

# Paper towel dispenser for high traffic washrooms

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# Summary

<b>Title</b>	Paper towel dispenser for high traffic washrooms
<b>Key words</b>	Dispenser, SCA, paper towel, high traffic washrooms.
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<b>Problem</b>	What would be the optimal size of a paper towel dispenser for high traffic washrooms? How can competitors' paper be excluded from being refilled into SCA dispensers?
<b>Purpose</b>	By performing a thesis study we intend to investigate what changes has to be made to the dispenser for paper towels, to make the handling process easier for cleaning personnel, and also what profits this new product would bring customers of SCA, and thereby strengthen SCA's position on the market.
<b>Method</b>	<p>In this thesis different field studies of the flow in high traffic washrooms have been made. We used methods such as semi structured interviews, observations and literature studies to get the information we needed to write this thesis.</p> <p>In order to receive an understanding for the research field, we have combined literature studies with information searches on the Internet.</p>
<b>Conclusions</b>	The developed dispenser both makes the paper proprietary to the dispenser and reduces the refilling frequency remarkable. The dispenser holds 2000 towels and only needs to be refilled once a day, if two dispensers are used in a washroom with 1600 visitors per day.

## **Foreword**

This Master's Thesis is the final course of the program Mechanical Engineering at Lund Institute of Technology, which leads to a Master of Engineering. The project is conducted at SCA Hygiene Products' Away From Home (AFH) division in Göteborg, Sweden.

We would like to thank our supervisor, Björn Larsson, for his help and support throughout the project. We also wish to thank Manuel Weiser and Markus Kalf at Gebrueder Schmidt for their help manufacturing the dispenser cover. Our thanks also goes to all the people we have interviewed, for taking the time to answer our questions and letting us take part of internal information.

Lund, 2005-12-12

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# 1 Introduction

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*This chapter presents the background and the purpose of this report. Furthermore it considers the focus and company description.*

---

## 1.1 Background

One area in the paper industry is paper products for consumers at home, outside home, industries, institutions and public establishments. The producer also develops and sells dispensing systems for these products. It is crucial that the companies' dispensers can prevent competing companies' products from being refilled into their dispensers.

Hygiene products can be paper towels, wipers and tissue paper. The companies that produce these paper products also produce dispensers for them. When selling dispensers to their customers, the company wants their paper to be refilled in the dispensers.

## 1.2 Problem

In high traffic washrooms the consumption of towels is very high. To maintain hand towels at all time for visitors the service interval has to be frequent. This is a large expense for cleaning companies that have to employ the staff filling the dispenser. If the service interval frequency could be reduced the cleaning company would save money. If SCA could provide a system that needs less maintenance this would be a considerable reason for the cleaning companies to chose SCA as their supplier of dispensers and hand towels. Here arise another problem and that is that today's competitor's paper fit in SCA's dispensers. To avoid this problem it would be desirable to construct a solution that locks out the competitor's paper from SCA's dispensers.

All steps involved in handling the product should be considered; from the supplier to when the hand towel is used. To make it a product that is easy and efficient to ship, use, dispose of and yet will fulfill the needs and demands of the users. An important aim in the design work is to develop a dispenser that will contribute to a good working environment for the staff. Filling the dispenser has to be convenient and easy whether you are tall or short. Neither should maintenance be heavy or harmful in any way. Time required to refill these dispenser is also of interest, as the cleaning companies wish to keep it as short as possible.

Waste management is another problem that has to be solved. Keeping down the amount of waste produced is both better for the environment and would make the workload lighter. Used boxes should take minimal space so they are not in the way and off course as much waste as possible should be recyclable.

### ***1.3 Purpose***

The purpose of this report is to find the optimal size, and to design a dispenser for paper towels used in high traffic washrooms, located at airports, train stations, arenas, amusement parks etcetera. Another aim is to find a solution for how competitors' products could be prevented from being refilled into SCA dispensers.

### ***1.4 Focus and delimitations***

The focus of this report will be on developing a dispenser for folded paper towels for high traffic washrooms. Other washroom dispensers will be ignored.

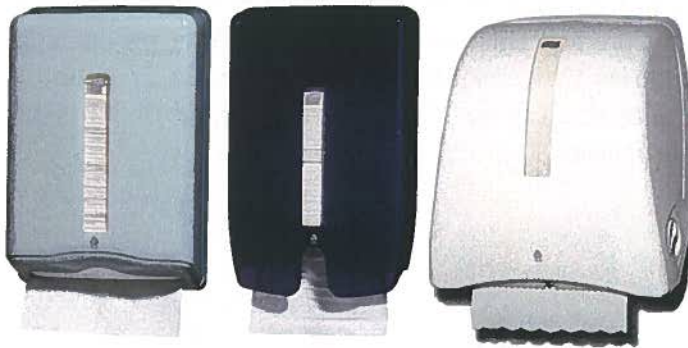
### ***1.5 Target group***

This report is intended mainly for SCA Hygiene Products AB. It may also be read as enlightenment for students interested in product development and packaging logistics.

## **1.6 SCA company description**

SCA is an international paper company that produces and sells absorbent hygiene products, packaging solutions and publication papers. Based on customer needs, new products are developed for consumers, institutions, industry and retail. SCA is a leading supplier of customer specific packaging solutions, not only conventional transport packaging but also consumer and display packaging, protective packaging and high visibility plastic packaging.<sup>1</sup>

SCA is Europe's second largest producer of containerboard. Sales in 2004 amounted to SEK 32 billion in 50 countries, with 35,000 employees. SCA business group consist of SCA Tissue Europe, SCA Personal Care, SCA Packaging Europe and SCA Forest Products. Some well known SCA brands on the Swedish market are Edet, Tork, Libresse, Tena and Libero. SCA also develops dispensers to many of their paper products, figure 1 below shows three dispenser for paper towels.<sup>2</sup>



**Figure 1. SCA Paper towel dispensers.**

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<sup>1</sup> [www.sca.se](http://www.sca.se) SCA 2005-05-02

<sup>2</sup> Ibid.

## 1.7 Competitors

SCA's main competitors are Kimberly Clark, Georgia Pacific, Hagleitner and Metsä Tissue. All of which produce a wide variety of paper tissue products and dispensers for different applications.

AFH, Away From Home, market shares is shown in table 1<sup>3</sup>:

	Europe	North America
	%	%
<b>SCA</b>	17	22
<b>Kimberly-Clark</b>	17	23
<b>Georgia-Pacific</b>	12	37

Table 1. SCA's AFH market shares.

### 1.7.1 Kimberly Clark<sup>4</sup>

Kimberly Clark is located in USA and organized into three global segments, Consumer Tissue, Personal Care and Business-to-Business. Their products are sold in more than 150 countries with manufacturing facilities in 37 countries and more than 62,000 employees. Figure 2 below shows three of Kimberly Clark's competing paper dispensers.



Figure 2. Paper dispensers from Kimberly Clark.

<sup>3</sup> [www.sca.se](http://www.sca.se) SCA 2005-12-04

<sup>4</sup> [www.kimberly-clark.com](http://www.kimberly-clark.com) Kimberly Clark 2005-12-04

## 1.7.2 Georgia Pacific<sup>5</sup>

Georgia Pacific is based in the United States and is one of the worlds leading manufactures and distributors of tissue, pulp, paper, packaging, building products and related chemicals. They have more than 55,000 employees at 300 facilities in the United States, Canada and 11 other countries. Georgia Pacific's Away-From-Home Products consist of paper towels, napkins and liquid soap. Figure 3 shows four of Georgia Pacific's competing paper dispensers.



Figure 3. Paper dispensers from Georgia Pacific.

## 1.7.3 Hagleitner<sup>6</sup>

Hagleitner is located in Germany. With approximately 600 articles in 6 different product groups several demands in the area of professional hygiene are covered, such as washrooms with the LUNA Dispenser System, sanitary hygiene, kitchen hygiene, laundry hygiene, floor hygiene and care as well as all purpose hygiene. In total approximately 350 employees are employed with Hagleitner today. Figure 4 below shows two of Hagleitner's competing paper dispensers.

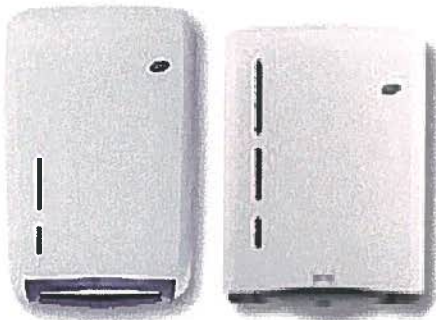


Figure 4. Paper dispensers from Hagleitner.

<sup>5</sup> www.gp.com Georgia Pacific 2005-12-04

<sup>6</sup> www.hagleitner.at Hagleitner 2005-12-04

### 1.7.4 Metsä Tissue<sup>7</sup>

Metsä Tissue is located in Finland and the producer of Katrin products and one of Europe's largest suppliers of soft paper for private households and large scale consumers. Other Metsä Tissue brands are Lambi, Serla, Leni, Saga and Fasana. Sales in 2004 amounted 685 million Euros, with mills in Germany, Finland, Sweden and Polen, with 3000 employees. Figure 5 below shows four of Katrin's competing paper dispensers.

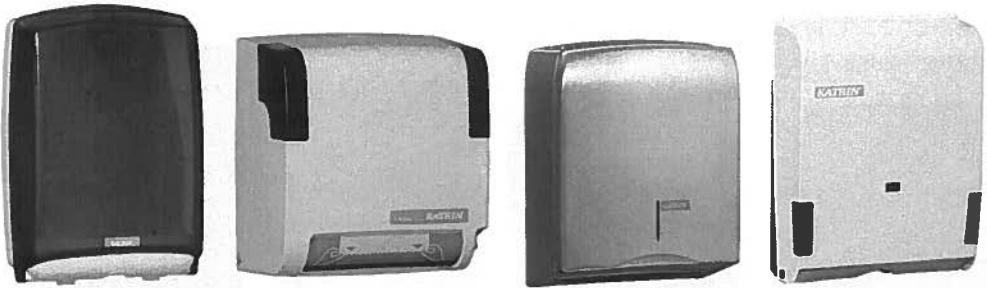


Figure 5. Paper dispensers from Katrin.

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<sup>7</sup> [www.katrin.com](http://www.katrin.com) Metsä Tissue 2005-12-04

## ***1.8 Swedish cleaning companies using SCA products***

### **1.8.1 ISS Facility Services AB**

ISS is one of Sweden's largest service companies with over 10.000 employees and more than 10.000 customers. ISS Facilities Services AB is part of the international service company ISS A/S in Denmark. Last year the company's turnover was 3.7 milliards SEK.<sup>8</sup>

### **1.8.2 Sodexho**

Sodexho is a service company with 8.000 employees, providing service solutions tailored to the needs of customers in office, industry, and the public sector by combining various service functions, such as food, cleaning, and janitorial services. The company's turnover last year was 2.6 millions SEK.<sup>9</sup>

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<sup>8</sup> [www.se.issworld.com](http://www.se.issworld.com) ISS 2005-09-01

<sup>9</sup> [www.sodexho-se.com](http://www.sodexho-se.com) Sodexho 2005-09-01



## 2 Method

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*This chapter describes how the purpose of this master thesis is fulfilled. Different research approaches are described and how to ensure a trustworthy data collection.*

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### 2.1 Approach

Knowledge in methodology is not an objective in itself, but should be seen as a tool used to achieve the goal for the study. A method is necessary to achieve a more accurate understanding in the investigated area.<sup>10</sup>

Depending on what information we are looking for, it is common to speak about two different methods, quantitative and qualitative methods. Quantitative studies are based on data, like statistics, and use systematic observations to describe a situation. Qualitative studies have focus on a deeper comprehension, and are based on participating observations and interviews.<sup>11</sup>

Both studies have the fundamental similarity of having the same purpose. They both focus on greater understanding of the society we live in and how different people and groups act and influence each other. In order to choose between the two studies it is easiest to examine the problem statement and see which study seems to be the most appropriate.<sup>12</sup>

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<sup>10</sup> Holme I. M., Solvang B. K., (1997) *Forskningsmetodik*, Studentlitteratur Lund, page 11

<sup>11</sup> Ibid. page 13

<sup>12</sup> Ibid. page 77

## 2.2 Implementation

We have chosen to use qualitative studies (see figure 6) since it provides us with greater understanding and important influences for the assignment.

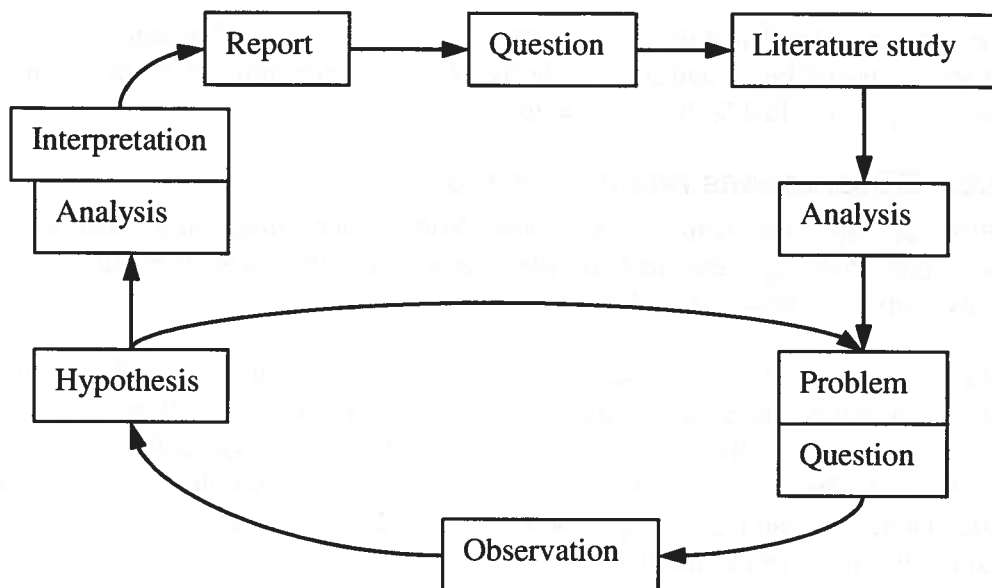


Figure 6. The qualitative study process.<sup>13</sup>

### 2.2.1 Problem statement

Before the assignment can commence it is important to determine and state the problem.<sup>14</sup> During the assignment minor changes of the problem statement have been made, due to new problems and unexpected issues being brought to light.

