CHALMERS

Air Dinner
Designing modern and sustainable airline tableware
Master of Science Thesis in Industrial Design Engineering

Rikard Rehnmark

Department of Product and Production Development
Division of Design & Human Factors

CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

Disposable products put great stress on the environment due to the sheer volumes required to fulfill the demand. An industry growing dependent of disposable products is the airline food industry. Today many airline meals are fully composed of different disposable items. These products end up in landfills and/or combusted after use.

The focus of this master thesis is through product design explore different alternatives to the current disposable airline tableware in order to reduce the environmental impact of the airline tableware. Based upon an iterative product development model airline tableware concepts were created in order to explore, test, analyze and verify potential approaches and ideas. The promising concepts and ideas were later matured into a single final product candidate.

The final product, *Air Dinner*, utilizes both aspects of design and carefully selected materials in order to reduce the environmental impact of the airline tableware. This is achieved through its light weight design, user friendly features, simplified waste management, structured layout and improved packaging.

This thesis demonstrates that it is possible to through careful design decisions develop an airline tableware that has a reduced environmental impact compared to common alternatives; though it is also shown that through further improvements it is possible to reduce the product's impact even more. As this thesis shows, there is great potential within the area of sustainable designed airline tableware and that the airline meal industry is lagging in their development within these types of products and initiatives.

Key words: Airline Tableware, Airline Meal, Sustainable Design, Packaging, Product Design

PREFACE

It is hard to point out exactly how the idea for the master thesis developed but one thing that is for sure is that my fascination of airline tableware began back in 2005 during a visit at the National Museum of Fine Arts (Nationalmuseum) in Stockholm, Sweden. The Nationalmuseum has together with the classical fine art a industrial design exhibition which lets the visitor follow Scandinavian design history through important and characteristic products. These are coupled with internationally recognized industrial design icons. Among all these great and in some cases legendary pieces of design the part of the exhibition that really caught my attention was the Scandinavian Airlines (SAS) airline meal history. They displayed the evolution of the SAS airline meals with each generation of uniquely designed tableware specifically for SAS. Since then this has been one of those products I have wished to get the opportunity to explore and design.

Up until the fall of 2011 I had not felt that an opportunity to purse the airline tableware had emerged. During that year I was in some miraculous way lucky and got to travel to the United States, China and Kenya. All this traveling made me to a proud silver member in my frequent flyer program but more importantly brought my mind back to the airline tableware. During all those long distance flights I got the time to think and explore all different types of airline meals that were served to me. This is when I started to feel that the time had come to pursue one of my dream projects. Together with the fact that I was rapidly closing in on my diploma thesis which I planned to begin with in early 2012. Me designing an airline tableware as part of my diploma thesis just made perfect sense.

Acknowledgements

CONTENT

INTRODUCTION

Today, one of the more important design aspects of a modern product is to minimize the product's environmental impact. This has grown to become a necessity in order to secure a sustainable future in a consumption society. Therefore as a designer, it has become of high priority to account for the product's whole life cycle when designing. Everything from the materials and manufacturing methods to how the product will be taken care of when it reaches end-of-life (EOL). These aspects also become increasingly important the shorter the lifespan of the product and therefore very crucial for disposable use products with a high consumption rate.

A sector that is largely dependent of disposable products is the airline food industry. In many cases the whole meal can be packaged in different disposable containers and packages made out of paper, plastic and/or aluminum. These products are most common in economy class and therefore the disposable products represent a large amount of the meals served on flights across the world.

When looking at airline meals over the past twenty years you will find a steady growth of disposable products that replace the reusable alternatives. The main cause of the growth is the high competition within the airline industry and therefore every attempt to cut costs are welcomed (PRWeb, 2012).

It is rather hard to grasp how large the airline industry is and how many passengers it serves annually. To break it down a bit, 16 million passengers traveled through Stockholm Arlanda Airport in 2009 (Swedavia, 2009). Even if just half of those passengers are served a meal it is still a substantial amount of waste that is produced. That would mean that there are at least 8 million meals served for one single airport, which additionally is a small airport in comparison to the larger hubs across the world. Therefore reducing the waste generated by the meals is an important step for the airline industry to take in order to become an environmentally sustainable transportation method.

1.1. PROJECT EXTENT

1.1.1. PURPOSE

The purpose of the master thesis is to design and develop a sustainable alternative to today's airline tableware. The new design shall utilize the products more wisely and reduces the amount of waste produced by the meal.

1.1.2. AIM

The project will present one final concept of a new and sustainable airline tableware design that utilizes the tableware and packaging efficiently, generating a low amount of waste. The final concept will include a full set of tableware and packaging which will benefit the environment positively compared to the original product. The final design of the airline tableware aims to include the following aspects:

- » Minimize excess packaging of the airline meals.
- » Design a more integrated user experience throughout the whole airline tableware. Simple, intuitive and consistent.
- » Reduce the overall environmental impact of the airline meals through both reduced CO_2 emissions and waste generated.
- » If possible show a decrease in CO_2 emissions per passengers.
- » Simplify recycling of the airline tableware and the waste.
- » Promote proper care of the waste products.
- » Create a fluent design language throughout the whole airline tableware. This includes both form, material and graphical elements.
- » Include all users of the airline tableware not only primary users.
- » Differentiate itself from traditional airline tableware.

1.1.3. REQUIREMENTS

For the design to become successful it must meet the set industry requirements while still delivering something new, fresh and innovative. A set of requirements were

defined to guide the work in the right direction and to verify the design. The final design shall include the following aspects:

- » Follow international guidelines for airline meals and food safety.
- » Compatible with the current food/waste trolleys.
- » Realizable within the next five years.
- » Have the same product functionality as the current tableware.
- » Possible to brand the product depending on the airlines .

1.1.4. USERS

There are several users of the airline tableware, the primary users of the product is the passengers whom are served the meals. The product has two secondary users, the airline and the caterer.

1.1.5. LIMITATIONS

The airline meal service consists of several instances, products and actors which makes it a very large area to study. Therefore it will not be time efficient to study all the products and instances throughout the whole chain and identify individual need for each instance. Due to this, the master thesis will focus on the tableware and not the surrounding products such as food/waste trolleys and the overall system.

1.1.6. SUSTAINABLE DESIGN

As mentioned in *1.1.1. Purpose* the focus of the master thesis is to create a product that, compared to the current, has less or no negative impact on the environment. Therefore sustainable design will be heavily incorporated throughout the whole project and in each of the concepts developed. The sustainable aspect will be highly influential during concept evaluation and material selection.

METHODS

Initially the process throughout this masters thesis is described in detail and is followed by a detailed methods description. The methods and tools used throughout the master thesis are divided into six different groups based upon their purpose and how they were exercised in the project. The six groups are; *data collection methods, analysis methods, means of communication, ideation techniques, visualization techniques and evaluation methods.* The methods which are presented within the groups are order based on their appearance throughout the project's process. The purpose of each method is described and how it has been utilized with in the project. Together with the details concerning the project process, other important factors concerning the method is described such as; persons interviewed, extent of a survey, computer software used, specific adjustments of the method for the project and other various factors which affect the utilization of the method in the project.

