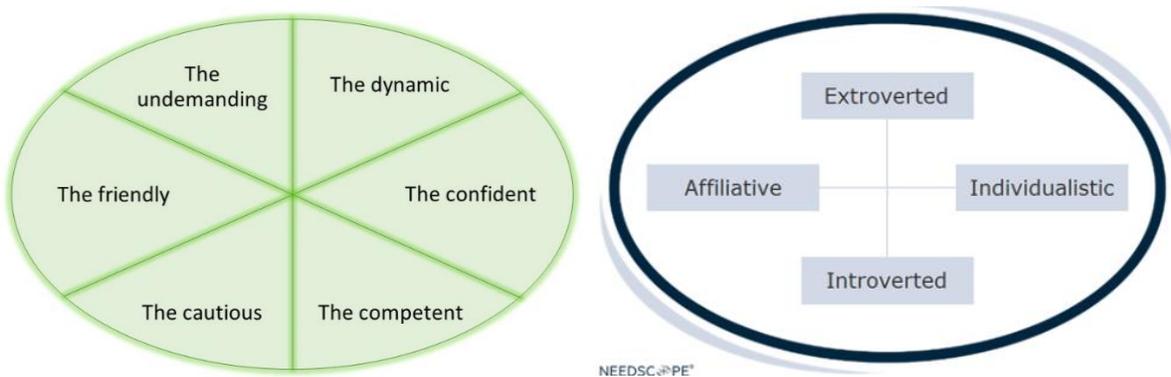


Figure 21. To the left archetypal personalities and to the right a model describing basic personalities by Needscope [72].

Even if *the victim* is directly portrayed by Volvo Cars' brand archetype *the caregiver* (figure 22), the information given in the exploration of the scope point to a more "hard flirted", I-oriented ecotype. When looking on the opposite side of "the victim" in the chart, the I-oriented archetype, "the dynamic" is found. This can be translated to the ecotype, *the pioneer*. If *the pioneer* can be convinced to use a Volvo car with an integrated child seat, it would be no problem to convince *the victim*. *The pioneer* is also more consistent with the new audience - the Millennials.

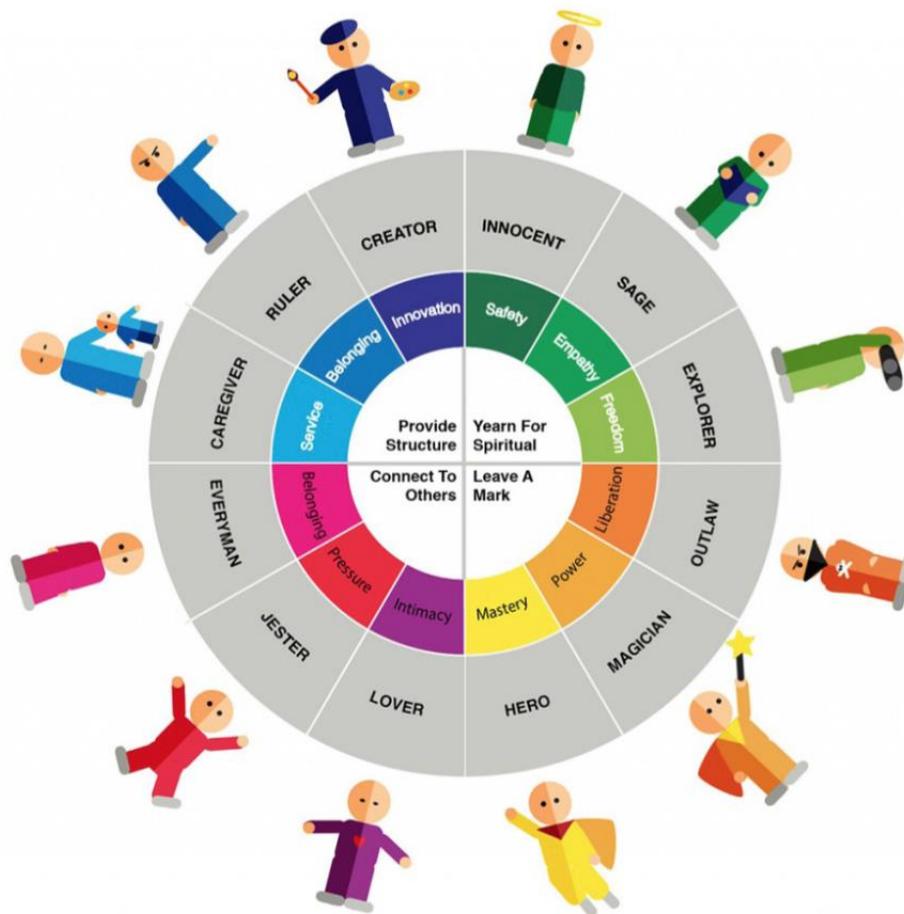


Figure 22. Brand archetypes.

### The pioneer

*The pioneer* is an action oriented, extrovert person who believes in technological progress. The name *pioneer* derives from the fact that the person in question often wants to be first with new things. The person believes in new positive development and new technology as a solution to many problems. The pioneer wants to have awesome, spectacular solutions and would buy symbolic acts to show his or her position but sells the products again if they prove too boring. In order for a pioneer to consume a product other than he/she intended to the product should comply with the criteria in table 1 [72].

Table 1:

- The performance of the product must not be worse, have lower quality or be more difficult to use and/or understand.
- Experiences always go first.
- Important that there is a selection to choose from, not only one alternative
- Utilize components in a smarter way.
- Convenience is important, products should not brake or interfere with ordinary life.
- The product should be cool, trendy, modern, different, new and exciting, something that stands out and adds additional luxury.
- The product may not be boring.

## 5.2 The functions of the IBC

A function analysis is done to examine what features the product consists of and if there are features that can be changed in any way to improve today's product.

### 5.2.1 Function analysis

A function analysis examines the features of today's product and identifies important elements for its existence. These areas are then divided into groups concerning whether the function should be improved, retained, adjusted or eliminated. This is done in order for further development to be positive.

The existing IBC was divided into the various parts of which it consists. Why are those parts important? Are there possible problems with the function? How to solve the problem?

### 5.2.2 Results of the function analysis

The result of the functional analysis gave main areas, each leading to a field that can improve the product. The order in the product name IBC, integrated booster cushion, was considered to be the three main functions of the product, which should be retained but improved, *Integrate*, *boost* and *a design on a cushion*. The features are presented in table 2 and the functions are all important for having the opportunity to improve an IBC

Table 2:

- A. *Integrated solution*. The function should be preserved as it provides a flexible rear seat for different users and usage.
- B. *Boosting*. The function, to boost, should be preserved and improved in order to maintain the safety of the user.
- C. *Cushion*. Can be deduced to a certain seat that has a certain appearance and certain dimensions. Being able to offer a seat is also a function that should be preserved in order to travel comfortably.

## 5.3 Users

A product can meet a significant amount of users during its service life. In this project, different perspectives have to be taken into consideration. Volvo cars is the product owner and developer and children between 4-10 years old are the main user group but it is not only their needs that have to be met. The empirical study shows that the product has many different users and it is therefore important to identify all users in order to properly meet all users' needs.

### 5.3.1 Method

In order to further develop and improve a product, account must be taken of the users. In this chapter, the different users of the product are identified and divided into different target groups.

#### Define target group

The definition of the target audience is done both through tangible and intangible data. Cultural, social, personal and psychological circumstances are taken into consideration. Demographic and psychographic identification of the target groups follows the one derived from the brand analysis (see chapter 3.4.3.1)

The needs of all users do not have to be met to the same extent in a project, meaning that it is important to group and rank the target groups and make priorities. By listing primary, secondary, side and co users, an image is obtained that there are a diversity of people who come in contact with the product and that it can be used in different contexts.

### 5.3.2 Definition of the target groups

In this chapter the target groups and priorities are presented.

#### Target group

Those who use the product for its primary purpose are defined as primary users and thus in this case include children of 4-10 years and/or 95-135cm. A person who uses the product, but not for its primary purpose, is defined as secondary user and thus includes the children's parents and other relatives. Persons who depend on the product without having decided to use it are defined as side-users and a person who cooperates with primary or secondary users without using the product is defined as co-user.

#### Primary target group

The primary target group is anyone who needs to use the product for its primary purpose and it is, according to law, anyone who is travelling by car and is between 95 and 135cm tall. The primary target group has also been divided individually, presented in different ways. The primary target group is divided into what physical requirements the user places on a solution and what mental and individual needs need to be met. At the time of writing, these mental and individual needs are determined by Generation z - Alphas (see chapter 2.2.2). The physical requirements that the primary target group places on a solution relates to the anthropometric data that is available for children of 4 to 10 years. Particularly important measurements are those of the thighs, head width, shoulder width, hip width and total length.

#### Secondary target group

A person who uses the product, but not for its primary purpose, is defined as a secondary user. The secondary target group is in this case the children's parents and other close

relatives. At the time of writing, the mental and individual needs of this target group are determined by the generation Millennials. The secondary user is the one who basically determines the use and purchase of a solution for the primary users. It is a Volvo user and thus essentially a caregiver archetype and is further composed of the generation type Millennials.

#### Side and co-users

Although the primary and secondary target group is of highest priority, a future solution has to be adapted so that a Volvo car could function optimally, no matter who uses it. A side user for this project is a person affected by the product, without deciding to use it. An example of a side user is a person travelling in the backseat without the need for a boosting solution. Side users are thus mainly of the eco-type pioneer. Co-users, on the other hand, are persons who cooperate with the primary and secondary users without using the product. If we disregard the pre- and after-market, this target group consists, for example, of retailers, car pools, taxi drivers and grandparents.

## 5.4 Usage

According to the study, there are several types of car users; Those who own, those who borrow, those who rent and those who share. There are also many areas of usage for a car. Based on the responses retrieved from the empirical study, see Chapter 4, the use of a car can be divided into three different usage types; frequent, sporadic and spontaneous.

The main sequence of usage of a CRS solution and the trends of future usage will be analysed and concluded.

### 5.4.1 Frequent usage

The frequent user own his/her car and uses the car every day, mostly to get to and from work and at the same time drive the children to and from preschool / school as well as to and from recreational activities. It is most common for parents of today to own their car, especially if they live outside the city centre.

### 5.4.2 Sporadic usage

The sporadic user uses the car one to two times a week or more seldom, for special occasions. Car pools, car sharing and also borrowing/hiring cars is usually practiced, if a need arises. This is most common for families and people living in the city centre. The car is used for going to shopping centres / big furniture stores outside the city, trips for the weekend or going grocery shopping on a weekly basis.

### 5.4.3 Spontaneous usage

The spontaneous users are those who, for example go by taxi, travel with someone else under spontaneous occasions, but who most often do not drive by themselves. These users would normally use other means of transports.

### 5.4.4 Constellations

Different constellations of rear seat passengers were also detected during the empirical study. This could indicate that a future CRS solution should facilitate not only for the child using it but also when not in use by a child. The different constellations of the rear seat passengers can be seen in figure 23.

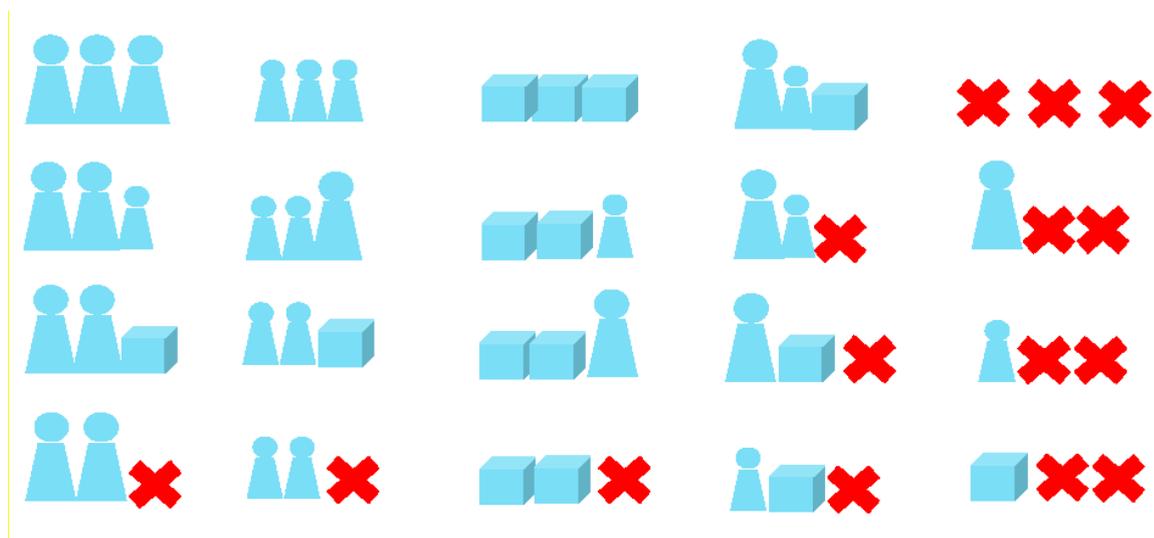


Figure 23. Different constellations of rear seat passengers.

### 5.4.5 Steps of usage

It is desirable that the CRS solution can be used in every Volvo car. Based on the data obtained from the empirical study, the sequence of usage of the solution is summarized. A schematic view of the touch points between the users and the product have been made to investigate what steps the users take when using the product and to find out if there are possibilities to change or eliminate any of the steps to facilitate the usage.

#### Sequence of usage

Based on the observations, a typical user journey with a few key steps, using an IBC (two step version) and a mobile booster solution could be stated. The steps are the same for both children and adults although the performance may look slightly different depending on how much help the child in question needs.

From the observations, together with the literature study, some critical tasks and problems within the steps were noticed, see below.

### **ENTER THE CAR (Open the door)**

*Mobile booster solution* - hard to reach

*IBC* -

### **INSTALL THE SOLUTION**

*Mobile booster solution* – difficult to install, takes time, may lead to incorrect installation, requires strength, requires a two handed grip

*IBC* – fast and cannot be placed incorrectly, can be misused due to the two different heights, requires adult supervision, may be hard to click in position

### **GET SEATED**

*Mobile booster solution* – displaces itself, difficult for short children to climb up, the required space for buttocks is too narrow due to guiding loops

*IBC* - difficult for short children to climb up

### **BUCKLE UP**

*Mobile booster solution* – difficulties to see and reach the buckle and to do right belt routing

*IBC* – no belt routing needed, easy buckling up

### **RIDE**

*Mobile booster solution* – head/side support in the way, uncomfortable leg position, lack something to put feet on, crowded in rear seat with more solutions than one, boring, cannot reach things (on floor, in pocket of front seat), difficult to use tablet solutions because arms do not fit between side supports

*IBC* – uncomfortable leg position, lack something to lean on, lack something to put feet on, boring, cannot reach things (on floor, in pocket of front seat)

### **UNBUCKLE**

*Mobile booster solution* – difficult to reach and to see - guiding loops hide the buckle

*IBC* – easy access to buckle

### **LEAVE SEAT**

*Mobile booster solution* – displaces itself, wobbly

*IBC* – stable

### **DEINSTALL THE SOLUTION**

*Mobile booster solution* – takes time to uninstall, nowhere to store it when not using it, bulky item, difficult to uninstall

*IBC* – easy to store, can be tricky to uninstall, have to use force

### **LEAVE CAR (Close car door)**

#### 5.4.6 Future usage

The trends point to a different pattern of usage in the future much depending on the behavioural patterns of the coming generations Millennials and Alphas. One assumption is that, with the trend *Share is the new own*, car pools and car sharing might be more common than owning a car and thereby the group of sporadic users will be more frequent.

## 6. Definition of problems

After the pre-study it is important to define the problem areas to enhance the opportunity to improve the existing solution and adapt it for the users. With the help of a KJ-analysis, it has been shown that right attitude, comfort experience, handling and safety approach in the use of CRS solutions for children has a positive impact on child safety in cars. This, together with future usage and space in next generation cars constitute the main problem areas. By enhancing these areas, through a solution and adapting the solution to its target group and usage areas, it will reduce injuries, increase the appropriate use and might save lives. It is also very important to allocate resources correctly by prioritizing the problem areas in order to achieve the best possible results.

### 6.1 Method

Two methods have been used in order to identify the problem areas and rank them correctly. The KJ-analysis is effective for sorting a large amount of data and was used to identify problems and possible later problem areas. These problem areas were then ranked with the help of a Pick-Chart.

#### 6.1.1 KJ-analysis

A KJ-analysis [73] is used when compiling an overall picture of a large amount of collected data is desirable. The method is good for grouping information that can be formulated into problem areas and further to requirements. The method is performed by sorting collected data on "post-it" labels with one statement or information per patch. Each post-it is then placed on a large surface one by one. If the patch is related to any of the previous patches, these are placed together. The patches will eventually be grouped into thematic groups [73]. Data from literature review, empirical gathering and exploration of scope dealing with some kind of problems are written down in order to compile problem areas.

#### 6.1.2 Pick-Chart

Within Lean Production, there is a method used to prioritize tasks, called Pick-Chart - Possible / Implement / Challenge / Kill [74]. Effect is placed on the X-axis, and effort is placed on the Y-axis, and then the data is evaluated based on the two variables and placed in the chart. The information placed in the first quadrant should be addressed first in order to get most value from the effort. The method focuses on value, not time, which is usually common in prioritization, therefore the method fits well to rank problem areas in larger projects like this.

## 6.2 Problem areas

Through the KJ-analysis, five main problem areas were plotted out. *The car's many application possibilities* and *misuse* are issues that are mainly related to the usage. The *wrong attitude* and *poor adaptation for children* is connected to the users. The fifth problem area is related to

the vehicle in which the solution is to be implemented, it has got *restrictions in size* and therefore puts certain demands on the solution.

### 6.2.1 Poor adaption for children

Volvo Cars' vision for 2020 is that no one should be seriously injured in a new Volvo. As studies have shown good comfort in general results in good safety, since discomfort results in changing position, and so less safety.

Children are required to sit still in their CRS and keep their seat belt in a correct position in order to ensure that they are safe in case of a collision. However, children are moving influenced by their comfort experience and as a result of activities as well as the child's personality and age. Many children consider a mobile booster uncomfortable (and childish), which has resulted in a shortened period of usage than recommended and in some cases even in none usage. The IBC is considered to be less uncomfortable than other booster solutions, yet not comfortable enough.

Different CRS solutions cause different lateral postures. Seated on an IBC, children often lean inboard in the vehicle in order to see between the two front seats, which results in the seat belt getting further out of the shoulder. Sometimes children lean the lower arm, elbow and/or the head towards the door panel which results in an outboard tilting of the torso and it will be perceived as uncomfortable since the seat belt lays against the neck and they will adjust it. Seated on an hbB, the presence of a large lateral head support resulted in children moving their heads outside the volume of the hbB to get a better view out of the window or about the interior of the vehicle. Children's subjective assessment was, that they disliked the side wings on the hbB which made them feel restrained and locked- in and the wings prevented them from looking out through the side window.

Another problem with the IBC is that children get an incorrect leg position when using it due to the construction and design of it. The measures of the seat create some inconvenience and thus some dispositioning. Some booster seats have been evaluated as too short and the car's own seat length as too long, even for some adults. As a result, an occupant will be forced to slide forward in a slouched position on the seat so their knees can bend comfortably at the seat cushion edge to allow comfortable leg positions. An upright position will make them feel pressure on the back of their legs. The slouched position raises the lap belt high on the abdomen and often places the shoulder belt in an uncomfortable and even unsafe position in case of a collision. In some cases the children even put their feet on the "foot support" which causes an uncomfortable angle, especially for taller children. However, it is not only the children's comfort that has to be considered but also other rear seat passengers'. Studies have shown that the IBC's mechanism makes the rear seat perceived as hard and reduces the experience of good comfort for rear seat passengers.

For the new solution to be able to offer high comfort and be adapted to the primary target group, children 95-135cm, it is of high importance to consider the anthropometric data for the smallest children of 95cm as well as for the largest children of 135cm. The important measures when it comes to seats are the length of the thigh and lower leg as well as the breadth of the

hip and shoulder. It is also desirable to have to make as few adjustments as possible for the solution to adapt to the extent of length that is included in the primary target group.

A proper belt fit will above all be obtained by raising the child. From a safety point of view the side support is mainly used to keep the child in right position for a proper belt fit. By shortening the cushion length, the possibility of a sloughed position would decrease, which would increase the safety. A foot support would give the child a better leg position and thereby increase the perception of comfort. Therefore, the new solution should shorten the length of the seat, raise the seat as well as add foot and side supports, all according to the anthropometric data of the primary target group.

To satisfy all customers and users and to meet all personal needs, the rear seat has to be individualized, which is most easily done if the rear seat is divided into three separate seats.

The comfort aspects regarding the IBC and possible implementations of side supports will be examined more closely in the Master Thesis of Linköping University of Technology conducted by Sofia Boberg and Tove Fredrikson, and will not be of primary priority for this Thesis. Still, some suggestions will be developed.

## 6.2.2 The car's application possibilities

Since mobile boosters are more available to the public, they are the ones that are mostly used. The problem is that they are heavy, ungainly and take up much space both when used, stored and/or transported. In this project, clear advantages with an IBC have been seen when it comes to the utilization of the space and the functionality of the rear seat, since the IBC can be easily stored on the fly. It provides flexible seating for a diversity of passengers and provides a more extensive usage when it comes to transporting bulky items. Another advantage with an integrated solution is that relatives can provide safe transport of children without the fuss of installing a mobile child seat.

A Volvo car can be used anywhere and anyway and as we travel more and more and in different constellations, humans of tomorrow will value flexibility and availability more. New customer behaviours will mean more car sharing and car pools which will increase the demand for flexible CRS solutions, like an IBC. New multi-generations will have other demands on solutions like convenience and on demand. To be able to improve the IBC, the solution should be integrated, should not take more than a few seconds to install and uninstall and should not affect the comfort of the rear seat.

## 6.2.3 Lack of space in future vehicles

One of the problems explained by Volvo Cars in the beginning of the project was that the mechanism of the IBC is too big for future vehicles. Cars are built more compact and to reduce carbon emissions, all future cars also have to be more light-weighted. To fulfil these requirements for future cars, future CRS solutions should also be light weighted and compact. Therefore, a solution would be to implement the inflatable material Volvo Cars is using for other projects, see chapter 2.10. The space available for the rear seats in Volvo cars today

depends on which model you investigate. The measures are approximately between 1150mm x 470mm x 90mm and 1350mm x 460mm x 120mm (WxDxH) for the seat. The new solution should not exceed these measurements.

#### 6.2.4 Attitude and safety approach

Parents and children have been seen to have negative attitudes and inaccurate or inadequate safety approaches when it comes to using a boosting solution. The majority of parents, in a study, understood that BCs reduce the risk of injury. However, about a third still said that they would not use a booster for short trips. The most common reasons for not using a booster were inconvenience, lack of space and the child negatively influenced by friends. The last mentioned reason together with parents' inconvenience and poor knowledge about car safety, has shown that children stopped using the BC earlier than recommended. Children want to feel older. Not using a booster seems for them to be a sign of getting older. Another reason why children disliked boosters was, that they were perceived as too hard and children preferred to ride without a booster because they "were used to it" and it felt more comfortable.

The children thought that a booster should not be too childish but be more like adult seats, as also appeared in the literature study. When the older children told the interviewers how they travelled, nobody mentioned that they used a boosting solution, although later was found out they did. However, it was important for the children to tell that they used a belt. This indicates that the children understand that a car safety system should be used but they found it stigmatizing to use a boosting solution.

Upcoming customer generations that make up the project's primary and secondary target groups have been seen to tend to have different attitudes that must be taken into account. Based on the interviews, there was an epithet that distinguished the difference in the secondary target group. For parents it was safety and for the young adults (Millennials) it was efficiency. The now young adults (Millennials) want products to be fast, simple, personal, handsome, user-friendly and automatic and the product may say something about the person's identity and status. Additionally, it should not be boring for any child or adult to use a product and it may be useful that it contains some kind of new technology that adds value and meaning.

There are also specific attitudes towards the IBC that concern purchasing and possibly ownership of the solution. Based on interviews and observations, it is assumed that all car owners do not want an IBC, since a compromise must be made between IBC and other features that may be of greater value to the customer. This in turn has led retailers actively to choose not to inform about IBC. This might be one reason for the perceived ignorance amongst customers. The public seems not to be aware of the existence of the IBC.

By solving the problem of poor attitude and safety approach, a child safety system becomes more accessible and actually actively and properly used, in accordance with regulations, which in turn increases safety. To solve the problem of the ignorant attitude and vague safety approach, the solution needs to be positioned properly in the market and meet the needs of the target groups.

## 6.2.5 Misuse

A problem with mobile boosting solutions today is that there are many steps to go through to install and use such a solution, which increases the risk of misuse. Other problems with mobile booster cushions is that it has been shown that it takes time to install, it can be improperly installed, the booster can be displaced when entering the car, buckling up is difficult due to covering guiding loops and belt routing. These problems have in some cases lead to non-usage of boosters, which implies zero safety for the child.

IBC on the other hand, has shown to be easier to handle. It takes less time to install and the installation cannot be done improperly. The simplicity to buckle up without complicated and covering guiding loops is also a clear advantage. The only problem is that it can be uninstalled by the children during ride without notifying the driver.

Even if IBC has been proven better in many ways, the coming generations have more demands on the solution than it can offer today. To improve the IBC, the solution should offer a convenient usage and have less steps from entering the car to sitting in a safe position in order to eliminate the risks of misuse. It should also offer a slick user experience together with even more convenient usability in form of automation.

## 6.3 Problem prioritising

To be able to allocate resources correctly and achieve the best possible results, the problem areas must be divided into groups of priority. Using a pick-chart, the problem areas were placed into two different groups. Diagrams along with the degree of significance of the project and the sequential order of construction could determine the order of priority.

The problems that need to be solved first (priority 1) are construction-related problems and mainly comprise *poor adaptation for children* (see chapter 6.2.1) and the restrictions a car sets for a solution (chapter 6.2.2 and 6.2.3) as these problems are most significant for the project in order to improve the IBC. The problem with the *cars' application possibilities* (see chapter 6.2.2) is also set to a priority 1, since flexibility was considered to be primarily related to the construction. A good construction is crucial for being able to implement solutions for the problems that involve *attitude* and *handling* (misuse). Once a construction has been established, solutions to remaining problem areas can then be implemented on it.

### 6.3.1 Priority 1 – Construction issues

A new construction is required to improve the adaptation for children and since the solution will be implemented in a Volvo car that have little space for existing solution. The new way to use a car also requires that the solution is flexible and integrated. To achieve this, the physical needs of the primary target group must be taken into account. In order to make the solution more comfortable, the following areas have to be developed:

- Shorten the seat cushion
- Boost

- Foot support
- Side support

In addition, the car puts certain demands on the solution when it comes to size and weight (see more details in the requirement list, see chapter 7).

### 6.3.2 Priority 2 – Experience issues

According to the Pick-Chart it is predicted that the effect of implemented solutions on attitude and handling (misuse) is great compared to the effort needed. Ideas on how to improve the experience for the users can be implemented in the construction. This involves comfort experience, usability in the handling sequence, positioning on the market and adoption to appropriate users. Even the cars many application possibilities belong partly to this priority since a flexible solution contribute to an improved user experience.

## 7. Requirements

The main areas of development defined in previous chapter were summarized and specified in a Requirement list. The Requirement list is also based on the desired features stated by Volvo Cars in the beginning of the project, e.g. inflatable material, weight and space for implementation in next generation cars. New requirements have continuously been added during the process due to new findings and new information.

Due to the division into two priorities, the Requirement list is divided into priorities as well in order to facilitate the evaluation. The first priority consider problems concerning construction (boosting, shorten cushion lengthwise, foot and side support) and the rest is marked as priority two, including functions that enhance the user experience. The requirement list is presented in table 3 below.

<b>GENERAL</b>
For whom and for what purpose
<b>ADAPTION TO CHILDREN'S MEASUREMENTS</b>
How should the passenger travel and be seated (Shorten seat, boosting the seat, direction of travel)
<b>SIDE SUPPORT</b>
What the supports should contribute to
<b>CONSTRUCTION</b>
Weight, material, integration, size
<b>FLEXIBILITY</b>
Handling, installation, appearance and comfort, suitable for a diversity of passengers
<b>SEMANTICS EXPRESSION</b>
What should the solution look like and what should it express
<b>RESTRAINTS</b>
Compatibility with the restraint systems that exists today
<b>SAFETY</b>
Precautionary functions to retain safety for passengers
<b>MISCELLANEOUS</b>
Functions that give the solution an added value

Table 3. Short version of the requirement list.

## 8. Ideation

After the preliminary study and problem definition, the ideation phase began in order to find solutions to the defined problems. Ideation is an iterative process, which in this case takes place in cycles of three. Each cycle contains or ends with some sort of selection to converge the work (see Chapter 9, Evaluation) and a new ideation cycle begins to reach divergence. The different phases have different focuses.

Phase one – find new innovative solutions to the whole problem, construction and *user experience*

Phase two – find new solutions alternatively further develop solutions on construction

Phase three – find new solutions, alternatively further develop, solutions on *user experience*, see Chapter 10.

In order to reach an innovation height and not be limited and/or controlled by requirements, the project owners chose to involve other competencies in the first phase. To facilitate for the participants to find their creativity there are a number of creativity methods that stimulate to a successful ideation session. In this case, creative methods such as the *6-3-5 method* and *morphological table* were conducted. Each ideation phase ends when the ideas go towards similar solutions and are thereafter analysed in an evaluation session.

### 8.1 Phase One – Ideation

The first ideation phase was very open and addressed all priorities in the project (see chapter 6.3). The goal was to find as many ideas as possible, which would solve all problems. During this phase, the quantity of ideas was more advantageous than the quality of the ideas and all suggestions were welcome.

#### 8.1.1 Methods phase one

The first phase was conducted in three different groups with slightly different execution, where the methods and tools were carefully presented in advance and the project owners tutored the whole session. The ideas from the participants were sketched on paper and/or discussed together in the group. In order to facilitate the task for the participants during the sessions, they received pictures of the rear seat from newer Volvo car models.