### 2.2.2 Literature

The most common way of collecting data is from books, articles and reports. Books are usually a compilation of knowledge in the specific area. The latest findings can easiest be found in articles, reports and periodicals, since books require more time before being published.<sup>15</sup>

A lot can be won by investigating what sources are available. A source is a historical document and reflects the knowledge and opinions of that time. It is

<sup>13</sup> Backman J., (1998) *Rapporter och uppsatser*, Studentlitteratur Lund, page 50

<sup>14</sup> Patel R., (1994) *Forskningsmetodikens grunder*, Studentlitteratur Lund, page 31

<sup>15</sup> Ibid. page 33

important to define what type of source we come in contact with. If the source is real or fake, a primary or secondary source, confidential or public? The different categories usually overlap each other, but the types of source have great influence on the interpretation we make.<sup>16</sup>

The literature used in this thesis comes from libraries, the Internet, and data bases. Studying benchmarking made by SCA and competitors' product range has also given valuable information to our work.

### **2.2.3 Observations and interviews**

Most of our empirical results come from observations and interviews. Studying cleaning personnel in their work and the customers using the dispensers have been a valuable source for our work.

Observations can be done open or hidden. Open observations entails that the observed people are aware of the survey and that their work will be used as a reference. Hidden observations are the opposite, where no contact will be made with the actors.<sup>17</sup> Throughout this assignment we have used open observations of the cleaning personnel and hidden observations of consumers using dispensers in the washrooms.

For an accurate result to be received from the interviews it is of great importance to get in contact with the right target group for the survey. The interviews should be made systematically on the basis of formulated criteria that are theoretical and strategically defined.<sup>18</sup>

The majority of our collected information comes from persons that work in direct contact with the products in the washrooms. We have also interviewed people in other positions in the organizations such as supervisors and managers, to ensure correct value on different data. These two different information sources are called respond- and informative interviews.<sup>19</sup>

We have used a qualitative method for our interviews to ensure that the target group would get time to express the opinions.

## **2.3 Validity and Reliability**

It is not easy to transfer theoretical ideas in terms of concepts and models to empirical observations. Two important notions in this context are validity and reliability. Validity can be seen as how the terms of the model agree with

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<sup>16</sup> Holme I. M., Solvang B. K. (1997), *Forskningsmetodik*, Studentlitteratur Lund, page 138

<sup>17</sup> Ibid. page 111

<sup>18</sup> Ibid. page 101

<sup>19</sup> Ibid. page 104

operational definitions of it. It can also be seen as how a measured value from using an operational definition agrees with reality. Reliability means that the measured result is stable, that the same result will occur if the test is redone.<sup>20</sup>

The used data for the report can either be already existing data (secondary data) or data that has been collected firsthand for the assignment (primary data). These two types of data need to be evaluated and both have advantages and disadvantages. In the early stage of the working progress it is easiest and cheapest to use already existing data compared to collect it yourself.<sup>21</sup> Not only is it important to be sure to study what we intend to look into, that we have good validity. It is also important to do it in a reliable way, that we have good reliability.<sup>22</sup>

## **2.4 Analysis**

During this phase all the collected data has to be organized and evaluated. In our analysis we have used information both from theory- and empirical studies. The analysis chapter will begin with determining customer needs, a typical washroom and the target group. With this as a base we can develop different dispenser models and solutions for excluding competitors' paper from being refilled in the dispenser. These models will then be evaluated on the basis of the demands we have set up, and result in a final dispenser solution.

## **2.5 Report**

The thesis is written in conjunction with the research and development. Changes and recalculation of the paper consuming have been done in the report along the working progress, as new more accurate data and confirmation have been given.

The report will be concluded with a discussion about the research and the result, and how well it matches the used theory. We also give suggestions regarding continued studies, for those parts that need further research before it can enter the production stage. We have strived for a high reliability in this project, so figures and results may be used in future studies.

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<sup>20</sup> Wiedersheim-Paul F., Eriksson L.T., (1991) *Att utreda, forska och rapportera*, Liber-Hermods, page 28

<sup>21</sup> Ibid, page 76

<sup>22</sup> Patel R., (1994) *Forskningsmetodikens grunder*, Studentlitteratur Lund, page 85

## 3 Frame of reference

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*This chapter presents the theory for the design science used in the work.*

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### 3.1 Product planning<sup>23</sup>

In order to launch a new product it is important to have a well thought out plan. There are many factors which need to be taken into consideration when choosing to develop a new product. Strategic expansions with a new product to strengthen the company's positions on the market, or improvements on older products to better meet the consumer needs are examples of such factors. Company resources play an important role in the planning. To know when to start the product development project and get the timing of market introduction right is of great importance. Different development opportunities are identified by many sources, including suggestions from marketing, research, customers, current product development teams and benchmarking of competitors. Other ways to actively generate opportunities are for example:

- Go through complaints from current customers.
- Interview lead users.
- Try to foresee changes in trends and lifestyles.
- Study competitors.
- Keep an eye on new emerging technologies.

### 3.2 Identifying customers needs<sup>24</sup>

Knowing what the consumer wants is very important for successful product development and should be a common understanding in the development team. If the team succeeds in doing so it is easier to find latent, hidden as well as explicit needs and to ensure that no critical consumer needs are forgotten. To achieve this it is important to create a high-quality information channel that runs directly between customers in the targeted marketing area and the developers of the product. The whole team should interact with the consumers and experience the user environment of the product to reach optimal result. Using a structured approach with a well organized method is preferable in order to avoid mistakes and to ensure that no needs are being left out.

- Gather raw data from customers
- Interpret the raw data in terms of customer needs
- Organize and grade the needs
- Reflect on the process

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<sup>23</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 35.

<sup>24</sup> Ibid. page 59

### 3.2.1 Gather raw data from customers<sup>25</sup>

When gathering raw data from consumers, there are three methods commonly used to ensure a high quality information channel.

1. **Interviews:** Members from the development team discuss the product and ask the consumers questions.
2. **Focus groups:** A group of 8-12 customers and a moderator discuss the product and its needs. The dialog is not only just between the moderator and the consumers but also among the consumers themselves.
3. **Observing the product in use:** Watching consumers use an existing product can reveal important details about needs. Items which will not come up in interviews can be brought to light when observing the product being used in its right environment. The observations may be completely passive, without any direct interaction with the consumer, or members of the development team may interrupt with questions or even go so far as to work side by side with the consumers to get a first hand experience of the product.

When talking to the consumers, collecting all the different needs, it is important that the interviewer does not try to convince the customer of what he or she needs. The consumer should show how he uses the product and be encouraged to express his thoughts and critique for the product. It is important to be flexible and alert for surprises and expression of latent needs and not to be influenced by preconceived hypotheses of the product.

It is also possible to use written surveys to gather data. This method is not recommended in an early stage of the development process but can work as a good complement at a later stage. Written surveys are generally ineffective in revealing unanticipated needs and do not provide enough information about the use environment of the product.

### 3.2.2 Interpret the raw data in terms of customer needs<sup>26</sup>

After gathering the raw data, all the consumer statements must be reinterpreted in terms of consumer needs. In this step it is important that the needs are as specific as stated in the raw data, this to avoid any loss of information. During the interpretation of the consumer statement it is also important that they are not translated into solutions or to any implementation approach to solve the

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<sup>25</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 63

<sup>26</sup> Ibid. page 69

statement. That would be to go one step ahead and there is a risk of limiting the continued work. The needs should be phrased in a positive way. Words like “must” and “should” ought to be avoided, because those words imply a level of importance of the need.

### **3.2.3 Organize and grade the needs<sup>27</sup>**

To get a better overview of the needs they are sorted into groups. The needs are classified in primary and secondary groups and redundant statements eliminated. If there are many needs it can be necessary to sort them in different subgroups to keep a clear overview of them. When that is done the development team must grade the importance of the needs. Either the team can grade them themselves or go back to the consumers for another survey.

### **3.2.4 Reflect on the process<sup>28</sup>**

The final step is to reflect on the result. Evaluate if the image of the consumer needs are satisfied by the research done or if certain aspects have to be redone. Perhaps some important consumer type has been missed in our market. It is also time to think about how the assignment has progressed and if there is something to improve until the next time.

## **3.3 Product specifications<sup>29</sup>**

Product specifications describe what the product has to do in measurable parameters. It is a translation from generally expressed consumer needs to something the development team can aim to achieve. Customer statement such as “the dispenser can be refilled quickly” can be translated to the corresponding specification “the average time to refill the dispenser is less than 60 seconds. Then the development team has something concrete to aim for. Sometimes the target specifications can not be reached, since they have been set at an early stage, before all problems and constraints were known and could influence the assignment. The target specification represents the hopes and aspirations of the team. If it is not possible to reach the specifications, often hard trade-offs have to be made before the final specifications can be set.

A target specification requires that a list is made of metrics extracted from the customer needs. Gathering information of the competitors’ product range, so called benchmarking, should be performed to get an idea of the market situation. Two values for every parameter should be set, one ideal and one marginally acceptable target value. But it is not always possible to translate

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<sup>27</sup> Ibid. page 70

<sup>28</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 75

<sup>29</sup> Ibid. page 79

customer needs into a measurable parameter value. It is perhaps easy for “total mass” or “total height” but when it comes to statements such as “the design instills cleanliness” it becomes increasingly difficult. This is a subjective value and hard to set a measurable value on but should be kept in the specification list since it can be an important factor not to be neglected. With the final target specifications set it is time to move on to the next step in the product development process.

### ***3.4 Concept generation***<sup>30</sup>

A product concept is an approximate description of the products essential features equivalent to working principals, form, size and what technology is going to be used. A sketch with a short explaining text is enough to describe the concept in this stage. Concept generation begins with identifying consumer needs and setting target specifications. In this stage it is important not to discard any concept too quickly or focus just on a few concepts. With a large variety of suggestions it is more probable that all alternatives have been explored. Concept generation is a creative process and needs an open mind but the process can although benefit from using a structured method. A structured method reduces the chance of oversight of the considered concepts and guides less experienced team members to more effective concept generation.

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<sup>30</sup> Ibid. page 107



### 3.4.1 Concept generation method<sup>31</sup>

The five-step method, shown in figure 7, is a way of making the concept generation systematic and make sure that no important steps are forgotten. The method breaks up complex problems into simpler sub problems, and by using different search procedures solutions for the many sub problems are identified. The different identified solutions for the sub problems are then systematically combined to find a final solution.