2.1. PROCESS

The process and approach to the project was based upon an iterative development model, which was initiated with a pre-study and background analysis which was then followed by the tasks; ideation, design, creation and evaluation. The tasks were repeated in the same order until the set limit of cycles were reached or a set of requirements had been fulfilled (Ian Spencer, Kurt Bittner, 2005). When the set goals were reached the project entered the realization phase, the concepts generated were transformed into on final detailed product proposal.

The project was divided into four phases; a pre-study phase, a concept and ideation phase, a visualization and final product concept phase, and finally a documentation and summary phase which captured the whole project into a report and presentation (Harvey Maylor, 2010, p.32). The following sections are descriptions of goals and focus areas which were set for each phase. For a full detailed time plan see Appendix A Time Plan.

2.1.1. DESIGN PROCESS

Phase 1 – Pre-study & Background

The focus of the initial phase of the project was to get an understanding of what airline tableware is to all of its users and the functions it fulfills. This was follow by a market & competitors analysis to identify current trends and different products used across airlines. The identified products were analyzed in order to find their specific strengths and weaknesses. Along with these product based studies, interviews and observations were conducted together with the different users in order to gain an holistic view of the product's operating environment.

This information was compiled together with industry standards, inspiration within other sectors, how the product is handled, product life cycle and material samples. The compilation were of both visual and verbal help to find an approach to the product and project. The compilation also captured the inspiration, technical requirements, user input and key factors that need to be applied in a successful design and product.

Phase 2 – Ideation & Concept

The structure of the second phase differentiate itself from the other phases with three stages of concept generation. Basically each stage was identical except that the outcome of each stage shifts from quantity to quality (Bo Bergman, Bengt Klefsjö, 2010, p. 224). Each stage started simultaneous with the tasks ideation, visualization and prototyping. All of these three tasks followed the same quantity versus quality guidelines as each stage, which meant for stage one a lot of repeating of the tasks to accumulate a large quantity of concepts. The concepts were later evaluated, scrapped, combined or kept for the next stage (Scott Belsky, 2010, p. 76). During the next stage the same tasks were performed in the same order but with an increased focus on quality. This was repeated until the end of stage three where the turn out was the final product concept.

Phase 3 – Final Concept & Visualization

Based on the final concept generated in the previous phase, the third phase was initiated by evaluating and refining the concept in order to be able to proceed with designing and creating the final product proposal. The final concept was further developed through CAD 3D models and high detailed prototypes in order to create high quality visual material and a prototype for presentation and evaluation in phase four.

Phase 4 – Summary & Documentation

With the final design finished from the previous phase, the last and final phase of the project was focused on joining and ordering the material created and documented throughout the project; such as written and visual documentation of the design work, summaries of studies, literature and other material that was obtained throughout the project. The material was compiled into a logical structure which was later re-written and transformed into this report. The fourth phase, as well as the project, ended as the final presentation was finished.

2.2. DATA COLLECTION METHODS

2.2.1 LITERATURE STUDIES

In order to gain insight into the area of interest, background, market trends, competitors, industry regulations and cutting edge research, it was necessary to initially perform a literature study to understand the field and the on-going research concerning it. The literature study was performed throughout the first phase but mainly in the earlier part of the phase.

Literature was collected through academic databases, literature found at libraries, Internet forums, industry specific journals and concerned companies' websites.

2.2.2 OBSERVATIONS

The observations were performed during the initial pre-study phase to get an insight in how the products are handled and how the products differ among airlines and caterers. Furthermore, observations of the environment of use were also performed as environmental factors may affect the usage of the product itself. The observations was also important to perform as the product's size in relation to the environment could be observed. Observations of the caterers were conducted at Gate Gourmet in February 2012 and at LSG Sky Chefs in May 2012. Additional observations were made during a study-flight with Novair, from Gothenburg, Sweden to Antalya, Turkey in April 2012.

The data collected during the observations were recorded in written text and photographs.

2.2.3 INTERVIEWS

Interviews were conducted to complement the observations through gaining an insight not only based on visual impressions but also built on professionals' viewpoints. Several interviews with key persons were held at different occasions with Susan Sjöblom at Novair, Niclas Häverbring at Gate Gourmet and Stellan Ristic at

LSG Sky Chefs. Moreover, interviews were also held during the study-flight in April with the crew of the Novair flight.

The interviews were of semi-structured characteristics in order to be able to gather both quantitative and qualitative data from the interviews (MariAnne Karlsson, 2009, p. 26-27).

2.2.4 SURVEY

The survey was conducted to be able to map the users' attitudes and opinions about the product since this information were of importance for the future product development. The survey was conducted with potential users, i.e. airline passengers, during a study-flight from Gothenburg, Sweden to Antalya, Turkey. These respondents are theoretically representative to the product's target user group as the airline passengers are one of the user groups of the product (MariAnne Karlsson, 2009, p. 32). The response rate of the survey was 58 out of 58 participants. This amount of respondents is sufficient to discover 90% of the users' needs (John R. Hauser, Abbie Griffin, 1991, p. 13).

The questions were of closed nature, multiple choice. The survey contained questions regarding how the user perceive, interact and value the product. Specific questions concerning the passengers' habits when eating an airline meal was also included into the questionnaires.

2.3. ANALYSIS METHODS

2.3.1 MARKET ANALYSIS

The market analysis were exclusively focused on identifying market trends, key success factors and mapping main competitors. The analysis were performed in the early stages of the first phase to get an understanding of the market and the future of it.

The market analysis were made on the main actors in the airline industry, such as AirFrance/KLM, SAS, Lufthansa, Delta Airlines, United Airlines and Singapore Airlines, caterers such as LSG Sky Chefs and Gate Gourmet and the two market leading manufacturers and designers of airline tableware, deSter and Helios.

2.3.2 CURRENT PRODUCTS ANALYSIS

Collection of product samples from the airlines' tableware were done in order to be able to carefully observe and disassemble the products as well as getting an understanding of dimensions, quality aspects, food presentation and design.

2.3.3 STREAMLINED LIFE CYCLE ASSESSMENT (SLCA)

The Streamlined Life Cycle Assessment (sLCA) were used to determine the product's impact on the environment throughout the whole life cycle, from the design phase to the end-of-life phase. The method, which is a simplified version of a Life Cycle Assessment, was conducted as it in an easy manner provides data to analyze and evaluate the environmental impact of different factors.

2.3.4 KJ–ANALYSIS

A KJ-analysis were performed to structure the data collected from the observations and interviews. The verbal data collected from these methods were categorized into groups and sub-groups depending on the content. Thereafter, the problems identified

were noted and transformed into design guidelines (MariAnne Karlsson, 2009, Appendix 10).

2.3.4. MATERIAL ANALYSIS

The material analysis were performed through with the computer software Granta: CES Selector 2009 in order to identify suitable materials that meet the set requirements of the product. The software plots the selected material against each other in a graph based upon a set of variables such as recyclable, strength in relation to density, price, etc. The analysis were focused around the end of phase two.