#### Participants

A total of 11 persons participated in the first phase of the ideation, six male and five female in the age span of 22-47 years. They all had different experiences, interests, family relationships, occupations and level of education. The selection of participants was carefully made to gather as many perspectives as possible. None of the participants had been involved in any pre-study or in the generation of requirements. The participants performed the ideation sessions at three different occasions and were divided into three groups based on their age and/or profession:

- Group 1, *The Volvo group*. The group consisted of three Volvo Cars employees. All of them males, aged 25, with a background within industrial design engineering and working with digital user experience (DUX) and construction of front seats.
- Group 2, *Parents*. The group consisted of three parents with children within the target group. One female and two male, with an age span of 35-47 years. All of them had different background.
- Group 3, *Industrial design engineering students*. The group consisted of five 25 year old students (one male and four female) from Chalmers University of Technology, studying design and product development, focusing on user needs.

### Creativity boost

In order to warm up the participants' creativity and implicitly lead into the subject, two creativity exercises were conducted before the ideation began and each exercise was performed during two minutes. The exercises were:

1. Write as many associations you can think of on the word *children*.
2. Sketch and/or write words on what one can use an air mattress to and/or what one can do with it.

### Black box

The participants were given as little information as possible about the problem, this in order to keep their creativity flowing. Black box is a good method to use to zoom out of the problem and divide the problem into partial problems [75]. The method is based on finding solutions to a problem on as little given input as possible.

The only information that was given initially was that a child 4-10 years should be transported forward in the rear seat of a Volvo car. As the proposals declined, more information, input, problems or sub-problems were given. For example, that the child must be able to look out or that the child easily gets restless.

### Brain Writing, 6-3-5

In order to get ideas, the brain writing method "6-3-5" was used [76], see figure 24, and/or variants on the method depending on the number of participants. The method involves six participants who will sketch three ideas in five minutes on a given problem, in this case with limited information given. Then the ideas were explained and passed forward to the following person who, in turn, either choose to develop the existing ideas or tried to find new solutions during the following five minutes. The sessions result in many suggestions. All proposals are welcome. Negative feedback during the session is not allowed.

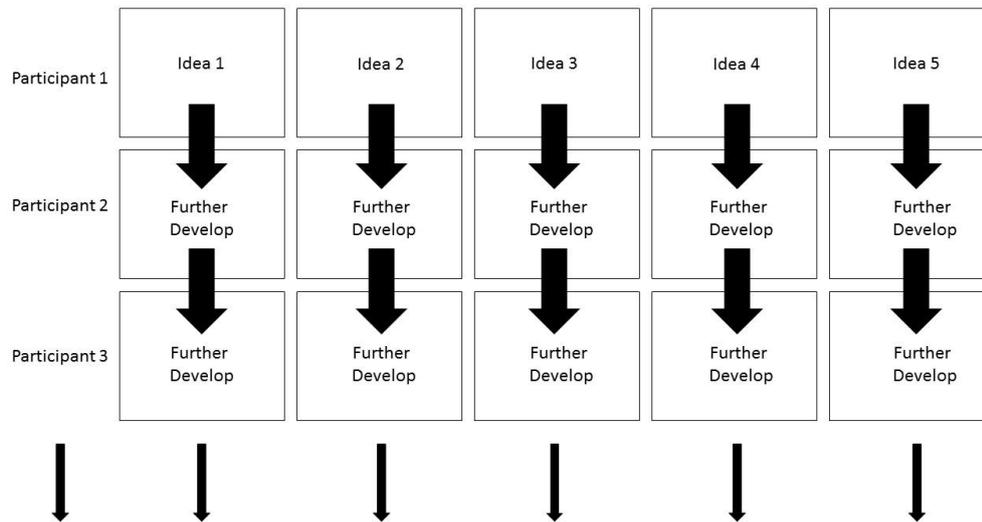


Figure 24. A schematic figure of the brain writing method “6-3-5”.

### Mediating objects as complement to ideation sessions

In user-centred design projects, it is important to define the characteristics of future users so that the product will match the users as well as possible. *Personas* and *scenarios*, see below, are good communication tools that create engagement for the user's situation and needs. It is desirable to remind people in the ideation groups that the solution should be developed for many different users with individual needs [77].

A number of personas and scenarios were used to facilitate the ideation in order to develop ideas suited for many different areas and which also satisfies as many needs as possible. Distributing, alternatively reading out loud the fictional personas and the scenario was a good way to provide the participants with complex data in a creative and comprehensive way.

### *Personas*

Personas are concrete fictional descriptions of potential users and are used to facilitate the communication between the members of the design team. As a basis for the personas lies the target group presented in chapter 5.3.2. The project resulted in five personas based on real people's characters and have been designed to achieve as wide a range of users as possible. An example of a persona is shown in figure 25, the other four personas can be found in Appendix 5. The goal with introducing the personas was for the participants to gain insights into the individuals and personalities of the people who may come in contact with a possible solution. At the same time they were to gain a deeper understanding of what is needed and solve problems thereafter.



## FILIPPA, 8

Filippa Hammar är 8 år, 134 cm lång och bor på **Södermalm i Stockholm** och det har hon gjort i hela sitt liv. Mamma är journalist från Sandhamn och pappa är kommunalpolitiker. Filippa har en **tvillingsyster**, en lillasyster faktiskt för Jenna är född hela tre minuter efter Filippa. Filippa och Jenna hanterar tvillingförhållandet bra. De är bästa vänner, **delar rum** och intressen men har ändå "egna" kompisar. Det är alltid **fullt upp** hos familjen Hammar med aktiviteter och föräldrar som tar med sig jobbet hem så systerarna får ofta klara sig själva. Något som gjort dom något **vuxna och ordentliga för sin ålder**.

Figure 25. The persona Filippa.

### Scenarios

Scenarios are fictional stories that show how a potential user treats a potential area of usage. They include as many different details as possible to be able to reflect the everyday complexity. Scenarios can help to see the solution in a context, to examine possible approaches and to imagine how users behave in different situations.

Five scenarios was created, each of which is linked to each persona. An example of a scenario to the persona Filippa is shown in figure 26. The other four scenarios can be found in Appendix 5. The scenarios was based on the area of usage presented in Chapter 5.4, and was designed to include a wide range of ways to use the solution. Thinking futuristically and discussing how the new solution can be received and used by the market and different users, gave opportunities for improved concepts [78]. The purpose of the scenarios was to facilitate the ideation sessions, investigate interaction between different situations and involved users.



Figure 26. Scenario of the persona Filippa.

### Steps for implementation

All three groups started the ideation by the creativity boost and continued with the 6-3-5 method where they sketched on the problem "How should children 4-10 years of age be transported frontward facing in the rear seat of a Volvo?" The duration of each 6-3-5 sketch session varied for the different groups depending on the participants' knowledge of the method. Also the use of personas and scenarios varied slightly between the groups:

- For the Volvo group, the personas and associated scenarios were read by the project owner between each sketch session in the brain writing phase. The ideation finished with a general discussion on the developed ideas and their potential issues.
- The group of parents was assigned the personas and scenarios, one by one, when each brain writing round was finished. For each round, the participants got to individually customize the developed ideas according to the new information. Thereafter a general discussion was held about the generated ideas.
- First, the group of Industrial design engineering students conducted a brain writing on the problem, without any further information. Then they were divided into two teams. Each team had to choose an idea to continue working with, thereafter each student was assigned a persona. The task was to combine and meet the needs of their personas and their scenarios. Thereafter, the ideas were pitched by each team whereas the opposite team's task was to look for features that collided with the needs of their personas.

### 8.1.2 Result phase one

The first idea generation session generated 130 suggestions, both solutions to the whole problem and on partial features. Many were unrealistic and some solutions had potential. The majority of the ideas of a realistic nature included some sort of partition of the rear seat into individual seats. It was clear that the creative exercise about air mattress had a major impact on the ideas. Many ideas contained pneumatic or inflatable parts, although it had not been expressed as a desired feature beforehand (figure 27). A clear distinction between the groups could also be seen. The Volvo Group had more mechanical suggestions, with a construction character, whereas the quantity of innovation was lower. Many suggestions for belt positioning were generated in this group (figure 28). The parents generated solutions for user experience to a greater extent. Their suggestions focused on how to entertain children in the car, to enhance the travel experience for both the children and the parents (figure 29). The students had more innovative solutions focusing on user-centered design (figure 30). This group also had more suggestions for a complete solution than the other groups. All sketches from the ideation can be found in Appendix 6.

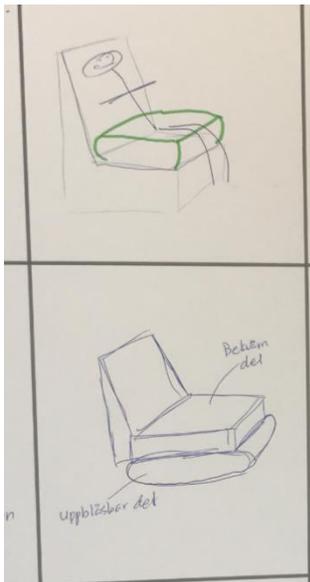


Figure 27. Some suggestions containing inflatable parts.



Figure 28 Suggestion on belt solutions.

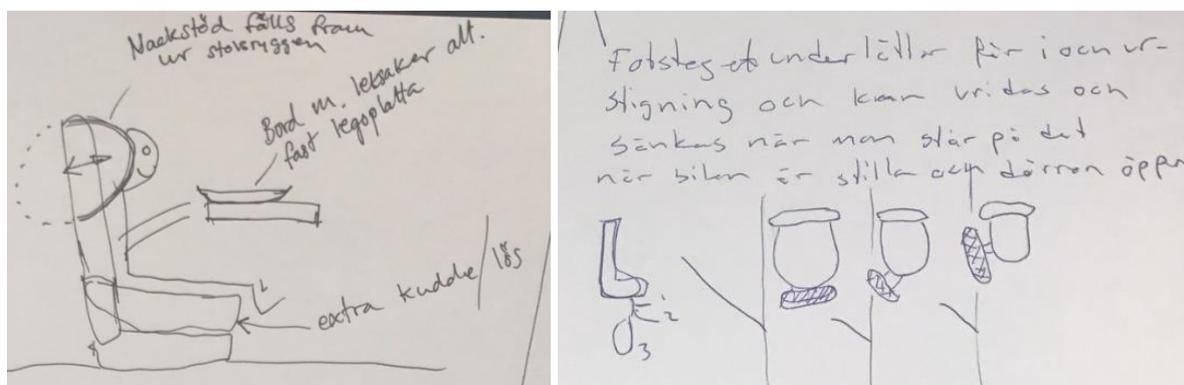


Figure 29. To the left, suggestion on activities in cars. To the right, suggestion on how to facilitate entrance and exit of the car.



Figure 30. Innovative suggestions. To the left, neck support is folded down. In the middle, the belt enables the child to move freely in the rear seat. To the right, Boosting pants that the child wears to be raised to fitting height.

## 8.2 Phase two – Ideation

After the first evaluation, see chapter 9.2, the second phase of the ideation began. The aim was to further develop the remaining concepts. This phase focused on finding a valid construction and therefore dealing only with issues related to priority one, shorten seat depth, boost seat, add foot and side support, see chapter 6.3.

### 8.2.1 Methods phase two

This phase was done by the project owners and was conducted through the use of new ideation methods, collecting inspiration from an exhibition and in symbiosis with experts at Volvo Cars.

#### Gathering inspiration by observation

Inspiration is always important, why the project owners visited an exhibition on assistive devices at the Svenska Mässan in Gothenburg – *Leva och Fungera*. The purpose was to get opportunity to study how to technically "boost" things, how to customize products depending on user's needs and measurements and to see what is possible to do with a car to suit a need and new materials.

## Morphological chart

According to Ulrich & Eppinger [75], a morphological chart is used to systematically find different combinations of solutions. By combining the different sub-solutions with each other, many solutions can be generated. For example, if there are four sub-solutions for each sub problem,  $4 \times 4 \times 4 = 64$  different solutions can be generated.

Under the first evaluation phase, see chapter 9.2, all suggestions on solutions were divided into groups that solved parts of the problem. These groups were then named A-D where each letter represented a number of ideas that solved the sub problems:

A = Solutions on how to shorten the seat depth

B = Solutions on how to boost/raise the seat

C = Solutions for a foot support

D = Solutions for side support/head support

The solutions to each sub problem are formulated to specify how to solve the problem, while leaving abundant space for different ideas.

## Brainstorming

Brainstorming is a well-known, simple and good method to generate as many ideas as possible and can be used both in everyday life and in ideation processes [76]. Brainstorming generates many ideas in a relatively short period of time and is useful to break stale and established thought patterns. A brainstorming session may look different and be conducted in different ways, either verbally, in writing or in thoughts and it can be conducted in groups or individually. In this project, brainstorming has been used to find technical solutions for combinations of suggestions about how to solve sub problems and how to implement the inflatable material to the maximum extent.

## Design by drawing

Design by drawing is a method similar to brain writing, but instead of writing down the thoughts they are sketched [79]. This method was used extensively throughout the project, especially during phase two of the ideation. The method was used partly to find solutions for the problem areas but first and foremost because a sketch with supplementary oral and/or written explanation is the best way to present concepts to people who have not participated in the ideation sessions, such as the client.

## Ideation with expert on seat belts

After the discussion with experts, see chapter 9.2.7, it was found that solutions on how to solve a good belt geometry were lacking. A meeting was held with an expert on seat belts at Volvo Cars to discuss how to incorporate seat belts in the remaining concepts, where ideas were generated on belt solutions.

## 8.2.2 Result phase two

The outcome of the second idea generation resulted six concepts that all were depending on individual seats i.e. split seats. These are shown and generally described below, without valuation. All concepts consist of seats whose A-surfaces are similar to those used by Volvo in their cars today. In order to facilitate the description of the concepts, the *seat types* are referred to as *the adult seat* (the seat in its original design) and *the child seat* (the custom seat adopted for shorter users). The concepts contained, ideas on how to shorten the seat depth, boost the cushion and to implement foot- and side-support. The solutions were of different levels of complexity and the majority contained inflatable parts.

### Concept 1 – The folding seat

Concept 1, shown in figure 31 is a manual solution based on the function of folding the rear seat forward to provide space in the trunk. The process of installing the solution undergoes many steps that begin with that the adult seat is folded forward, similarly to how it is done today. Thereafter, a construction is folded out of the chairs backside creating a new seatback to the child seat. Out of this seatback, another construction is folded out and fills the cavity and creates the seat cushion of the child seat. The footrests that are intended for the concept is a telescopic solution that is screwed onto the car's body (body in white/BW) and is adjustable in two directions.

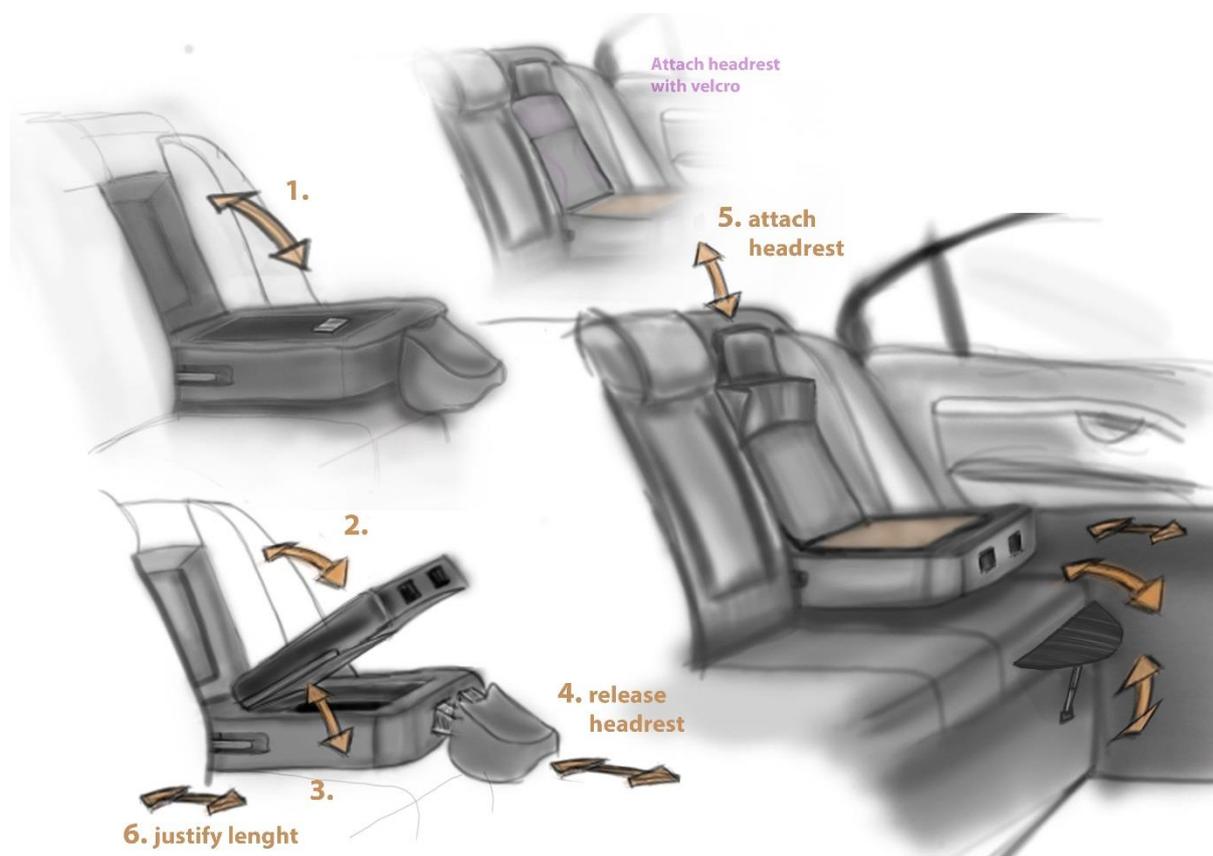


Figure 31. Concept 1 – The folding seat.

## Concept 2 - U-Rail

This concept (figure 32) consists of a seat where the seat back and seat cushion are separated. In the rear end of the adult seat there is a bag of drop stitch inflatable material which is always inflated in order to provide sufficient volume for an adult seat cushion. When the bag is deflated, the seat back moves forward on a u-rail and this results in a shortened depth of the seat cushion for a child seat. Thereafter the cushion is boosted by a mechanism that is placed under the seat. The mechanism consists of two scissor mechanisms that is expanded and locked in position when an inflatable bag is inflated. The foot supports for this solution are similar to those used on wheelchairs today. Two telescopic rods are snapped into the body in white when the cushion is boosted and a volume to put feet on is mounted.

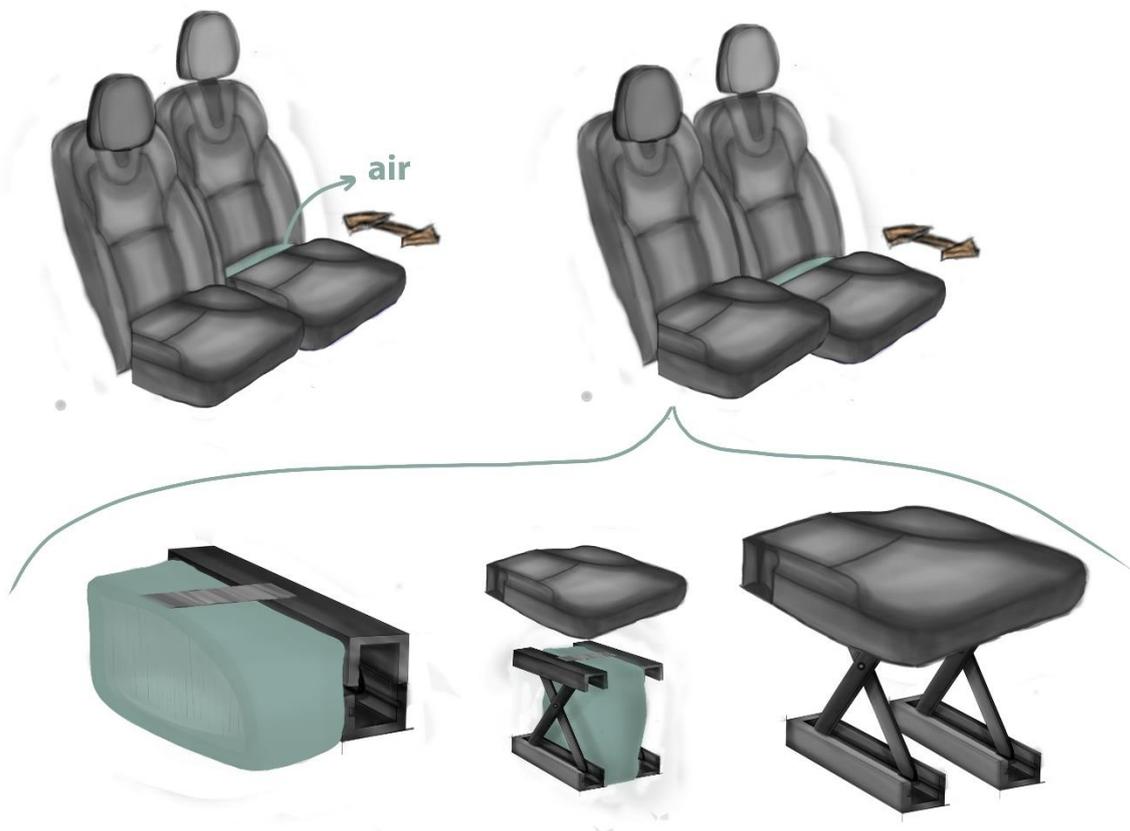


Figure 32. Concept 2 – U-Rail.

## Concept 3 – Inflatable bags

Concept 3 (figure 33) is, as well as concept 2, depending on a situation, where the seat back and seat cushion are separated. The seat backrest can slide over the seat cushion to shorten the seat depth. This is done by drop stitch inflatable material bags that are attached behind the back rest and push the seat back while expanding. The number and shape of the bags in the back allow the seat back to be tilted. The seat cushion can be adjusted vertically in order to boost the seat. The seat cushion is split into two parts that follows the stitching on the Volvo Cars seat. The inner part is the child's seat and this part is also activated by the drop stitch inflatable material bag cushion that is attached underneath the cushion.

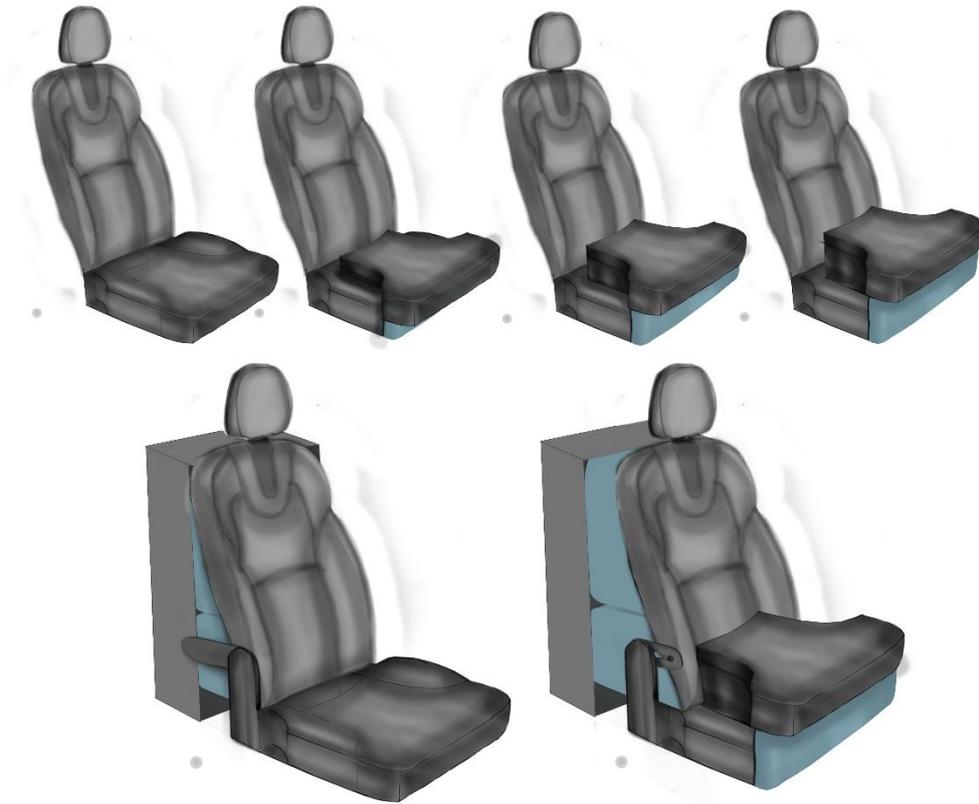


Figure 33. Concept 3 – Inflatable bags.

#### Concept 4 – Sliding spring

Underneath the seat of concept 4 (figure 34) there is a drop stitch inflatable bag. The bag activates a mechanism consisting of two rigid metal plates and a spring. The mechanism is attached to a u-rail which raises the whole seat into a height adoptable for children's anthropometry. The seat works a bit like the seat extension Volvo Cars has in its cars today, but the other way around. The seat cushion runs freely in the x-direction and while the seat is raised, the seat depth is shortened as the rear end of the cushion disappears under the backrest. Under the mechanism there is a footrest that runs freely over the u-rail. The foot support is adjustable in x-direction and it is possible to angle the support in the Z-direction. At the head end there are two head supports integrated that are activated in the same way as Volvo Cars' lumbar support.

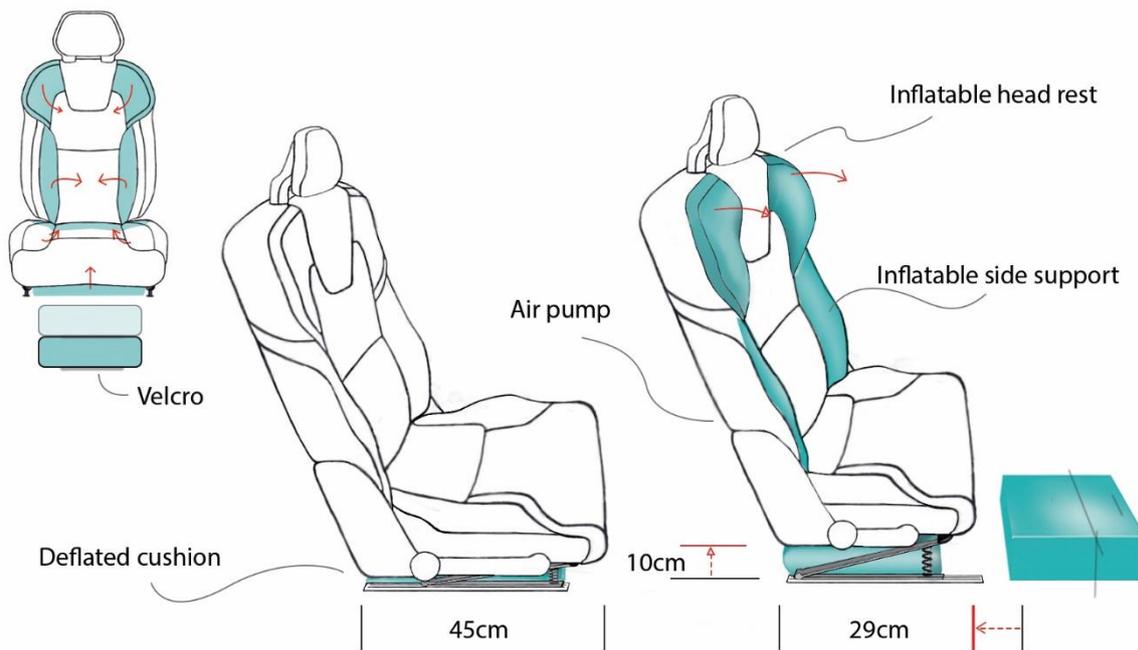


Figure 34. Concept 4 – Sliding spring.

#### Concept 5 – Change air

Concept 5 is a seat whose front part consists of drop stitch inflatable material (blue in the figure 35). On the adult seat this part is always inflated in order to provide a sufficient area for an adult seat. When the child seat is installing, the air from the front end moves to a drop stitch inflatable material bag which is placed underneath the seat cushion and thereby the seat is boosted and the seat depth is shortened simultaneously. On the side of the seat, a telescopic foot support runs freely in a track. The support is adjustable in all directions using a jointed rod.

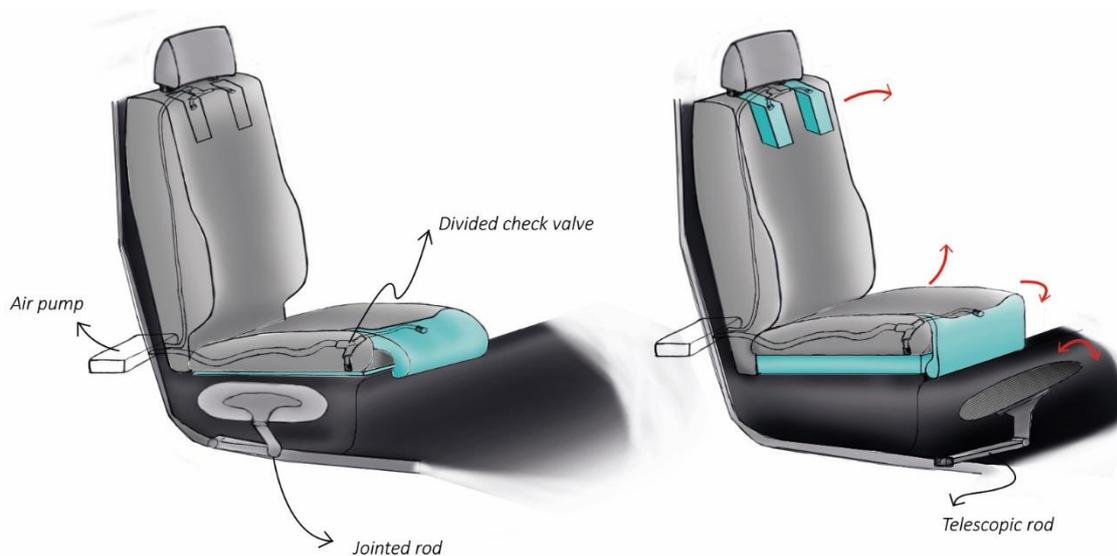


Figure 35. Concept 5 – Changing air.