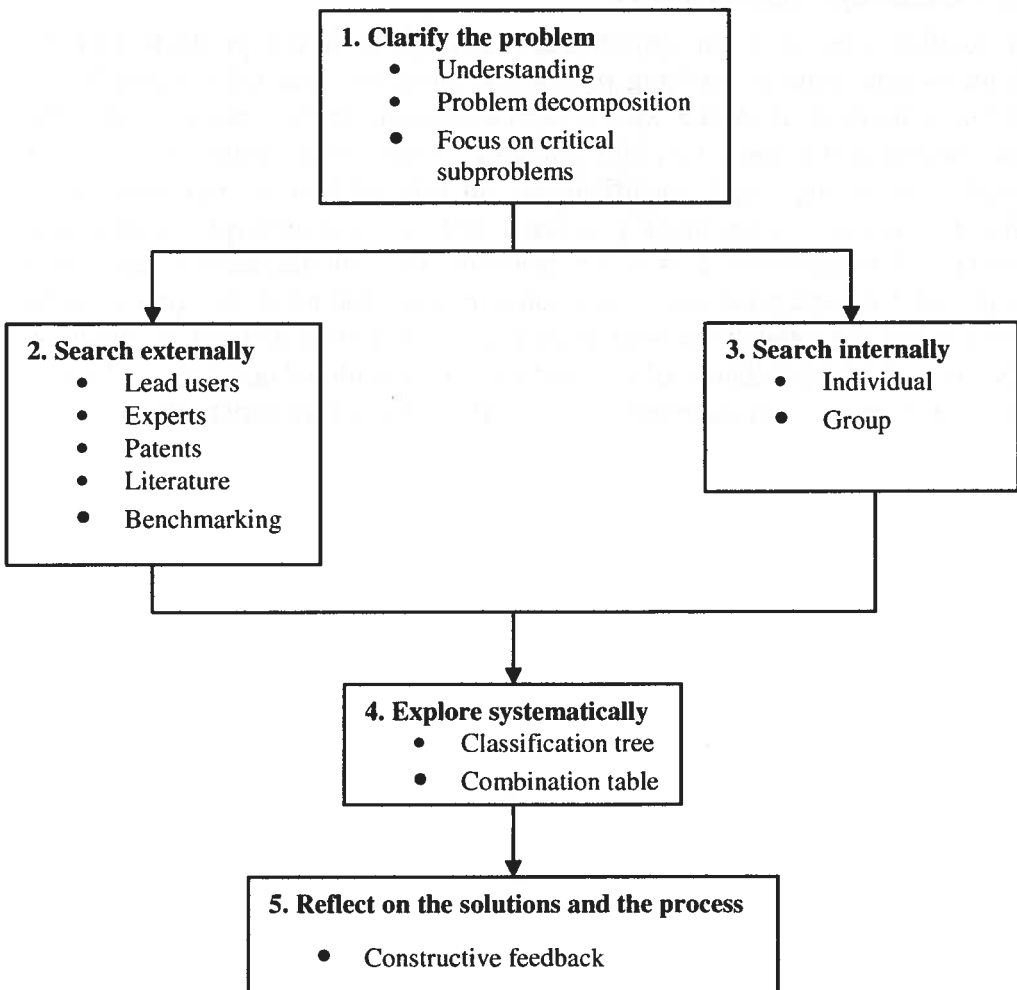


Figure 7. The five step concept generation method.<sup>32</sup>

<sup>31</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 109

<sup>32</sup> Ibid. page 110

- 1. Clarify the problem:** To break down a complex problem into simpler sub problems is very useful because many design challenges are too hard to solve as a single problem. When the problem is divided into simpler parts the overall understanding of the problem clarifies and it is easier to focus on the critical areas. Though if the product is very simple it may not always be useful to break down into sub problems.
- 2. External search:** To look at already existing solutions is a good way to start. It both saves time and gives inspiration and ideas to own solutions. Using already existing solutions on many of the sub problems gives the team more energy to focus on the critical ones. There are many places to look for already existing solutions, for example at lead users in the field. They usually experience consumer needs months or even years before the majority. Other ways to gather information is to search the different patent databases. It is good to go through these patent databases, both for getting inspiration and to see concepts that are already protected. The protected concepts should be avoided or need a license. To read published literature like magazines, consumer reports, conference proceedings, journals or market reports can be very helpful. Consult experts with knowledge of the sub problems is another way to find solutions to the different problems.
- 3. Internal search:** Internal search is when the team members use their experience and creativity to generate solution concepts. Here it is important to generate many ideas, not only to explore the solution space, but every idea also acts as a stimulus for other ideas. In this stage no criticism of other team member's ideas are allowed. Suggesting improvements or coming up with alternative concepts is then to prefer.
- 4. Systematic exploration:** This means the organization and synthesizing of all the generated solutions. By combining these solution fragments the final concepts appear.
- 5. Reflect on the solutions:** The final step is to reflect on the result. Time to go through if the solution space has been fully explored. Is the developing team satisfied with what they have come up with?

### 3.5 Concept selection<sup>33</sup>

Concept selection is an integral part of the entire product development process. It is the process of evaluating concepts with respect to customer needs and other criteria, and selecting one or more for further investigation. There are many ways when choosing a concept, and although instinct and intuition often works, it should be used together with a structured method. Some different methods are listed below.

- **Decision matrix:** The team rates and weights each concept against a pre-specified selection criterion.
- **Prototype and test:** Prototypes of each concept are built and tested. The selection is then based upon the test data.
- **Multi-voting:** The team members vote to select the winning concept.
- **Advantages and disadvantages:** Strengths and weaknesses of each concept are listed. The choice is then based upon group opinion.
- **Intuition:** The concept is chosen by feel. The concept just seems better.
- **Product champion:** A leading member of the development team chooses the concept he or she believes in the most.
- **External decision:** The decision is not made within the developing team. The selection is turned over to the customer, client or other external entity.

#### 3.5.1 Decision matrix<sup>34</sup>

The decision matrix method can be performed in one or two steps. If the product is not very complex or there are only a few concepts it is often enough with just one step. The first step, screening, is a quick, approximate evaluation method aimed at producing a few viable alternatives. This step may suffice if the design is simple. For a more complex design the concept scoring method is to prefer. The approach used by both concept screening and concept scoring is very similar. Both methods follow the same six-step process in the selection activity. The steps are:

1. Prepare the selection matrix.
2. Rate the concepts.
3. Rank the concepts.
4. Combine and improve the concepts.
5. Select one or more concepts.
6. Reflect on the result and on the process.

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<sup>33</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 137

<sup>34</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 143

### 3.5.2 Concept screening<sup>35</sup>

Concept screening is the first step in concept selection. The purpose here is to quickly narrow the number of concepts and to improve them if possible. First, prepare the selection matrix by choosing selection criteria and arrange a table like table 2 below.

Selection Criteria	Concepts						
	A Reference	B	C	D	E	F	G
Criteria 1	0	0	+	0	-	0	0
Criteria 2	0	+	+	0	0	0	0
Criteria 3	0	0	0	0	-	+	+
Criteria 4	0	-	0	-	+	-	-
Criteria 5	0	-	-	-	+	0	0
Criteria 6	0	0	+	+	0	0	0
Criteria 7	0	-	0	0	0	+	0
Sum +'s	0	1	3	1	2	2	1
Sum 0's	7	3	4	4	3	5	5
Sum -'s	0	3	1	2	2	1	1
Net Score	0	-2	2	-1	0	1	0
Rank	3	7	1	6	3	2	3
Continue ?	Revise	No	Yes	No	Combine	Yes	Combine

**Table 2. Concept screening matrix. The concepts marked with yes goes on to the concept scoring for the final decision.**

Choose a reference concept and judge the other concepts with plus or minus whether they are better or worse than the reference. Sum up the result and rank the concepts. In table 2 there are three concepts that finish with the same score. In this example perhaps concept E and G can be combined? Use the advantages from each concept if possible, making a new one that goes on to the next step.

<sup>35</sup> Ibid. page 144

### 3.5.3 Concept scoring<sup>36</sup>

With just a few concepts left it is time to decide which concept to develop. Using the concept scoring method the resolution increases and it is easier to differentiate the remaining concepts. The procedure is similar to the concept screening method. The main difference is that the selection criteria is weighed in relative importance and then rated with a grade from one to five. Table 3 shows a concept scoring matrix. Concept scoring is more thorough and requires more time.

		Concepts					
		C		EG		F	
Selection Criteria	Weight	Rating	Weight score	Rating	Weight score	Rating	Weight score
Criteria 1	25%	4	1	2	0,5	2	0,5
Criteria 2	20%	5	1	3	0,6	3	0,6
Criteria 3	15%	3	0,45	4	0,6	4	0,6
Criteria 4	15%	2	0,3	4	0,6	3	0,45
Criteria 5	10%	1	0,1	5	0,5	3	0,3
Criteria 6	10%	4	0,4	2	0,2	2	0,2
Criteria 7	5%	3	0,15	3	0,15	5	0,25
	Total Score	3,4		3,15		2,9	
	Rank	1		2		3	
	Continue?	Develop		No		No	

**Table 3. Concept scoring matrix. In this example concept C got the highest grade and will be further developed.**

<sup>36</sup> Ulrich Karl T., Eppinger Steven D., (2000) *Product Design and development*, McGraw-Hill, page 148

### 3.6 Design sciences

#### 3.6.1 Requirements on the design

The requirements that are being used when developing a product are usually formulated by the company on the basis of demands and desires by their customers around the world. Also the company brand is an important factor in the process of deciding the design.

The life of the product can give an overview of where the demands and desires come from, see figure 8. All phases in the products life together create these requirements and the final product represents a balance between all of them.

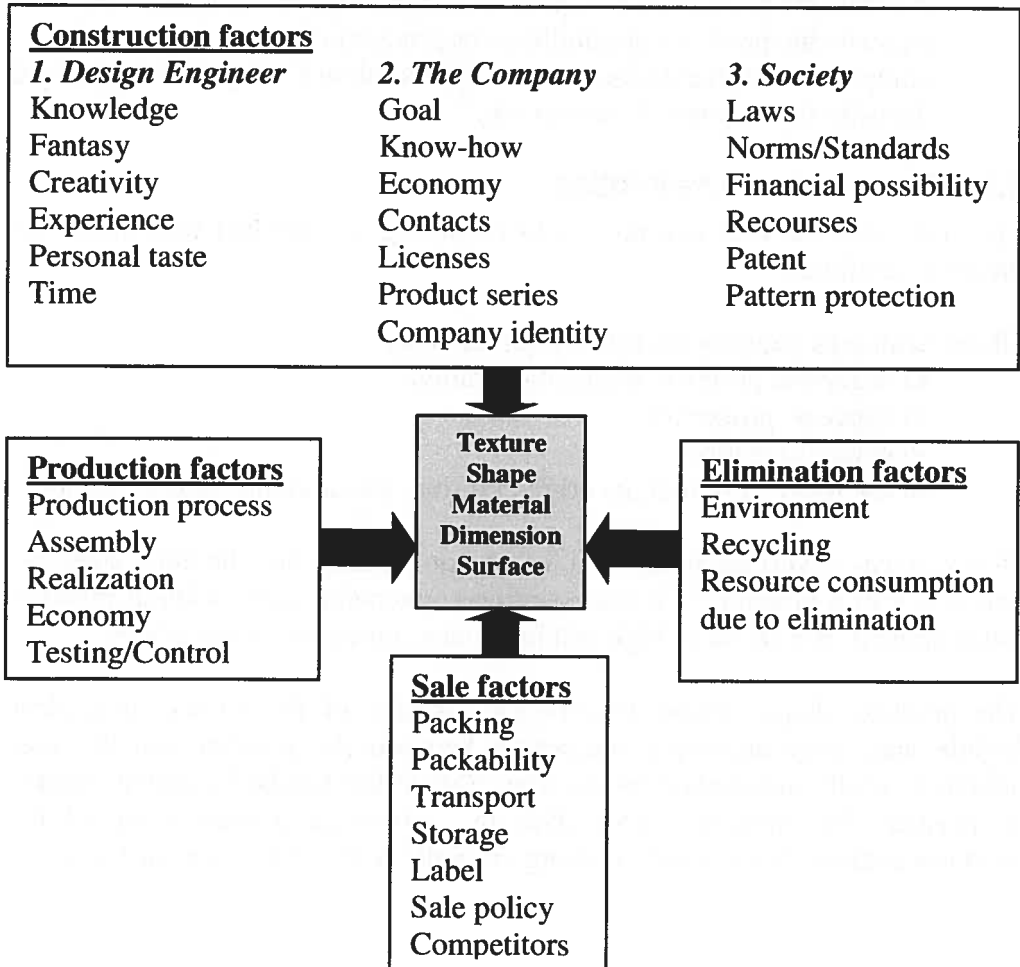


Figure 8. Overview of product factors.<sup>37</sup>

<sup>37</sup> Hamrin Åsa, Nyberg Malin, (1994) *Kompendium Huvudkurs i Produktutformning*, Hlu, page 110

### 3.6.2 Study of product needs

During the first stage between customer needs and determining the product type in the developing process, the following tasks have to be performed:

Throughout the first stage between the needs to determining the developed product type, the following tasks have to be performed and interacted around:

- decision and description of requirement area
- research of the requirements size, composition and magnitude
- demands and criteria for the solution
- accomplish and establish overview and accounts over product types
- estimate technical possibilities for the product
- estimate the products consequences and possibilities in the market
- estimate the products possibilities for production
- compile recommendations and basis for choice of product type and decision for its possible realization.<sup>38</sup>

### 3.6.3 The products semiotics

The signs that the user perceive from observing the product tells about the products semiotics.

Object semiotics requires the following functions:

**to describe:** purpose, mode of operation

**to express:** properties

**to exhort:** reactions

**to identify:** a product, its origin, kinship, location, nature or category<sup>39</sup>

How can we convert the words in a list of requirements into the lines, surfaces, and colors of a product? We make similar conversions daily without thinking twice about it. We speak of high and low tones, strong and weak colors.<sup>40</sup>

The products shape should describe the function of the product in a clear legible way. Any necessary interaction between the product and the user should be easily understood by the user. Should the handle be pulled, pushed or twisted? The semiotics also gives the viewer an understanding of the products qualities for example inviting, friendly, heavy, expensive or fragile.

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<sup>38</sup> Hamrin Åsa, Nyberg Malin, (1993) *Kompendium Funktion och Form*, Hlu, page 73

<sup>39</sup> Rune Monö, (1997) *Design for Product Understanding*, Liber, page 81

<sup>40</sup> Ibid. page 80

## **3.7 Models<sup>41</sup>**

There are different model types used at presentations to better describe a product. The two main types are mock-ups and prototypes. Mock-ups are divided into two sub types; block model and functional model.

### **3.7.1 Mock-up**

Mock-up is a simple full-scale model of a product or a whole work space and made out of cheap material that are easy to work with.

#### **3.7.1.1 Block model**

In order to get a complete understanding of the look of the product, it is sometimes necessary to make a three dimensional model. The block model does not show the function of the product and is usually made out of paper, foam or wood. This model is good primarily for early testing for ergonomics, usability and form. The actual measurement on the final product should agree with the model.

#### **3.7.1.2 Functional model**

A functional model is also a three dimensional model, and gives the viewer both an idea of the look as well as the function of the product. All controls and levers should appear to work as on the final product, but are made with a simpler design. This model is good when evaluating reliability, durability, performance and failure.

### **3.7.2 Prototype**

A prototype is fully functional full scale model made out of the same material as the final product. It has the same look and function as the final product. The only difference between the prototype and the product is the way it has been manufactured, since the product usually will be mass-produced and the prototype only comes in one or a few copies.