The material analysis were made on both commonly used materials in the airline meal industry, such as paper and different plastics, and more alternative materials, such as biodegradeable plastics and wood.

2.3.5. RADAR CHART

A radar chart was constructed in order to visualize the data obtained through the focus group questionnaires. The radar chart is a good way to visually create an understanding of how each of the products were rated compared to each other. It also visually highlights features which stand out among the rest of the features in that way one could easily see any particular aspects of the product which needs to be further developed in order to achieve the same standard as the rest of the product. The scale used in the radar chart corresponds with the span used in the questionnaire, 1-4. The data is then plotted based upon the mean values for each product and category, for example *cup* and *aesthetics*.

2.4. MEANS OF COMMUNICATION

2.4.1 DESIGN GUIDELINES

A list of design guidelines were created in the initial stages of phase two in order to list the most important aspects for the design of the product. The list of guidelines included both requirements and desirable features from the product's stakeholders (Kenneth Österlin, 2003, p. 43).

2.4.2 STORY BOARD

A Story Board was chosen to be constructed in order to illustrate the different scenarios of how the product was used and handled by the different users and which connection they had to each other. In order to describe the whole process several images, illustrations and texts were gathered and put together into a Story Board. The Story Board was used in the initial part of the design process with aim of easily creating an understanding of the complexity and gaining an holistic view upon the whole product and its life cycle.

2.4.3 IMAGE BOARD

The Image Board was used to summarize inspiration that were collected during the pre-study. The method was therefore used in the later part of the pre-study and helped conclude some of the findings and visualized them in a simple manner.

2.5. IDEATION TECHNIQUES

2.5.1 SUMMARY BOARD

The method Summary Board is a creation by the author of this master thesis. The method was used to summarize the pre-study of the project and had the function of creating guidance throughout the conceptual phase, phase two. The Summary Board summarize personal notes, sketches and different findings throughout the pre-study which were found important or inspirational. These were then translated into simple words which were written down next to each other on a blank sheet of paper. The words then acted as a "verbal concept" of the product. The result of the Summary Board then becomes a kind of broad first stage concept.

2.5.2 BRAINSTORMING

Brainstorming was used as one of the key methods during the ideation phase of the project to trigger and generate ideas. The ideas were sketched on paper to be able to iteratively develop them during the ideation phase.

2.5.3 SKETCHING

Sketches were used to express ideas and concepts during brainstorming and were then used as foundation for developing more advanced visualization of the concepts, such as 2D and 3D images and prototypes. Sketching as a method was one of the core methods during the ideation and were helpful throughout the whole second phase. Sketching was also used during the first phase during the observations to be able to capture spontaneous ideas and thoughts during the pre-study phase.

2.6. VISUALIZATION TECHNIQUES

2.6.1 DIGITAL VISUALIZATION

The sketches from the sketching sessions were used as a foundation for developing advanced visualization of the concepts. When the concepts were mature and properly evaluated, they were visualized more advanced through computer software such as Adobe Creative Suite and later on Solidworks. These tools were used in the mid to later part of the second phase and were continuously used to the end of the third phase.

2.6.2 PROOF OF CONCEPT PROTOTYPES

Prototypes were built as a final step in order to verify the design, both by form and function. By the creation of quick visual prototypes of the more prospective concepts it were possible to test them towards the users and to gain a deeper understanding of the form. Prototypes were used throughout the whole second phase and third phase to create demonstrative models of the concept to test and explore their functionality. The prototypes in the second phase were focused on representing the concept and its primary function.

2.6.3 FUNCTIONAL PROTOTYPE

At the end of the third phase prototyping was focused towards a more advanced prototype representing the actual finished product with accurate form and function. With high detailed CAD models created during the third phase rapid prototyping became a highly suitable prototyping alternative due to its ease of creating the base forms for the prototype. In order to achieve high realism in the product the base created from the rapid prototyping was then refined through traditional hand craftsmanship, where the prototype was sanded, painted and decals were added to the prototype.

2.7. EVALUATION METHODS

2.7.1 FEATURE MATRIX

Based upon the product features identified during the pre-study an evaluation matrix was created in order to compare the different features. These features were evaluated towards the three different user groups and the features' possible environmental impact. The evaluation method was used in the earlier stages of the second phase to identify which features were of greatest importance to the product and thereby were to be focused on during the ideation.

2.7.2 FOCUS GROUPS

The focus group took place in October 2012 and consisted of seven potential users that were representative to the target end user group (passenger). The session was initiated with the participants being exposed to the prototype without any prior introduction to the product and asked to feel, use, understand and discuss the prototype. When the group discussion started to phase out the participants were introduced to the prototype in an more presentation wise manner, where they had the product described for them by the author. Afterwards each participant individually filled out a questionnaire which contained questions of how they experienced the product. This was followed by a one on one discussion about the product with the author where the participants qualitative data was noted. The quantitative data was analyzed through a radar chart.

2.7.3 MATERIAL EVALUATION

To evaluate the material selection the CAD model of the product was supplied with accurate material and their various properties like CO_2 emissions, weight, energy consumption, manufacturing methods, region of manufacturing and assembly, region in which the product will be used in, means of transportation and estimated life time. This data was used to perform numerous product life cycle simulations in the computer software Solidworks to evaluate the material selection and compare it with other materials and identify for example the differences in CO_2 emissions between disposable and reusable products.

PRE–STUDY

The pre-study's aim and purpose was to gain an understanding of the whole airline meal system, how it works and the different users. To understand how these users interact with each other and work with the product. It also introduces the airline meal, the trolley, new trends, previous attempts to innovate the product and the products it consists of. Each and every product that creates the airline meal is described by its function, material, history and design in detail in order to understand it and be able to properly evaluate each product further on.

This is achieved by more or less shadowing the product through its whole life cycle observing, analyzing, interviewing and documenting each user of every step in the cycle. Starting at the caterer where the airline meal is produced and composed, followed by several hours up in the air where it reaches the passengers and after that back again to the caterer.

3.1. AIRLINE MEAL

It is claimed that the first commercial airline meals were served on the Koninklijke Luchtvaart Maatschappij (KLM) flights between London and Paris starting the 11th October 1919. The airline was founded four days earlier making it one of the world's first commercial airlines and one of the few airlines of today that retains its original name (Loretta O'Hara, Christopher Strugnell, 1997).

Since then, airline meals have changed forms several times to match the sought dining experience of the airline; everything from simplified meal boxes to onboard chefs has been tried, some failed while other succeeded and became a norm (Peter Jones, 2011, p. 94). Most passengers today are used to is either a smaller snack/sandwich with a beverage or a complete meal served on a tray consisting of an entrée, main dish and a dessert. See image 1 on the following page for an example of an airline meal and tableware.