## Concept 6 - Cogwheel

In the sixth and final concept, the cushion slides over the root of the seat back to boost the seat. This is done mechanically with help of a motor that drives the wheel and thus moving the seat upwards. To fit children, the seat can be shortened by pressing a button, located underneath the seat and then pushing the seat towards the back rest until it is locked in position. To lengthen the seat, the button is pushed and the seat is dragged out until it is locked in the outer position. Similarly to concept 5, the seat's material disappears under the rear of the cushion as seen in figure 36.

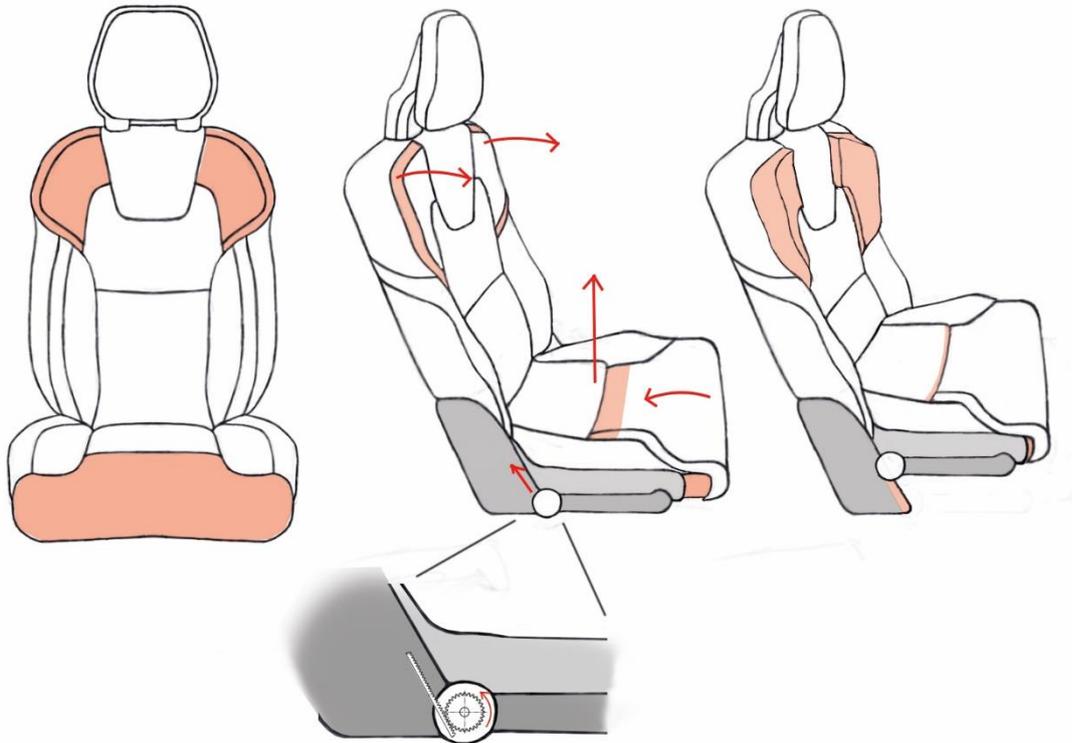


Figure 36. Concept 6 – Cogwheel.

## 9. Evaluation

The ideas that emerged from the ideation phase were of different character and quality. The purpose of the evaluation phase is to reduce the number of ideas successively so that one concept remains in the end.

In the evaluation, a variety of methods were used to choose durable solutions for further development into a final concept. This was done by combining solutions for the various sub problems and opting out of proposals that were irrelevant and lacking potential. The evaluation results in one solution based on the construction issues (priority one) thereafter a further development is conducted in order to find and evaluate ideas on priority two – experience issues (priority two). Documentation (Chapter 9) takes place in chronological order and the development of concepts and selection takes place through divergent and convergent thinking. This means that focus is first placed on identifying opportunities and problems surrounding the solution (divergent thinking) and then focusing on prioritizing the opportunities that arise and seeing the benefits of different ideas (convergent thinking). This occurs in cycles until the number of solutions has been reduced.

### 9.1 Division into priorities

Because the first ideation addressed both priorities one and two, it was both necessary and beneficial to split and sort all ideas according to the prioritization (construction vs experience).

#### 9.1.1 Positive, Negative and Interesting

PNI (Positive, Negative, and Interesting) is a method used to evaluate concepts and sketches by analysing if there are any positive, negative and/or interesting aspects in the different concepts. The method was used as a complement to the division into priorities in order to make sure that no ideas that had potential were rejected.

### 9.2 First evaluation

In the preliminary evaluation, the 130 unique ideas from ideation phase one were sorted and grouped to get an overview. Thereafter, irrelevant and completely unrealistic ideas were rejected. The goal of the first evaluation was to sort the ideas based on prioritization and find solutions to work on to reach a construction that shortened the seat depth, boosted the seat and solved foot and side support. Either separately or in its entirety.

#### 9.2.1 Realism and goal achievement chart

To get an overview of the number of ideas and simply get the opportunity to reduce the ideas, they were placed in a single selection chart. In a simple selection chart, the ideas are based on how well they meet two variables. The method can generate different outputs depending

on the variables chosen to be placed on the axes. Proposedly, the concepts are named with a letter or number for easier insertion into the chart.

In this case, realism and goal achievement were measured and used as variables to identify solutions that met the goals and at the same time were realistic. This means that each idea was analysed from a realistic point of view, and was matched to the requirements and wishes as specified by the requirement list, which gave the ideas' degree of goal achievement.

In order to streamline the selection, the measurement was subjectively made. The goal of "goal achievement" was given on the basis of an approximate number of fulfilled requirements, while the level of realism was estimated. The factors influencing "realism" were whether the concept could be produced using today's technology, and to what extent it is considered that users would choose the concept solution instead of existing products.

The ideas or groups of ideas were subjectively assessed and placed in the chart. The solutions that ended up in the first quadrant of the chart are most realistic and are considered to fulfil the goals the best.

The chart was used as a complement to selection methods and is used in cycles since the process is iterative. The number of ideas is reduced depending on grouping, combinations and sorting during the project.

### 9.2.2 First reduction

After the first ideation, 130 ideas of different characters were found, see figure 37. The ideas were looked through and discussed one by one. All irrelevant or unrealistic ideas were removed using the realism and goal achievement chart and subjective assessments by the project owners. Because the ideation took place in different groups, the same ideas were repeated several times. These ideas were clustered and the number of ideas was further reduced. After an initial reduction, 39 unique ideas remained, see figure 38.

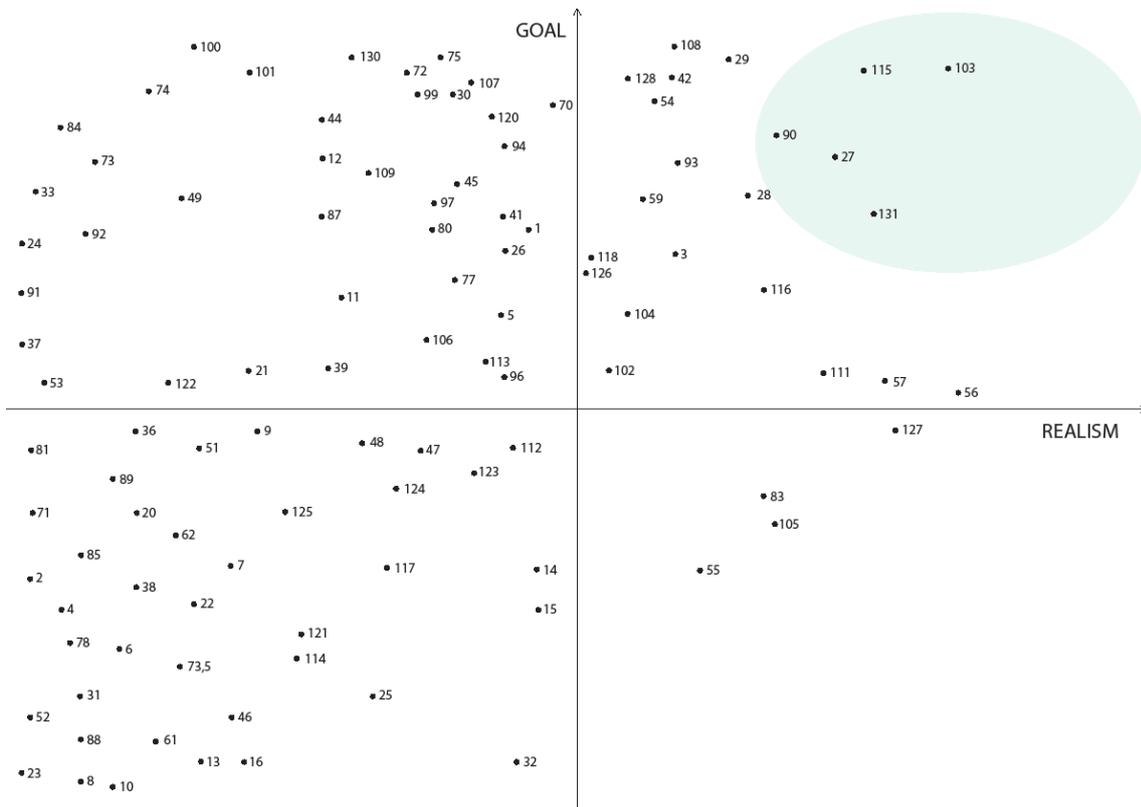


Figure 37. All 130 ideas that were generated through the first phase of ideation.

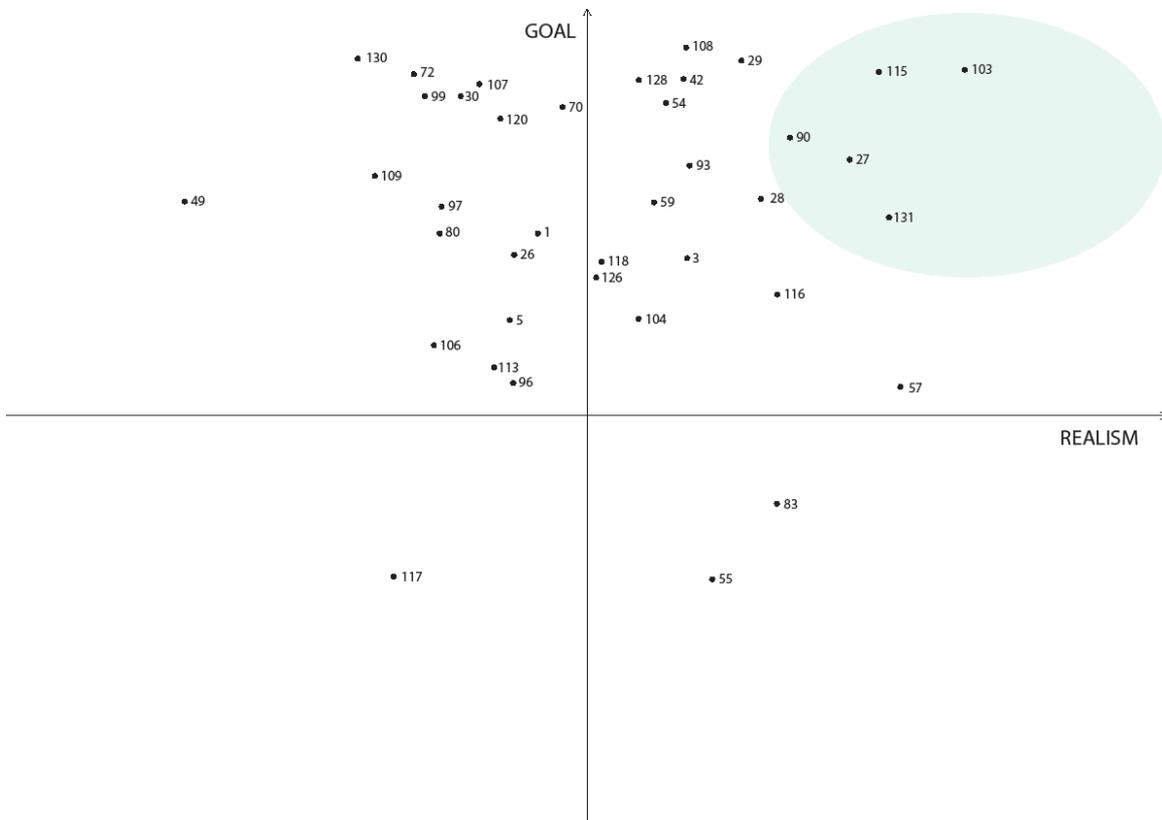


Figure 38. After the first evaluation, unrealistic and irrelevant ideas were discarded and 39 unique ideas remained.

### 9.2.3 Set-based concurrent engineering

In the early stages there are many ideas, including those that are not fully thought out and sometimes they can be rejected prematurely and vice versa. In order to minimize the risk of early selection of a concept for further development, which possibly does not prove to be the most ultimate, the project owners chose to work based on the method *Set-based concurrent engineering*. This is a method that can be linked to the vehicle manufacturer Toyota's way of working [80].

Set-based concurrent engineering focuses, unlike traditional product development where the most promising solution is chosen at an early stage, on investigating and developing multiple solutions in parallel and eliminating alternatives that for some reason fail.

The aim of the method is to continue with as many solutions and for an as long period of time as possible. The method can be regarded as time consuming as many concepts are worked on at the same time, instead of a few as in traditional product development. The authors consider this favorably versus the risk that the wrong concepts were chosen at an early stage. Thus, the method involves considering possible solutions that gradually decrease in number. During the overhaul, attempts are made to find solutions if, for any specific solution, requirements are not met [81].

### 9.2.4 Categorisation

Since it was important in the first phase to find solutions for a construction that solves the stated problems of Priority 1, it was advantageous to group the generated ideas into the four categories: *shorten the seat depth*, *boost the seat*, *foot support* and *side support*.

The ideas that concerned construction problems were divided into partial solutions and were assigned a category. The partial solutions were considered as independent and they could be combined without interfering with the other sub-solutions. The grouping reduced the number of ideas for the problems of Priority 1 significantly, see figure 39.

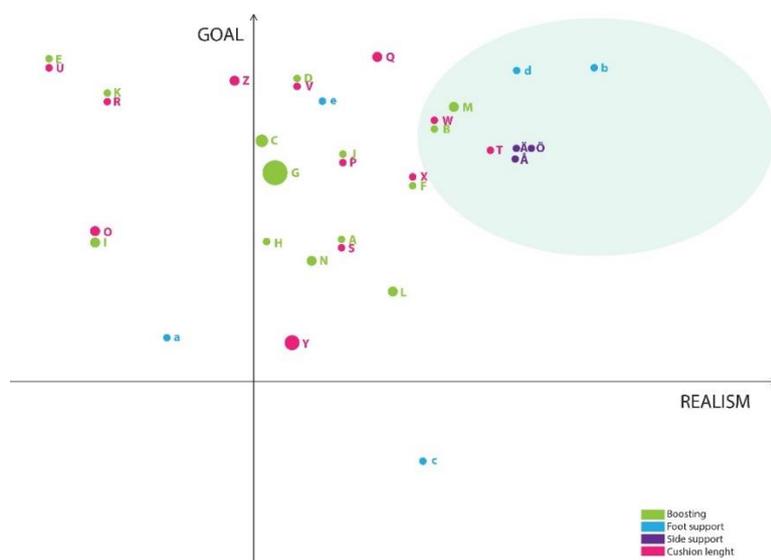


Figure 39. The reduced numbers of ideas after the categorisation.

### 9.2.5 Weighting of desired requirements

Since it is not always possible to meet all the requirements for a product, it may be useful to weight them to see which preferences should be prioritized. With the help of a criteria matrix, priorities of the desired requirements regarding construction issues were weighted. The weighting is done so, that two desired requirements at the time are weighted against each other. The value (0) or (2) were placed if one or the other weighted higher. The value (1) is placed if the two desired requirements are weighted equally high [82]. Once all desired requirements have been weighted against each other, a ranking list and a list of weight percentages will be obtained.

### 9.2.6 Weighted concept selection matrix

A grading matrix is a valuation method for investigating how well different concepts meet the set requirements, here regarding priority 1 - construction. The necessary requirements got the value of 1 and the desired requirements got the value they received in the ranking (see chapter 9.2.5). Thereafter, the six concepts that emerged from the ideation phase two (chapter 8.2.2) were assessed against each of the requirements and received a compliance number, according to a scale 0-4, where 0 corresponds to *completely insufficient fulfilment of the criteria* and 4 corresponds to *excellent fulfilment of the criteria*.

The value of the requirements is multiplied by the fulfilment number and are summed up for each concept. The maximum number of points a concept can receive is 68. For a concept to proceed to further processing, it should earn a sum of at least 85% percent of the maximum number of points thus 57,8 points [83]. This resulted in two remaining design concepts, Concept 2 and Concept 4 with total points of 63,27 and 58,38 respectively.

### 9.2.7 Evaluation with expertise

The two remaining concepts (figure 40 and 41) were discussed with four different persons at Volvo Car Corporation. These four have different expert areas that were used to evaluate the concepts further based on feasibility and safety perspectives. They were:

- Lotta Jakobsson – Adj. Prof, PhD, Senior Technical Leader, Safety Injury Prevention
- Helena Wallin – System Responsible, Child Safety
- Bhagyesh Ashtekar– SA Rear Seats
- Marcus Agnedal – Lead Engineer, Rear Seats

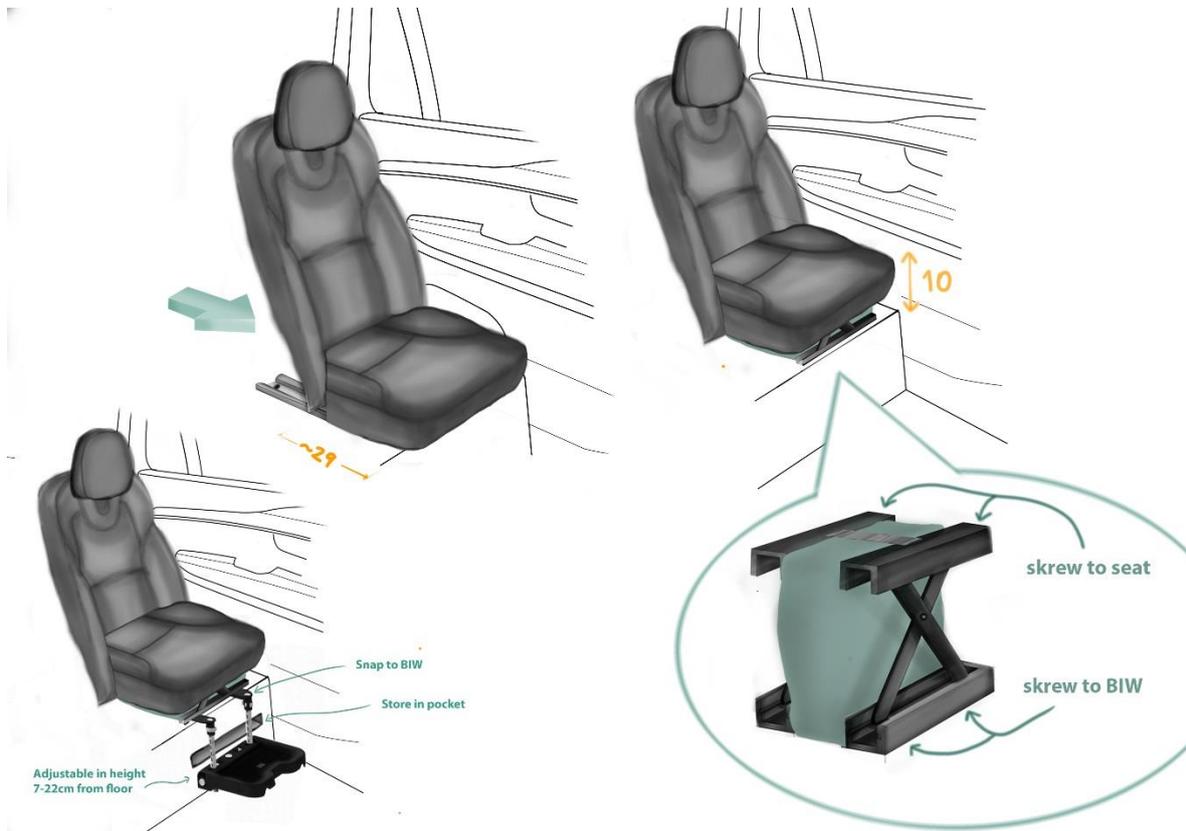
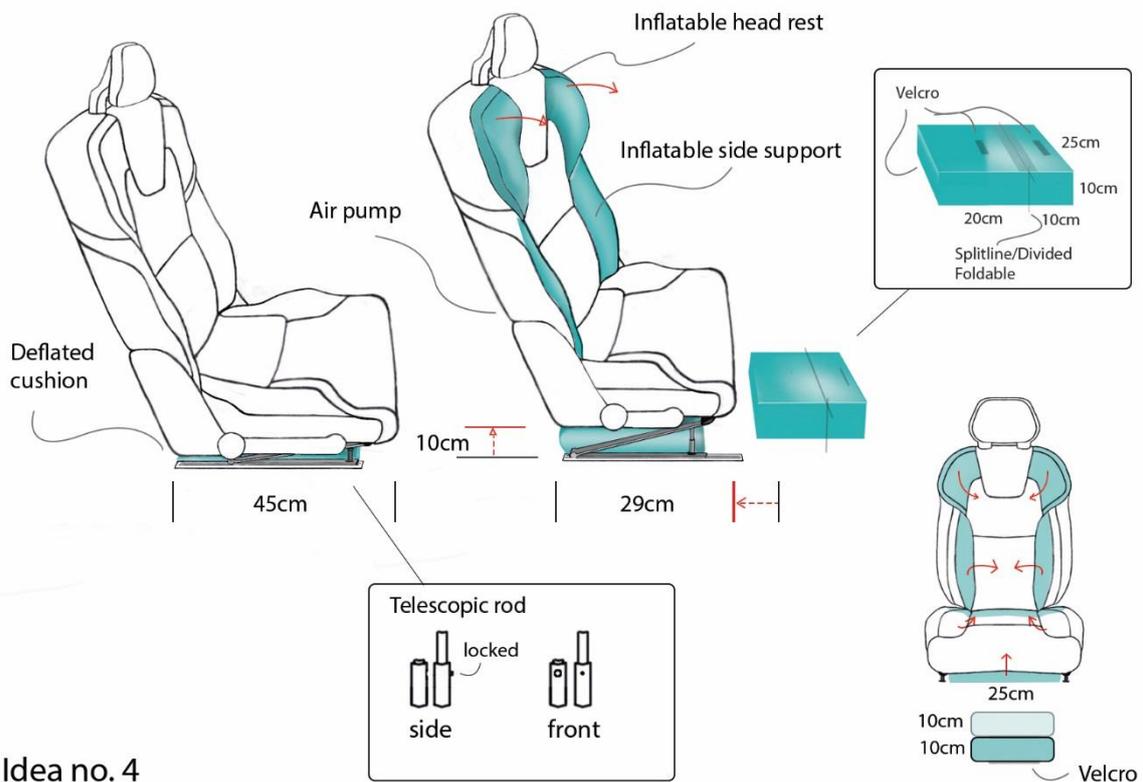


Figure 40. Concept 2 that were discussed with experts at Volvo Cars.



Idea no. 4

Figure 41. Concept 4 that were discussed with experts at Volvo Cars.

It was found that the solutions were conceptually acceptable for the dimension adjustments, but lacked solutions for belt geometry. A meeting was therefore arranged with Gert Aldeborg, (Concept Designer, Seatbelt, Volvo Cars) to discuss the belt geometry. This resulted in a concrete proposal for solving the placement of the belt attachment by using a buckle that is connected to the side of the backrest and slides on a rail when shifting position of the seat. The original idea can be seen in figure 42. According to Gert Aldeborg, the angle of the buckle should be between  $50^\circ$  and  $60^\circ$  to maintain the safety aspects of the seat belt, see figure 43. After the discussions and careful considerations it was found that a merge of two concepts would give the most positive result.



Figure 42. First solution on how the belt buckle could function. The buckle is attached to a rail and slides with the backrest when shifting position.

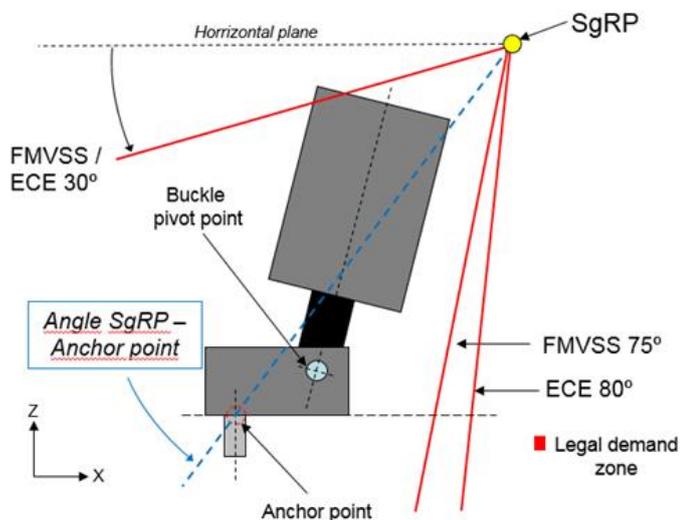


Figure 43. Optimal degree of the buckle is between  $50^\circ$  and  $60^\circ$ .

## 10. Further development of concepts

The conclusion of the expert meetings was that the two concepts were to be merged into one final concept. Solutions regarding priority two, *experience issues* (Chapter 6.3.2), should now be implemented on the final concept. It is important to find attributes that makes people want to own and use an integrated child seat. This involves comfort experience, usability in the handling sequence for usage, positioning on the market and adoption to appropriate users. Even the cars many application possibilities belongs partly to this priority since a flexible solutions contribute to an improved user experience. The implementation of solutions on experience issues takes place simultaneously with the merging of the two concepts since the merging determines the possibility and extent of experience solutions. The presentation of this chapter occurs in chronological order, with evaluation in or between each step. The result of this, third ideation phase is presented in the following chapter – final solution.

### 10.1 Digital sketching in Adobe

The chosen parts from the two concepts to be merged into one final concept were isolated and assembled in one assembly in Adobe Photoshop. This was done to facilitate modulation in CAD and to be able to evaluate the comfort. The findings of the Master Thesis of Linköping University were also taken into account (chapter 4.1.6). Example of things that were pointed out were the "leftover" material of the inflatable rear part of the seat cushion, which could be solved through implementing a plastic cover and rods where used instead of the bulky scissor mechanism.

### 10.2 Modulate in Catia V5

A CAD-model of a front seat of a Volvo Car model V90 2017 was used in Catia V5 to add, remove and adjust parts in order to visualise the construction of the final concept. The seat was placed in a context which more or less corresponds to the one that will be relevant for the solution. This enables the solution to, to a greater extent, interact within a context since an adaptation to interface can be made. Moreover, the modulating occurs in parametric design which enables quick change of measurements and design if needed. It was, for example, discovered that the side bolster, seat cushion and back rest interfered with each other but this problem could be solved by redesigning the cushion.

### 10.3 Positioning

It is established, in this project that users of child seats can have an ignorant attitude towards the usage and a vague approach to safety, which in turn has led to the fact that child seats are not used to the extent necessary. Other noticed facts are that child seats are not always available and that the IBC is not generally known. These issues can be solved by positioning the new solution correctly on the market. To do that, the target groups need to be convinced about the necessity to consume the product. This is done by dividing the potential consumers (all adults) into two groups - one who really needs a child seat solution and the other who does not have an explicit need for a child seat for the moment (table 4) and then trying to find

solutions that can motivate the different groups to own or hire a car with an integrated child seat and to use it. A mind map was drawn over elements that could motivate the groups to purchase and/or use a child seat and common denominators of the two groups were found. This to investigate what motivates them in addition to safe, comfortable and flexible solutions.

*Table 4:*

1. Own or rent a car with an integrated child seat having a *need* for it

To convince this group, the solution has to be better or as good as the most used child seat today, which according to the pre-study, is a mobile booster cushion. The solution should also be positioned to Millennials and satisfy their needs as they are expected to be the largest consuming target group having an explicit need for a child seat. This group will also be convinced to own a solution if they understand the benefits of it and actually use a child seat. Therefore, it is important to motivate the usage.

2. Own or rent a car with an integrated child seat having *no explicit need* for it

To convince this group, the solution has to include attributes that makes people willing to own and use an integrated child seat. The solution should be positioned towards pioneers (chapter 5.1.2) and satisfy their needs since they are predicted to be the largest consuming target group that does not have a direct need for a solution.

# 11. Final solution

The final concept is called the integrated child seat concept (ICSC), see figure 44 and targets the different groups of users, as stated in chapter 5.3.2. The concept fulfils the requirements (chapter 7) on the product. Through further development and ideation, the construction of the concept increases the flexibility of the rear seat and makes CRS more available for all users. The concept is intended for the outer seats of the rear seat in one of Volvo Cars' future cars. It consists of four main functions: shorten the seat depth, boost the seat, include side support and foot support. The concept is compatible with Volvo Cars' restrain system. A majority of the desired requirements are also fulfilled by the concept through the construction and through add-ons, see chapter 7. More pictures of the concept can be found in Appendix 7.



*Figure 44. The integrated child seat concept.*

In this chapter, the features, components and possible implementation of the concept are described. It is also described how it is meant to be used and how the concept responds to the issues that have been highlighted.

## 11.1 The design of the concept

The ICSC is an integrated solution that contains inflatable parts and is intended to enhance the car trip for children between 95 and 135cm that travel forward facing in a Volvo car of the future. It consists to a large extent of a combination of two concepts, 2 and 4, presented in chapter 8.2.2. The idea of how to shorten the seat depth as well as how to boost the seat

has been preserved from concept 2, U-rail. From concept 4, Sliding spring, the ideas on how to implement side supports as well as a foot support has been preserved.

The construction is based mainly on existing parts in Volvo Cars' front and rear seats, and currently has the function of showing the idea behind the concept rather than showing a complete construction.

### 11.1.1 Boost the seat and shorten the seat depth

In the following description, the term adult seat is used to describe the original seat and the term child seat to describe the seat which, after transformation, is intended for children. The concept has also divided the seat into two parts, the seat back and the seat cushion.

#### *Shorten the seat depth*

The seat cushion is divided into two sections (figure 45). The rear part of the seat cushion contains the drop stitch inflatable material, which is always inflated in order to provide sufficient volume for an adult seat cushion. The dimension of the rear part is 160mm x 450 x 80mm. To obtain good comfort and follow the visual impression, 30-50 mm padding is glued to the top of the inflatable part (51mm thick) and then wrapped in the same surface material as the rest of the seat.