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<sup>41</sup> Hamrin Åsa, Nyberg Malin, (1994) *Kompendium Huvudkurs i Produktutformning*, Hlu, page 171



## 4 Empirical study

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*This chapter contains information collected from field observations that were made in Sweden, Denmark, Germany and England.*

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### 4.1 Arlanda airport

Arlanda airport is located in Stockholm and has four terminals and serves 67 airlines. During 2004 16.3 million people traveled through Arlanda. Two out of three traveled on international flights.<sup>42</sup>

ISS Facility Services is responsible for the washroom- and janitorial service at Arlanda. Luftfarsverket decide what products are assembled in each washroom. They are also in charge of deciding what paper, soaps etcetera. are going to be used in the airport. ISS can make suggestions and requests about what they think is best, but in the end it is Luftfartsverket that decides what to do.

#### 4.1.1 Arlanda airport washrooms

The washrooms at Arlanda airport differ prominently from each other. There are washrooms with hot air dryers and washrooms with expensive designed dispensers. There are also washrooms with a mixture of brands. Expensive dispensers from d-line were used in some washrooms, resulting in a quite luxurious touch to the washroom. The toilet stalls were more like rooms with proper doors. In the newer parts of the airport, where the more exclusive dispensers are, it is obviously that Luftfartsverket have aimed for an exclusive image in the washroom.

Some of our own reflections from the visit to Arlanda were that it was common that inferior paper sort, mugs and soap were being used in the different dispensers. Since Luftfartsverket is responsible for the purchase they should be responsible for making sure that intended products for each dispenser is available for the cleaning personnel.

#### Sky City

In the ladies washroom there were three toilets in total. Every toilet stall had one wash basin and one dispenser. In the common ladies area there were three wash basin, two dispensers and one hot air dryer. In total, there were five paper towel dispensers in the ladies room. According to our guide (an ISS team leader) every dispenser was in average filled up with 0.5-1 bundle every hour. This would mean that during one eight hour shift 20-40 bundles would be consumed. The towels they used in this washroom were Tork Xpress Plus.

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<sup>42</sup> [www.lfv.se](http://www.lfv.se) Luftfartsverket 2005-05-10

## **Terminal 4**

In the ladies washroom (see figure 9) there were five toilet stalls with one wash basin and dispenser in each stall. In the common ladies area there were five wash basins and four dispensers. Totally there were nine paper towel dispensers. According to our guide (an ISS team leader) every dispenser were filled up in average with 0.5-1 bundle every hour in this washroom as well. This would mean that during one eight hour shift 36-72 bundles would be consumed. The towels they used in this washroom were Tork Xpress Comfort.



**Figure 9. Ladies washroom in Terminal 4 at Arlanda airport.**

## **Work routine**

The cleaning crew work 8 hour shifts. Every washroom is checked every hour. This is to assure that the washrooms are kept fresh looking, even though the dispensers do not need to be refilled. When the washrooms have been checked the personnel put their signature on a list in the washroom showing that they have been there. During holidays and vacation, when traffic may increase, the refilling frequency can be as much as nine times during a shift.

## **Field study**

During a 30 minute observation outside one of the washrooms in terminal 4 during peak hours, we counted the number of visitors to 50 in the men's room and 23 in the ladies room.

### **4.1.2 Feedback from the personnel**

Some important comments from the personnel concerning the handling of the paper and the dispensers were:

- The paper bundle itself was not difficult to open, but there were problems with the pile overturning when the personnel opened the dispenser. If the pile is just slightly imbalanced, caused by the paper being crumpled in the bundle ends, it will tip over.
- The dispensers were often installed high up on the wall. Short personnel have difficulties when refilling these dispensers and they sometimes even have problems reaching the lock on the lid.
- The locks break easily. Injuries have occurred when metal lids have fallen out and hit the person standing next to it.
- The stainless steel fronts on some of the more exclusive dispensers were difficult to keep clean and free of water marks. The edges on the metal lids could also cause cut wounds.

## **4.2 Frankfurt**

Frankfurt airport is one of the world's largest international airports with over 50 million passengers and nearly 460.000 flights per year. Including the taxi staffs and people waiting to pick up an arriving passenger, the total number of visitors is estimated to 155 million people a year. That is 420 000 people per day. Frankfurt airport is owned and operated by Flughafen Frankfurt/Main AG.<sup>43</sup>

The airport chooses what sort of paper, soap and dispenser used at the airport washrooms. GCS, Gesellschaft für Cleaning Services, is then responsible of purchasing these products, although they can present their own wishes to the decision makers.

GCS wishes to have a refill for paper towels, instead of the lose bundles that they use today. The refill should hold a lot more paper than what can be fitted into the present dispensers. This would save a lot of time on this sub operation. The company also wishes to use the same sort of paper all over the airport, to make the handling as quick and efficient as possible.

### **4.2.1 The washrooms at Frankfurt airport**

The washrooms in Frankfurt were built to be more efficient compared to the ones in Arlanda airport. The airport also seemed more eager to keep the costs down. The paper used was among the cheapest on the market. The toilet stalls in the washroom were "real" stalls, the doors and side walls were thin wood boards which did not reach the floor or the ceiling.

#### **Terminal 1 basement:**

This washroom consisted of eleven stalls in the ladies room, and five stalls and nine urinals in the men's room. There were five wash basins, three paper towel dispensers and three waste bins in both the ladies and men's room. The paper towels were in a module, part of a complete panel, with the waste bin directly underneath. It was possible to pile four bundles of paper towels. When the dispenser was fully loaded it was difficult to pull out a towel because of the pressure. According to one of the cleaning personnel they refilled the dispenser with two bundles every half an hour. This means that during one eight hour shift 96 bundles would be consumed. The towels they used in this washroom were Tork Classic Standard ZZ.

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<sup>43</sup> [www.frankfurt-airport.de](http://www.frankfurt-airport.de) Frankfurt airport 2005-09-01

## Terminal 2

There was the same interior here as in the other washrooms (see figure 10), except for large waste bin placed on the floor next to the hand basins.



Figure 10. Washroom in terminal 2 at Frankfurt airport.

## Terminal 1 B

This washroom consisted of five stalls, four wash basins, two SCA paper dispensers and two waste bins under the dispensers (see figure 11).



Figure 11. Washroom in terminal 1 B at Frankfurt airport.

## Work routine

Between 6 a.m. and 10 p.m. the personnel checks the washrooms every half an hour. This is to assure that the washrooms is kept fresh looking, even though the dispensers did not need to be refilled. During the night there is only one

single check done. When the washroom has been checked the personnel put their signature on a list in the washroom showing that they have been there. It is not the same person that checks and cleans the toilets that empty the waste bins. One person on the cleaning staff is responsible of collecting the trash bags from the washrooms. During our study we noticed that sometimes the garbage man put his signature on the cleaning personnel's checklist. On the list it looked like the toilets were checked every half an hour like it should be, but this was not the case.

### **Field study**

The washroom that was studied was Terminal 1 B.

#### Time 3.45-4.15 p.m.

Ladies 73 persons

Men 100 persons

#### Time 5.15-5.45 p.m.

Ladies 91 persons

Men 120 persons

During a 25 minute time period during peak hours the pile of paper towels were reduced by approximately one bundle; 200 towels.

### **4.3 Tivoli**

The Tivoli amusement park is located in central Copenhagen, Denmark. The park has 38 restaurants, several shops and over 20 rides. The field study was made in July during high season. During a 30 minutes study 103 ladies were counted using the washroom. There was a constant queue to the six stalls. Hot air dryers were used in the washroom and the personnel checked the washrooms every hour.

### **4.4 Malmö Stadion**

The Stadium in Malmö holds 26.500 spectators, of which 14.000 are seated. This makes Malmö Stadium Sweden's third biggest arena. The Stadium has one washroom in each seating section. In the standing section the washroom consisted of six stalls, a 15 meter long urinal, three hand basins and two paper towel dispensers. Directly below the dispenser were two waste baskets placed (see figure 12).



**Figure 12. Washroom in Malmö Stadion.**

During a football game between Malmö FF and Häcken there was 15.585 spectators present. During the 15 minute break there were 125 men in the standing section who visited the men's room.

## 4.5 Summary of collected data

Table 4 below is a summary of fieldtrips done by thesis writer at SCA.

Location	Gents [nr/h]	Ladies [nr/h]	Toilets [nr]	Time of the study
Arlanda	100	46	6	1945-2015
Frankfurt 1	200	146	5	1545-1615
Frankfurt (later)	240	182	5	1714-1744
Tivoli toilet 1	48	86	11	1330-1400
Tivoli toilet 2	170	206	7	1530-1600
The Natural History Museum	78	72	10	1005-1035
Viktoria and Albert - Museum		96	6	1105-1135
Debenham – mall	68	142	16	1940-2010
Piccadilly Circus - subway		104	24	1850-1920
Liseberg	59	96	5	2005-2035
IKEA - Göteborg	48	72	6	1400-1430
Filmstaden Göteborg		67	6	1805-1835
Landvetter	96	92	5	1050-1120
Heathrow Terminal 1 (landside)	152	136	16	1140-1210
Heathrow Terminal 2 (landside) 1	42	36	5	9.45-10.15
Heathrow Terminal 2 (landside) 2		164	10	1220-1350
Stansted Toilet 1	296	308	16	1215-1245
Stansted Toilet 2		380	12	1205-1535

**Table 4. Summary of the data collected on the field trips.**



## 5 Analysis

*In this chapter the empirical results are analyzed to discern the important aspects when choosing a final design and function for the dispenser.*

### 5.1 Analysis of the consumption

When looking at the towel consumption it is important to know which type of towel that is used. The average number of towels used per person differs depending on which towel is being used. The number of towels per bundle differs also depending on the type of towel. Table 5<sup>44</sup> below shows the amount of towels in every bundle and the average number of used towels per visit regarding a certain type.

<b>Towel name</b>	<b>Towels/ bundle</b>	<b>Towels used per visit</b>	<b>Place where used</b>
Tork Xpress Plus	136	3.09	Sky City (Arlanda)
Tork Xpress Comfort	100	2.36	Terminal 4 (Arlanda)
Tork Classic Standard ZZ	200	(3-5)	Frankfurt airport

**Table 5. Matrix over the amount of towels used per visit regarding a certain type.**

According to the personnel at Arlanda airport the towel consumption per hour in Terminal 4 was 4.5-9 bundles (450-900 towels) and in Sky City 2.5-5 bundles (340-680 towels). When we counted the people entering the washroom in Terminal 4 we counted 50 persons in 30 minutes. That is 100 people per hour and if every person uses 2.36 Xpress Comfort towels in average the consumption will be 236 towels per hour in that washroom. It is a big difference between this value of 236 towels and the value of 450-900 towels the ISS personal gave us. If the numbers the ISS staff gave us is correct the number of visitors should be around 190-380 consumers per hour. The time of the study was just before a long weekend so the amount of people in the airport was definitely not below normal. To be sure we had understood the ISS personal correctly we contacted them again, and they confirmed the numbers. Considering that the washroom only contains five toilets 190-380 persons per hour sounds a lot. Every toilet visit should not take more than 0.8-1.6 minutes then. Another source of error could be the number of towels used per visit. But these figures are from a survey made by SCA and are rather reliable.

<sup>44</sup> Figures are from SCA survey made in the SCA headquarter building in Göteborg.

According to the personnel at Frankfurt airport the towel consumption was 12 bundles per hour in Terminal 1 basement. The number of towels used per hour is then 2400 towels. The washroom consists of five toilets and nine urinals. The average number of towels used per person is not really known with this type of towel. It is above three and probably not more than five. Here we will calculate with four towels per person. This means that at least 600 persons visit the washroom during one hour and is definitely a too high figure.

We can see the same pattern here as we did at Arlanda and that is that the cleaning personnel have a tendency to exaggerate the towel consumption. When we measured the paper consumption we got a value of four bundles per hour. We measured the paper consumption during peak hours by watching the pile sink so this number is reliable. This gives us a consumption of 800 towels and around 200 people visiting the washroom during one hour. This value corresponds well to the number of consumer we counted in our survey.

## 5.2 Customers needs

After several fieldtrips interviewing the cleaning personnel, team leaders and managers, we started to get a full picture of the needs. The following customer statements were brought up during the interviews. In table 6 below the raw customer statement and the interpreted needs are listed. The interpreted needs are rewritings of customers' statements to better understand what the customers mean. The needs are a good starting point in the concept generation process and works later as a base in the selection phase to be able to grade the concepts.