3.1.1 AIRLINE TABLEWARE

This project mainly focuses on a complete meal and therefore will the smaller meals be left out. The whole meal is served on the tray simultaneously together with a coffee cup, water, butter, milk, piece of chocolate, cutlery, napkin, salt, pepper and a refreshing towel. All these items come on the tray in a, by the airline, pre-defined layout furthermore, in business and especially first class it is common that the entrée, main dish and dessert are served separately in a more "restaurant-esque" style to meet the higher demands of the passengers in the respective class. The meal could also be served on more exclusive tableware without all the packaging that covers an economy class meal. The materials of the tableware in business and first class are also more genuine and often consist of metal, porcelain and glass. It is often common that airline uses famous designers with the same nationality as the airline to design tableware; for example, KLM partner in 2011 with dutch designer Viktor & Rolf to enrich their first class experience (Airlinetrends.com, 2011).

The economy class meal is normally served on a full size or a half size tray depending on the type of meal, airline and class. The tray dimensions are based on the type of

IMAGE 1(p. 27): How an airline meal often ends up looking after the passengers finishes their meal.

airline trolley standard used. There are many different variations of trolleys among the airlines, some use their individual designs while other use standard designs. The two most common trolley standards are the ATLAS and KSSU trolleys and together they represent the greater market share of trolleys across the world. The trolleys are coupled with trays specifically dimensioned for them, for example a full size ATLAS tray has the dimensions of 381 x 274 mm. For full technical drawings see Appendix B ATLAS Tray.
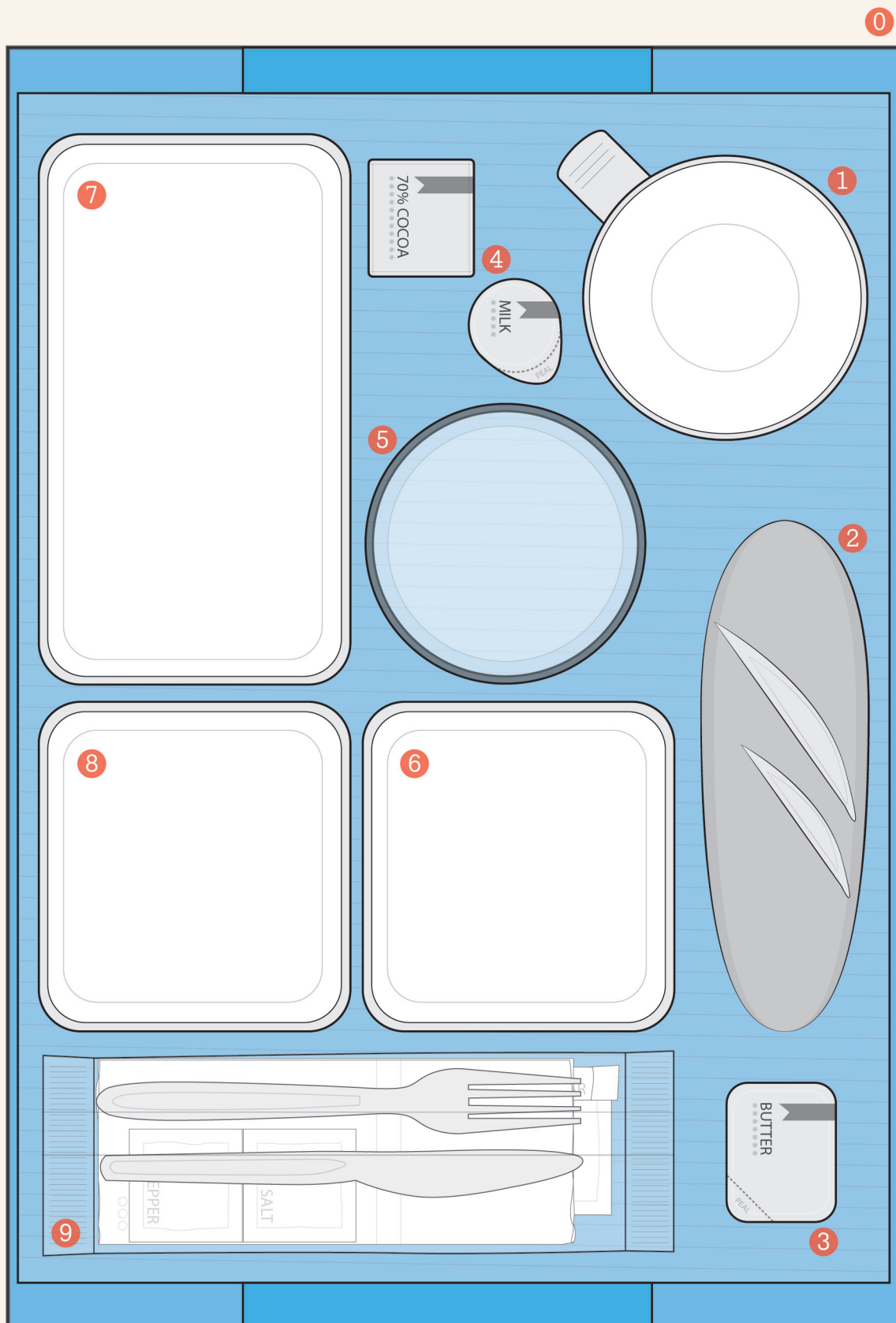
3.1.2. AN ECONOMY CLASS AIRLINE MEAL

On the following page is an explanatory illustration of a full size ATLAS tray and the products most commonly served to the passenger. See image 2 on the following page. These products are numbered in the illustration and will be explained accordingly in the following text.

Tray (0):

The tray is used bear the several different products which together create the airline meal. As mentioned earlier, there are several tray standards as well as several custom designed trays where the most common are the ATLAS and KSSU tray standards. The majority of trays today are flat with a one to two centimeter high edge around it. Most trays that are served to the passenger have an anti-glide paper on it in order to keep the products from moving around during handling and turbulence. Trays are used for most types of meals, from a sandwich and coffee to complete meals.

Coffee Cup (1):

On short distance flights it is common that coffee together with a smaller snack is served. Due to this, the coffee cup becomes the most widely spread tableware across all different types of meals served on the flights. Depending on flight distance, airline and travel class the cup is either paper, plastic or porcelain. Among full meals in economy class it is most common with the plastic cup. The coffee cup, when served

IMAGE 2 (p. 29): Illustration of an airline meal showing the components of the product.

70% COCOA

MILK
PEAL

BUTTER
PEAL

EPPER

SALT

with a full meal, often come with a package of water inside it. See number five in image 1. By doing so, a lot of space can be saved in the tray as the coffee cup always will be filled up later on by the flight attendant. This is widely spread across the industry and could be seen as an industry standard and therefore it is important that the two are designed so they can be put together.

Bread (2):

Often served as a part of the meal. The bread is either placed on the tray or handed out by the flight attendant during the serving of the meal. This often depends on the size of the tray used, where the full size comes with bread and the half size does not.

Butter (3):

Comes together with the bread. The butter is almost always served on the tray independent of how the bread is served. The butter is commonly packaged in a branded package.

Milk/Creamer & Sweets(4):

Depending on the airline the meal comes with milk or creamer. In general, more exclusive airlines serve milk or liquid creamer while the budget airlines tend to favor powder creamer. The powder creamer is often pre-packed together with the cutlery and other necessities. The milk or liquid creamer come often in branded packages while the powder creamer packaged together with the necessities are often not branded.