*Figure 45. The ICSC in uninstalled position (adult seat) and installed position (child seat). The seat cushion in the uninstalled position consist of two sections and the installed position consist of one section.*

The seat back of the concept is built in the same manner as the backrest of the front seat. The "frame" of the seat back, see figure 46, is attached to two rails that in their turn are attached to the body in white (BIW). To adjust the seat back horizontally for the child, the seat back can

be moved forward by sliding electrically in the rails from position one to position two, see figure 47. The inflatable part in the rear end of the cushion will deflated simultaneously in order to provide space for the moved seat back. There is an electrical hasp in both positions that locks the seat back in place. The transfer takes place electrically and shortens the seat depth from 450mm (adult seat) to 290mm (adjusted seat for children). A small part of the lower part of the back rest also contains inflatable material and is, in the same manner as the seat cushion, fitted with padding and surface material. This part measures 20mm x 450 mm x 100mm. When the seat is transforming from adult seat to child seat, the part in the rear end of the seat cushion and the part in the seat back is deflated simultaneously. This creates a negative volume, which provides space to store the rest of the material.

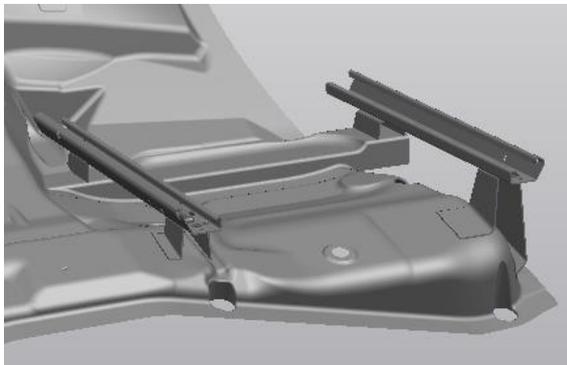


Figure 46. Two rails attached to the BIW.

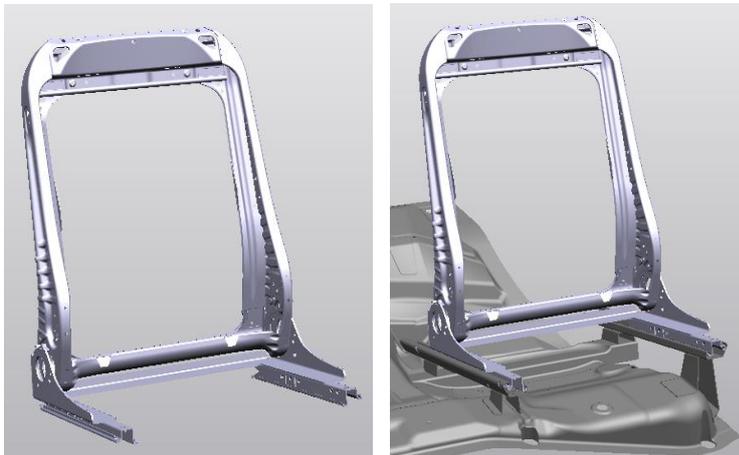


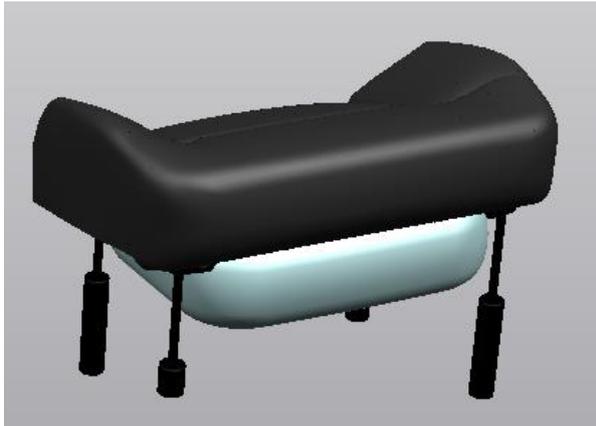
Figure 47. The frame of the backrest is attached in the two rails and slides forward when installing the solution.

The roll, from which the passenger ejects the seat belt is located in the car's C-post and the belt buckle is located next to the seat cushion. The buckle is anchored in the back rest, in the same way as in the front seat and will follow the backrest in the transformation and maintain the angle of 50-60 degrees as recommended.

#### *Boosting seat cushion*

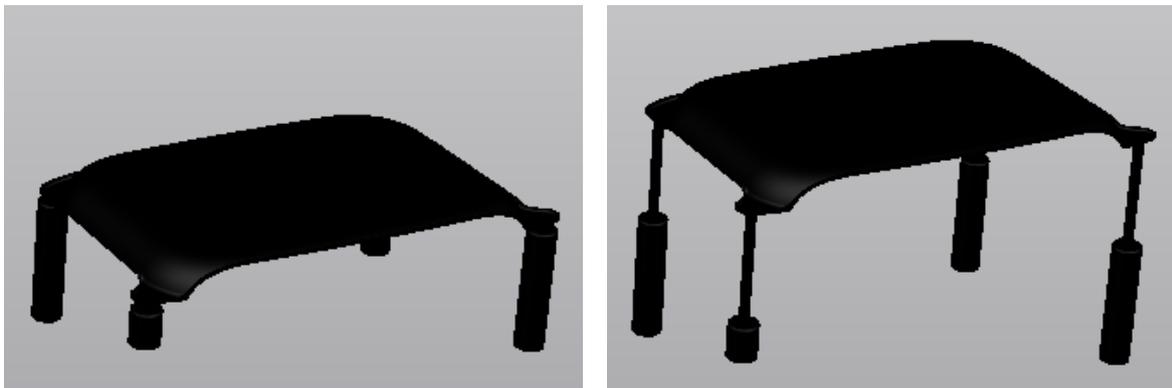
In order for the child to get a safe belt geometry, the seat cushion is raised 100mm from its original position. As mentioned earlier, the seat cushion is divided into two sections. Underneath the front section, an inflatable part is placed and anchored in the seat structure (figure 48). The part consists of drop stitch inflatable material and a pump is located in the floor

of the baggage compartment. The seat cushion is boosted dynamically in z-direction by filling the drop stitch material with air at a high pressure.



*Figure 48. Seat cushion in installed position showing the telescopic rods and the inflatable cushion.*

Since it, from a safety perspective, is not beneficial to sit directly on a construction containing air without a part that hinders the air from deforming, four static telescopic rods are attached to the BIW in each corner of the inflatable part, see figure 49. The other ends of the telescopic rods are attached to a supportive plate that is fixed under the seat cushion. When the inflatable part is fully expanded the telescopic rods lock the cushion automatically into place.

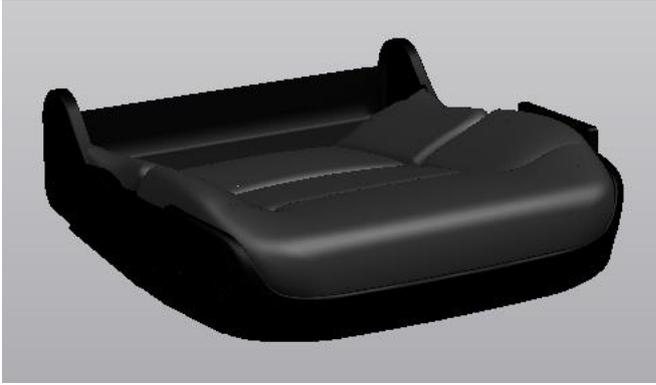


*Figure 49. The supportive plate and the four telescopic rods, to the left in an uninstalled position and to the right in an installed position.*

The inflatable part underneath the front section of the cushion is 360mm x 300mm x 15mm (WxDxH) when not installed. When it is fully inflated/installed it is 100mm high.

#### *Plastic cover*

As a support and collector of the seat, there is a plastic cover to conceal the inflatable material, construction and seat structure, see figure 50. The cover is divided in two parts, a vertical and a horizontal part. The vertical part covers the mechanism on the sides and the lower part of the back rest. At the end of the seat back, the cover is vaulted and changes to a horizontal orientation. The horizontal part is located under the seat cushion and covers a small part of both side and front of the seat cushion.



*Figure 50. The plastic cove seen here in black.*

The vertical part runs in the horizontal part to facilitate when the seat back is moved. The horizontal part is fixed and attached to the body in white. The inflatable part, supportive plate and electrical wires are located between the cushion and the horizontal part. The side nearest to the car door of the horizontal part is wider and contains a storing pocket (figure 51).



*Figure 51. Storing pocket for e.g. tablet or book.*

#### *Folding the seat*

The back rest contains a folding mechanism. The lock can be released by pressing a button located behind the backrest in the baggage compartment. To restore the backrest to its original position, "hands on" action is required.

### 11.1.2 Side support

To provide a safe sitting posture for children, side supports are added to the solution (figure 52). The side supports consist of low pressure inflatable bags integrated in the backrest and they function in the same way as the lumbar support does on some Volvo seats. A pump, also located in the backrest regulates both side supports simultaneously. The pump is regulated through a button on the side of the chair. The side support cushions can be filled to give an extra support without interfering with the space for the pelvis and/or shoulders. The inflow of air into the side supports is seamless. The side supports are 300mm in height and are based on the lower end of the backrest. They are 100 mm in width and when fully inflated they stand out 60mm. The measure between the inflated side supports is 260mm.



*Figure 52. Side supports.*

### 11.1.3 Foot support

In order to adapt the solution to the children's legs measurements vertically, namely from the popliteal to feet, a foot support is added see figure 53. It is made out of the drop stitch inflatable material. The foot support is portable and deflated it will be stored in the pocket under the seat, the same that already exists in the new XC60. The foot support is attached to the carpet on the floor in the car with Velcro. For extra safety a strap can be attached to a loop under the front seat. The foot support is divided in two serially connected compartments with a built-in pump and can be inflated separately. Each compartment measures 100mm in height, which indicates that when only one compartment is inflated the foot support measures 200x300x100mm (WDH) and when it is fully inflated it measures 200x300x200mm (WDH). The support can be used either as it is or in a supplied/included fabric cover.

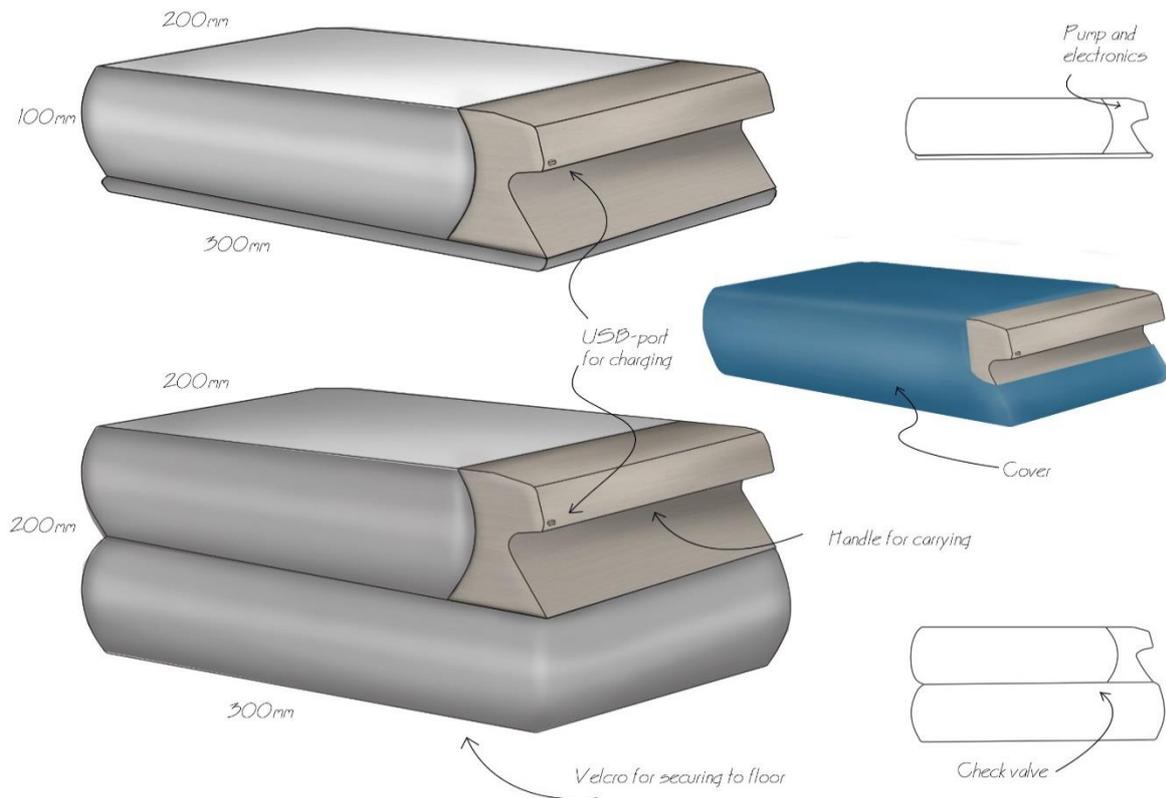


Figure 53. The foot support.

#### 11.1.4 Features for added value – add-ons

In addition to boosting the seat, shortening the seat depth and including foot and side supports, the solution also offers suggestions on other features that give the users added value. Features that are added are tilting of the seat back, seat heating, portable cushion in form of the foot support and the extra pocket on the side of the seat. The tilting of the back rest seat functions in the same manner as for the back rest of electrical front seats and is managed by a button on the side of the seat or through the middle console (figure 54). The seat heating is facilitated by electrical connections under the seat cushion and distributed in the seat. The wires will run between the front part of the cushion and the inflatable part and is regulated by a button in the middle console.



Figure 54. Interface of the middle console.

### 11.1.5 Implementation

The following is an overall description of the implementation of the solution. In order to facilitate the understanding, the two positions are referred to as *installed* (child seat) and *uninstalled* (adult seat). To install the seat the occupant enters the car, gets seated and fastens the seat belt in the bucket. Thanks to the electrical connections in the seat cushion the system can identify a weight span/range of the passenger. For an occupant between 15 and 36kg the car will be notified automatically about pending installation. When needed, for passengers above or under the weight range, the driver can order an activation through the middle console. The driver can, in the same manner notify the system of de-activation in case of an unwanted installation. The solution can only be installed when the system is notified that the occupant in the actual seat is buckled up and when the car is in neutral gear shift. When installing the child seat, the driver will be notified through the dashboard. The inflatable parts that are normally inflated in uninstalled position, both in the end of the seat cushion and in the seat back will now deflate. The mechanism for shifting the seat back moves it now forward and locks it in correct position. When done, the inflatable part under the seat cushion inflates and boosts the seat. The telescopic structure locks the seat in place.

If the foot support is needed, it can be taken from the pocket under the seat where it is stored and be placed on the floor. The support will be inflated by either the Volvo app, a remote control or by the driver through the middle console (figure 54, above). The foot support will be adjusted in two heights depending on the child's need.

The side support can be installed by the passenger by pressing a button next to the chair or by the driver through the middle console. This activates the pump that is located in the backrest. The side support has a child lock to minimize the risk of misuse by the child. If the

driver so wants, the side support can be pre-set to fit standard users, in the same way as the driver seat can be pre-set to be individualised.

To uninstall the ICSC, the driver will notify the system in the middle console, the telescopic structure releases the lock and the inflatable parts are deflated. The inflatable part in the rear end of the seat cushion respectively in the end of the seat back inflates and the seat back moves to its original position and will be locked.

The uninstallation can only be done when the car is in neutral gear shift or turned off. The passenger can leave the car when the solution is still installed. The solution can then be uninstalled, if so decided, when locking the car.

The uninstallation of the foot support takes place via the remote control or by notifying the system through the middle console or app. The driver can also choose to make the foot support to deflate when locking the car. The passenger has the option to leave the support on the floor or store it in the pocket under the rear seat or under the front seat. The fact that the support is portable leads to more application areas. The supplied/included fabric cover is a handbag and the foot support can accompany the passenger and act like a boosting solution on other occasions than travelling by car.

The side support can be uninstalled by the passenger by pressing the button next to the chair or by the driver through the dashboard in the middle console. The passenger can also choose to leave the side supports inflated.

### 11.1.6 Expression

The appearance of the ICSC's solution does not differ so much compared to the original Volvo Cars rear seat. Since the concept is partly based on parts of existing Volvo Cars seats, the design of the A-surfaces is generally maintained intact and it is possible to choose different upholstery. This makes the concept follow Volvo Cars' design language thus to express safety, quality and comfort, which was desirable. Through the soft body and gentle curves it expresses *calm and care* and through the new adjustable functions, the new side pocket and the foot support it will express technology, thoughtfulness and professionalism.

The ICSC does not affect the appearance of the rear seat when uninstalled. The solution for the placement of the bucket gives the seat the same uniform impression. The only thing that differs is the new design of the new longitudinal division in the seat cushion, which is assembled with the same stitches as in the remaining seat but still gives a hint of multi-functionality, flexibility and adaptation.

The fact that the seat is an adopted solution and designed for both children and adults makes the ICSC perceived as a personal and dedicated solution and the child solution is camouflaged and thus expresses "not-childish".

## 11.2 Fulfilments

Safety has been a central part in designing the actual child seat since the solution is intended for a Volvo car. Many factors affect the safety aspect and the solution itself contributes to an improved child safety. The reasons are, among others, that it is adapted to children's anthropometry to a greater extent than previous solutions and that it is positioned right on the market, which means that it will be used to a greater extent. In the following chapter, the advantages of the ICSC are described as well as the solutions this concept will bring concerning the problem areas described in chapter 6.

### 11.2.1 Adapted for children

As mentioned in the chapter about problem areas, children's safety might be compromised if they do not sit still their CRS. Poor comfort and the children's activities might have a negative impact on the safety. ICSC is designed with the children's anthropometry in focus. The seat is adapted for the children's leg measurement both horizontally and vertically thanks to the moving back rest and the shortening of the seat depth. The foot support together with the shortened seat depth makes the children perceive the solution as more comfortable. Unsafe slouched positions can be avoided.

Through the 100mm elevation, the child gets a good view through the window and obtains a correct belt geometry for the pelvis. The fact that the seat back moves forward and the belt roll stays in the car's C-post makes the shoulder strap end up behind the child's body. This makes it safer for the child as the belt does not fall off the shoulder, according to Gert Aldeborg. In addition, it provides a comfortable feeling, which means that the children do not manually remove the shoulder strap.

The solution for children interacts with one of Volvo's pride for safety; the three-point belt, on several levels. The solution:

- provides the use of pretensioning and load-limited belt
- obtains a correct angle relative to the hip point as the belt sleeve follows the movement of the seat back.
- allows the belt to run freely as it, for example, does not get caught on any guiding loops when retracting
- provides an easy buckling up. It is easy to see and reach the buckle when buckling up.
- causes a difficulty for the children to unbuckle since the buckle is covered.

The side support creates one assigned seating area which is advantageous since the child can only sit in one, correct and safe, manner. The side support does not block the view for the children and does not prevent them to talk to occupants in the front seat, which leads to a safe laterally sitting position. The side support does not hinder the entrance and/or exit. It also gives children a cosy feeling while providing sufficient space for both pelvis and shoulders.

The adaptation applies not only to the anthropometrics of the children but the solution is also adapted mentally to children through for example the implementation and add-ons, which lead to safe travelling in the CRS. Although the rear seat can be used by a diversity of passengers,

the rear seat with this type of solution is generally more suited for children since 0-14 years olds are the main users of the rear seat (71%).

Another aspect that has a negative impact on safety is the children's negative attitude towards boosting solutions. Since the ICSC is adapted to children's anthropometry, the children will experience the solution as a more comfortable alternative and the attitude towards the product will no longer be "I'm used to travel without". The children are also adversely affected by each other as they find that the use of boosting solutions is not a sign of maturity, which is something they generally aspire to. Since the solution is comfortable and visually similar to an adult seat, this hopefully leads the children to use the solution to a greater extent and as long as recommended. In addition, installation takes place automatically, which leads to less room for discussion between children and adults whether or not to use a boosting solution.

### 11.2.2 Adopted for future travelling

As seen in the study, the IBC has got clear advantages for use in many application areas since it is integrated. The ICSC is also integrated and benefits from these advantages. A safe child seat is always available. The ICSC can be used by a diversity of passengers, is easy to use and can be used in the Volvo car's many application areas. Share is the new "own" for the future! Co-users can provide their customers with a flexible solution and side users will not be affected by the solution. The ICSC does not exceed the measurement for a rear seat and there is space for three passengers in the rear seat.

It is beneficial to have used the existing seat parts for this new solution. Not only because the design complies with Volvo Cars' design language and thus creates congruence and consistency to the brand, this also means that the parts themselves, such as the seat structure and the back and neck protection, are already tested in the *Volvo way* and are therefore more prepared for testing and for the market.

Sustainable solutions are important for the future and by utilizing the new material, this relatively complex solution can be implemented without significantly affecting the car's overall weight. In addition, the solution does not need to be adjusted to fit the age range of the primary user group, which reduces the amount of different solutions.

### 11.2.3 Adapted to the audience

The flexibility and the adaptation to the children's measurements makes the solution adapted to the target groups. The children get a positive experience and feel cared for and the seat feels dedicated to them. The children become more comfortable in this kind of solution and happy children are generating happy parents and vice versa.

ICSC is *designed around you* which fits the target groups, especially the self-oriented target group Millennials. Users will feel:

- Custom design. As it is adapted to the mental and physical abilities of the target groups. It is appealing and does not affect the seat design or Volvo design language. In addition, the solution is designed for flexible use and is a safe alternative for all travellers.

- Life feels easy. Since it is an automatic solution that installs itself and in only one, right way. The children can easily get in and out of the car themselves and it is easy to buckle up because the buckle is easily accessible and visible. In addition, the adults can provide the sleeping children a safe and comfortable position through the use of side supports and the tilting of the seat back easily by pressing a button close to their seats.
- Pleasure while drive. Millennials will find it cool and fun with the new, innovative and automatic solution that makes them special. The solution is smart and thoughtful and adults can benefit from some of the add-ons such as tilting of the seat and side supports. The technology-raised generation relies on technology and will feel more confident with this solution than with a manual one.

One wish is that all Volvo cars should be able to offer a safe solution for children, all the time, to increase the child safety. If renting or sharing a car, hopefully, the co-users will understand the importance of this solution and appreciate that all Volvo cars have integrated the solution to increase accessibility. In addition, to convince and motivate the pioneers, typically side-users in this project even more, the solution has an advantage in the feeling it conveys. It is cool, trendy, modern and different and it uses components in a smart way, which is perfect for the Millennials. Additionally, it does not influence "regular" users but rather adds something extra. ICSC can, for example, be tilted and adjusted to other passengers than children. This adds additional luxury and value to the user, which makes the solution more popular and liked in a long-term perspective and hopefully some people choose the solution even if there is no explicit need for it.

## 11.3 Suggestions for future development

Since the result is a concept, the construction has not been fully discussed during the thesis work, and therefore no major emphasis has been placed on manufacturing construction. The project rather focuses on other aspects that could provide new information for the company. There is still work to do before the concept may become a reality. The next step would be to continue detailing the concept with focus on testing and on improving the construction. It may also be beneficial to look further into the positioning by generating more solutions focusing on motivation and user experience. This is something that Volvo Cars may want to consider. Areas that need further development are:

- **Inflatable parts:** The size and strength of the inflatable parts should be investigated. A small part is inflated faster and requires less material while a larger part may be more durable and more stable. It may also be worth investigating whether the air can be moved from the rear end of the adult seat to boost the child seat in order to optimize the solution.
- **Pumps:** What pressure should be achieved and which pumps should be used? How can the pumps maintain an even pressure?
- **Electrical connections:** Examine whether it is possible for electrical connections to be drawn through the inflatable parts without being clamped when the solution is uninstalling and see how the connections can be distributed in the seat.
- **Users' experience:** With the project going into two directions, both construction and positioning have been investigated. However, idea generation around user experience has not generated as many results as desired. Future investigators may benefit from the rigorous study on the topic that has been made, for example, how to make the children sit still or how to further develop solutions for sleep comfort and *how to give something extra to the user*.
- **Foot support:** The concept is depending on that the solution is integrated. It may be beneficial to investigate whether the foot support should be portable or not. It could also be beneficial to investigate whether the foot support can be an asset in other areas of usage, which could motivate purchasing and use, especially for pioneers?
- **ISOfix:** Some of Volvo's car models include slots that provide easy access to ISOfix. It would be beneficial to investigate whether the concept is compatible with ISOfix in the same easy manner. The ISOfix brackets could perhaps be accessible through deflation of the inflatable part in the lower end of the seat back.

In order to evaluate the concept, it would be beneficial to produce a prototype and carry out a number of tests. With a physical prototype, a cognitive walk through can be performed with the right target groups and correct handling can be investigated. Other test proposals include comfort, safety and realization.

- **Comfort:** It may be beneficial to make a comfort study on the concept for both adults and children in the age range. The concept has been adapted to anthropometry but can still be perceived as uncomfortable. Although the solutions differ, Volvo can certainly benefit from the above-mentioned thesis work from Linköping University of Technology, see chapter 4.6.1. The inflatable, low pressure parts as side supports need to be investigated concerning comfort. The fact that the children are boosted

100mm and thus placed in the backrest structure intended for an adult body may negatively affect the comfort. It may also be beneficial to investigate a construction with a seamless boosting.

- **Safety:** The solution is conceptual and no safety tests have been done in addition to those already executed on existing parts that have been utilized also in this concept. The new composition of these already used parts should be tested from a safety point of view as well as the aspects of using air. Can you sit directly on high pressure drop stich inflatable material without the belt geometry being negatively affected in case of a collision? If so, could the telescopic rods be removed in order to offer a lighter and more compact solution? In addition, it should be investigated if the distance to the front seat is safe or not, in case of a collision.
- **Realization:** A prototype should be tested during use in order to get a qualitative evaluation. How long does it take to install the solution? How long does it take to fill a bag when someone sits in the seat? In what order should the installation take place for the best possible results? How much weight does the construction tolerate? Which weight range is optimal for the solution? Is the finish/appearance of the seat appealing as the seat is changeable?

## 13. Discussion

The purpose of developing a conceptual proposal for an integrated belt positioning booster, intended for children in the age 4-10 years for future cars of Volvo Cars, has during the time period of the thesis work been fulfilled. The goal that the solution should fit the Volvo brand has also been reached. The solution is attractive, flexible and compact to satisfy and fit the new audience and has through that increased the safety by making it more available. This has been done thanks to, among other things, a good understanding within some subjects and well performed analyses, generating sessions and evaluations. A collaboration with supervisors, colleges, class mates as well as friends and families have contributed to the result. In retrospect, something that may have improved the result had been to belong to a relevant work group at Volvo Cars in order to get near colleagues, attend meetings and get quick answers and information about the subject instead of sitting in an independent department.

During the project a broad user group has been mapped and analysed, even the brand has been analysed and all together this has contributed to the correct adaptation and positioning. The target group's usage, opinions and perceptions have been examined both through scientific studies and through commonly held perspectives. Because the Thesis work has consisted of the development of a product intended for children, perhaps more interviews with children could have contributed positively. A good idea would have been to have had contact with children in the age range in good time before the project started and thereafter have analysed the views and critique of the actual users continuously throughout the process.

Difficult in the project has been to rely on one's own competence and judgements to a greater extent. It has been tempting to turn the coat after the wind after each meeting with various experts at the company since satisfying everyone's wishes has been desired. This has affected the work negatively concerning the overall planning and structure. It has also resulted in that the project has considered both construction and user experience simultaneously and perhaps not to the extent as wanted by the project owners. In order to accomplish another result in the short timeframe, delimitations and course of action should have been determined earlier in the project and more in-depth research could have been done in one specific area. However, it is also positive that both construction and user experience have been developed in parallel so that future development projects can take advantage of the facts produced in both directions.

Finally, based on the knowledge and useful methods that have been learned during the education, the project owners are pleased to have developed a concept. A concept that Volvo Cars could further develop to ensure that they think of future user demands and usage needs and design around them when it comes to car safety.



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# List of appendixes

Appendix 1 – Speed interviews

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Appendix 5 – Personas and scenarios

Appendix 6 – All ideas from the ideation

Appendix 7 – Pictures of the concept

## Appendix 1 – Speed interviews

- Har du bil? Tillgång till bil? Äger / hyr du bil?

Äger bil

Äger flera bilar

Delat ägarskap med granne

Hyr bil

Lånar – föräldrar / grannar / jobbets

- Vad använder du din bil till?

Till och från jobbet

I jobbet

Köra grejer i

Köra barnen

Åka till träningen

Hälsa på mamma/föräldrar/ mor- och farföräldrar

Åka till sommarstugan

Flytta åt barnen

Agility

Jaga

Handla mat

Åka till IKEA

Skidresa

Hockeyträning /annan träning

Bila till Kroatien

- Vad har du för typ av familj

Två barn (nära ålder <4 år)

Föräldrar som granne

Barn <4 och barn >4

Storfamilj

Delad vårdnad

Bonusbarn

Vuxna syskon

Mormor och morfar långt borta

Hundar

- Har du barn? Brukar någon annan hämta dom i bil?

Brukar du hämta barn i bil i bland?

Fastrar / farbröder

Mor- och farföräldrar

Grannar

Vänner

Åka med kompisar

Tränare

## Appendix 2 – Focus group with adults/parents

### ***Vad använder ni för bilbarnstol idag?***

Bälteskudde - 1

Bältesstol - 3

Integrerad bälteskudde(pop-up) – 1

### ***Vad är en integrerad bälteskudde?***

Ja, det låter ju onekligen smart. Och praktiskt... Mycket användbart. Och tänk vad lite plats det tar. Behöver inte tänka på att ta ut den när jag ska hämta mormor och morfar från flyget..

### ***Hur känner ni inför användandet och hur känner era barn inför användandet?***

Mest positivt. Ibland lite bråk. Syskon som vill göra som de äldre barnen. Ofta inget problem. Men den tar upp mycket utrymme. Mormor får inte plats i mitten. Det blir lite gnäll ibland då barnet inte kan se ut. Sonen kräks ibland. Svårt att kunna se ut ordentligt. Fast det var värre förr, när han åkte bakåtvänd.