Question/Prompt	Customer statement	Interpreted need
Typical uses	You have to be careful so you do not drop all the towels when you open the banderol.	<i>The handling of the paper towels need to go smoothly when opening the bundle.</i>
	To store extra bundles beside the dispenser which the consumers themselves are going to fill when the dispenser is empty does not work	<i>Storing extra bundles beside the dispenser is not desirable.</i>
	The bundles can be difficult to pile if they are lumpy in the ends.	<i>The dispenser ought to be designed to be easy to refill so the bundles lies steady and do not fall out.</i>
	I want the dispenser to be fast to refill so I can save time on that work element.	<i>The dispenser can quickly be refilled.</i>
	The cardboard box is difficult to open. The old box that was glued together was better. On this one you have to use a knife to get it opened.	<i>The box needs to be easy and fast to open.</i>

<b>Likes-current dispensers</b>	It is good with a see-through window so you can see the paper level.	<i>It ought to be possible to read the paper level without opening the dispenser.</i>
	It is good when the lock is placed on the side, because then short people can reach it.	<i>Easy to reach the lock even for a short person</i>
	It is good when the dispenser can be opened like a regular door. Then it is easy to reach and fill the dispenser.	<i>It ought to be easy to reach the dispenser when refilling.</i>
<b>Dislikes-current dispensers</b>	Some dispensers are difficult to open and close.	<i>The lock on the dispensers needs to be easy to open and close.</i>
	It gets heavy to pull out the towel if the dispenser is filled to the top. Especially if a couple of extra towels is wedge in.	<i>It ought to be easy to get the towel out at all times.</i>
	The dispensers that open towards you are very difficult to refill if you are a short person. Some of the cleaning personnel have to climb up onto the wash basin or a box in order to refill the dispenser.	<i>It ought to be easy to reach the dispenser when refilling it, even for a short person.</i>

	I do not like the stainless steel dispensers because they get stained easily.	<i>The dispensers need to be easy to keep clean.</i>
	It is sometime obvious that men have installed the dispensers in the washrooms because they are placed so high up on the wall that it is difficult to reach if you are short.	<i>It ought to be easy to reach the dispenser even for a short person.</i>
<b>Suggested improvements</b>	It would be good if there were handles on the shipping box making it easier to handle.	<i>The box needs to be easy to lift and handle.</i>
	I want the same paper to be used on the whole airport making the handling easier.	<i>The same paper need to fit all the dispensers.</i>
	It would be good if we did not need to refill the dispensers so often.	<i>The dispensers need to hold lots of paper.</i>

**Table 6. List over the customer statements and the interpreted needs.**

### 5.3 Typical washroom and target group

To design a good product it is important to have a well defined picture of the target group. So what is a typical high traffic washroom? During the research many kinds of washrooms were investigated, from Filmstaden in Göteborg to Frankfurt airport in Germany. Both can perhaps be called high traffic washrooms, but the difference between them is so major that it is necessary to narrow down the target area.

The target washroom is defined as figure 13 shows, with ten toilets for the ladies and seven toilets plus a urinal for men. There are four wash basins and two waste bins and two or more dispensers depending on what dispenser model that is used. The average numbers of visitors is set to 1500-2000 persons/day. The average amount of towels used is then 3500-4700 towels/day. Data over the variation of visitors during a day at the airport was given to us by the cleaning companies at the airports. Peak hours were in the morning, at noon and in the evening. The set figures in our typical washroom are based on the given data combined with our surveys. We think this will represent a good approximation of a high traffic washroom. With a dispenser suitable for this washroom we believe that it would be a product which would work better than today's dispensers in many of the existing washrooms.

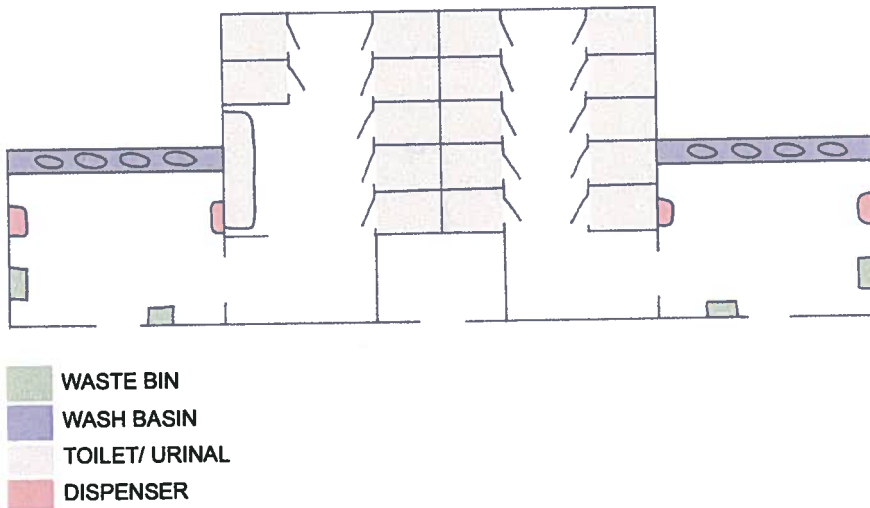


Figure 13. Target washroom.

## **5.4 Concept generation**

After the concept generation a large number of different ideas were produced. The ones we believed in the most are described below. These concepts are later going to be evaluated to find the best solution.

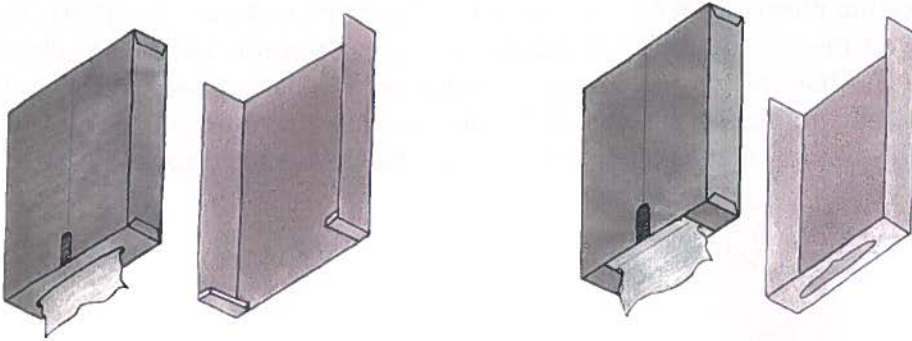
### **5.4.1 The cassette design**

By using a cassette instead of bundles, the refilling process can be done more quickly. This saves time for the cleaning personnel and makes their work less monotonous. Another great advantage with a cassette system is that it is possible to make the paper proprietary to the dispenser, meaning that only SCA's paper can be refilled in SCA's dispensers. This is highly wanted by SCA, since this guarantees that the customer does not change paper supplier and SCA has a continued sale of paper to the customer. Two of SCA's paper systems are H2 and H3. The main difference between them is the width, H3 is wider than H2. The two main alternative cassettes concepts generated in this project are one in plastic and one in cardboard. Both types come in a number of different models depending on the dispenser the cassette is going to fit in.

## 5.4.2 Cardboard cassette

The cardboard box cassette holds 2.5-6 bundles. If the box is filled with more than three bundles, there is a need for brakes to reduce the pressure. Holes in the side of the box have to be made in order for the brakes to function. In the front there is another hole showing the number of towels left in the box. Two possible designs of the dispenser have been developed and the outlet hole on the cardboard cassette differs depending on the dispensers design.

First solution, as shown to the left in figure 14, the dispenser is designed only supporting the cassette on the sides, and the box has to be designed to work like a dispenser.



**Figure 14. Cardboard cassette.**

Second solution, as shown to the right in figure 14, the outlet hole on the dispenser is formed like a normal dispenser which means that cassette does not need to have that function. The cassette should only prevent the paper from falling out of the cassette. The cardboard cassette comes delivered with perforated lines that the cleaning personnel easily tears open when loading the dispenser.



### 5.4.3 Plastic cassette

The plastic cassette is made out of a see-through plastic bag material. The cassette holds 2.5-5 bundles. If the cassette is filled with more than three bundles, holes in the side of the bag have to be made in order for the brakes to function. The concept generation process generated different solutions. The different concepts, figure 15-18, fit different dispenser designs. When delivered there is just perforated lines for the holes. This ensures the cleanness of the towels is maintained during transport without needing a secondary shipping box.

#### 5.4.3.1 Hanging plastic cassette 1

The hanging plastic cassette 1, as shown in figure 15, consists of a plastic bag filled with towels, two holes in the top for the suspension and a hard plastic disk in the bottom for the dispenser function. With the plastic disk in the bottom and with the suspension device the dispenser bottom can be a straight hole. This blocks all attempts to pile ordinary bundles in the dispenser.

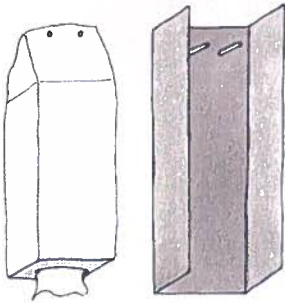


Figure 15. Hanging plastic cassette 1.

#### 5.4.3.2 Hanging plastic cassette 2

The hanging plastic cassette 2 is very similar to the previous concept. The difference is that this cassette is loaded into the dispenser from the side compared to the front, see figure 16.

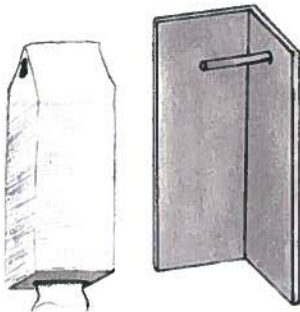


Figure 16. Hanging plastic cassette 2.

### 5.4.3.3 Standing plastic cassette 1

The standing plastic cassette 1 is also very similar to the above concepts. The difference is that the cassette does not hang in the dispenser. It stands on the dispenser bottom resting only on narrow ledges, as shown in figure 17. This results in that the hard plastic disk in the bottom of the cassette is still needed.

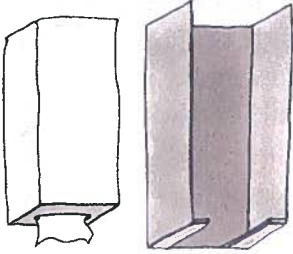


Figure 17. Standing plastic cassette 1.

### 5.4.3.4 Standing plastic cassette 2

The standing plastic cassette 2 is very similar to standing plastic cassette 1. The difference is that there is no plastic disk in the bottom of the cassette. The dispenser function is in the dispenser instead, see figure 18. This allows competitors bundle to work in the dispenser if there is no other mechanism to prevent it.

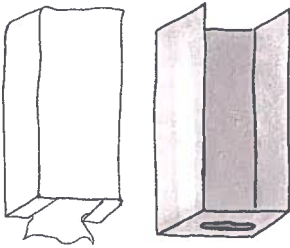


Figure 18. Standing plastic cassette 2.

#### 5.4.4 Other ways to lock the paper to our dispensers

A cardboard box cassette or a plastic cassette does not fit all our generated concepts. To still make SCA's paper proprietary to the dispensers other solutions have to be used. To change the shape on the towels is one way to solve the problem. SCA has already a patent on a towel with a shape where the short side of the towel is not perpendicular to the long side of the towel. Were the bundle normally is cut in a right angle this skewed bundle is cut with a slightly altered angle. Figure 19 shows the skewed bundle and what the towel looks like when unfolded.

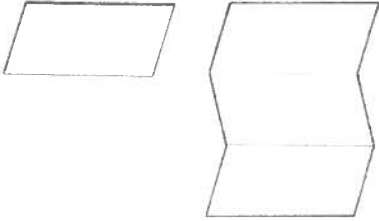


Figure 19. Skewed bundle to the left, unfolded towel to the right.

### 5.4.5 Curved dispenser

The curved dispenser as shown in figure 20 has its special shape to reduce the force acting on the bottom towel. When many bundles are piled on top of each other, the weight of the paper increases to a point where it becomes hard or even impossible to pull out the towel. With the curved shape the force on the bottom towel is reduced. The towels in the curve take some of the load off the bottom towel. The roller in the opening reduces the friction between the towel and the dispenser opening. The greater part of the friction is between the towels. Depending on which towels used, mechanical breaks might be necessary in order to reduce the force even more. With the curved shape cassettes are difficult to use so the dispenser is filled with bundles. The bundles used are skewed bundles described in the previous chapter, guaranteeing that only SCA's paper is used. The dispenser holds up to six bundles. Six bundles are a large number and the pile of paper gets rather high. This would be a problem in an ordinary dispenser because the cleaning personnel would have difficulty to reach up so high when refilling the dispenser. However, the curved dispenser can be installed lower down on the wall solving that problem for the cleaning personnel. The towels are not pulled out straight down but more at an angle towards the consumer. The consumer can still see the towel and does not have to bend down to access the towels, as they would be forced to if a normal dispenser had been installed at this height on the wall.

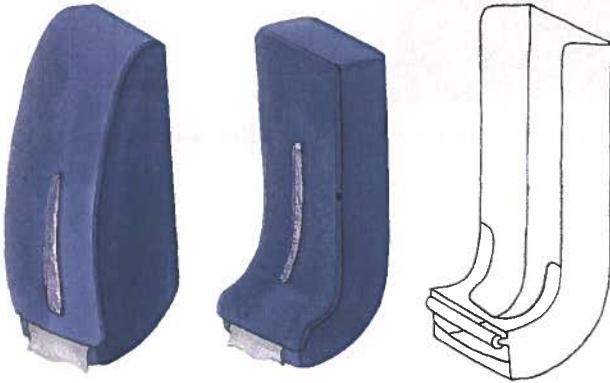
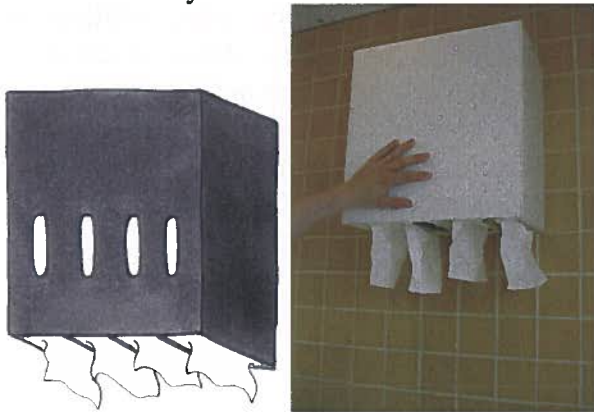


Figure 20. Curved dispenser.