A small piece of chocolate or sweets is often served with the meal, it is most often separately served in a branded package on the tray.

Water (5):

Comes often placed inside the coffee cup in a transparent plastic container with a branded aluminum or plastic seal on top of it. The size and form factor is rather similar to the coffee cup with a capacity of approximately two deciliters.

Main Dish & Dessert/Starter (6, 7 & 8):

There are often two types of food containers, a larger one for the main dish and two smaller ones for the starter and dessert. This of course depends on the type of meal and therefore the amount of the smaller containers may vary. The smaller container is approximately half the size of the larger container. The same overall container design is most common to create a harmony between the tableware, same goes for the dimensions. Plastic is the most common material for the containers, but like the coffee cup, depending on travel class and airline it can consist of either porcelain, paper, plastic or aluminum. Some airlines that depend on more disposable tableware often use different types of containers, for example transparent plastic containers for the dessert and starter while the main dish is served in an aluminum container.

Cutlery & Necessities (9):

In economy class it is common that the cutlery comes packaged together with other necessities such as napkin, salt, pepper, refreshing towel, etc. When it comes in these types of packages disposable cutlery is often used. Before the terrorist attacks on September 11th 2001 first class passengers were provided metal cutlery and for some airlines also business and economy class. After the incident metal cutlery were evaluated for their potential use as weapons on flights and restricted among most airlines all over the world. This resulted in an increased use of plastic cutlery. The restriction has since then been relaxed in many countries (The Telegraph, 2005).

Recently airlines have made a move towards using reusable plastic cutlery, similar to the containers and coffee cups used, in an attempt to lower the large amount of disposable items sent to landfills (The New Zealand Herald, 2010).

3.1.2. INNOVATING THE SERVICE

The airline meal industry has from the start been trying to create an innovative system/service on how the product is served to the passengers in order to attract new customers and create a more profitable product. This has pushed the industry to numerous attempts of innovating and testing out new ways of getting the product to the passenger. Many of these attempts have been short lived while a few have caught on and have become a part of the airline meal system today. The failed attempts were often due to inefficiency and/or low interest from the passengers. Some examples of services and changes the airline companies have introduced are food coupons, "gatemeals", in-flight food bars and healthy alternatives (Peter Jones, 2011, p. 8).

Food Coupons

In order to still be able to serve the passengers food during the flight without the need to handle and store the food onboard the flight, food coupons came up as a feasible alternative. By supplying the passenger with a food coupon that is valid at the airport's restaurants the passenger can pick up a meal before their flight and enjoy it either on the airport or on the flight. The main problem with this service is that if the passenger is short on time it is not possible to pick up a meal prior the flight. The complicated part of the airline meals are moved from the airline and caterer to the restaurant and passenger.

Gatemeals

This is something in between coupons and the regular in-flight food services. The passengers can pick up their meal right before they board at the gate. This has been executed in a few different ways, Scandinavian Airlines (SAS) had a buffet setup at the gate where the passengers could select food of their taste and receive it in a carry on meal box which they could take with them on their upcoming flight or eat their meal while waiting at the gate. Another way has been to have pre-made food-boxes at the gate for passengers to pick up. The gatemeal alternatives are rather complicated

today due to that they still depend on a caterer and personnel serving the passengers their meals at the gate. Therefore it does not have any mayor benefits compared to the a regular in-flight airline meal and has to be more refined in order to become successful.

Pre–order

The pre-order is one of the most common alternatives today. The passengers books both their trip and their meal decision at the same time. Some airlines give the passengers several alternatives to their in-flight meal. On some airlines the passengers have to pay extra to get a meal while some airlines use the service more for the ability to let the passenger choose. Therefore the service can both be used to save weight on the flight and to achieve a higher passenger satisfaction. These aspects are important to the airlines future and therefore this is a rather viable alternative. See image 3 for an example of web-based meal pre-ordering service. The pre-order meal system has been successfully adopted within other segments of the travel industry, railway:

> *The Swedish train operator SJ use a pre-order meal system where the passenger when booking their trip selects if and what meal they would like for their upcoming trip. It comes with an extra fee depending on the type of meal the passenger selects. On board the train smaller meals are served to satisfy passengers whom did not book a meal for their trip (SJ, 2012).*

An alternative approach to the pre-order meal services has been tried by Lufthansa that setup specific kiosk, at which the passengers could login and select their type of meal one hour or more prior departure.

Light Weight Packaging

Efficiently using space and reducing weight are important factors for the airline industry in order to decrease their environmental impact. Many airlines have dropped

IMAGE 3 (p. 34): Example of how KLM lets their
passengers select a specific meal for their flight.

25

Your meal on board

Step 1: Enter your personal details

Discount for Flying Blue members

Enter your membership number for possible discount on the extra options

Enter your details

Privacy

KLM protects your privacy with the greatest possible care and according to Dutch law.

Privacy policy KLM

Step 2: View the menu

Indonesian rice dishes
SEK 121.00

A beloved culinary tradition: spicy chicken satay, ikan bumbu rujak nasi, a fresh Asian fruit salad and 'spekkoek'.

1 **2**

Step 3: Select your meal for each leg of your journey

Stockholm (Arlanda Airport) - **Amsterdam** (Schiphol)

| Passenger 1 | Snack, sandwich and/or meal | *MEAL SELECTION* | free |

Amsterdam (Schiphol) - **Rio de Janeiro** (Rio Internacional)

| Passenger 1 | Choice in standard meals (free) | free |

Choice in standard meals (free)
Indonesian rice dishes (SEK 121.00)
Bella Italia (SEK 129.00)
Japanese delight (SEK 129.00)
Dutch tradition (SEK 103.00)
Nature's favourite (SEK 103.00)

Rio de Janeiro (Rio Inter... ...ternational)

| Passenger 1 | | free |

Sao Paulo (Guarulhos International) - **Amsterdam** (Schiphol)

| Passenger 1 | Choice in standard meals (free) | free |

Amsterdam (Schiphol) - **Stockholm** (Arlanda Airport)

metal and glass packaging for lighter alternatives like PET, aluminum and Tetra Pak packaging solutions. Packages designed to be easier to stack and therefore optimize the space in the trolleys is becoming more common. The following is an example, though not airline tableware, of how modernizing equipment can affect the overall airplane weight:

> *A recent trend among airlines has been to ditch their current in-flight entertainment system and exchange it with tablets to offer the passenger a better experience and save weight. The airline Scoot, the budget unit of Singapore Airlines, showed that they could reduce the weight of their four Boeing 777 by 7 percent, even after adding 40 percent more seats on the airplanes. These huge weight reductions are due to the, almost, 6 kg per seat that the regular in-flight entertainment system weigh. For perspective that would add up to almost a ton of entertainment system on a Airbus a380 (Bloomberg Businessweek, 2012). This shows how important weight reduction within the airline industry is, both for the airlines economy and the global environment.*

Several airlines have started to serve their meals in the disposable pre-packaged aluminum or paper container they are delivered in from the pre-made food manufacturer, and therefore not serving them in the traditional airline tableware. This is an attempt to lower the overall weight of their meals. By using disposable containers they can also cut down on the cleaning costs which come with the reusable containers. LSG Sky Chefs in Sweden for example charges 0.30 SEK for each item that is washed, leading to an approximate total cost of 1.50 to 2.40 SEK per meal (Susan Sjöblom, 2012). From an environmental point-of-view this is a rather negative trend that accumulates large amounts of plastic and aluminum waste.