### ***När använder ni den och hur ofta?***

Till och från förskolan, handling på helgerna. Och så en lång bilsemester på somrarna.. Åker till farmor och farfar nästa varje helg.. det är kanske 10mil eller så. Blir rätt mycket bilresande. Och så sommaresemester med husvagn..

Till träning och skola..

### ***Längre /kortare resor?***

Mestadels korta resor..kanske 10-15 min/dag

### ***Gillar era barn sina bilbarnstolar?***

Det är kanske inget de ifrågasätter sådär jätteofta.. kanske lite när sonen var i trotsåldern.. eller ja, det känns som om han fortfarande är det.. men ibland är det kämpigare än annars.. speciellt om han har kompisar med sig som inte har någon stol att sitta i. då tycker han det är orättvist. Klagar inte så mycket i början av resorna.. men under längre sträckor får de ont.. i ben och rumpa. De är rätt hårda och obekväma.

### ***Brukar barnen ta med sig nåt till bilen? Vad gör de i bilen?***

På de längre resorna är de nån kudde eller filt, nja mest kudde som tas med.. och nåt gosedjur, bok, pyssel eller annan leksak som de ändå inte leker med. Sen är det klar att Ipad eller annan platta följer med. Vårt barn blir lätt åksjuk så vi försöker hålla igång lekar där man behöver titta ut eller framåt för att undvika kräkningar... typ "jag ser en sak som börjar på".. eller kan någon se ett gult hus/röd bil/blå traktor osv,På de kortare resorna: leksak, halsband, docka, småkrafts, papper/teckningar från fsk/skolan

### ***Prisbild?***

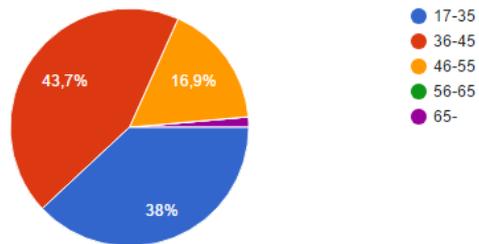
Tja, en ny kostar väl runt 1500 och upp till 2000kr kanske.. men en begagnad kan du få för runt 500lappen.Ja, det kanske inte är något som du köper som helt ny.. dagens slit och slängsamhälle är inget vi vill bidra till iaf.. så. Den vi har nu är köpt begagnad. Skulle säga runt 500 för en begagnad, beroende på ålder och skick..

Vår IBC har vi i tjänstebilen.. annars skulle vi nog inte fått tag i den. En kompis som rekommenderade den .. visste inte ens att en sån fanns innan. Men den är ju jättesmart. Har letat efter en begagnad bil med en sådan men det finns typ inte. Skitsvårt att få tag på iaf. Jättekonstigt, tycker jag..

## Appendix 3 – Online survey

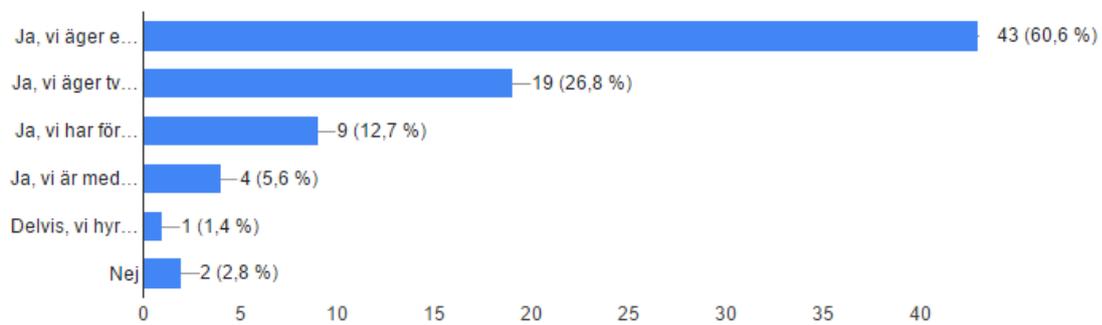
### Ålder

71 svar



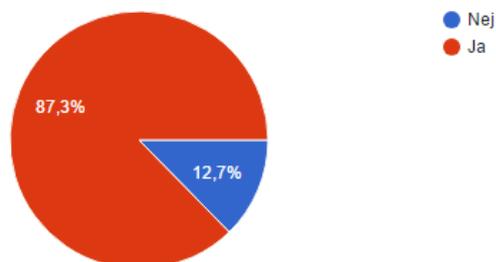
### Har du eller någon i familjen tillgång till bil?

71 svar



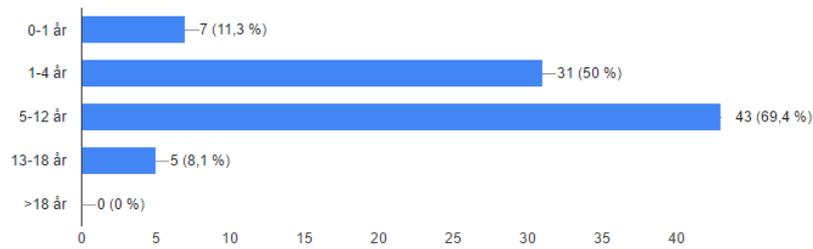
### Har du barn/ barnbarn/syskonbarn?

71 svar



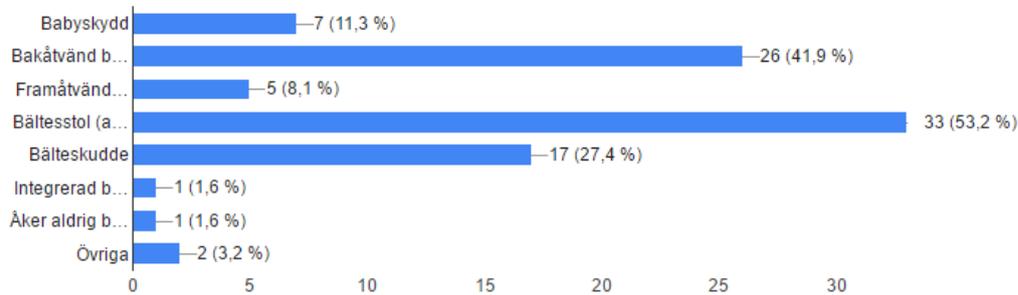
### Vilken ålder är barnet/barnen?

62 svar



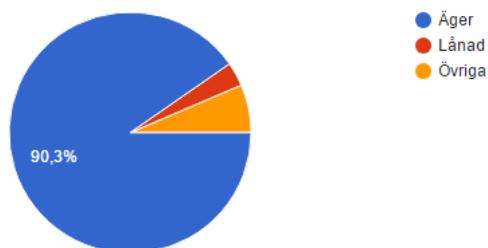
### Vilken säkerhetsutrusning använder du för ditt/dina barn i bilen?

62 svar



### Äger du säkerhetsutrusningen som du beskrivit ovan eller är den lånad?

62 svar



### Vid köp av säkerhetsutrusning, vilka parametrar/egenskaper grundar du ditt val på?

71 svar

- Säkerhet
- Pris & säkerhet
- Säkerhet och pris
- godkänd, pris
- Ntf godkänt, pris
- Pris, godkänd
- Säkerhet
- Säkerhet
- Upplevd säkerhet. Passform i bilen.
- Upplevd säkerhet. Passform i bilen.
- Säkerhet och enkelhet
- Säkerhet, totalbetyg i tester. (lägre krav på bäälteskudde)
- Säkert, smidighet och hur stor plats de tar
- Att det ska vara en säker och bekväm bilbarnstol
- Säkerhet, bekvämlighet, smidighet
- Säkerhet för mitt barn, utrymme i bilen, användningstid.
- Säkerhet, Montering, egenskaper som gör det möjligt att tex tilta stolen, tvättbar klädsel
- Säkerhet, bekvämlighet och pris

## Testfakta

Ålder på barnet och vad som krävs för att barnet ska få åka med i bilen.

Säkerhet, smidighet

Kvalitet, testresultat, design. I andra hand pris

Pris, byte mot större, säkerhet, smidighet

Nu köper ju inte jag sånt, men barnets säkerhet är väl kärnan tror jag.

Säkerhet och enkelhet i användning

Säkerhet, bekvämlighet. Bakåtvänd stol leder till illamående och högljudda protester.

Soliditet, pris, certifieringar

Säkerhet, bekvämlighet, storlek, praktiska lösningar

Testad säkerhet

Det som rekommenderas av trafikmyndigheterna för barn i den åldern

Läser test och kollar pris

Bäst i test

Råd & Rön/tester

Säkerhet, lättinstallerat

Pris och testresultat

Lättanvänd och säker, att den ska funka i vår bilmodell

Säkerhet, pris, funktion/smidighet

Testad säkerhet, enkel installation, pris

Testresultat

Test resultat

Desto mer desto bättre

Tester, pris, hur det passar i bilen, komfort

Lätt att använda i vardagen, flexibel, integrerad, passa barnen, inte massa lös skit som skall stivas undan o till slut hamnar i garaget.

Erfarenhet

Bra testresultat

Tester och pris

Säkerhet. Bäst i test.

att dom är godkända

Nytt och oskadat

Säkerhet. Kunna använda under en lång period.

Testresultat och storlek

Betyg dvs hög säkerhet, pris, samordning med bilen, övriga bilbarnstolar i bilen,

Säkerhet för mitt barn

säkerhet, smidighet

Säkerhet, komfort, kvalitet, omdömen

Säkerheten testad

Bäst i test, pris

Bekvämlighet för barnen, stolen skall vara skön

Säkerhet och enkelhet

Trafikverkets råd

Främst säkerhet. Efter det fick vi ta hänsyn till platsen då vi har tre barn som vid en tidpunkt behövde stol/kudde alla tre.

Testresultat, komfort, användbarhet

Säkerhetsbedömningar och test

Smidig att montera, spänna fast barn och tar lite utrymme i bilen

Tester i tex råd och rön och att barnet sitter bra i stolen

Rekommenderad av NTF

Välkänt och trovärdigt märke, lätt att använda, pris

Pris och CE märkning

Testad säkerhet, smidighet att använda

Vad är det som gör att en säkerhetsutrusning utstrålar säkerhet?<sup>71</sup> svar

Vet inte

Vet ej

?

Tester

Testresultat

?

Vet inte

Information

Bra information.

Fempunktsbälte och att det går att göra. Justeringar.

Känns robust, inte för billig.

Känt märke, gärna testad

Känns rejäl och bra

Vet inte om utseendet utstrålar säkerhet utan det blir till att lyssna till säljare, kolla på genomförda tester ex råd och rön och på stolens säkerhetsinfo. Först när jag har olika stolar att välja mellan med liknande säkerhet väger utseende, smidighet och pris in.

Gedigen kraftig konstruktion utan gnisslig plast.

Stabil, säkerhetsmärkning, remmar mm sitter bra och går lätt att justera

Inget speciellt, pratar med NTF om lämplig bilstol som passar vår bil

Se ovan samt att det är ett känt märke

Vet ej.

Fastspänningen

Ett märke jag känner igen och testad av lämpligt institut

Robusthet, visuellt och taktiskt

Kraftiga delar, tydligt material/teknik, bra design i övrigt

Stabilitet i konstruktion och känsla av genomtänkt.

Genomtänkt och robust

Att den sitter stadigt. Att den är enkel att använda rätt och man inte hela tiden misstänker att man gjort nåt fel.

Tålig och solid konstruktion, samt starka kontrastfärger

Utförda säkerhetstestad, "bäst i test"

Storlek, märke, olika inställningar

vet inte

Test

Välprovat

Gediget

Ser säker ut, välkänt varumärke

Enkel o genomtänkt

Vi köper ej begagnat och följer typ "bäst i test"

Ett etablerat märke, allmänt "rejäl", funktionella o genomtänkta finesser, samt en väl påläst säljare.

Stabilt material, känns robust

Väl genomförda säkerhetstester

Märke, kvalité

när man testar den och man känner att den funkar och man kan lite på den

Utseende

Integrering med bilen

Gediget intryck

Att den blivit testad

Tester.

att barnet sitter riktigt

Godkänd

Mycket bälten. Skydd runt barnet. Rejält utseende.

Att det finns någon markering eller säkerhetsklassning

Stadig, fast, stabil.

Stabil konstruktion

tester

Tester, beskrivningar

Stabilt, tester och följa rekommendationer

Material, utseende

Allt skall vara anpassat efter barnet inget som skaver eller ser vasst ut

Design

Känns stabil

Jag har alltid utvärderat inköp av bilbarnstolar baserat på tester utförda av pålitliga källor (t.ex råd & rön).

Kvalitativ finish, seriöst företag

Stabilitet

Ser gedigen ut ej plastig

Säker enkel montering

Känt märke och att den känns stabil. Att jag kan se att det är skydd från sidorna

Att den är rekommenderad av NTF

Välgjorda/välgenomtänkta detaljer, dova färger

CE märkning

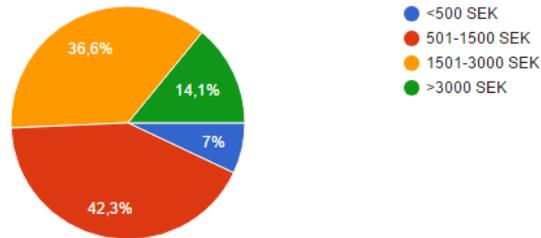
Ser gedigen men enkelt uppbyggd ut

Robust.

Klassificering och stämpel

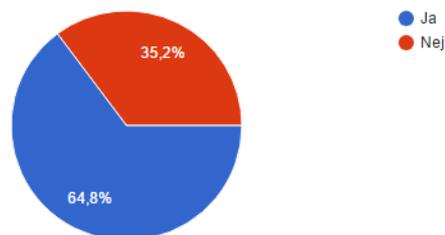
Vad anser du är en rimlig kostnad för en säker säkerhetsutrustning?

71 svar



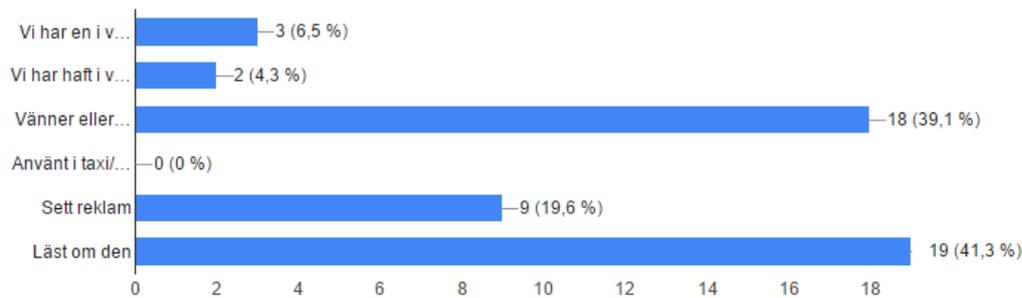
Har du hört talas om en integrerad bälteskudde?

71 svar



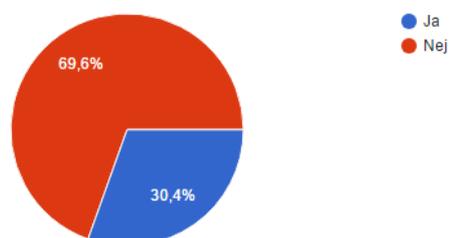
Hur fick du reda på att en integrerad bälteskudde finns?

46 svar



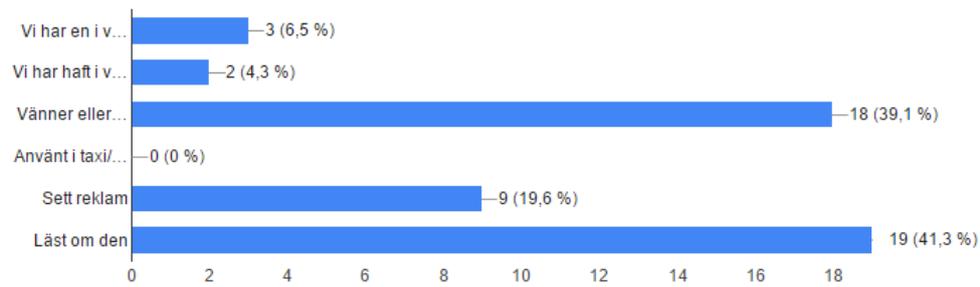
Har du använt en integrerad bälteskudde någon gång?

46 svar



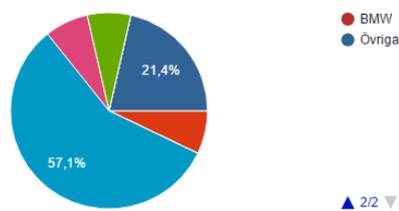
## Hur fick du reda på att en integrerad bälteskudde finns?

46 svar



## Vilket bilmärke har bilen som har den integrerade bälteskudden ni använder / har använt?

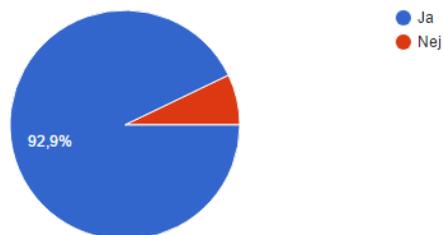
14 svar



8st volvo, 3st övrigt, 1st saab, 1st VW, 1st Mercedes

## Är / var du nöjd vid användning?

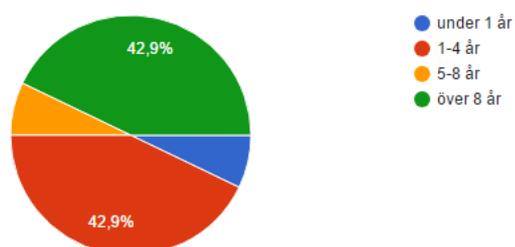
14 svar



1 icke nöjd, 13st nöjda

## Hur länge har du känt till att det finns en integrerad bälteskudde?

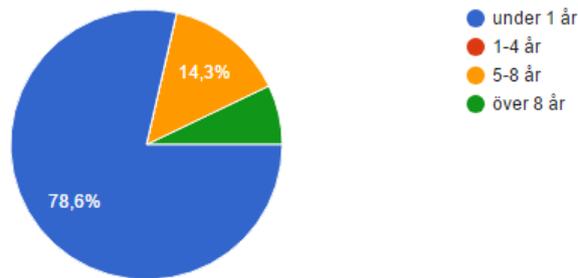
14 svar



1st under 1år, 6 st 1-4år, 1st 5-8år och 6st över 8år

## Hur länge har du använt en integrerad bälteskudde?

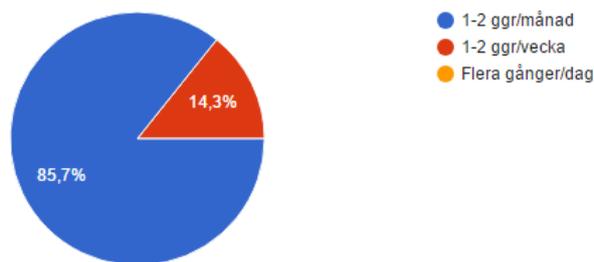
14 svar



11 st under 1år, 2st 5-6år, 1st over 8år

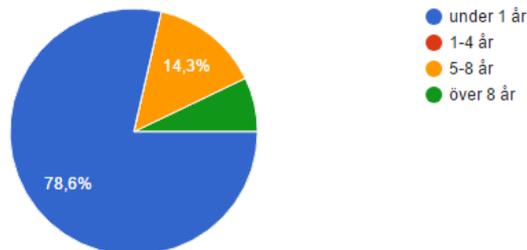
## Hur ofta använder du den integrerade bälteskudden?

14 svar



## Hur länge har du använt en integrerad bälteskudde?

14 svar



## Känner du dig säker med att använda den? Beskriv gärna vad som får dig att känna dig säker/osäker

14 svar

Nej

Nej

Har inte gjort det så många ggr. Känner mig säker, litar på biltillverkaren

Använder inte längre... kändes säker dock

Ja

Det va väldigt många år sedan (20 år sedan kanske) men då kändes den inte lika säker som en separat

Kuddens / IBK:ns positioner är väl definierade av biltillverkaren och kan inte / sällan användas på fel sätt.

Ja men den är smal inte så bekväm.

Känns säkert, ett stabilt bilmärke och inget löst som kan flytta på sig

Ja den var alltid på plats

Ja men hade inte valt att alltid använda den som alternativ

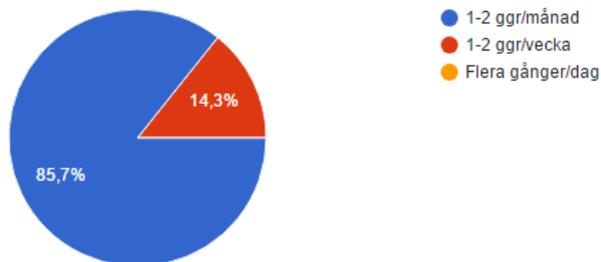
Frågade NTF om det var lika säkert som lös kudde, då jag trodde att avsknande av hornen som finns på den lösa kudden gjorde integrerad kudde mindre säker

Ja. Den fyller sin funktion för äldre barn, utvecklad av Volvo

Säker. Obs! Ovanstående fråga kan jag inte svara som jag vill, vilket är 1 gång/år...

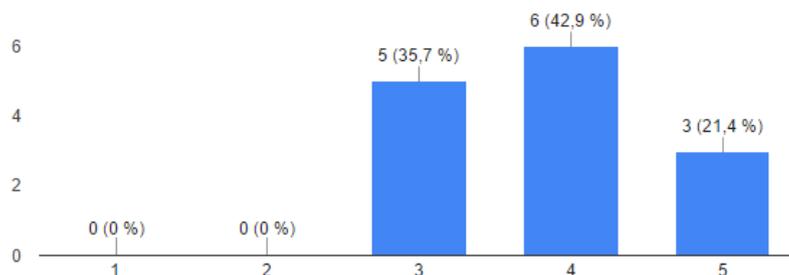
### Hur ofta använder du den integrerade bälteskudden?

14 svar



### Hur säker anser du att den är i förhållande till annan säkerhetsutrusning för barn i bil?

14 svar



### Finns det något du skulle vilja förbättra med lösningen? Är det något du saknar? Beskriv gärna vad. 14 svar

Nej

Nej

Vet ej

Vet ej, kanske möjlighet att tilta stolen

Vet ej

Nej inte som jag kommer ihåg

På den tiden fanns inget stöd för nacken och det va bara som en puff som man satt på Rumpvärme

Den är smal att sitta på.

Inget jag kan komma på

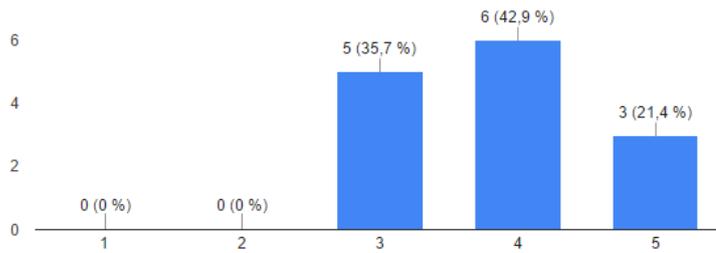
Vet ej då vi inte hade egen

Bekvämlighet och fler justeringar tillgängliga

Ett yngre barn 5-9 år som somnar i bilen har inte något skydd på sidorna som håller dem kvar om de somnar i bilen. (nu jämför jag med bältesstol)

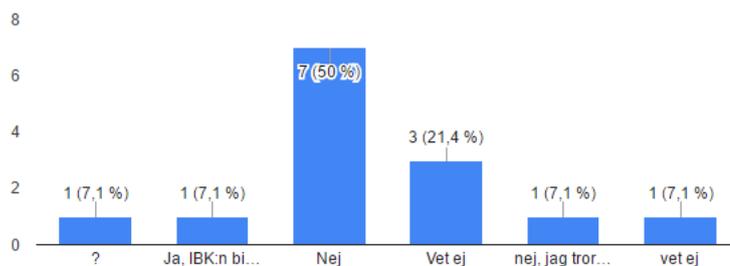
## Hur säker anser du att den är i förhållande till annan säkerhetsutrusning för barn i bil?

14 svar



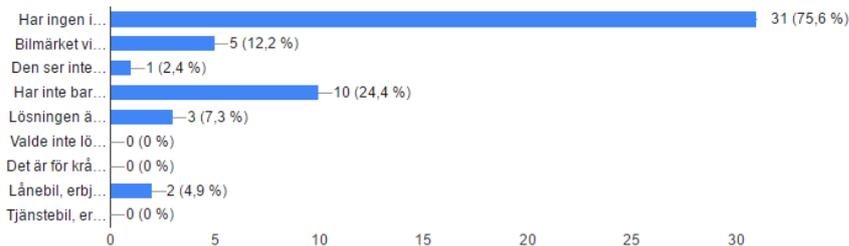
## Upplever du att komforten för baksätesspassagerare i allmänhet försämras när en bältesstol är integrerad?

14 svar



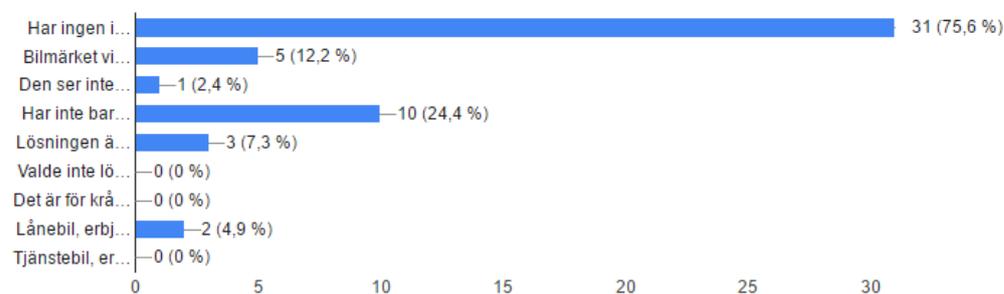
## Varför har du inte använt en integrerad bälteskudde

41 svar



## Varför har du inte använt en integrerad bälteskudde

41 svar



## Vad är ditt första intryck av lösningen? 71 svar

Bra

Smart och funktionell

Bra

Praktisk och bra

Enkel

Bra

Smart

Smart

Bra

Smart

Funktionell

Smidig

Smidig

Smart och enkel

Ser smidig ut. Ser "vanligt" ut

Ser funktionellt ut. Och ser ut som tre kuddar!

Smidigt

Bra

Smidigt

Funktionell

Praktisk

Låter jättebra! Älskar att inte kunna glömma saker

Ett mycket bra alternativ till bälteskudden, dock tveksam hur den är som ersättare för bältesstolen.

Det verkar bra

Att det är väldigt smidigt.

Bra men inte aktuellt för oss än. Hur löser man det om någon annan ska köra barnet? Ska man ha en extra då?

Smart, smidig

Smidigt

Verkar jättebra! Borde vara standard i alla bilar.

Snygg. Andrehandslösning

Hög tyngdpunkt

Den e la goo

Bra med inbyggd, grymt! Funderar på hur lätt det är att återställa till vuxenläge? Och hur dyrt att välja till i och med att man sällan köper ny bil och det generellt är dyrt. Ofta köper man ju bil i andra hand så då kan man ju liksom inte påverka tidigare val, och man väljer ju inte bil efter såna här parametrar främst när man står i ett andra-hands bilval. T.ex. ett val mellan en energisnål bil versus en energikrävande bil som har integrerad kudde (då väljer man ju säkert hellre det extra besväret med en extern kudde). Men är den lätt att hantera generellt och skulle bli integrerad i de flesta bilar är det ju en revolution för föräldrar, tror jag.

Bra och smidig lösning

Bra - inser att vi åkt taxi med sådan tidigare. Lämpar sig ju inte för små barn, men annars bra.

Framför allt vore det ju toppen om alla taxibilar hade sådan, himla besvärligt med barn annars. Viktigt: LÄTT ATT RENGÖRA, särskilt för dem som hyr bilar oerhört viktigt, att inte ha med lukten av tidigare barns spyor.

Smart. Slipper ha lösa delar i bilen.

Smidig, synd på värmen

ser smal ut att sitta på

Dåligt sidoskydd?

smidig

Om den är säker så är det en bra lösning

Den verkar lättanvänd

Praktiskt

Att det är smidigare att ha en lös som går att förflytta mellan olika bilar

Ser klen ut.

Ser ut som en bra idé för äldre barn

Bra och smidigt

Att den ser likadan ut som för 20 år sedan

Låter bra och smidigt.

Gillar den

Praktisk och stabil

Smart!

Smidigt!

bör utvecklas till något bättre

Smart. Det jag sett tidigare är i mitten. Volvo

Passar äldre barn, känns smidigt.

Smidigt!

smart om den inte tar plats för dom som inte behöver den

Så smart

Bra om den lätt går att ta bort.

Toppen

Verkar bra

Ser bra ut

Positiv. Fördel att slippa lösa kuddar.

Smart för äldre barn som kanske knappt skulle använda bälteskudde annars

Jag förstår inte riktigt hur den är monterad/integrerad.

Smart enkelt för större barn

Super smart. Och snyggt.

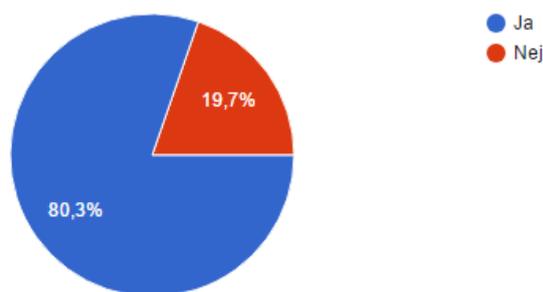
smart. Och underlättar att större barn (8-10 år) använder kudde, inte lika "pinsamt" som kudde. Syns ju knappt att de har den

Smart grej, men den ser inte så optimal ut. Mer som om man har gjort sitt bästa med att med minsta möjliga insats erbjuda funktionen.

Smart

### Anser du att den ser säker ut?

71 svar



57 ja – 14 nej

### Vad är det som gör att den ser säker ut?<sup>54 svar</sup>

Den är integrerad

Att den sitter fast i bilen utan bälte

Den sitter fast i en bil.

Att det är i en Volvo

Den sitter i en Volvo

Integrerad

Integrerad i bilen

Att den är inbyggd i bilen. Säker bil säker kudde tänker jag. (Förstår ju att det inte måste vara så)

Den gör samma jobb som en bälteskudde men sitter fast och kan inte flyga iväg.