### 5.4.6 Dispenser with the short side of the towel turned to the consumer

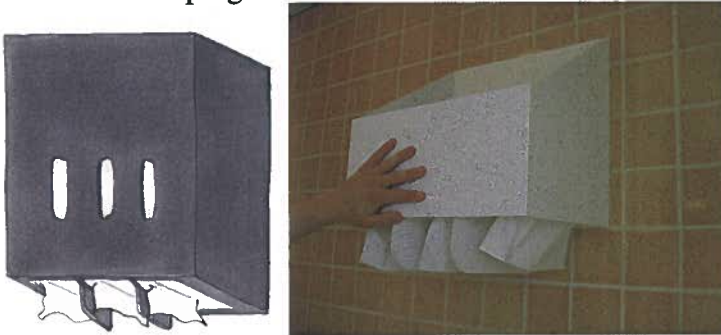
The large number of towels requires a larger sized dispenser. One way to make the dispenser larger without using so much wall space is to put the short side of the towel against the consumer. Figure 21 to the left shows the concept with the short side of the towel turned against the consumer. The dispenser holds a total of 10 bundles, four cassettes with 2.5 bundles in every pile. The towel that is used is from the H2 system with a width of nine cm. Instead of using two hands when pulling out a towel like in an ordinary dispenser, only one hand is necessary here. To be sure that it would work with only one hand, a simple mock-up was built in kapa board, shown to the right in figure 21, to simulate the situation and it showed that it worked perfectly fine using only one hand. But the test also revealed that when you grabbed one towel you also touched the neighboring towel. This is not hygienic, as no one wants to use a towel touched by someone else.



**Figure 21. Sketch and mock-up of dispenser with the short side of the towel turned to the consumer.**

### 5.4.7 Dispenser with protection flaps

The dispenser with protection flaps is a modification of the last design. It is a bit smaller, it only holds 7.5 bundles. But the bundles are from the H3 system so they are a bit wider than the towels in the last design (12cm compared to 9cm). The advantage with the wider bundles is that the towels are more separated from each other, making it less likely to touch the neighboring towel. Just as figure 22 shows to the left there are protection flaps between the towels making it even less likely to touch the neighboring towel. Figure 22 to the right shows a mock-up to simulate the concept. The picture also shows that a smaller part of the towels from the H3 system is outside the outlet hole. This also facilitates keeping the towels clean.



**Figure 22. Sketch and mock-up of dispenser with protection flaps.**

### 5.4.8 Dispenser with slide lid

The dispenser with a slide lid is very much like the dispenser with the short side of the towel turned towards the consumer. They both hold 10 H2 bundles divided in four plastic cassettes. The big difference is that two of the stalls are closed by a slide lid. When the two opened stalls are empty the consumer slides the lid and the two other stalls can be used. There is a risk that the consumer misunderstands the meaning of the slide lid and pushes it thinking that is the way to get a towel. To prevent this, a smart design of the dispenser is important. Figure 23 shows an example with a big window so the consumers first see the towels before they see the slid lid function.

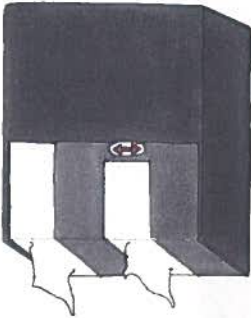


Figure 23. Dispenser with slide lid.

### 5.4.9 Triple dispenser

The triple dispenser holds a total of 7.5 bundles divided in three plastic cassettes. The design is like three ordinary dispensers side by side with the middle one prominent like figure 24 shows. The dispenser in the middle stands out to make consumer rather choose to take paper from this one instead of the two other ones. This design is to get uneven paper consumption between the stalls.

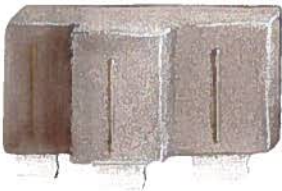


Figure 24. Triple dispenser.

### 5.4.10 Triple cassettes dispenser with different levels

The three cassettes dispenser with different levels is very similar to the previous dispenser regarding the fact that the design is to receive uneven paper consumption between the stalls. The main differences are that the short side of the towel is turned towards the consumer and the middle cassettes is in a lower level than the other two like figure 25 shows. The dispenser holds three plastic cassettes with 2.5 bundles in each.

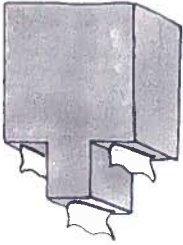


Figure 25. Triple cassette dispenser with different levels.

### 5.4.11 Double dispenser

The double dispenser holds five bundles divided in two plastic cassettes. The design corresponds to figure 26 with one cassettes sitting outside of the other one. Having two cassettes sitting outside each other saves wall space. The outer cassette sits higher up compared to the cassette closest to the wall. The consumer sees the paper in both compartments. Another reason for this design is that if the cassettes would have been in the same height, the neighboring towel would have been touched when a towel is picked.

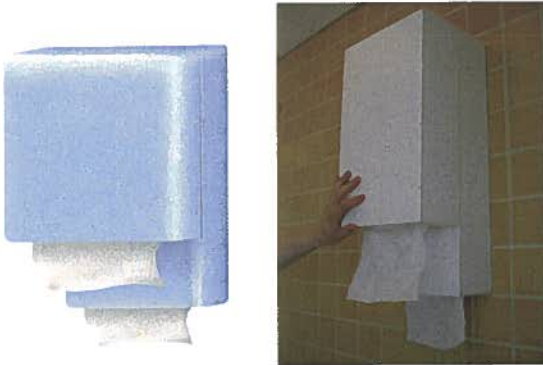


Figure 26. Sketch and mock-up of double dispenser.



### 5.4.12 Side dispenser with loose bundle

The side dispenser with loose bundle is a dispenser with the towels placed horizontally like figure 27 shows. The dispenser is designed like this to remove the towel pile weight on the bottom towel. The towels are moved to the opening by a small spring or by a small decline towards the opening.

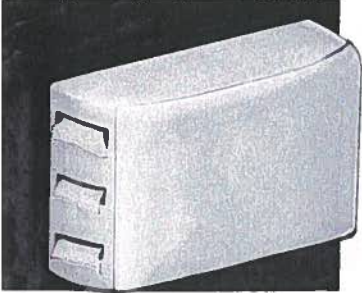


Figure 27. Side dispenser with loose bundle.

### 5.4.13 Side dispenser with cassette

It is the same concept as the last one described. The difference is that the dispenser is loaded with a cassette instead of bundles. The cassette is a cardboard box cassette. A cardboard box cassette works better with the spring function than a plastic cassette would do. If the dispenser have a slight tilt towards the outlet hole will cardboard box work better than plastic cassette, since it have less friction against the towels.

#### 5.4.14 Vending machine dispenser with the screw principle

The vending machine dispenser with the screw principle is a concept with a feeding mechanism much like the ones you can find in a candy vending machine. The bundles lay in a big spring like figure 28 shows. When the spring is turned a new bundle is fed forward. With this principle it is possible to pile large amounts of towels without increasing the pressure on the bottom. This principle work horizontally as well.

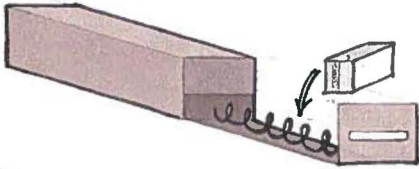


Figure 28. Vending machine dispenser with the screw principle.

#### 5.4.15 Floor dispenser 1

The floor dispenser 1 is a dispenser in which the towel is pulled out from the top of the dispenser. The dispenser is not necessarily required to stand on the floor, but if mounted on the wall it would make the cleaning personnel's job easier to clean the floor. The dispenser is loaded with a cardboard box cassette which holds 6.5 H2 bundles. The mechanism as shown in figure 29 consists of a wire and spring system that keeps the uppermost towel in the same height all the time, reminiscent of plate dispensers in restaurants. It does not matter if the cassette is full or almost empty. The uppermost towel is always pushed to the top cover with approximately the same force. Stuck towels due to pressure would in this case never become an issue. A variation with this concept is having two floor dispensers side by side. Both dispensers have a lid over the outlet hole. Only one dispenser is open for the consumer to take towels from and the other one is closed until the first one is empty. The lid opening is linked to the spring device and opens when the spring reaches its end position.

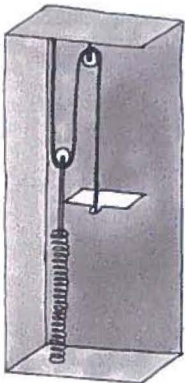


Figure 29. Floor dispenser 1.

### 5.4.16 Floor dispenser 2

The floor dispenser 2, see figure 30, is similar to the previous concept. The main difference is that the spring system has a simpler design. This cuts down on production costs and maintenance.

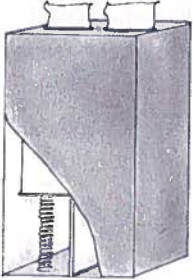


Figure 30. Floor dispenser 2.

### 5.4.17 Triple dispenser with slide door

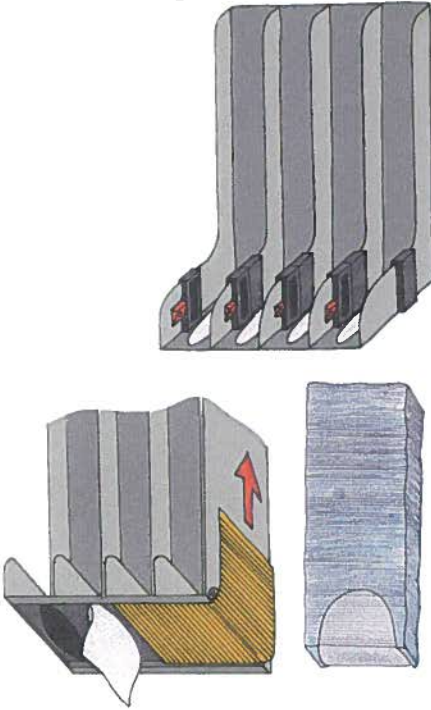
The triple dispenser with slide door holds three cassettes with 2.5 bundles in each. The cassettes are placed side by side in the dispenser as figure 31 shows. The same slide door covers all the outlet holes. The door is made by a flexible material so it can slide up on the dispenser side when a cassette is opened. The door is driven either mechanically with a spring or electrically with a small engine. When one cassette is empty the door moves a step and reveals a new cassette.



Figure 31. Triple dispenser with slide door.

### 5.4.18 Dispenser with brakes and automatic doors

The dispenser with brakes and automatic doors holds up to 20 bundles divided in four plastic cassettes. Figure 32 shows the dispenser and the cassette with the short side of the towel turned towards the consumer. With five bundles in every cassette the dispenser is equipped with mechanical brakes to remove some of the pressure on the bottom towel. The dispenser also has sensors that tell when a cassette is empty. When a cassette is emptied, the neighboring cassette will open.



**Figure 32. Dispenser with brakes and automatic doors**

### 5.4.19 Panel

The Panel is a large dispenser consisting of one floor dispenser 1 and one small dispenser at the top like figure 33 shows. The small dispenser is loaded with bundles and is closed as long as there are towels in the floor dispenser. Not until the floor dispenser is empty will the automatic lid on the small dispenser open. When the cassette in the floor dispenser is replaced, the small dispenser is closed again.



Figure 33. Panel.

## ***5.5 Advantages and disadvantages with the cassette***

With the paper already carefully packaged in the cassettes there is no need for a secondary packaging. Both the cardboard box cassette and the plastic cassette can be piled directly on a pallet with shrink plastic around. For smaller customers not needing a whole pallet the cassettes could also be shipped in a secondary box.

A disadvantage with cardboard box cassettes is all the waste they leave behind in the washroom after they have been used. The cleaning personnel have to remove the empty boxes when exchanging them. Despite that there is no need for a secondary shipping box when transporting the paper, there will still be more amount of waste compared to today's system. The used cassettes lead to more waste in the washroom, compared to only having the waste in the supply room. This is an advantage with the plastic cassette because the waste takes less space compared to the empty cardboard box cassette. The used empty plastic cassette is easy to dispose of in the waste bin in the wash room. If there is a recycling demand it is still easier for the cleaning personnel to bring a small plastic bag with them compared to a large cardboard box.

One of the main reasons for the cassette is the ability to lock out competitor's paper from being used in the dispensers. When the cassette itself does not house the dispensing function like the standing cassette 2, ordinary bundles can be used in the dispenser. To prevent the customers from using ordinary bundles it is possible to design the dispenser in such a way that it becomes difficult to place the bundles if there is no plastic cassette keeping them together. Some of the developed dispenser concepts apply this strategy.

In the standing plastic cassette 1 the dispenser function is a part of the cassette with a plastic disk in the bottom. The cassette rests on thin ledges making it impossible to use ordinary bundles. But if the plastic disk in the cassette is too stiff, the disk can be reused. The disk is removed from the plastic cassette and placed in the bottom of the dispenser enabling ordinary bundles to be used in the dispenser. To prevent this, the plastic disk in the cassette should neither be too stiff or long lasting. Of course it must not break before the cassette is empty. There is always a risk that the competitors will manufacture a plastic disk of their own which can be used with the dispenser. The cassettes have many advantages but there are a few problems. The plastic cassette can for example not be changed before it is empty and this can cause problems. To illustrate the problems an example with the dispenser with the short side of the towel turned to the consumer is used. Some different scenarios that can take place in the washroom are listed below.

1. There are four piles in the dispenser and the distribution of the towel consumption is the same in every pile. This results in the cassettes running out of towels at virtually the same time. The cleaning personnel are not always around so the dispenser will stand empty for a while.
2. The towel consumption is not even, it is for example greater on the outer dispensers. The cassettes on the outer sides empty first and can be replaced before the two middle ones empty. Sooner or later every stall will empty but it will happen much more seldom. This can definitely be acceptable, at least if there are two dispensers in the washroom. If only one or two cassettes are replaced, the actual amount of paper towels in a newly filled dispenser can vary from almost full to less than half empty. This because of the remaining cassettes in the dispenser can be anything from almost full to almost empty. The impressive number of holding 12 bundles is then not really true.