Alternative Ways of Profit

According to LSG SKY Chefs, airlines like Lufthansa have started to sell advertisement space on the back of the packaging for the refreshing towel. This is a new attempt to lower the cost of the airline meals but still keeping a good standard (Stellan Ristic, 2012)

A study performed by Triad Consulting showed that advertisement on tray tables were an underestimated source of media. Their study showed that 79% of the 8 600 participating passengers were later able to recall the advertisements without any aid. When shown the advertisement 90% of the passengers were able to recall it. The study also showed that 26% of the passengers had a stronger purchase intent followed by the advertisement (Brand Connections, 2012). Triad Consulting commented on the study as quoted:

"The data from the tray table advertisement studies is impressive. The very high recall rate may be due to the fact that the consumer is viewing the message for an extended period of time, and as a result, the key points more easily transfer into long term memory. Regardless of the mechanism, this seems to be an impressively effective advertising platform." Dr. Mark Guadagnoli of Triad Consulting

To strengthen these findings, a separate study showed that only 26% of the passengers were able to unaided recall the television advertisements which are displayed on the in-flight entertainment system (Brand Connections, 2012. These results indicate that there lies a huge potential within in-flight advertisement which is directly linked to the passengers meal. Like Dr. Mark Guadagnoli mentions it is probably linked to the long exposure times, but it may also be connected to the media form. The form is rather new to the users and they are not exposed to it everyday like they are to television advertisements.

Recycling & Environmental Responsibility

Currently the amount of products recycled depends on whether it is a domestic or an international flight and the airlines own policies. The greatest obstacle for recycling within the airline meal industry is the international biosecurity laws. They require that all international waste has to be combusted at special plants to avoid spreading of biological hazards globally. Due to the inconsistency in the meals origins, wether the are domestic or international, the caterers find it difficult to know what and when to sort and therefore tend to treat all waste similar. According to Gate Gourmet,

Stockholm Arlanda Airport, in 9 out of 10 cases they throw all waste in the same container in order to keep their operations efficient and profitable. In a few cases they are able to sort the aluminum cans from the rest of the meal. Basically the meals are not designed to be sorted and recycled (Niclas Häverbring, 2012).

In response to this airlines have started to work towards using more *rotable* items (reusable) that last at least ten washes before they are disposed instead of sending millions of disposable items to landfills each year.

3.2. TROLLEY

All passenger equipment and necessities are packed into trolleys; this includes all meals, drinks, trays, tableware, blankets, toiletries, newspapers, magazines, duty-free/sales items, headsets and first aid kits (Peter Jones, 2011, p. 156). As every trolley look rather similar they are marked with a sticker of what it contains and where in the trolley it is stored. An example of how this can be arranged is that the upper part of the trolleys is filled with special meals after those vegetarian meals and then meal choice one and meal choice two. Among the special meals is food for the crew, pilot and copilot stored. See image 4 on the following page for an example of how the inside of a trolley can be arranged. The trolleys used for the airline meals are usually equipped with trays while trolleys with other purposes, like drinks and necessities, are equipped with large drawers.

In order to optimize space and reduce the weight onboard the aircraft it is important that the trolleys and their containing articles are carefully packed to maximize the trolley's internal space. Therefore it is important that the products within the trolley are carefully designed in order to utilize the space as efficiently as possible (Peter jones, 2011, p. 158).

There are two common standards of trolleys, ATLAS and KSUU, which are the same as the trays are based upon. Some airlines like British Airways use their own customized standard, ACE. North American airlines also tend to favor customized designs. The KSSU is used by airlines such as SAS and KLM while ATLAS is used by Air France, Lufthansa and Novair, which are interviewed later in part 2.5 (Peter Jones, 2011, p. 248). The pictured trolley on the right is a full size ATLAS manufactured by Jet and fits 28 ATLAS trays and 14 Drawers. The meal trolleys are equipped with a cooling tray in the top of the trolley where dry ice or ice can be stored. There are also half size trolleys which are approximately half the length of a full size. The half size trolleys are more common on short distance flights while the full size trolleys are common on long distance flights. See Appendix C ATLAS Trolley for detailed dimensions.

IMAGE 4 (p. 39): Illustration of an ATLAS trolley showing dimensions and meal placing.