Tillverkande märken har höga krav på säkerhet, därav att det känns säkert

Den går inte att "glömma" o den sitter fast i bilen

Eftersom det använder bilens övriga säkerhetsutrustning så tänker jag att den ser säker ut. Saknar dock komforten och sidoskydd.

Den ser inte osäker ut rättare sagt. Det ser bara ut som en dyna.

Lika säker som en annan bilkudde

Den ser enkel och avskalad ut, då blir det svårare att göra fel. Den finns alltid där.

Att den sitter fast i bilen, att en ej kan montera in den fel osv.

Att den är utvecklad av Volvo som har hög säkerhetsklass

Litar på Volvos design

Den kändes väl integrerad och genomtänkt. Gillar också att den matchade övrig interiör, bilbarnstolar och kuddar är ju generellt ingen vacker syn.

Som en del av bilen känns det säkert.

Den ser inte ut att kunna lossna...

Del av konstruktionen

Gissning,

?

Om den sitter i en Volvo så känns den säker. Bra att bältet sitter på rätt plats

Sitter fast

Att den är integrerad

Ser inte mindre säker ut än en "vanlig" kudde

Passar med bilens bälte och sitter på plats

Ser ut som barnet kommer upp bra

Den ser säker ut för äldre barn men känns som mindre, som precis vänt sig framåt behöver mer stöd och vara mer omhuldade.

Dess integration

Bra proportioner

Sitter fast i bilen och kan inte kana omkring

Fast

.

Allt sitter fast.

Barnet sitter på den. Det är en "kudde", inte bilbarnstol.

Ser inte osäker ut, men skulle inte använda enbart kudde till mindre barn tex 6 år. Kudden enbart passar äldre barn.

Borde sitta ordentligt på plats i alla lägen, inget kan hamna snett eller fel

Stabil och sitter fast

Vet ej

Bekvämt o att bältet kommer på rätt ställe

Den är i en Volvo

Barnet ser ut att sitta bekvämt och säkert

Just att den är integrerad och anpassad efter bilen bör göra att den passar bilens bälte bra.

Hade egentligen velat svara vet ej då jag inte riktigt förstår hur den fungerar.

Den ska väl bara höja upp barnen till rätt höjd? Och det gör den.

bältet ligger rätt

Att Volvo har den.

Den är inbyggd/sitter fast

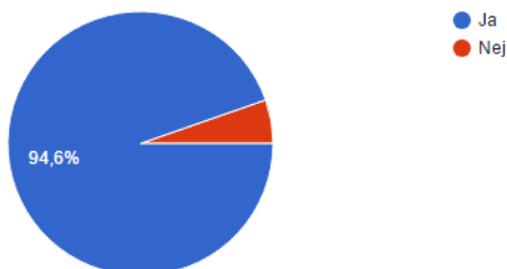
Sitter på plats och halkar inte runt

Integrerad i bilen ock kan inte glida bort.

Barnet kommer upp vilket är viktigast upp till 140 cm

Ser du några fördelar med stolen?

56 svar



3st nej - 53 ja

Vilka fördelar ser du? 54 svar

tillgänglig.

Den kan plockas undan utan att ta plats

Den sitter på plats.

Den är alltid med

Finns alltid på plats

Alltid med

Alltid med

Den finns alltid med! Samt att när man skjutsar andras barn

Alltid med, ingen extraplats, sitter fast även om ingen sitter i den

Extremt smidig, alltid med och aldrig i vägen om den inte behövs

Att den hela tiden finns tillgänglig i bilen. Om man ex kör andras barn. Att den är smidig.

Smidigt om man växlar mellan barn och vuxna i baksätet.

Enkel och smidig

Den är alltid med, enkel och passar in med den övriga klädseln

Lätt att använda och ta bort

Främst att den sitter fast i bilen. Ser stadig ut.

Att den alltid finns med vid behov

Alltid där utan att ta plats

Den är en del av interiören.

Finns alltid med och tar mindre plats än lösa bälteskuddar

Att den sitter där den ska och kan vikas bort

Kan inte tappas bort, kommer att användas.

Den är alltid med, den går att fälla bort

Finns fast i bilen

Slippa släpa med sig barnkudden. När man skjutsar andras barn så slipper de tänka på barnkudde

Sitter helt fast?

Tar inte upp plats då den inte behövs, lätt att bli av med då den inte behövs

Slippa en lös kudde

Smidigt att lätt ta bort eller fram vid behov

Smidigt att den alltid finns tillgänglig, snyggare

Att slippa köpa extra stol och att man slipper montering av stol.

Den finns alltid i bilen

Integrerad i bilen och kan inte kana omkring

Alltid där

Finns alltid med.

Att den alltid finns med oavsett om man alltid använder den eller om mormor har en sådan bil.

Slippa köpa separat kudde. Tar ingen plats när den inte används.

Finns redan i bilens sits.

Smidigt alltid med, lätt att få undan, hamnar alltid lätt

Finns alltid med

Att den sitter fast, inte far omkring när den ej används.

Går inte att glömma

Slipper tänka på bilbarnstol då den redan finns, om man exempelvis åker med i någon annans bil.

Ingen lös kudde. Alltid tillgänglig om man skjutsar kompisar till barnen utan att behövs ha extra kuddar. Förhoppningsvis bättre anpassad till bältet.

Bra för just äldre barn

Att den alltid är med.

Enkelt lätt vid lån/hyra av bil

Man slipper lösa delar, det blir snyggare. Den verkar lätt att fälla ner om man vill ha en vuxen på platsen istället.

Större barn använder den, att de inte slutar för tidigt. Att det får plats fler personer i baksätet

Man behöver inte tänka på att ha med sig kudde.

Inga lösa delar och den kan enkelt fällas upp/ned

Den är smidig att ta fram. Man har alltid med sig den

Integrerad!

Flexibel

## Finns det något som skulle kunna förbättras?<sup>54 svar</sup>

18st – Vet ej

3st – Borde finnas i mitten (om det inte finns)

3st - Nej

Nackkudde/stöd för huvudet

Kanske kunde finnas en i mitten också om man skjutsar tre barn. Toppen modet vore standard så då skulle nig andra bilmärken också ha kudde som standard

Inte vad jag vet idag då jag inte provat.

Bör vara standard i något som säljs som familjebil!

Nej inte vad jag kan komma på

Vet ej då jag endast använt en vid ngt enstaka tillfälle.

Det ser dyrt ut.

Dynan känns kanske lite liten

Jag tror priset, alla skall ha råd att ha den bästa bilstolen. Det är inte de som skall kosta skjortan när man skall göra tillval.

Priset. Annars - Vet ej.

Ev. göra det enklare att nå bälteslåset (svårt att utvärdera via en bild). Integrerat nackstöd på sidorna om det inte finns.

Antagligen

En lösning för riktigt små barn som är integrerad i interiören och lätt kan ställas om till vuxenläge.

Evtl. någon sorts armstöd att vika ned vid behov, skulle de göra den lämplig för mindre barn?

Vet inte. Svårt att säga utifrån bilden.

Sidoskydd för huvudet

Någon lösning för yngre barn som somnar

Vet ej, ergonomin på kudden behöver vara bra vid långkörningar

Pris?

Svårt att säga utan att ha provat på

Den ser inte jättebekvämt ut och skulle behöva göras mer ergonomisk, stöd för huvudet

Mer "omhuldande" för de mindre barnen.

Rumpvärme

Komforten om en vuxen ska sitta där istället.

Vet ej utan att ha sett och känt.

Går den att ta lös om man vill? Isf bra.

Svårt att uttala mig om det när jag inte vet så mycket om den.

Någon kreativ lösning för klädsel skydd, vintersmutsiga barn geggat ner allt

Troligtvis

Kunna komplettera med sidostöd och nackstöd för yngre barn som oftare somnar i bilen

## Vilka egenskaper är det som gör att den inte ser säker ut? 17 svar

För enkel

Ser för "enkel" ut

Inga detaljer

klen

Ser inte ut som andra

Ser den inte tydligt på bilden

Lite för enkel

Tycker den ser klen ut

Sidoskydd? Ser ut som barnen skulle glida ur

Såg lite "enkel" ut

Har inte sagt staden inte ser säker ut

Ser klen ut.

barnet verkar kunna glida ur

Den ser liten ut

jag är inte kvalificerad att avgöra

Jag vet inte konstruktionen, ser inte om den går lätt att fälla ner.

Inga detaljer, ser hafsigt ut

## Vad skulle kunna få dig att använda den? 17 svar

Smidigheten

Ifall den fanns i min bil utan att jag hade behövt köpa ny!

Smidigheten

Att den är integrerad i bilen

Enkelhet... om jag hade barn...

Lågt pris, möjlighet att låta den sitta kvar helt ur vägen för vuxna, att se att den verkligen fyller sin funktion

Om jag hade den i min bil

Om den fanns i bilen skulle jag kanske testa

Ett pålitligt test som visade att det funkar

Att den testats och fått bra resultat

Om jag hade 300 00 att köpa en ny Volvo med tillval

En bra pitch

om inget annat val finns

Jag skulle använda den om det inte fanns något annat alternativ.

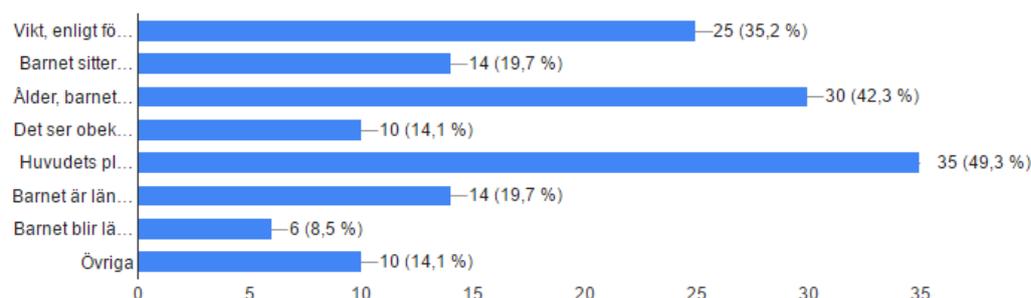
oberoende test

Om den är testad och säker, och får bra omdömen.

Att den är bekväm för barnet, att jag blir informerad om hur den funkar och blir försäkrad om att den är säker.

## Vad är det som avgör, för dig, när ditt barn bör byta från bakåtvänt till framåtvänt skydd för ditt barn?

71 svar



## Hur länge anser du att man bör använda bälteskudden? 71 svar

- ?
- Så länge barnen går med på att sitta på en kudde..
- Så länge de går med på det.
- Ingen aning
- ?
- Vet ej
- Ca 10-12 år
- 10-12 år
- Tills bältet inte kan kväva barnet
- Tills bältet inte kan kväva barnet
- Oj. Mina barn har inte börjat med den ännu men det bör man väl använda tills de är stora nog att sitta utan
- Så länge bältet inte hamnar bra över axeln.
- Tills rätt längd är uppnådd
- Tills barnet är nog lång
- Tills man är tillräckligt lång för bältet.
- Jag kan inte åldersrekommendationen för bälteskudde.
- Tills man har rätt längd
- Tills barnet är lång nog att sitta utan, osäker på ålder. Tittar på längd och kroppsform
- Tills bältet sitter bra på barnet och det är tillräckligt stort/ långt
- Så länge barnet får plats.
- Så länge barnet går med på det.
- Enligt rekommendation
- Tills det blir lika säkert att inte använda den
- Tills bältet inte skär in i halsen
- Jag hade min till jag var sex år typ, så antar att jag skulle applicera det också på mitt barn. Vägt mot dess längd då, givetvis.
- Till barnet är tillräckligt långt för att sitta utan
- Beroende på barnets längd
- Tills man är lång nog.
- Tills barnet är över 140 cm lång
- Så länge som det rekommenderas
- Tills den inte behövs längdmässigt
- 9-10 år
- Så länge det går
- Tills längden är rätt på barnet
- Så länge som möjligt

Från 5 år

Tills rätt längd.

Tills bältet sitter bra utan

Tills barnet enligt säkerhetsrekommendationer inte behöver den längre

Tills bältet ligger bra mot kroppen

Tills barnen är tillräckligt långa

Beror på hur långt barnet är men runt 10-12-års åldern

Enl biltillverkarens rek

Ca 12 år

Tills man kan använda bilbältet på ett säkert sätt utan.

Tills tillräcklig längd uppnåtts

Vet ej. Googlar när det blir aktuellt.

tills barnet är tillräckligt lång

Tills barnet blir ca 140

Till barnet är tillräckligt långt att vara utan.

Typ 10 år. Beror på hur lång man är.

Så länge som bara möjligen

Så länge det behövs, min känsla är att många plockar bort det lite väl tidigt

minns inte teoriprovet, det var nåt med cm

Till bältet sitter bra och barnet ser bra ut genom fönstret och inte blir åksjuk.

Till ca 10 års ålder

Beror på barnets storlek, men ca 8 år.

Så länge den fyller funktion

Tills barnet är långt nog för bältet

Längden avgör, bör vara ca 140 cm så bältet inte löper för högt upp på barnet.

Tills man är lång nog att bältet sitter bra

Samma svar som ovan.

Då länge som möjligt!

Vet inte 9 år? Följer rekommendationerna.

Till 10 år eftersom höftbenen inte är utvecklade innan

Vet ej, kanske till 9-årsåldern.

Tills barnet är tillräckligt långt.

Tills barnen har tillräcklig längd

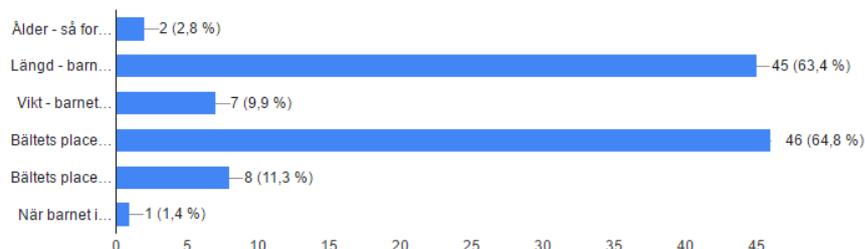
Tills man är 140 cm

Tills man är minst 140 cm.

Tills man är 140 cm ca 10-12 år

Vad är det som avgör, enligt dig, att man ska sluta använda säkerhetsutrustning för barn i bil?

71 svar



Har ditt/dina barn uttryckt något missnöje med sin skyddsutrusning?

Om ja, beskriv gärna vad. 71 svar

Endast bråk om färger, men annars nej

väldigt lite i så fall, kanske utseendemässigt typ färg

Väldigt lite. Mest bråk om färger.

37 st som svarade nej

Ja. Att det skulle vara trångt och obekvämt.

Ja, det är obekvämt och trångt

Vet ej

Vet ej

Tvååringen gillar inte att sitta fastspänd men det är så att säga inte förhandlingsbart

Inte bilbarnstol men babyskydd.

Nä, tar inte den diskussionen :)

Hård att sitta på när vi åker långt

Ja, att bältet sitter för hårt över magen.

Har inga barn

De ville sitta som vuxna

Inga barn

Alltså syskonens barn skriker/gråter/är extra känsliga för allt i bil. Allmänt kaos som bara en padda eller riktigt engagerande leksak verkar lösa.

Tycker inte om att "sitta fast"

Har ej barn.

Sidoskydden skymmer sikten

Sitter lite illa

Ibland vill han sitta som oss men det får han inte

Inte nu när han använder bälteskudde

har inga barn

Trångt och hårt underlag, samt att hen vid baklängesåkning inte ser framåt.

De vill gärna åka framåt när det börjar bli trång

Mådde dåligt när hen åkte baklänges

hon är så liten än

Inget klagomål ,

Vill inte vara fastspända

Ej plats för benen för 3,5-åringen

Trångt och svårt att komma åt bälteslås.

Vår son var väldigt ledsen i sitt babyskydd, tror det berodde på att han inte såg ut.

Ja. Trångt.

Har inga barn

**Vad anser ditt barn om sin skyddsutrusning i bilen?**<sup>71</sup> svar

Vet inte

Bra

OK

Bra

Bra

Accepterar dem

Bra

Ingen åsikt

De vet inget annat.

De ver inget annat.

Ok

Bra,typ

Ok

Helt ok

Helt ok

Accepterar den.

Bra

Ingen av dem har nog några direkta på skyddsutrustning

Har nog inte frågat en hon tycker det är "spännande" att använda kudden när stolen inte är ett alternativ (oftast för att den inte är med)

Spädbarn - inga åsikter

Dom är nöjda med sina bilstolar

Bra

Hon älskar bilbarnstolen.

En självklarhet, ifrågasätter inte användandet.

Neutral

Att det är viktigt att ha skyddsutrustning.

Har inga barn

Sitter bra

Varierande. Coolt med ny sak, efter ett tag förstår de att det bara är för barn och vill vara vuxna

Har Inga barn

Syskonens barn anser det som pest är väl min uppfattning om det. Men acceptansen för den ökar ju med åldern uppfattar jag det som.

Tycker bra om den

Barnet är nöjd bara det kan se bra, dvs. inte bakåtvänt

Har ej barn.

Pratar aldrig om den. (Vet ej)

Har inga åsikter, det är en självklarhet

Tråkigt att åka bakåt, kul att pka framåt. Jag har två barn.

Ingenting, de är så vana vid att ha det

De vet inget annat

Besvärligt ibland

De vet inget alternativ

Ingen

Ingenting, det är helt naturligt

Han tycker om att åka bil, därför tycker han också om bilstolen (vi åker ganska sällan bil)

har inga barn

Bara positivt, vet inget annat än att man sitter så som barn.

Inget konstigt

Inga protester

Ingen åsikt

Inga synpunkter

inget. för ung

Självklart och bra med kudde så ser de ut bättre

Kan ej prata

Ingen åsikt tror jag.

Anser inget, de är nöjda!

Dom verkar nöjda, nioåringen vill sluta men mest när det är med kompisar som inte har stol längre, men han sitter bra i den.

somnar

Vill inte sitta fast

De är bekväma med det

Barnen tycker att det är Ganska självklart

Finner sig men inte mer

Samma som ovan

Den yngsta (drygt 3 år) vet ju inget annat men det börjar bli trångt. De två äldre har inte haft något problem med att sitta i bältesstol eller på kudde men det är just att det är trångt och svårt att komma att knäppa bältena som det gnälls mest över.

Bättre än babyskyddet men inte alltid poppis att åka bil.

Nöjda

har valt den själv och gillar den fortfarande (4 år senare) Kan klaga på att sätet är kallt när det är minusgrader ute :)

Ganska ok.

Har inga barn

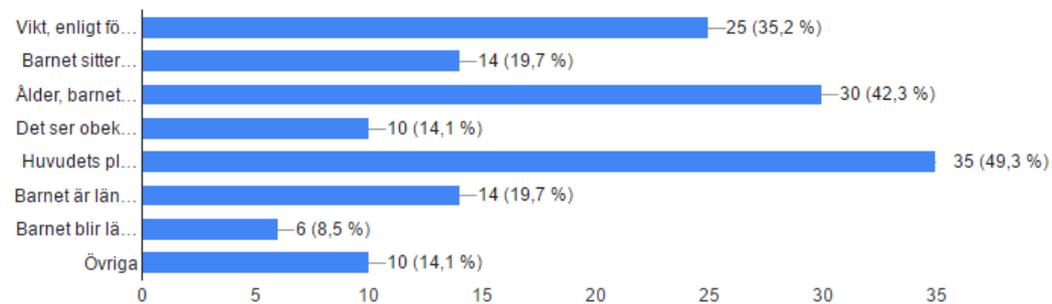
Cool

Tillhör bilåkandet helt enkelt.

Toppenbra!

Vad är det som avgör, för dig, när ditt barn bör byta från bakåtvänt till framåtvänt skydd för ditt barn?

71 svar



## Appendix 4 - Focus group with children

### Frekvens

- *Brukar ni åka bil?*
- *Vart brukar ni åka?*
  - *Långt / kort*

Fotbollsträning

Mormor

Ishallen

Hem efter skolan

Handla med mamma

Fjällen

Bauhaus

Till kompisar

Aerobicsträningen

Till båten

### Placering

- *Hur sitter du?*

Med bälte

I baksätet

- *Var sitter du?*

I baksätet                      19st

I framsätet                      2st

- *Sitter du ensam där?*

Äldre syskon, 11-13 år.

Sitter ensam

Mamma

Mormor

Tonårssyskon >14 år

Yngre syskon, 3 år-10år

Hund

Ur undersökningen visade det sig att barnen utanför "storstaden" körs runt på en hel del så som till olika aktiviteter och att det är med på de flesta ställen som de vuxna åker till som till exempel inköp vid stora byggföretag/gosister?. När barnen skulle svara på var de satt i bilen var det ingen som nämnde att de använde en boosterlösning fastän det, senare i intervjun visade sig att en tredjedel ändå använde booster. Däremot var det viktigt för barnen att nämna att det använde bilbälte. Fördelningen mellan huruvida barnen uppfattade att de använde en HbB, IBC, IBC+komfortklädsel, booster eller endast CRS var spridd. Den boosterlösning som var mest använd, om en knapp vinst, var en vanlig icke hight back booster. Näst efter kom endast CRS. Den som används minst var IBC (2fall) och IBC+komfortklädsen (1 fall).

En subjektiv bedömning visar att det var flickor och de kortaste barnen i klassen som hade en mer positiv inställning till boosterlösningar. Barnen hade svårt att sätta fingret på vad med lösningen som var bra. *Är det bra så är det bra*. Det var dock en flicka som tyckte att hennes highback booster var skön att sova i och en grupp om fyra barn, som alla använde aftermarket boosters, som enades om att det var bra att boostern ockuperade deras plats. "När min booster är där betyder det att det är min plats för ingen orkar flytta på den". Barnen hade däremot lättare för att berätta vad det var som det inte tyckte om med sina boosters och de negativa aspekterna i den här studien rörde främst stigmatisering, komfort och konflikt med vuxen

### **Booster perception/åsikt**

- *Har du en booster?*
- *Hur ser den ut?*
  - *Vilken?*

HBb	3st	
IBC	2st	
IBC + komfortklädsel	1st	
Booster cushion		8st
CRS	7st	



- *Vad tycker du om den?*
- *Vad är bra med den?*

*"Den är skön att sova i"*

*"När den är där vet alla att det är min plats"*

*"Den är rolig att fälla upp och ner (IBC)"*

- *Vad är dåligt med den?*

"Den är ful"

"Jag vill inte åka på den"

"Bråkar alltid med mamma när jag ska sätta mig på den"

"Bältet är obehagligt"

"Jag vill sitta fram"

"Det är jobbigt att hoppa in i bilen"

"Jag smutsar ner och då blir mamma arg"

"Det är trångt"

"Jag ser ingenting!"

"Jag når ingenting"

"Den är hård"

"Jag får ont i benen"

"Den är varm"

- *Har du några syskon? Hur gamla är de? Brukar de åka på booster?*

Bror 12, CRS användare. "Jag vill inte heller ha booster men mamma säger att jag också ska få ska få sluta använda kudde när jag fyller 11. Ibland åker jag utan"

Majoriteten av barnen satt i baksätet, på yttersätena, och det visade sig även att alla möjligt konstellationer av resenärer förekommer men det var vanligast att sitta bak med ett syskon i relativt nära ålder. Nästan alla barn tyckte det var tråkigt att åka bil med undantag om det skedde speciella omständigheter så som att åka tillsammans med klasskompisar. Dock gällde detta bara kortare sträckor. I bilen uppfattar brukar barnen att de under kortare resor endast tittar ut eller pratar med medresenärer och under längre resor brukar de använda någon form av electrical device för att underhålla sig. Ett problem med det var att det inte hade någon naturlig storing place och att sladden var för kort för att ladda med. När barnen fick spåna fritt kring hur den ultimata booster cushion skulle se ut svarade det att det var ultimatum att inte använda någon alls, att den skulle följa något speciellt tema (så som star wars) eller att den skulle vara väldigt artificiell och människoliknande interaktiv och antingen flyga/sväva eller prata och röra sig eller vara ett spel.

## **Sysselsättning**

- *Är det roligt att åka bil?*

Nej.

"Till träning med kompisar är det kul, annars inte"

"När hunden är i baksätet hos mig är det det"

- *Vad brukar ni göra i bilen?*

Titta ut

Prata med syskon

Lyssna på musik

Spela på mobilen  
Ta kort  
Rita  
Titta på film

- *Vad har du med dig i bilen?*

Skolväska  
Träningskläder  
Ipad  
Iphone  
Laddare  
Block + kritor  
Banan

- *Var brukar du lägga dina saker?*

I sätet i mittensätet  
I bagaget (större väskor)  
På golvet  
I knät  
Hänga de på dörren

## **Förändring**

- *Vad skulle göra boostern till den bästa saken i världen?*

Minecraft  
Star wars  
Krama mig  
Vara som en bean bag  
Studsa på den  
Sväva  
Flyga  
Vara ett spel  
Vara en bio  
Prata med mig

- *Vad tycker du om att göra?*

Vara med vänner  
Leka  
Spela fotboll  
Titta på tv eller spela spel  
Studsa på studs matta  
Läsa böcker  
Bygga kojor och leka sjörövare  
Vara med min storasyster  
Rita och måla  
Bada



## Appendix 5 – Personas and Scenarios



# FILIPPA, 8



Filippa Hammar är 8 år, 134 cm lång och bor på **Södermalm i Stockholm** och det har hon gjort i hela sitt liv. Mamma är journalist från Sandhamn och pappa är kommunalpolitiker. Filippa har en **tvillingssystem**, en lillasyster faktiskt för Jenna är född hela tre minuter efter Filippa. Filippa och Jenna hanterar tvillingförhållandet bra. De är bästa vänner, **delar rum** och intressen men har ändå "egna" kompisar. Det är alltid **fullt upp** hos familjen Hammar med aktiviteter och föräldrar som tar med sig jobbet hem så systererna får ofta klara sig själva. Något som gjort dem något **vuxna och ordentliga för sin ålder**.



Det är **skärtorsdag** idag i ett soligt Stockholm och Filippa och Jenna står och samlar fräknar på skolgården och **väntar på mamma**. Systererna ska bli hämtade av mamma som har hämtat en bil från **bilpoolen**. De brukar åka taxi till och från skolan och aktiviteter. De ska till **mormor** ute på **Sandhamn** över påskhelgen. De ska äta lammstek, leta påskägg, kasta macka i havet, leka med mormors granne Lukas, **köra mormor** till en lägenhetsvisning i Tyresö. Hon börjar bli lite för gammal för att vara på Sandhamn ensam på vintrarna. Innan de kör den **2,5 tim långa resan mot färjan** åker de och **hämtar pappa på jobbet**. Han dröjer och då passar flickorna på att gå in på pressbyrån och köpa årets första glass.





## EMELIE, 27

Emelie är 27 år och har **precis flyttat** in i den efterlängtrade lägenheten i Göteborg. Hon lever ensam med en stor kompiskrets och **jobbar skift** med att sterilisera instrument på ett sjukhus nära lägenheten. Hennes mamma brukar säga att det jobbet passar henne som handen i handsken eftersom hon haft **bacillskräck** sen den dag hon föddes i princip. Emelie kan hålla med om det, hon **gillar vitt, sterilt och ordning och reda**. Innan hon flyttade in i lägenheten gjorde hon en riktig storstädning med specialmedel som hon tagit med sig från jobbet, trots att gamla ägaren bara bott i lägenheten 6 månader efter att den var färdigbyggd. Men. Så som lägenheten ser ut nu är lite väl steril...



Det är onsdag och Emelie **sitter på bussen ut till storasyster** Hannas bil. Hon ska **låna bilen** för hon vet inte vilken gång i ordningen. Emelie tycker att hon har planerat in lägenhetsflytten bra tidsmässigt för när syrran är hemma med den nyfödda bebisen använder hon inte bilen så ofta. Hanna tycker också det är bra att Emelie lånar bilen för **i gengäld får Emelie hämta systersönerna i skolan och på dagis**. Emelie tycker det är lite krångligt att hämta barnen på två olika ställen för **hon vågar inte lämna någon av dom i bilen när hon hämtar den andre**. Dessutom brukar dom inte vara villiga att samarbeta efter en lång dag och de **bråkar** ganska mycket med varandra. Men det går bra. Emelie tycker mycket om sina syskonbarn och resan tar bara 7 minuter från de att båda barnen är upplockade. När hon **lämnat av barnen** hos sin mamma ska Emelie **plocka upp sin kompis och de ska åka till IKEA** och köpa en bokhylla och två stolar... också lite annat småpill "som man hittar på vägen".



## VILLE, 6

Ville 6 år bor i **Kungälv strax** norr om Göteborg. Han är 120 cm lång och väger 20 kilo. Jämt och bra, det här morfar sägt. Ville tillhör dom längre i kompissskaran och **känner sig själv ganska vuxen** och förständig. Till hösten han börja i skolan inne i stan men först ska han njuta av sommaren ute på kusten och fiska krabbor och morfar har lovat honom att lära honom segla. **Ville bor ihop med sin pappa, hans nya fru Maria** och hennes **två döttrar som är 13 och 9 år**. Också Dixon såklart. Familjens svarta **labrador**.



Varje sommar åker familjen på bilsemester vilket de även ska göra denna sommar. Pappas fru är från **Genova i Italien** så de brukar köra ner dit och njuta av vad Rivieran har att erbjuda. Ville älskar det blåa havet och glass med Nutella. Det tar ca **20h att sträckköra** men familjen brukar **dela upp resan på tre dagar**. De försöker hitta spännande platser att besöka på vägen ner och **vissa sträckor blir väldigt långa** förutom korta **raster för Dixons skull**. Ville tycker resan är hemskt. Det är **trångt, han blir så rastlös** och han kan **inte rita eller spela för då mår han oftast illa**. Hans nya systrar brukar lära honom italienska på vägen ner, något som Ville faktiskt blivit ganska bra på efter alla dessa resor till Italien. Det underlättar eftersom de brukar stanna i Genova i ca tre veckor och Marias föräldrar inte pratar svenska.





## ALICE, 4

Alice Ranström är en nätt, liten och energifylld 4 åring som väger 15 kg och är 96cm lång. Alice bor med sin mamma, pappa och **storasyster Kajsa** som är 10 år i ett **hus i Åre**. Alice ser mycket upp till sin storasyster och dom är riktigt bra vänner trots ålderskillnaden. Nu i vintras fick **Alice börja i skidskola** vilket hon är jätteglad över för nu har hon äntligen chansen att bli lika duktig som Kajsa. Mamma och pappa är också intresserade av skidåkning och **familjen tillbringar mycket tid i spår och pist tillsammans**. När dom inte gör det arbetar dom och då är Alice i skolan där hon gillar att bygga koja.