This problem occurs with almost every dispenser loaded with a cassette. Trying to solve this problem, different dispenser concepts have been developed. The first example is the dispenser with a slide door. With the slide door design, the consumption can be controlled by only allowing access to one cassette at a time, never leaving all the cassettes empty at the same time. The triple and double dispensers are concepts attempting to make the consumption distributed in a more favorable way without using a slide door. The idea is that the dispenser design is going to steer the consumer to use one stall much more frequently than another. This leaves all the cassettes empty at the same time as seldom as possible. To increase this effect the cleaning personnel can swap places of the cassettes when loading the dispenser, leaving the full cassette in the stall with the lowest consumption. The double floor dispenser, the triple dispenser with slide door and the big dispenser with brakes and automatic doors work along the same principles as the dispenser with a slide door; to first empty one cassette before starting on the other. The panel also works in a similar way, but the top dispenser is more of a reserve dispenser only to be used while the cassette is waiting to be changed.

## 5.6 Concept selection

There are 14 concepts, but only one is going to be chosen for further development. To select the right one, the selection matrices method is used. The selection criteria that has been used comes from consumers needs, from SCA and what we think is important for this product to succeed on the market. All the criteria are weighed after relative importance on a scale from 1 to 10. 10 is reserved for the most important criteria. In table 7 the three highest ranked concepts are listed. The whole matrix with every concept graded can be found in the appendix.

Weight	Concept/ Selection criteria	Dispenser with brakes and automatic doors		Triple dispenser with slide door		Bended dispenser	
10	Refills per shift	10	100	6	60	6	60
10	Exclude competitor's paper	8	80	10	100	9	90
9	The towels are kept clean	10	90	10	90	10	90
7	Easy to pull out the towel	7	49	8	56	7	49
6	The dispenser is fast to refill	6	36	8	48	8	48
6	Possible to read the paper level without opening the dispenser	9	54	9	54	9	54
6	Good ergonomics	8	48	8	48	8	48
5	User friendly for the staff	9	45	6	30	8	40
5	User friendly for the consumer	7	35	7	35	7	35
4	The dispenser is easy to keep clean	6	30	8	40	8	40
3	Dependable function	7	28	7	28	7	28
2	Creates a stable pile	6	12	5	10	7	14
1	Aesthetic pleasing	8	8	10	10	6	6
1	Easy to fit in the washrooms	6	6	5	5	8	8
<b>Total Score</b>		<b>97</b>	<b>621</b>	<b>101</b>	<b>614</b>	<b>102</b>	<b>610</b>

Table 7. The concept selection matrices with the top three concepts.

The winning concept is the dispenser with brakes and automatic doors. The developing processes will continue for this concept and result in a prototype.



### 5.6.1 Criteria definitions

**Refills per shift:** This criterion is graded as the most important criteria. It refers to how often the cleaning personnel need to load the dispenser with more towels. The more seldom this has to be done the better. The criterion is almost a measure of the dispenser's size. This is true in most cases but the exceptions are for those examples when a dispenser is smaller but is intended to sit in groups in the washroom. To be more precise it is a measure of how much time and effort it takes to maintain the dispensers.

**Exclude competitor's paper:** This criterion is not something the cleaning companies want but it is something SCA requests. It has also received the highest grade of importance together with the previous criteria. The higher the possibility to lock out the competitors' paper from being used in the dispenser the higher grade the concept receives.

**The towels are kept clean:** To ensure that the towels are kept clean is also very important. No one wants to use a dirty towel and that is why this criterion is weighted with a nine. Consideration has been taken not only to when the towel is in the dispenser, but also to the process of refilling the dispenser.

**Easy to pull out the towel:** This criteria measures how easy it is for the consumer to pull out a towel. If the towel would be torn when pulled out, it would give the dispenser a low grade.

**The dispenser is fast to refill:** A fast dispenser to refill saves time and money. The faster the dispenser is to refill per towel the higher grade it gets.

**Possible to read the paper level without opening the dispenser:** To save time for the cleaning personnel and make their job easier it is preferable to be able to read the paper level without opening the dispenser. If it is easy to read the paper level the concept receives a high grade.

**Good ergonomics:** Wear damage on the staff is highly unwanted. To have a good working environment is very important for the personnel's well-being. The better work environment the dispenser creates the higher grade it gets.

**User friendly for the staff:** The dispenser should be easy to refill, and if not so it would be given a low grade.

**User friendly for the consumer:** The dispenser that risks being difficult to understand how to use will receive a low grade.

**The dispenser is easy to keep clean:** A dispenser for towels is something you want to associate with something clean. If the dispenser is easy to keep clean it both saves time for the cleaning personnel and looks better.

**Dependable function:** If the dispenser function is very complex it is a greater risk of breakdowns. If a dispenser is out of order it both costs money to repair it and until it is fixed there can be a shortage of towels for the consumer. A reliable dispenser with few things to go wrong on receives a high grade.

**Create a stable pile:** The dispenser should be easy to load. An instable pile that is difficult to handle and might fall out when the dispenser is opened is not wanted.

**Aesthetic pleasing:** The design is of high importance when the companies choose what product to purchase. Even in washrooms it is important to reflect the right image. A dispenser with capacity to look good gets high grades.

**Easy to fit in the washrooms:** If the dispenser needs a lot of space it can only be assembled in some washroom, and will be given a low grade for this criterion.

## **5.7 The chosen mechanism**

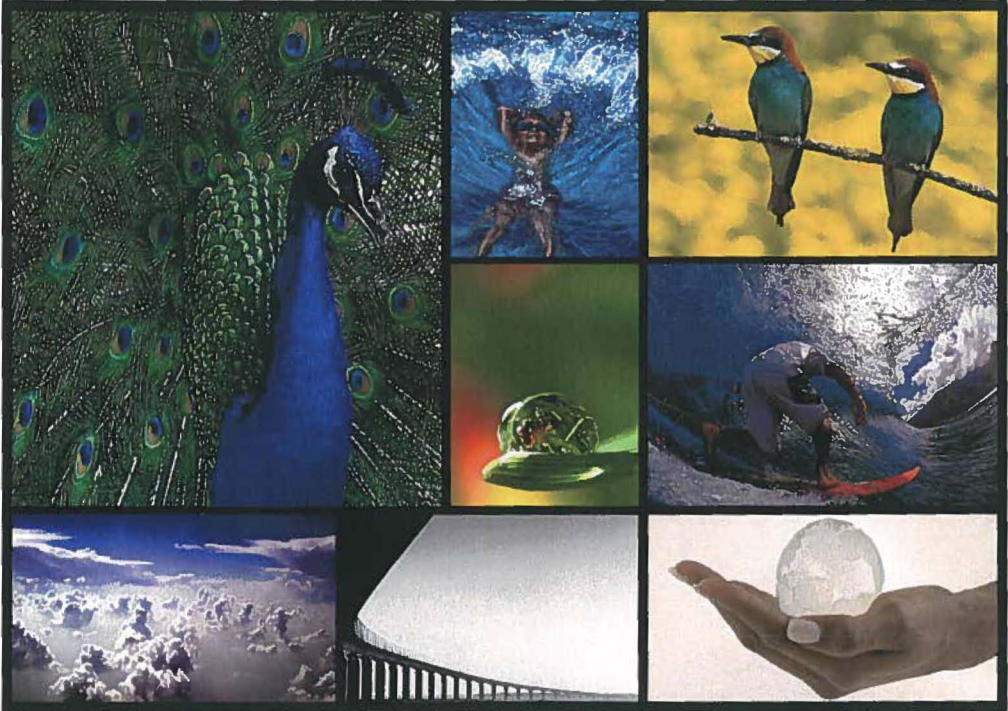
The developing process continued for the winning concept and many difficult decisions had to be made on what technical solutions to use in the dispenser. We also changed the name of the dispenser after it came out as the winner. From the beginning all concepts had describing names in order to separate them from each other. But with only one concept left and with the not so exciting name "The dispenser with brakes and automatic doors" we decided to rename the dispenser to "Lund". The final concept (Lund) became a technically very advanced dispenser with a lot of both mechanical and electrical solutions. It will be an expensive dispenser to produce, but with all the advantages compared to today's dispensers in high traffic washrooms we believe that it will still be a very competitive choice.

### **5.7.1 Technical description of Lund**

Lund holds 20 H2 bundles divided in four plastic cassettes. The cassettes are of type "standing plastic cassette 2". Due to the large number of bundles in every cassette, breaks are necessary to have in the dispenser. The break that is going to be used in the dispenser is already developed by SCA. Some minor modification needs to be made to the break as the SCA break sits on the short side of the towel and in this dispenser the breaks are going to sit at the towel's long side. The standing plastic cassette 2 has no dispenser function so the outlet hole is in the dispenser instead, enabling ordinary bundles to function in the dispenser. However, using ordinary bundles in this dispenser is difficult. There is not enough support on the sides to pile the bundles without the pile getting unstable and tipping over. There are four compartments for the cassettes and there are separate automatic doors in each one. Only one is open at a time assuring that towels are only picked from one cassette. When the cassette is empty the automatic door is closed and the next door is opened. To know when a cassette is empty photo sensors are used. The cover is assembled to the dispenser with hinges and opens like a regular door.

### **5.8 Image board**

Since the dispenser holds a remarkable amount of paper towels, its dimensions are a lot bigger than SCA existing paper towel dispensers. Even though it is a large dispenser it is important that the design expresses beauty, lightness, freshness, harmony and balance. The design should work globally and have an esthetically clean look. The figure 34 shows some of these expressions that were used during the design.

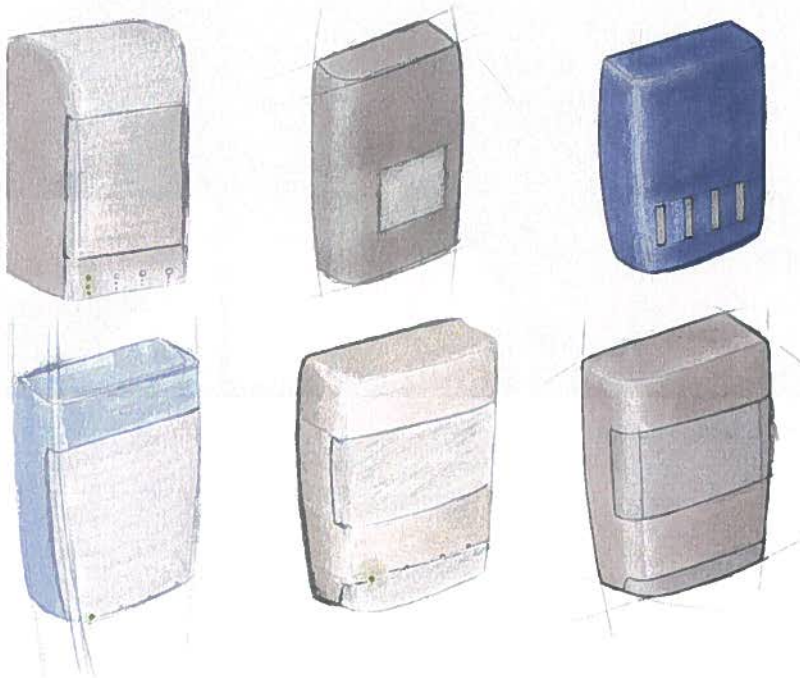


**Figure 34. Image board.**

## **5.9 Design Concepts (in the last phase)**

When the shape and the function for the cassette were decided, the design of the dispenser lid had to be developed furthermore as shown in figure 35. Since the cassette has a rectangular shape, we quickly rejected a round shape for the dispenser, as shown in the first sketch, in which a lot of unnecessary space had to be added to round the edges. When a rectangular look was decided different types of windows were evaluated. One large window would not only help the cleaning personnel to easily see when the cassettes have to be replaced, it would also give the dispenser a lighter look. A solid look would make the dispenser look heavy and ungainly.

In order to conceal the brakes, sensors and other mechanical components, the front of the lid was designed as two separate transparent sections. The components that needed to be concealed were placed in the space between them.

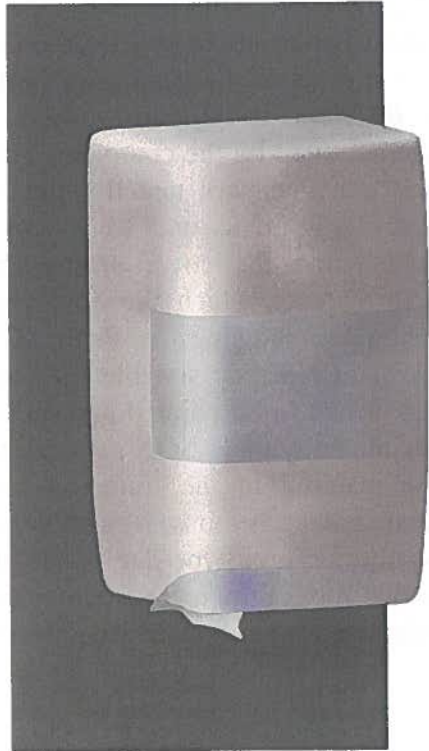


**Figure 35. Picture shows sketches from the last phase of sketching.**

## **5.10 Selection of final design**

The result from the evaluation, the selected concept, is showed in figure 36. It is a space saving design, considering the amount of paper it holds. It has a clean simple look but is easily understood by its users. The upper transparent part clearly shows the user that the box contains paper towels. It also clearly shows the personnel how much paper is left in each cassette. The lower transparent part shows the user where to pull out the paper.