810

1030

305
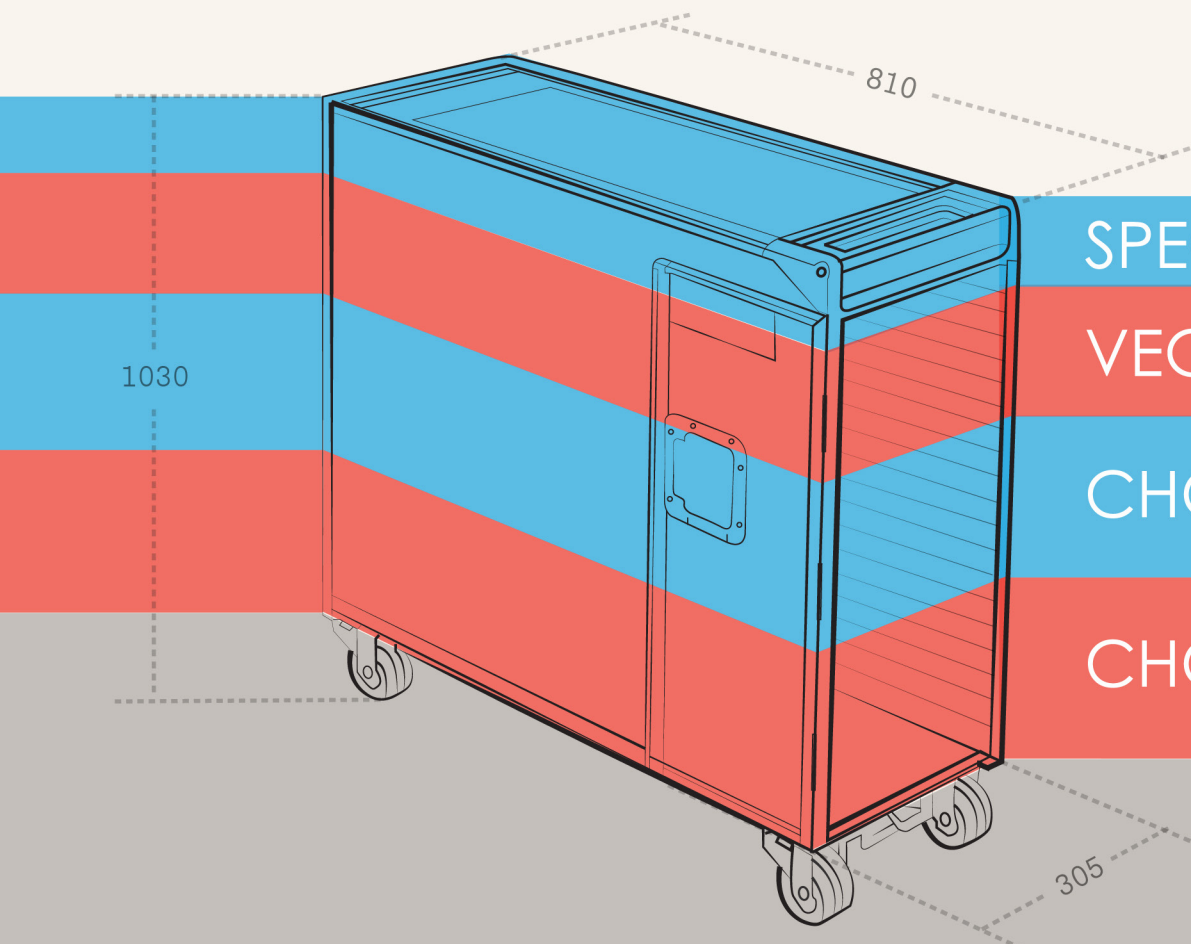
SPECIAL MEAL

VEGETARIAN
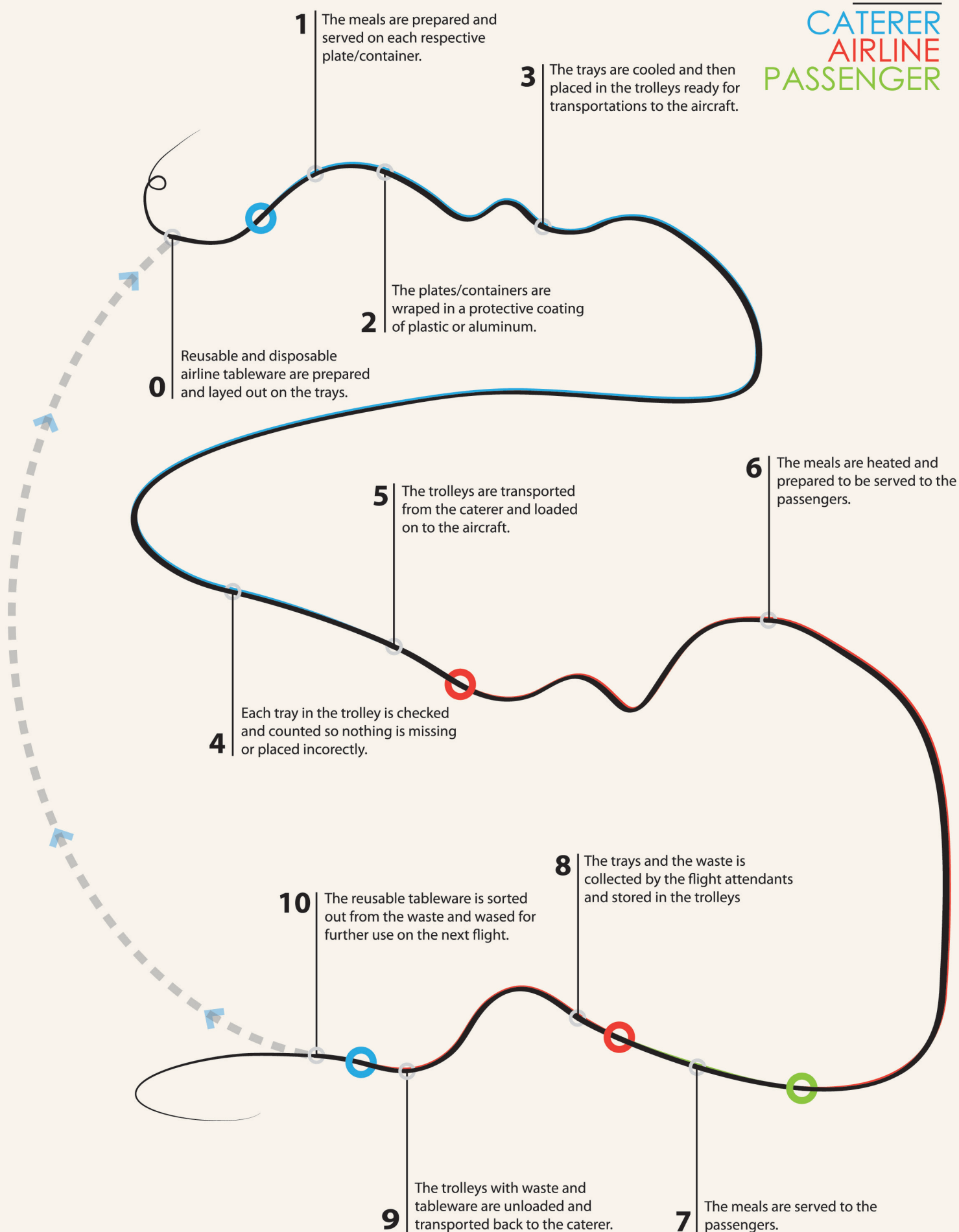
CHOICE ONE

CHOICE TWO

3.3. THE SYSTEM

The airline tableware passes through several different actors throughout its use cycle. One use cycle is from the point where the meal is prepared till it is disposed of or when it is washed and ready to be reused. During this cycle there are three main users that can be identified; the caterer, the airline and the passenger. The passenger is also the primary user, all other users work towards bringing the product to the passenger. This makes the airline (flight crew) and the caterer secondary users, and what could be considered a tertiary user is the loading/unloading personnel; they are a part of the system but does not come in direct contact with the product.

Image 4 on the following page shows the whole system with all the instances the tableware passes through. The user of the product shifts throughout the use cycle; it starts and ends with the caterer. If you distribute the different users throughout the use cycle it would be visualized as followed:

The Caterer → *The Airline* → *The Passenger* → *The Airline* → *The Caterer*

Just by looking at the distribution of the different users throughout the use cycle it is evident that the caterer and airline are more frequently in contact with the product than the passenger; even though the passenger is the primary user of the product. When examining this closer in the larger systems illustration, image 5, it becomes rather obvious that the user with most product contact is the caterer. The caterer is in most cases responsible for eight out of eleven instances in the use cycle of the airline tableware. In some cases the airport are responsible for the transportation and loading which makes the caterer only responsible for six out of eleven, but still the majority.

The airline tableware includes a wide variety of products, some disposable and some reusable. Therefore some of the products will be disposed of at the end of the cycle while others will be washed and reused for the next cycle. The reusable items often have an estimated life of 10-40 cycles depending on material, type of product and damages caused passenger or any other users.