På lördagsmorgonen går pappa Ranström ut i skidförrådet som ligger beläget strax intill garaget. Det är mycket rörigt där inne med **skidor i nästintill alla storlekar**. Pappan tar plockar på sig de skidor och pjäxor de kan behöva samtidigt som mamma håller på att göra iordning frukost och **matsäck** därinne. Idag ska familjen Ranström tillbringa en **heldag på Årefjället som bara ligger 20 minuter hemifrån**. Alice och hennes syster är ivriga och har redan klätt på sig underställ och flätat håret, **skidkläderna** tar det på sig när de kommer upp till fjället. Det blir så varmt i bilen annars.



## HAMPUS, 10

I skolan är han den **coolaste fotbollsskille**n som alla vill leka med. Hampus. Han har en personlighet som gör att han är något svårplacerad. Han är **både gullungen och jävelungen**, mobbaren och lagspelaren, bråkstaken och A-barnet på samma gång. Hampus är 10 år och är 135 cm lång. Han är en **något liten tioåring** men det rubbar inte hans självkänsla, inte synbart ialla fall. Hampus är ensam barn och bor i en **lägenhet i en förort till Stockholm** tillsammans med sin pappa varannan vecka och **varannan vecka** bor han med sin mamma och hennes nya familj i en **Villa på Lidingö**. Hampus älskar är däremot Fotboll. Det gör pappa också och när han inte jobbar som materialare åt AIK är han är tränare för deras fotbollslag.

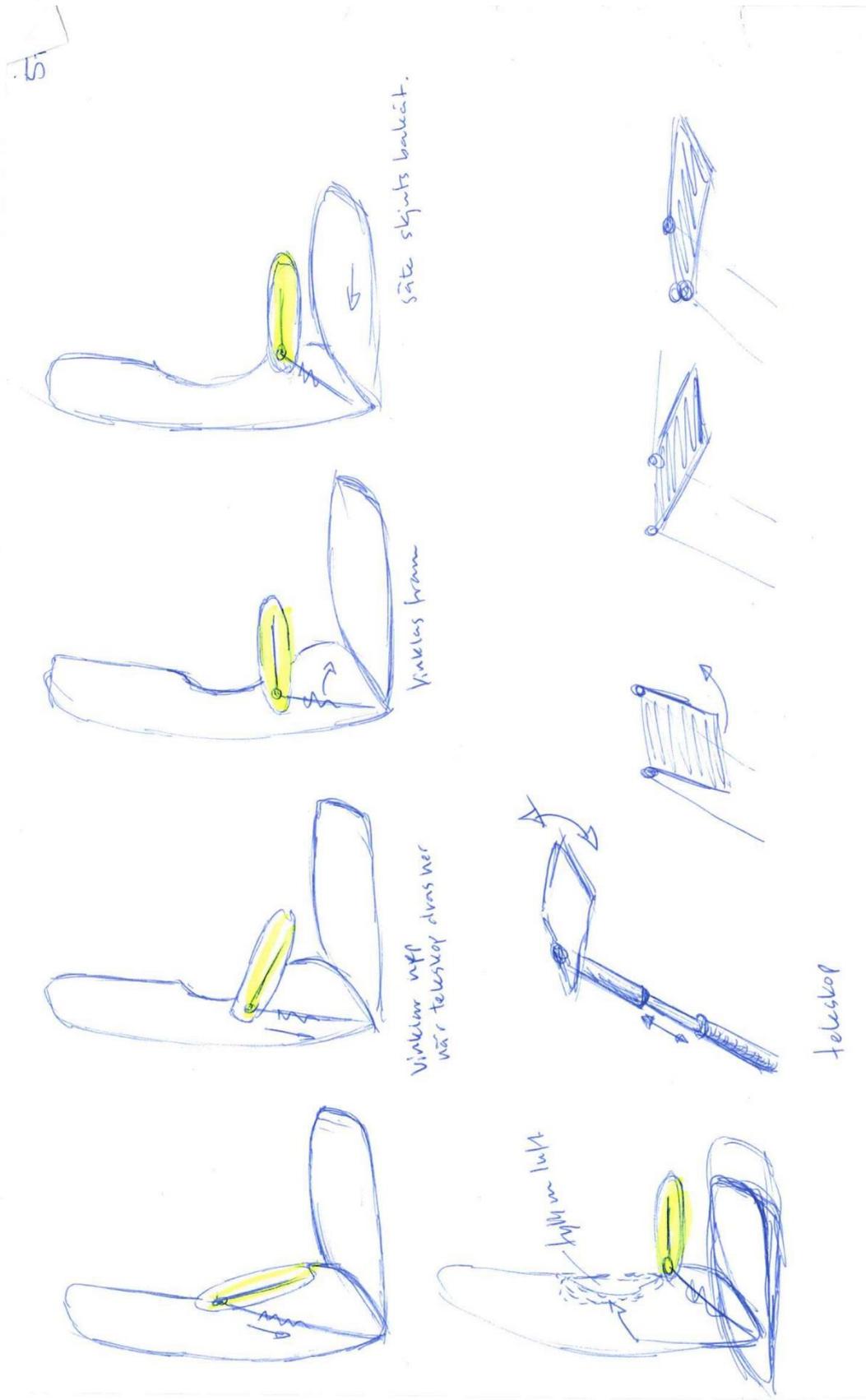


Idag är det torsdag.

Det **regnar** och har varit en ganska tråkig oktoberdag idag tycker Hampus trots att han har haft idrott efter lunch vilket han älskar. Bästa kompisen **Joels pappa kommer och hämtar** dom på fritids på eftermiddagen och kör dom till **IP. Det är match idag i Solna**. Pappa kommer strax efter att Hampus och Joel har kommit fram. Han har **hela bagaget fullt med matchkläder och fotbollar** och killarna i laget börjar latcha på parkeringen trots att det regnar lite. Hampus vet att pappa inte tycker om det för **"det blir så grisigt i bilen"** men han har så fullt upp med att dela in barnen i bilarna så han säger inte ifrån. Det tar en lång stund med logistiken men nu kan de äntligen åka. **Joel, Simon och Ali åker med Hampus.**



Appendix 7 – All ideas from the ideation



TRE LIKADANA GÄTEN

20 C

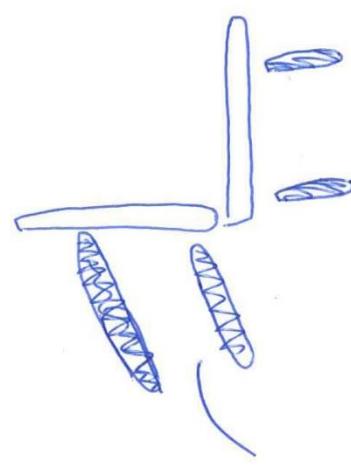
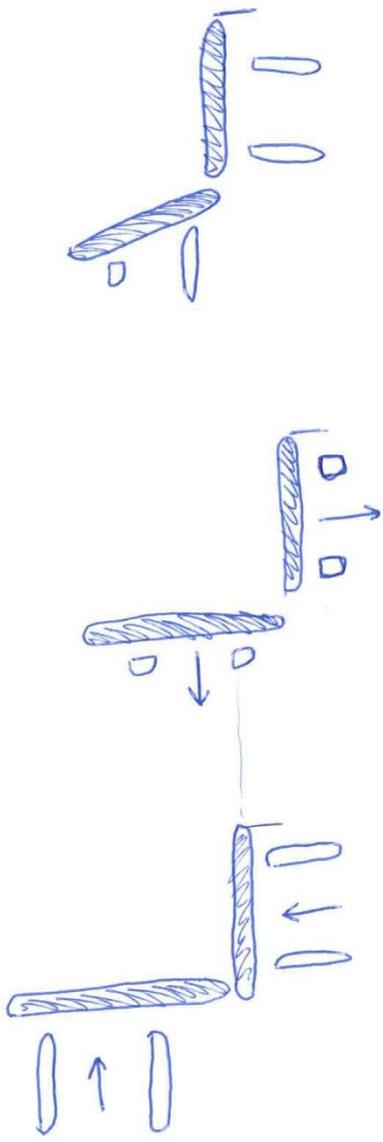


Blås upp

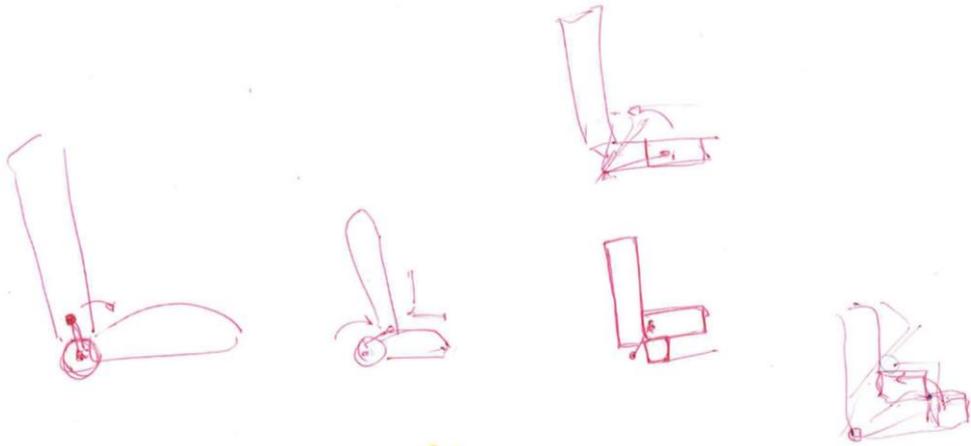
KARVA

Blås upp

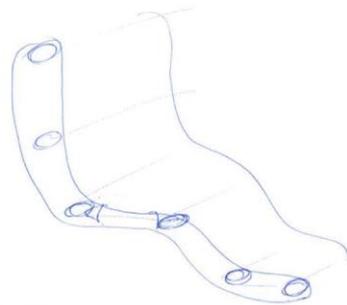
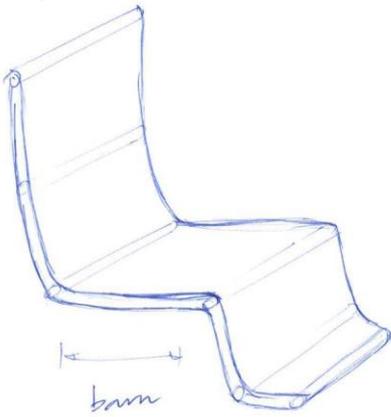
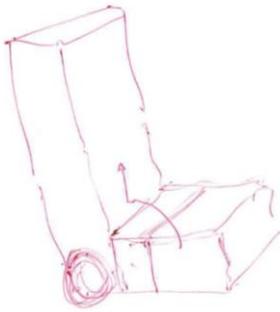
128<sup>F</sup>



upp & frame



29 D



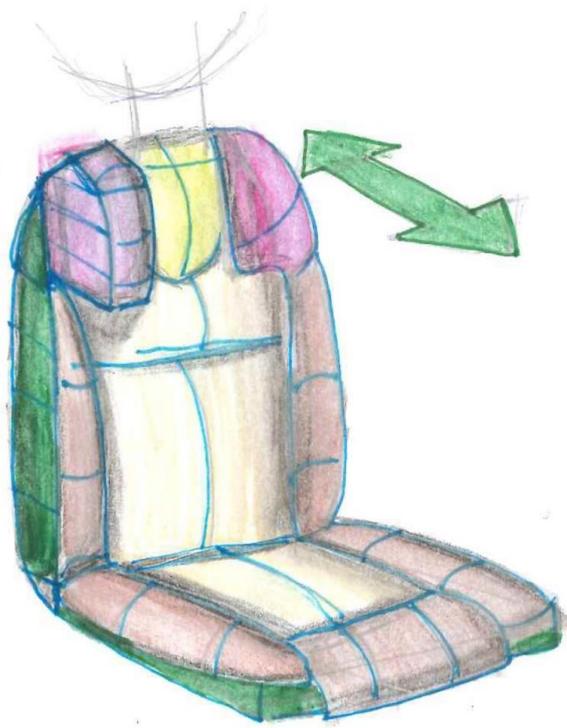
109 B



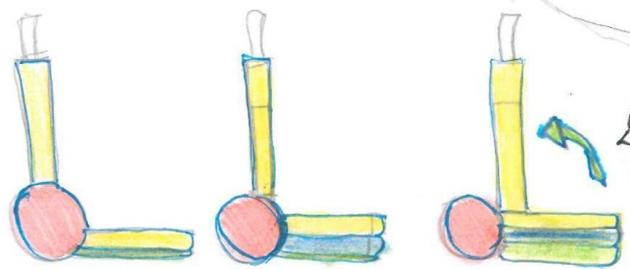
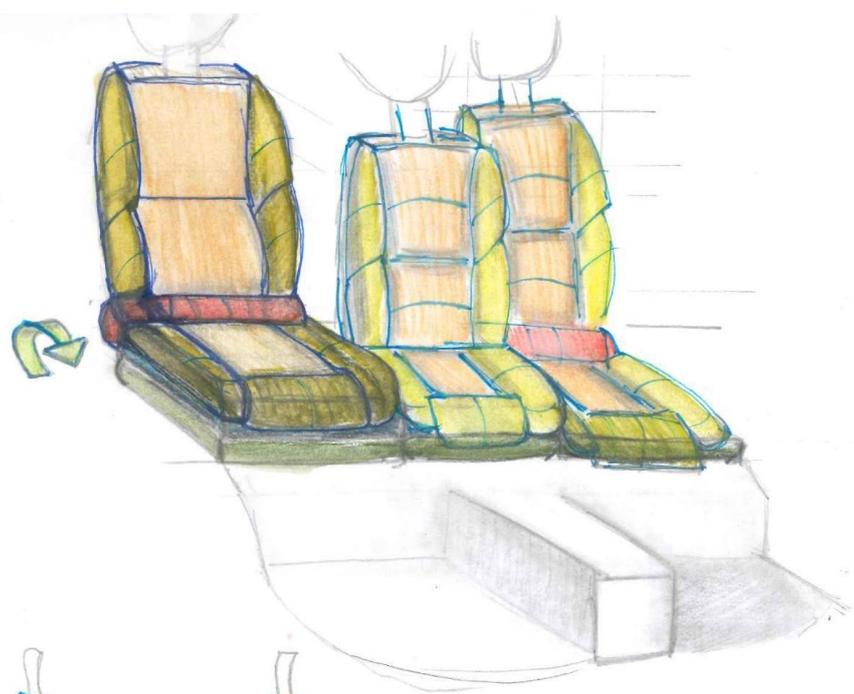
Head  
Support

five  
stret

bar...



30/3 & n



posibility  
to tilt  
seat

120

vinlas nær

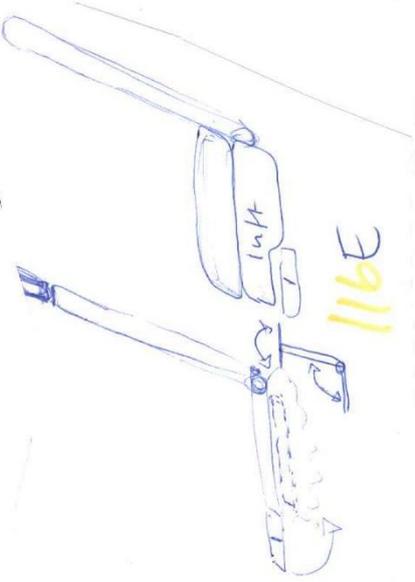
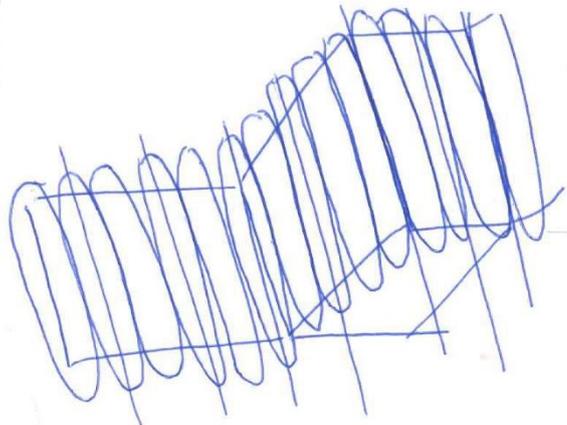
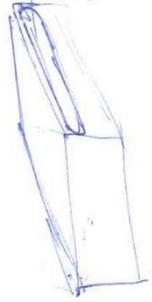


vinla nær



110G

blases ut  
sugs in



116E

sittigjærn

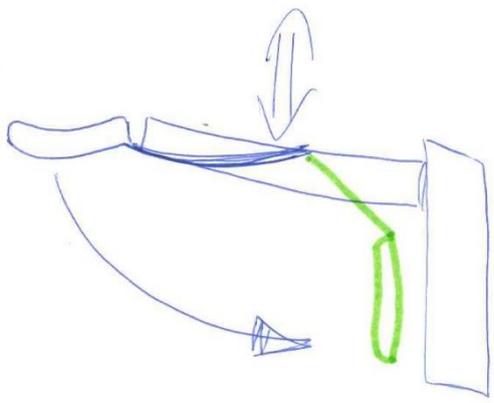
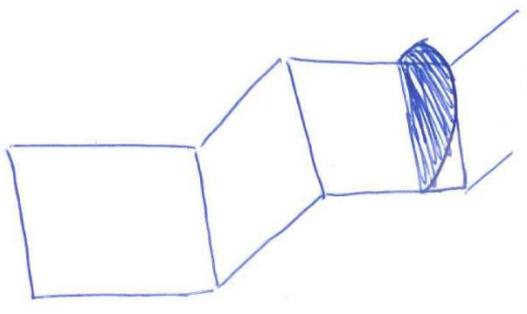
oppblåsbar luft  
kammer

ledraad

forstøid, gir ett vinla



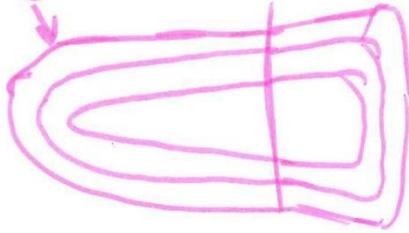
113H



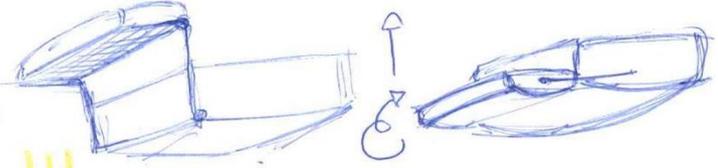
Använda  
gungan  
lyfts från  
ovansidan  
/nackvidet  
dysteras i  
högled



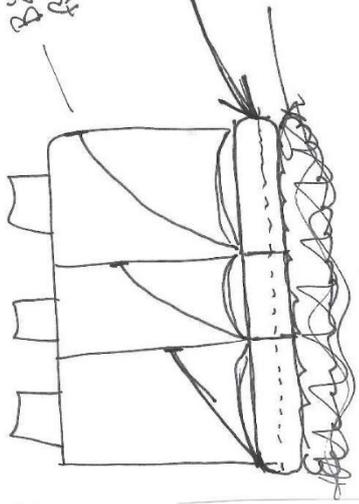
Dita kanaler  
blåses upp  
inifrån  
och ut



Mr inlädd och  
smurad så att  
undersida inte  
ligger upptät som  
fäststöd



Biltespunkter i olika  
nivåer.  
Möjlighet att  
sätta  
konstruktions-  
punkter  
i olika  
höjd  
och  
avstånd  
= Mer

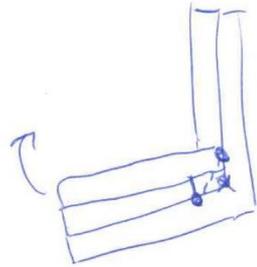


68

126

elektronisk  
höjningsanordning

Fäll ner



117G  
113H



luftkudde lyfter upp stötdynamen



luft byter plats



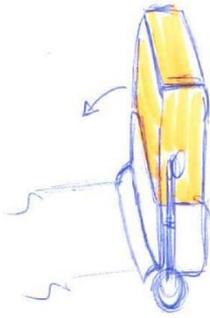
ligger "platt" mot body inuti

27D

justerbar (i änsd)



statisk



statisk

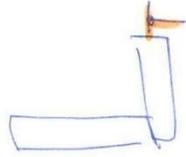
Metallplåt  
fläsnad i  
funktion av  
knuden



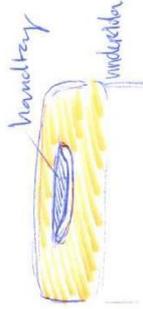
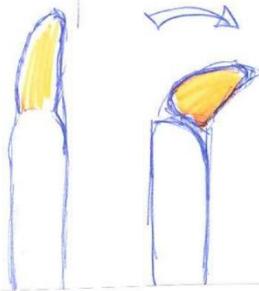
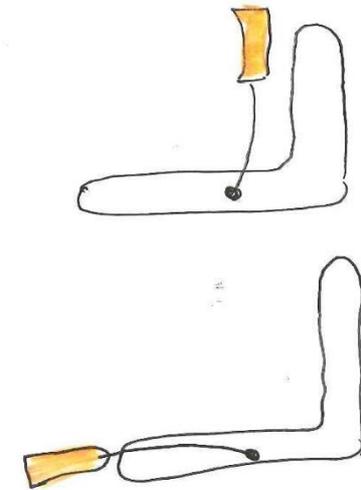
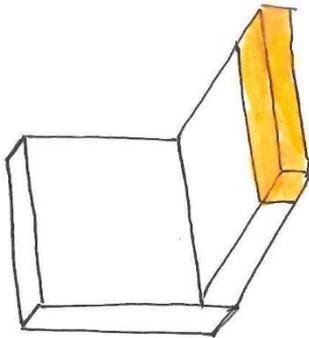
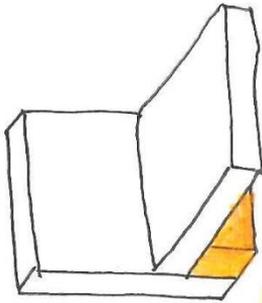
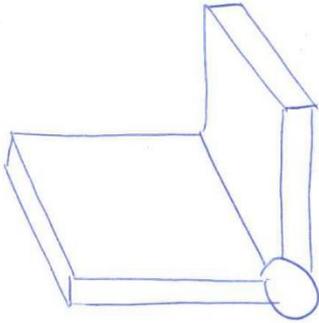
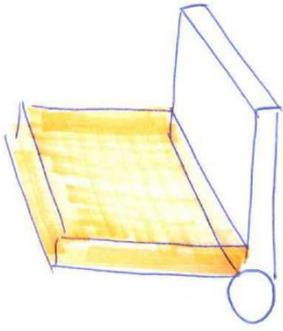
knopp för att lösa



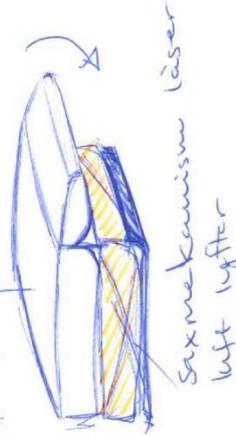
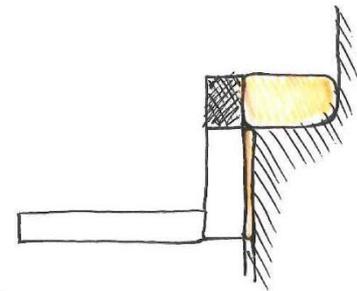
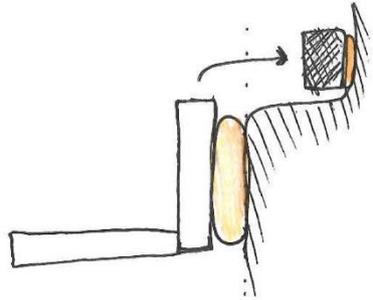
15H  
1511



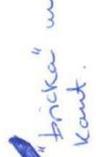
15H  
1511



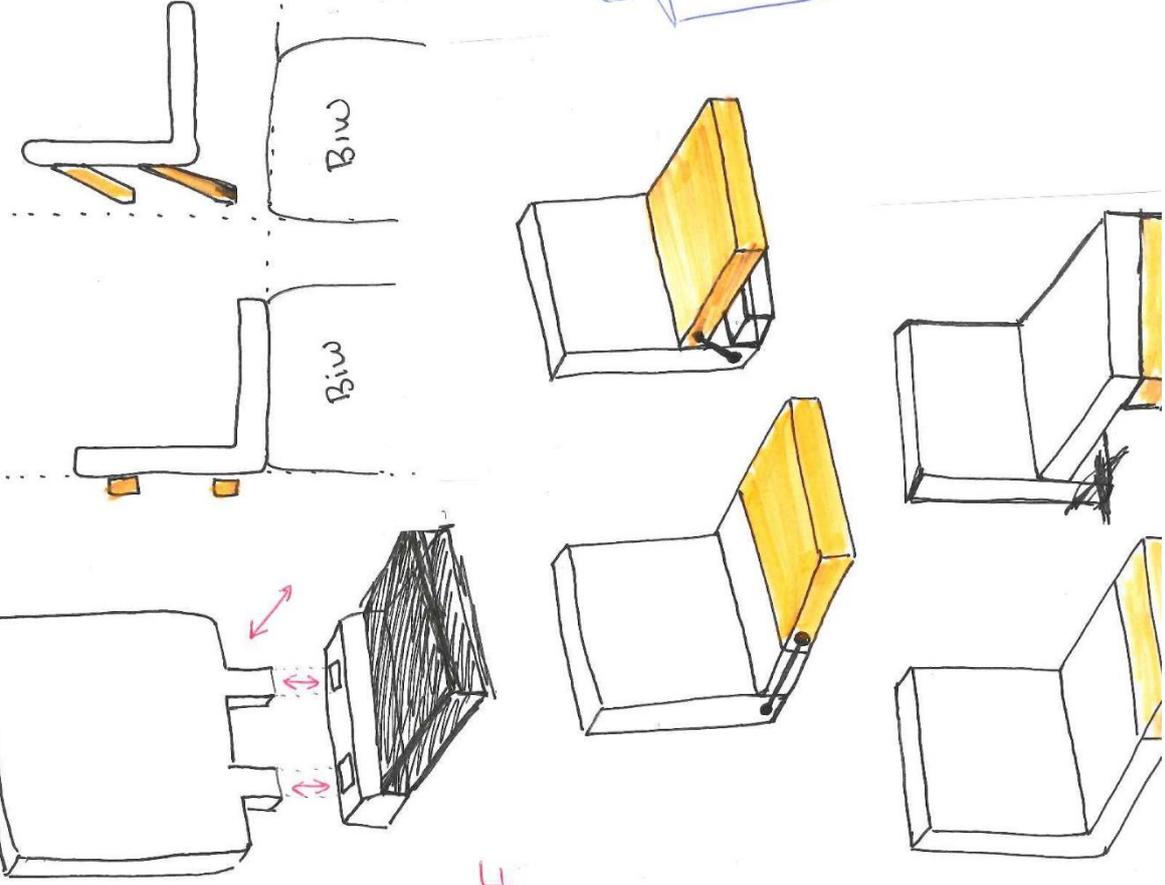
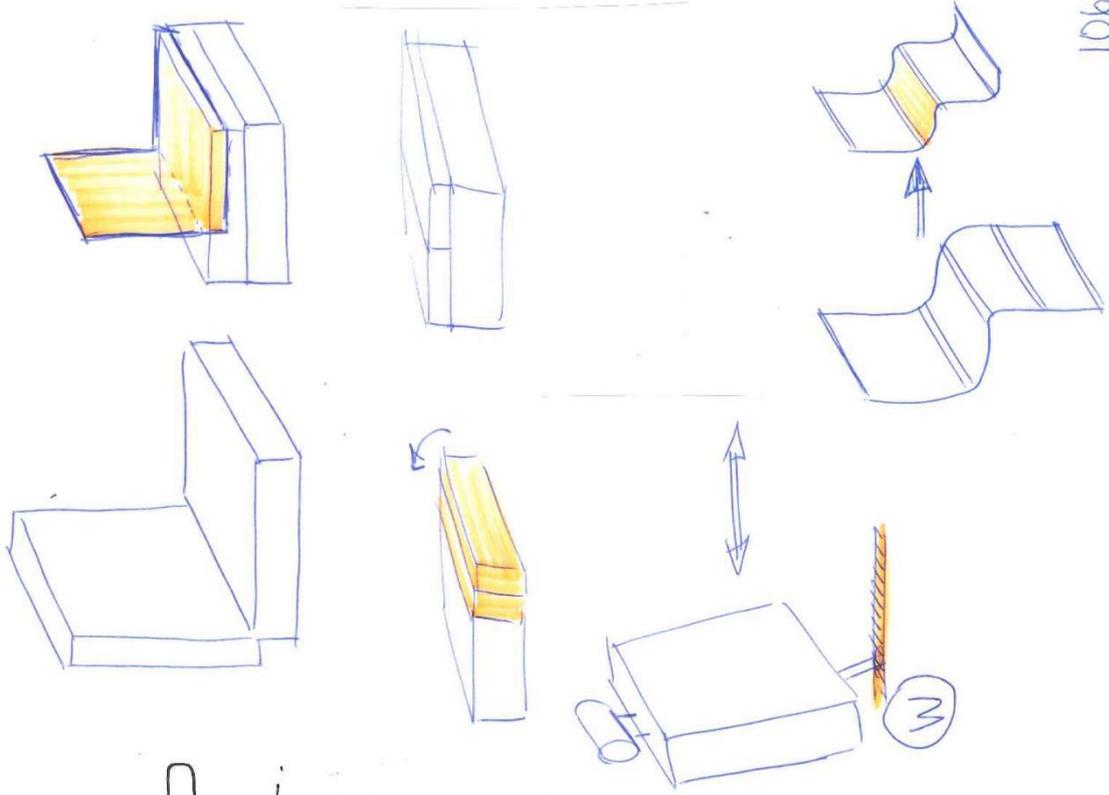
"handtryg" på undersidan  
trycker in, vinklar upp LITE  
och sedan släpper "spärren"  
och vinklar ner