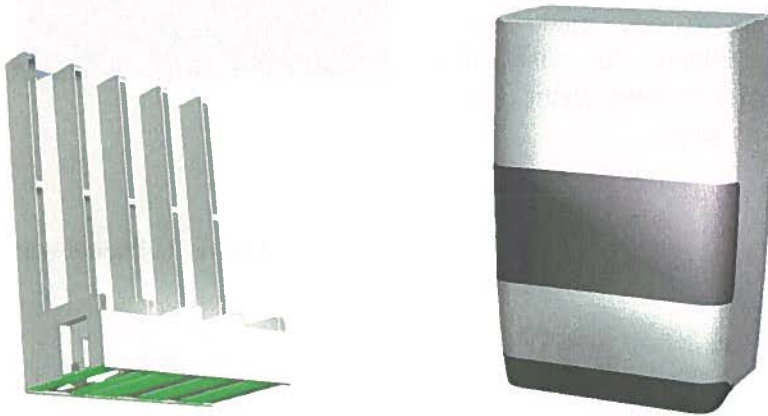
To indicate what compartment is open and active at the moment, four light emitting diodes, one for each cassette, are placed behind the lower transparent part of the lid. The lid is made out of plastic, where the transparent part has a frosted/blasted look. Plastic will make the dispenser lighter compared to one made out of stainless steel. Plastic is also more hygienic and easier to keep clean, since it is not as porous as steel.



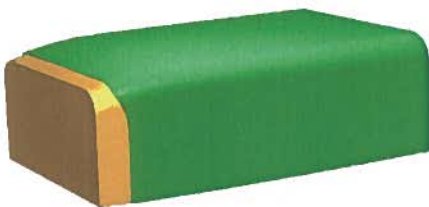
**Figure 36. Final design.**

### **5.11 CAD drawings of the prototype**

For the manufacturing of the prototype it was decided that the frame (figure 37 left) should be build by us in SCA's workshop and the cover (figure 37 right) should be manufactured by the German company Gebrueder Schmidt. SCA have a good relationship with Gebrueder Schmidt and have close cooperation in different developing project. Many of SCA's dispensers are today manufactured by the company. They also have all the necessary equipment in their machine park to build the cover, making them our first choice. They gladly assisted us and were very helpful. The technique that was used to manufacture the cover was vacuum shaping. Figure 38 shows the plug (yellow) over which the cover (green) was shaped. The program used to design the drawings is Pro/ENGINEER. The material for the cover is a transparent plastic suitable for vacuum shaping. To give the cover the right look it had to be painted and the windows had to be toned and frosted. This was made by us in SCA's workshop as well as the construction of the frame. The material in the frame is mainly plywood. The material was chosen because it is easy to work with and is cheap. It was not possible to build a fully functioning prototype due to the very complex functions on the dispenser, to do that more time and resources are required. But the prototype gives a good understanding of how the functions are intended to work.



**Figure 37. CAD rendering of frame (left) and cover (right).**



**Figure 38. CAD rendering of cover (green) and plug (yellow).**

## 6 Results and conclusions

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*This final chapter of the report concludes the result of the study made in this assignment. The chapter also contains pictures of the functional model that were built. Suggestions for further studies are also presented.*

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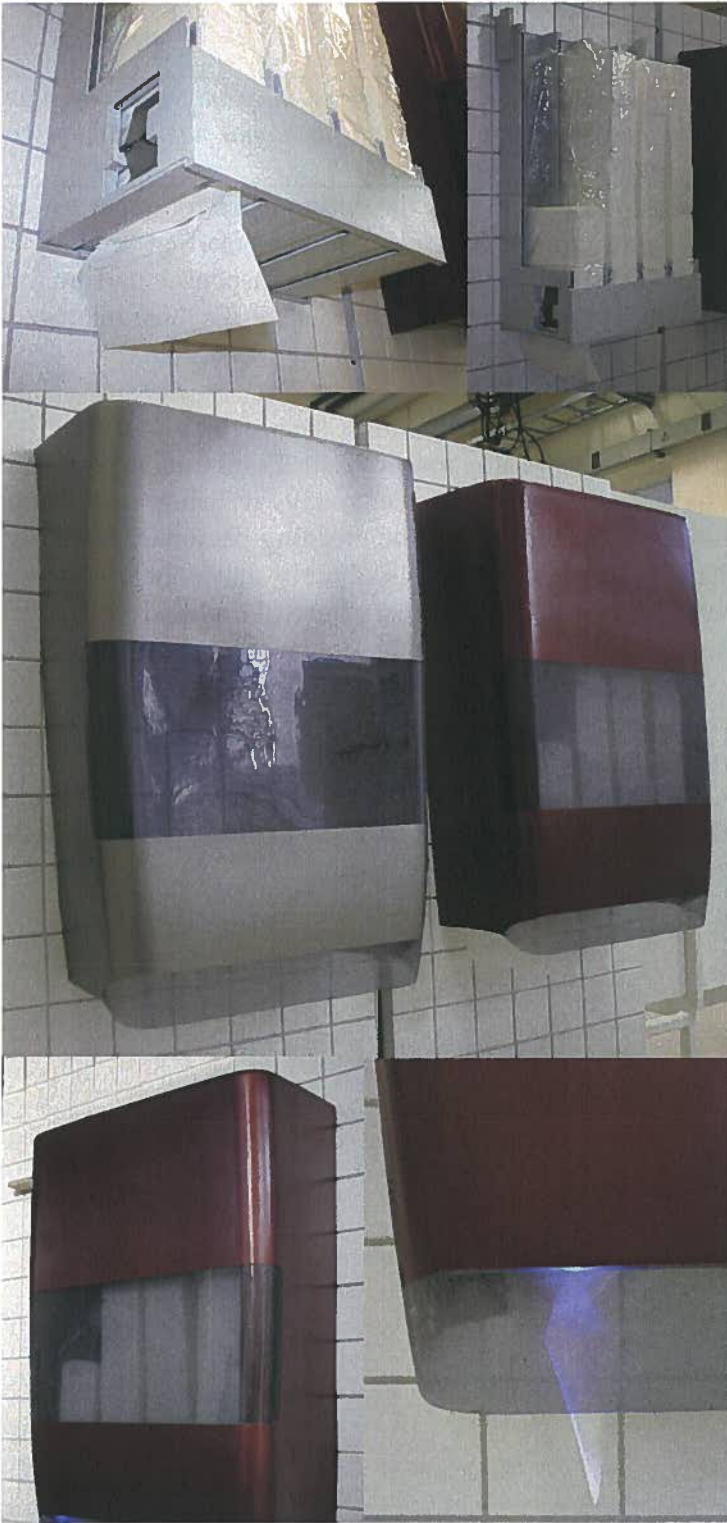
The objective with this master thesis is to find the optimal size for paper towel dispenser in high traffic washrooms. We have put the effort in finding a solution for how to make the paper proprietary to the dispenser and at the same time reduce the refilling frequency. With our concept we have managed to attain both.

The dispenser holds four cassettes with five bundles each, which in total give 2000 towels. At a high traffic washroom, for example Frankfurt airport, the dispenser would only have to be refilled once a day, if using two Lund dispensers. The large windows not only helps the cleaning personnel to easily see when the cassettes have to be replaced but also clearly shows the consumer the content of the dispenser and where the paper should be pulled out from. The light emitting diodes also signals which compartment that is active.

The chosen concept was turned into a prototype as seen in figure 39. The dispenser is built of plywood and the lid is vacuum shaped plastic.

Our collected data can be useful in further research for high traffic washroom products.





**Figure 39. Photos of prototype.**

## **6.1 Further research**

The brakes used in our dispenser already exist today, but need further research before it can be fully integrated in the Lund dispenser. The other mechanical parts in our dispenser, such as the sliding doors and hinges, need a deeper study of the design before entering the production stage.

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[www.frankfurt-airport.de](http://www.frankfurt-airport.de) Frankfurt Airport 2005-09-01

### **7.3 Personnel Interviews**

Rivera Sol, Team leader, ISS Facility Service Arlanda airport, 2005-04-29

Nordin Lennart, Manager, ISS Facility Service Arlanda airport, 2005-04-29  
ISS Airport Service

Büschüter Dirk, Manager, GCS Gesellschaft für Cleaning Services, Frankfurt  
am Main

# 8 Appendix

## 8.1 The concept selection matrix

Weight	Concept/Selection criteria	Dispenser with brakes and electric doors		Triple dispenser with slide door		Bended dispenser		Triple dispenser	
10	Refills per shift	10	100	6	60	6	60	5	50
10	Exclude competitor's paper	8	80	10	100	9	90	8	80
9	The towels are kept clean	10	90	10	90	10	90	10	90
7	Easy to pull out the towel	7	49	8	56	7	49	8	56
6	The dispenser is fast to refill	6	36	8	48	8	48	8	48
6	Possible to read the paper level without opening the dispenser	9	54	9	54	9	54	9	54
6	The refilling can be ergonomically correct	8	48	8	48	8	48	9	54
5	User friendly for the staff	9	45	6	30	8	40	8	40
5	User friendly for the customer	7	35	7	35	7	35	9	45
5	The dispenser is easy to keep clean	6	30	8	40	8	40	8	40
4	Dependable function	7	28	7	28	7	28	6	24
2	Creates a stable pile	6	12	5	10	7	14	8	16
1	Can be aesthetic pleasing	8	8	10	10	6	6	8	8
1	Easy to fit in the washrooms	6	6	5	5	8	8	4	4
<b>Total score</b>		<b>97</b>	<b>621</b>	<b>101</b>	<b>614</b>	<b>102</b>	<b>610</b>	<b>103</b>	<b>609</b>

<b>Weight</b>	<b>Concept/Selection criteria</b>	<b>Three cassettes dispenser with different levels</b>		<b>Dispenser with protection flaps</b>		<b>Dispenser with slide lid</b>		<b>Double dispenser</b>	
10	Refills per shift	6	60	5	50	6	60	4	40
10	Exclude competitor's paper	7	70	6	60	7	70	7	70
9	The towels are kept clean	10	90	10	90	10	90	10	90
7	Easy to pull out the towel	6	42	6	42	7	49	8	56
6	The dispenser is fast to refill	7	42	7	42	7	42	8	48
6	Possible to read the paper level without opening the dispenser	9	54	9	54	9	54	8	48
6	The refilling can be ergonomically correct	8	48	8	48	7	42	6	36
5	User friendly for the staff	8	40	9	45	7	35	6	30
5	User friendly for the customer	9	45	9	45	6	30	5	25
5	The dispenser is easy to keep clean	7	35	6	30	5	25	8	40
4	Dependable function	7	28	7	28	7	28	8	32
2	Creates a stable pile	8	16	8	16	5	10	8	16
1	Can be aesthetic pleasing	8	8	9	9	9	9	9	9
1	Easy to fit in the washrooms	7	7	7	7	7	7	8	8
<b>Total score</b>		<b>107</b>	<b>585</b>	<b>101</b>	<b>566</b>	<b>93</b>	<b>551</b>	<b>99</b>	<b>548</b>

Weight	Concept/Selection criteria	Dispenser with the short side of the towel turned to the customer		Side dispenser with cassette		Side dispenser with loose bundle		Floor dispenser 1	
10	Refills per shift	5	50	5	50	6	60	4	40
10	Exclude competitor's paper	2	20	4	40	4	40	5	50
9	The towels are kept clean	10	90	10	90	1	9	10	90
7	Easy to pull out the towel	8	56	8	56	8	56	4	28
6	The dispenser is fast to refill	6	36	6	36	6	36	4	24
6	Possible to read the paper level without opening the dispenser	9	54	5	30	10	60	5	30
6	The refilling can be ergonomically correct	8	48	6	36	6	36	5	30
5	User friendly for the staff	9	45	6	30	5	25	6	30
5	User friendly for the customer	9	45	7	35	7	35	5	25
5	The dispenser is easy to keep clean	5	25	4	20	4	20	6	30
4	Dependable function	7	28	7	28	7	28	6	24
2	Creates a stable pile	8	16	4	8	6	12	6	12
1	Can be aesthetic pleasing	9	9	8	8	7	7	8	8
1	Easy to fit in the washrooms	7	7	5	5	5	5	5	5
<b>Total score</b>		<b>97</b>	<b>529</b>	<b>80</b>	<b>472</b>	<b>76</b>	<b>429</b>	<b>75</b>	<b>426</b>

Weight	Concept/Selection criteria	Floor dispenser 2		Panel		Vending machine dispenser with the screw principle	
10	Refills per shift	5	50	6	60	5	50
10	Exclude competitor's paper	5	50	5	50	5	50
9	The towels are kept clean	10	90	10	90	1	9
7	Easy to pull out the towel	4	28	3	21	4	28
6	The dispenser is fast to refill	5	30	5	30	5	30
6	Possible to read the paper level without opening the dispenser	5	30	5	30	8	48
6	The refilling can be ergonomically correct	3	18	4	24	3	18
5	User friendly for the staff	6	30	4	20	3	15
5	User friendly for the customer	4	20	3	15	3	15
5	The dispenser is easy to keep clean	6	30	6	30	4	20
4	Dependable function	6	24	4	16	6	24
2	Creates a stable pile	4	8	3	6	4	8
1	Can be aesthetic pleasing	8	8	8	8	4	4
1	Easy to fit in the washrooms	5	5	2	2	2	2
<b>Total score</b>		<b>71</b>	<b>421</b>	<b>62</b>	<b>402</b>	<b>52</b>	<b>321</b>

Table 8. The concept selection matrix