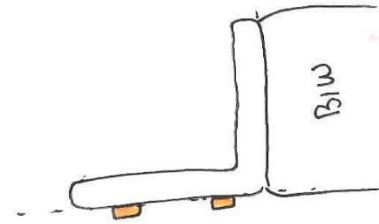
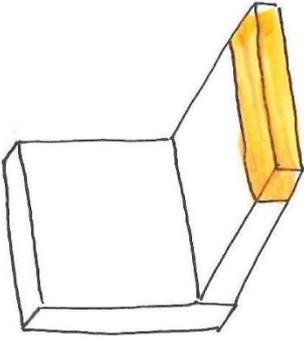
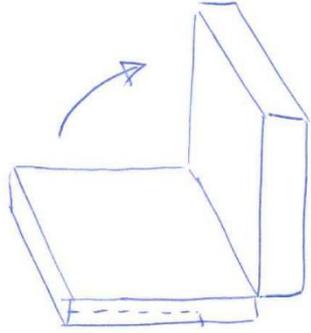
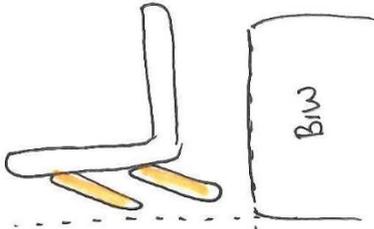
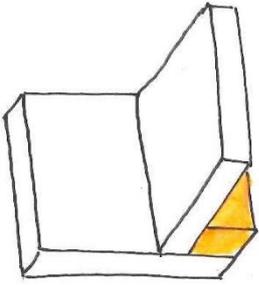
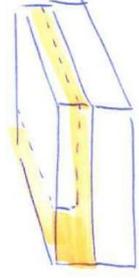
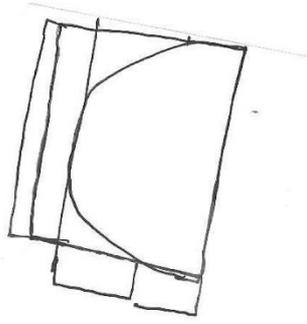
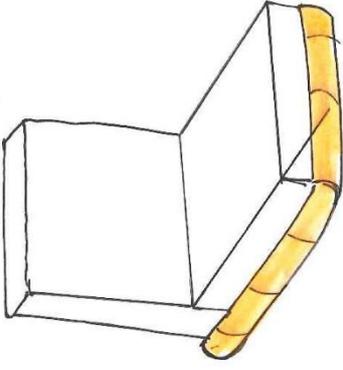
Saxmekanism läser  
luft lyfter



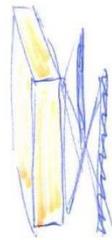
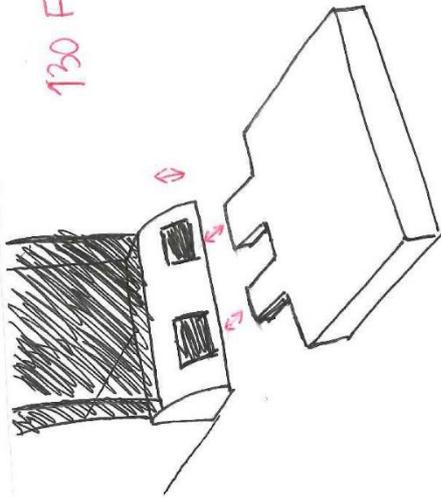
"bricka" in  
kant.  
Skenor  
för saxmekanism



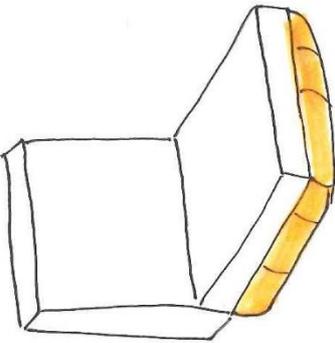
E



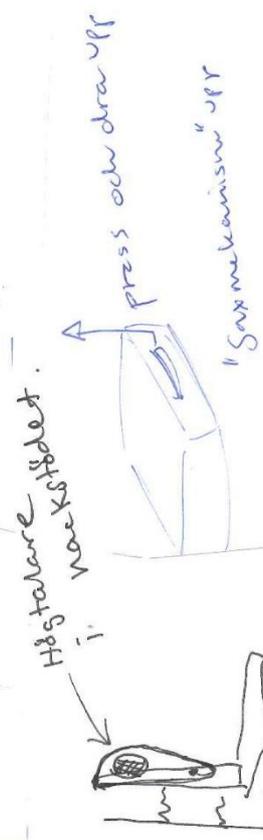
130 F



Saxmekanism

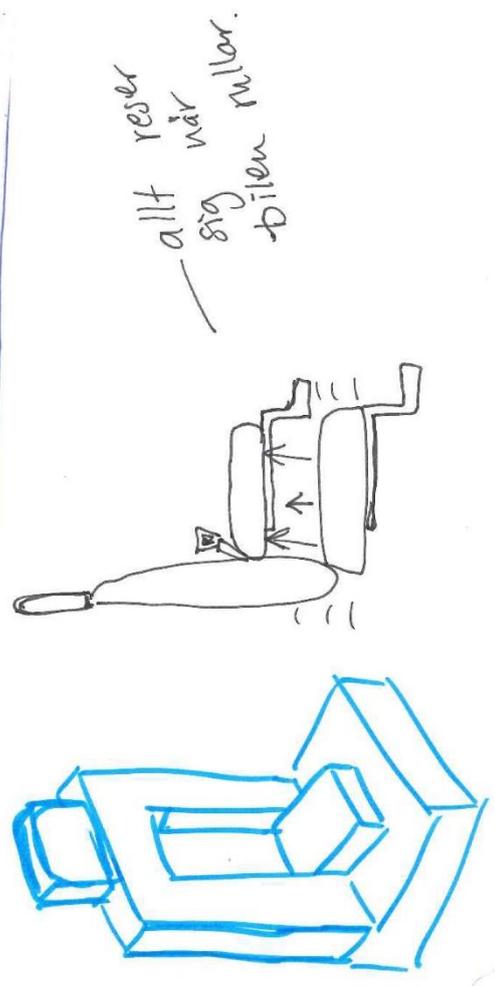
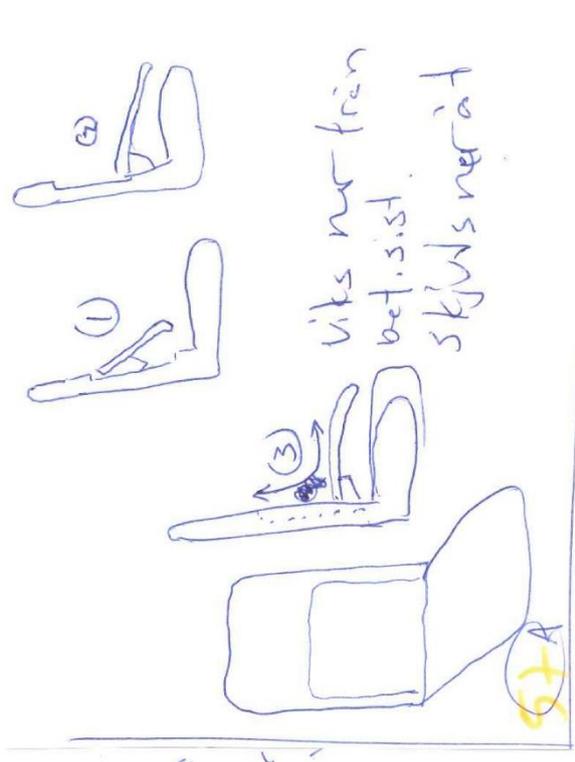


- 1. Ställbar ventilation per plats.
- 2. Interaktivt fönster med spel rum
- 3. ventilation i sidet under och på ryggen
- 4. en transparent skärm all tillä främre med interaktivitet.

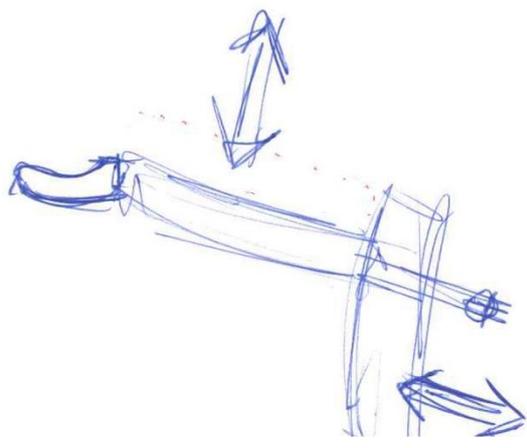
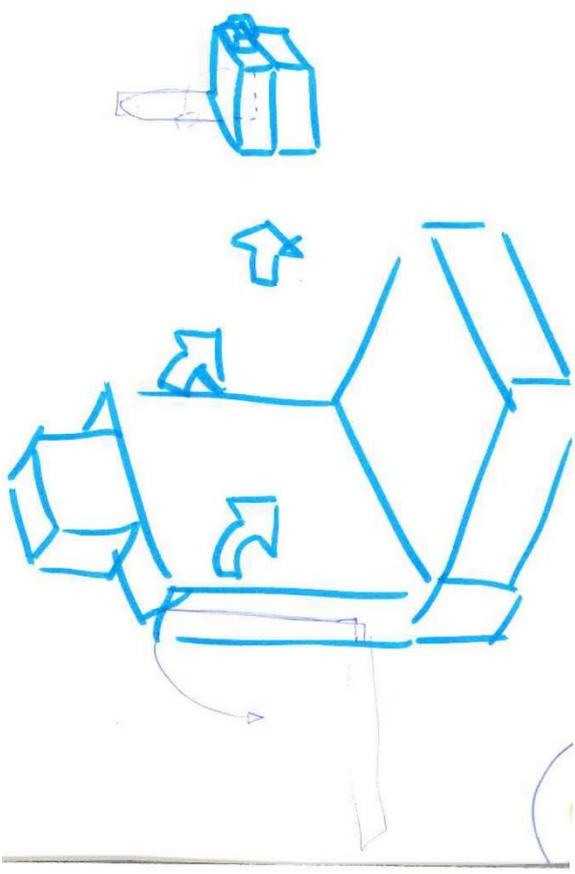


118<sup>te</sup>

- Hampus stöl
- smygkåjs
  - fortfarande coolt
  - ledningsning.

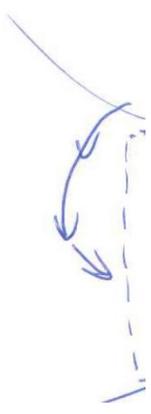






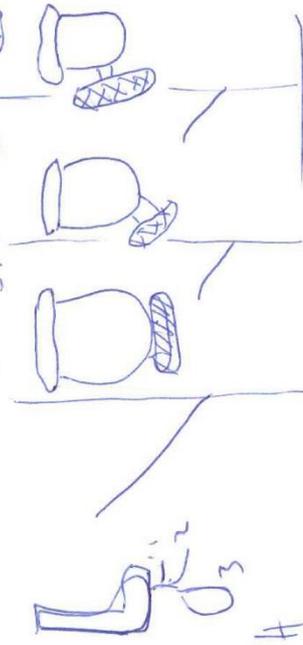
Bygg dem var sig  
 Over dynamo  
 F

Pusselbiter

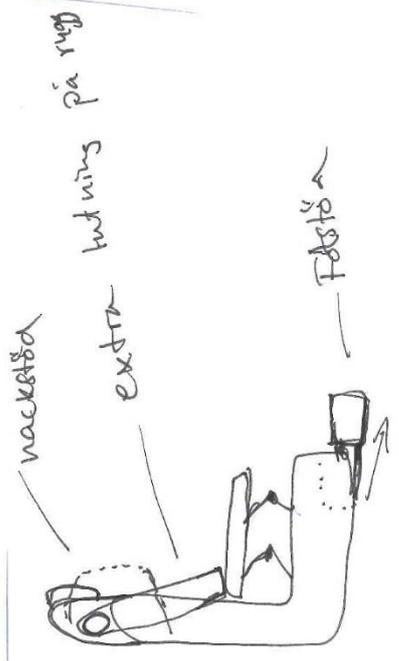


Upplösbar  
 mekanisk  
 for ad  
 umbraka  
 "Stegen"

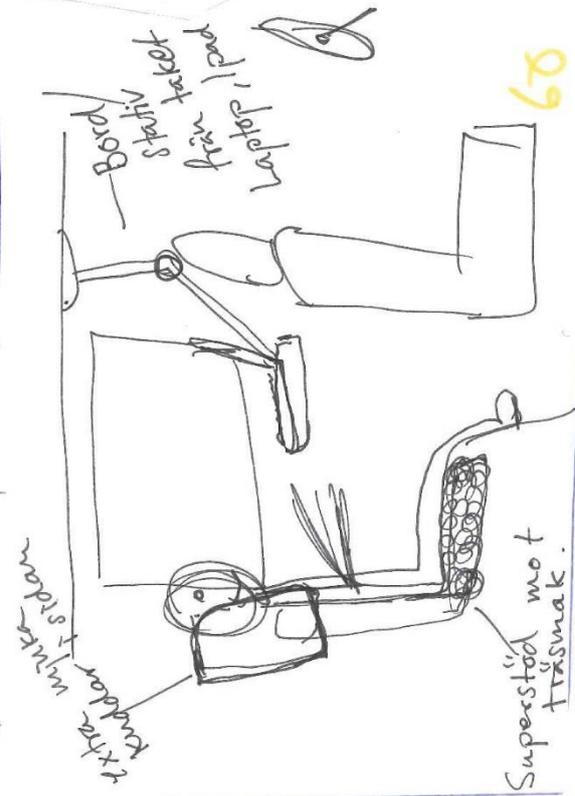
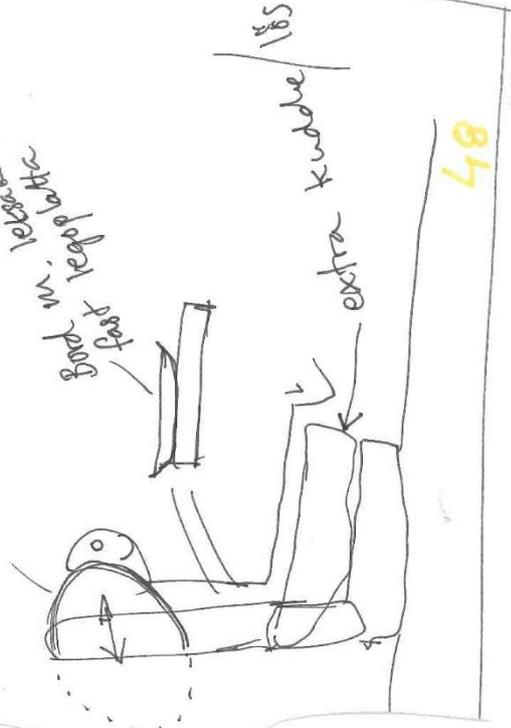
Fotstället under lällan för i och ur-  
 stigning och kan vridas och  
 sänkas när man står på det  
 när bilen är stilla och dörren öppen



54 #



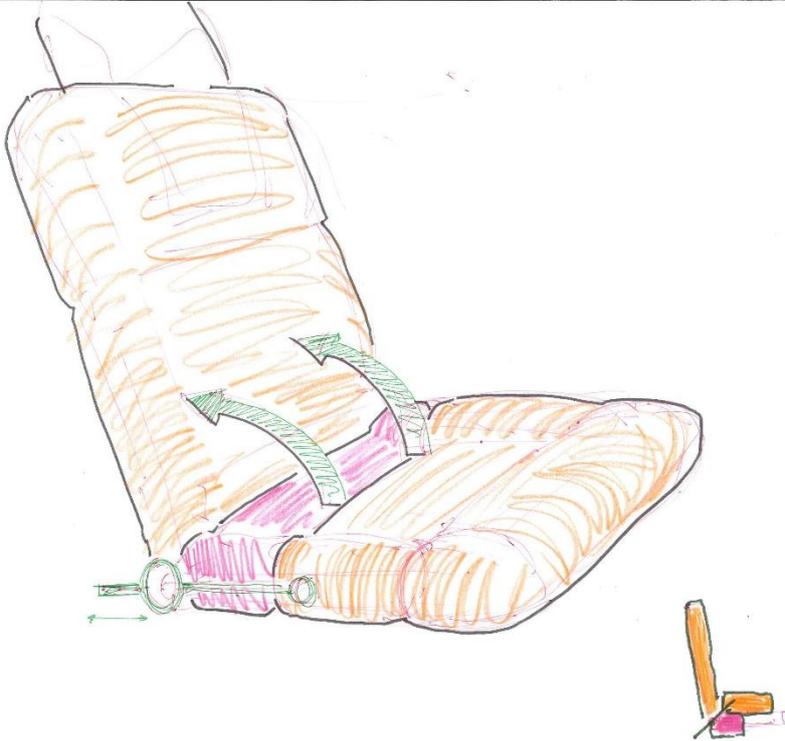
Nackstöd fälls fram  
 ur stövmattan  
 Mt.  
 100% polyester



Superstöd mot  
 träsma.



120°

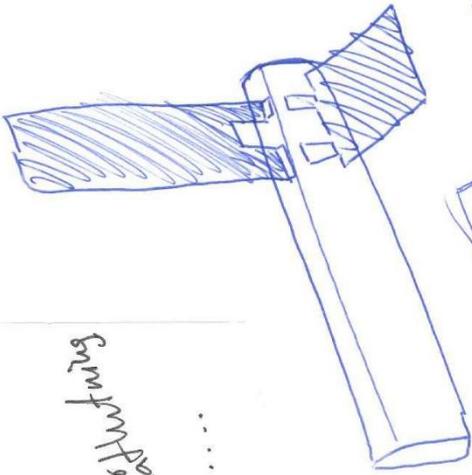


222222

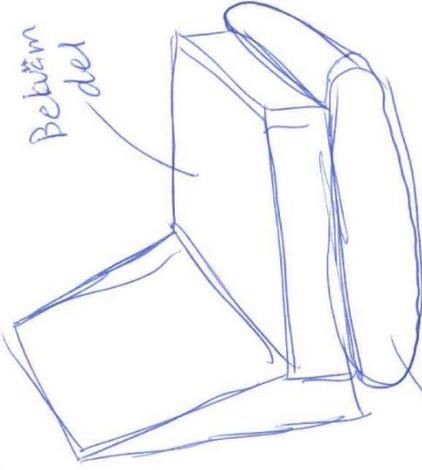


Den  
mjuka  
barnstols  
kattstumpning  
stolar...  
stolar

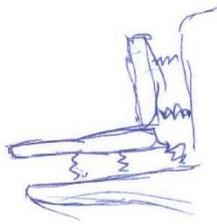
lm  
stolar



Bekäm  
del

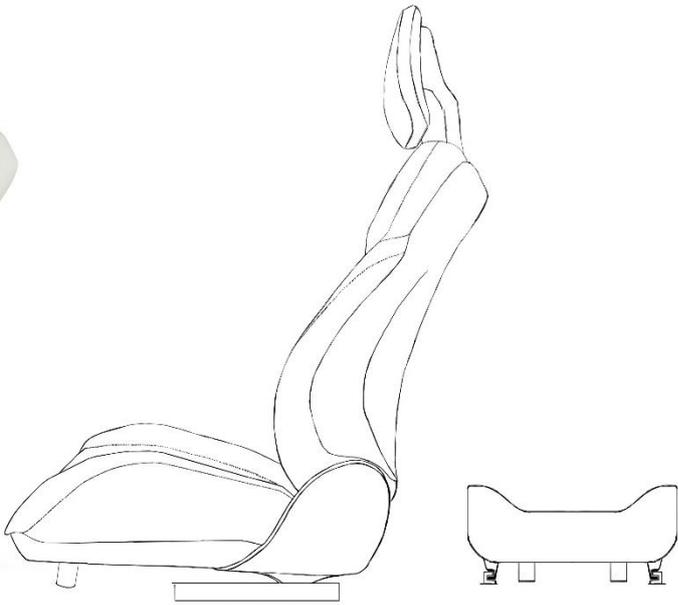


upplösbar del

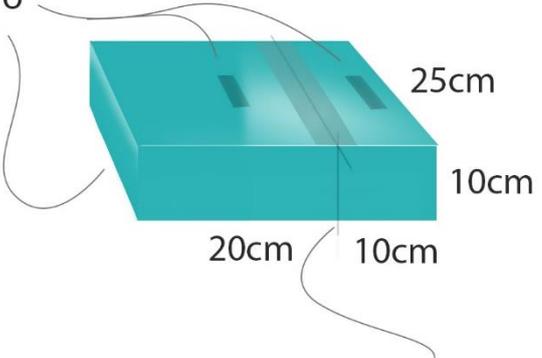


Fjärden och  
fram från  
sitt utseende  
sprunglar

55



Velcro



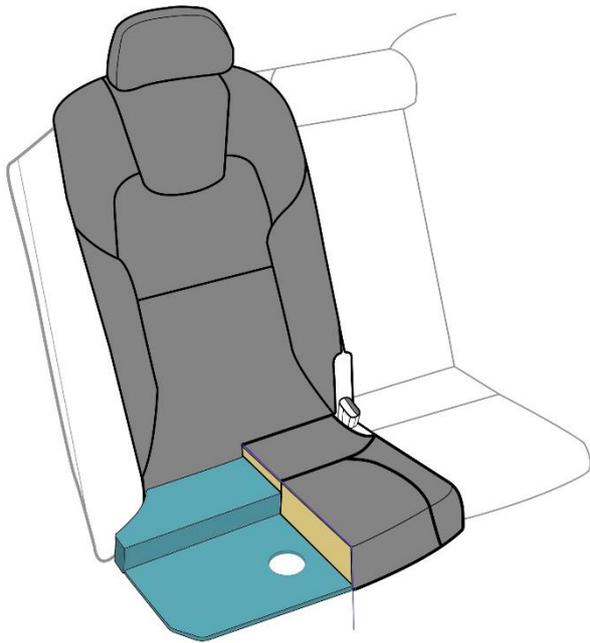
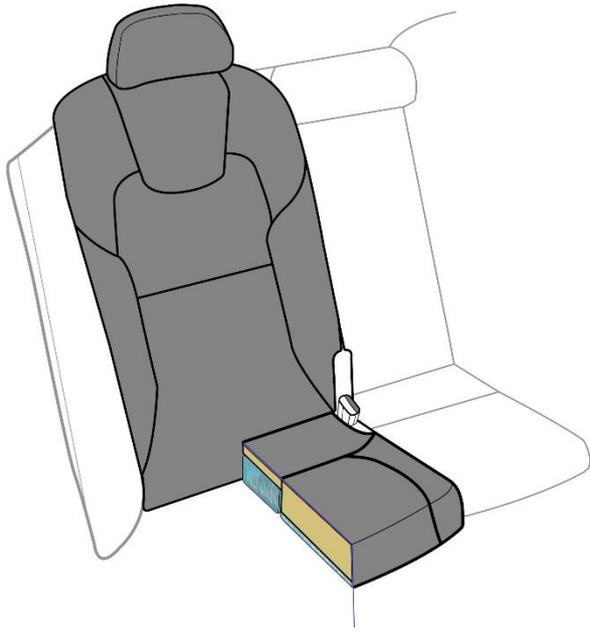
25cm

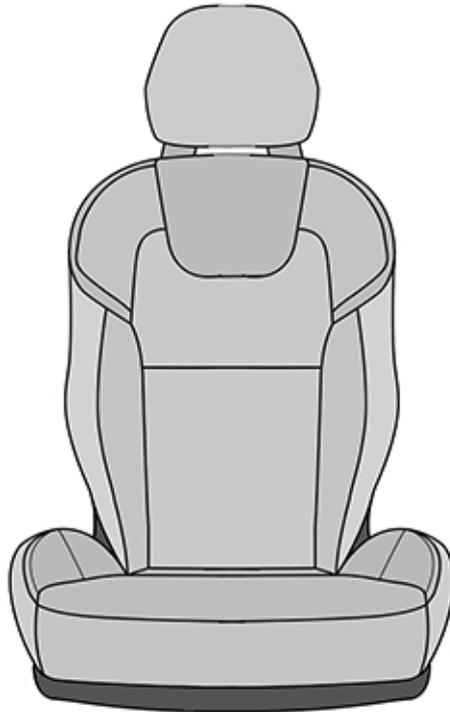
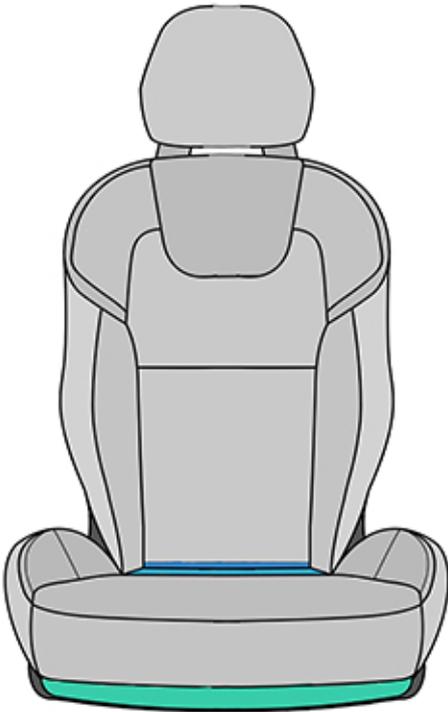
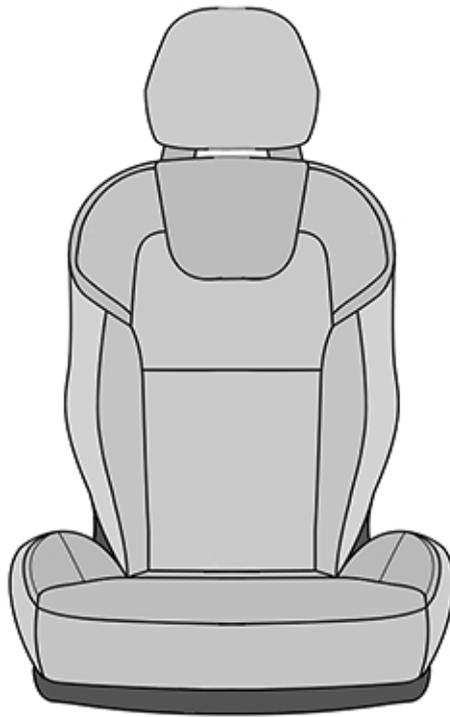
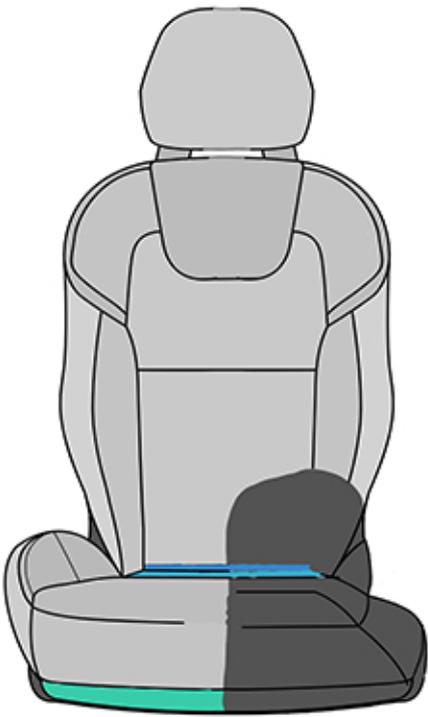
10cm

20cm

10cm

Splitline/Divided  
Foldable



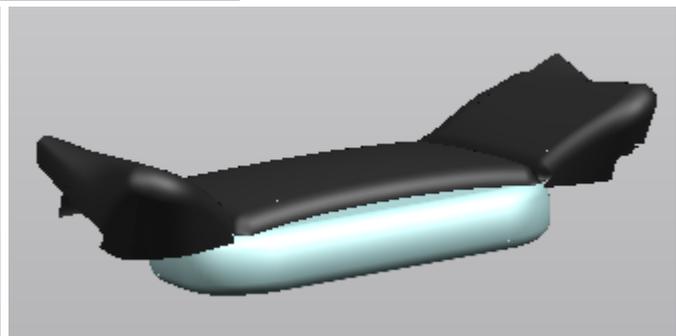
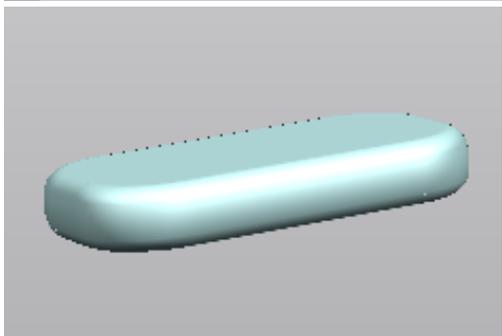


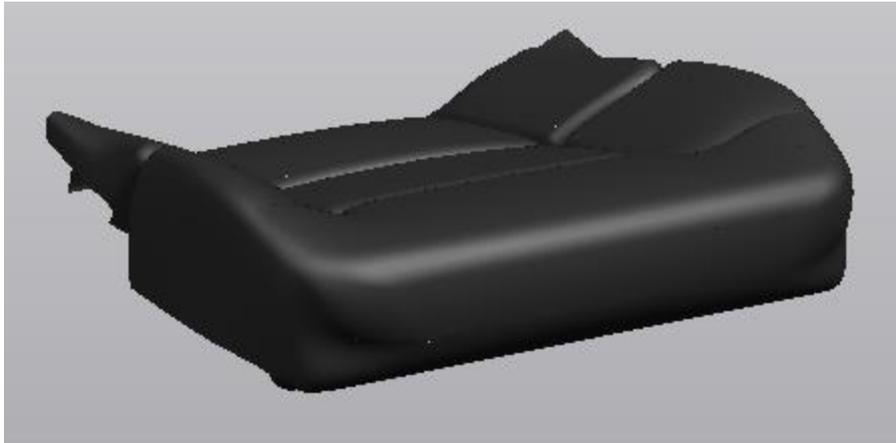
Appendix 8 – Pictures of the concept











Master of Science Thesis PPUX05

**Rethinking the Integrated Child Seat**

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

© Moa Nybacka, Andrea Slaattelia Larsson

Chalmers University of Technology  
SE-412 96 Goteborg, Sweden  
Telefon +46(0) 31-772 1000

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