1 The meals are prepared and served on each respective plate/container.

3 The trays are cooled and then placed in the trolleys ready for transportations to the aircraft.

2 The plates/containers are wraped in a protective coating of plastic or aluminum.

0 Reusable and disposable airline tableware are prepared and layed out on the trays.

5 The trolleys are transported from the caterer and loaded on to the aircraft.

6 The meals are heated and prepared to be served to the passengers.

4 Each tray in the trolley is checked and counted so nothing is missing or placed incorectly.

8 The trays and the waste is collected by the flight attendants and stored in the trolleys

10 The reusable tableware is sorted out from the waste and wased for further use on the next flight.

9 The trolleys with waste and tableware are unloaded and transported back to the caterer.

7 The meals are served to the passengers.

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3.4. THE CATERER

During the past twenty years the role of the caterer has changed drastically. As the name implies, their main role was previously to prepare and design meals on the request of the airlines. At that time the profession was all about the food, the caterers competed with skill and style to create the best looking and tasting meals that perfectly expressed the airlines brand. Later towards the 21st century the aviation industry saw a new trend, low price airlines. This was directly followed by the deregulation of the European air traffic in 1997 and ever since has low price airlines grown to become the larger airlines in Europe, such as Ryanair which is the second largest airline in Europe (Wikipedia Airlines, 2012). This new trend forced many traditional airlines to cut down on their in-flight services to be able to compete with the new wave of low price airlines. Due to the cut backs in in-flight services many airlines have exchanged the caterer prepared meals with pre-made alternatives that come in prepackaged containers. This required the caterers to adapt to the new trend and re-think their business which lead them to focus more on preparing the trays with the pre-made alternatives and packaging the trolleys making them ready to the flight.

According to Stellan Ristic at LSG Sky Chefs, Landvetter Airport, they have in recent years been forced to scale down their hot kitchen due to decreased demand of caterer prepared food. This is a result of both cut downs on in-flight services and the use of pre-made food. To counteract this downward spiral LSG needed to broaden their field of customers and is therefore also preparing food for schools in the Gothenburg region.

Today a flight caterer's main objective is to prepare the trays according to the directives from the airline and clean the incoming trays and tableware from the airlines. See image 6 on the following page. They still prepare food of their own, but this is most common on long distance flights and in business and first class.

3.4.1. AT THE CATERER

In order to identify the unique needs and demands of the caterer and understand how they work and handle the airline tableware two field studies were performed; one at

Gate Gourmet Arlanda Airport, Stockholm, with Niclas Häverbring and one at LSG Sky Chefs Landvetter Airport, Gothenburg, followed with an interview with Stellan Ristic.

The result from the field studies showed that the two caterers handle the product very similar and it did not differ at all. Both facilities had the same overall layout and workflow; from off load to on load was quite alike and followed the guidelines for catering facility planning and workflow (Peter Jones, 2011). The only noticeable difference is that they serve different airlines and that the LSG facilities were of a much smaller scale.

The caterer starts by off loading the trolleys and emptying them. The reusable content of the trolleys are sorted out from the waste and put into the dishwasher while the waste is disposed. Very little to none of the waste is recycled even through it contains recyclables such as aluminum cans, plastic containers and organic waste. All is disposed in the same container and later combusted at a local plant. Waste from flights that originate from outside of the European Union (EU) has to be treated specifically due to biosecurity laws. Therefore all non-EU waste is collected in a separate container which is then sealed and transported to a specific combustion plant in Linköping, Sweden.

While the tableware from the airline is washed, prepared and laid out on the tray ready to be served again the kitchen prepares the meal according to the airlines meal specification (Peter Jones, 2011, p. 91). The caterer's prepared meals are served on the tableware which arrives with the airplane. Both hot and cold meals are wrapped with a protective plastic film or aluminum foil that covers the container. The pre-made food is either served in its original package in the airline tableware or directly on the tray. These non-branded packages come in a aluminum container or a paper container with a plastic or aluminum seal on top. In what manner the aluminum and paper containers are served varies widely between the airlines. Some airlines serve them on tableware, some directly on the tray and some have a folded paper covering the container.

When the preparation of the trays are finished they are then returned to their trolleys. After the trolleys are fully loaded they are cooled down with blocks of ice or dry ice before they are controlled and sealed with security straps ensuring that the container has not been opened or tampered with. When the trolleys are sealed they are stored in the on-loading section waiting to be transported to the aircraft.

One of the major reasons to the almost non-existing recycling is that many airlines use a combination of disposable and reusable products combined with the bio-security laws makes it nearly impossible for the caterer to recycle the products. The disposable products are also often made out of different materials which make it even harder for the caterer to sort out the recyclable and non-recyclable waste. The amount of disposable and reusable products used is often dependent on the type of class, meal and distance of flight.

3.5. THE AIRLINE

In-flight services such as airline meals are at the core of airline branding and a way for the airlines to differentiate themselves from others. Therefore airline meals have come to be a strong part of the perception of commercial aviation among its passengers. This makes the airline the client for both the caterer and the airline tableware manufacturer. These two actors have to understand the airlines needs and present a possible product, service and meal solutions that fits the airlines brand, economy, passengers and heritage.

In order to gain insight into the industry and understand how an airline thinks when deciding upon the meals, cutlery, tableware and how they together shall create an experience that matches the airline and passengers expectations. These topics were discussed at a meeting with brand and catering representatives from Novair (Nova Airlines AB); Susan Sjöblom, Catering Coordinator, and Hansine Hjellmun, Director of Commercial & Production. Novair is a Swedish airline focused on holiday destinations around the Mediterranean that serves four of the major Scandinavian airports with their fleet of four aircraft (Novair). Image 7 on the following page shows the inside of one of Novair's aircraft, Airbus a321-200.

Due to Novair's fleet size they procure pre-designed tableware from major manufacturers like Helios and DeSter (both part of the Gategroup, a multinational supplier of in-flight passenger services and experiences). The pre-designed tableware often comes in several different colors and designs which makes it easier for the airline to find something that fits their own brand and type of meals served onboard. It is also possible for the airline to brand these products through custom coloring, logotype and graphics. The meals served on Novair flights are prepared by the pre-made food producer Dafgård (Gunnar Dafgård AB). These meals are created to fit Novair's brand and to be appreciated by the majority of passengers. As meals are not complementary on most of Novair's flights they invest more into the meals to give the extra paying customers the experience and value they seek.

With the meal and tableware selected by Novair it is up to the catering firm (LSG Sky Chefs) they have contracted to do their serving and tray layout. The caterer creates

EXIT

Door locking indication

OPEN

Disarmed !

Armed !

REMOVE BEFORE

DANGER

Locked   Unlocked

GEVALIA
FREEZE DRIED
INSTANT COFFEE

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several appealing meal presentations based upon the food and tableware used. This is later presented to the airline which then selects a meal presentation that they like. The layout is then later used as a template for the catering personal when preparing the meals.

3.5.1. ONBOARD THE AIRCRAFT

It is not only the brand and catering representatives that are in contact with the product at the airline. The flight crew work with the product each day and is a central product in their line of duty. It is therefore of importance to understand how they perceive the product and observe how they work with it both on ground and in the air. A field study was carried out on a Novair flight from Gothenburg to Antalya and back together with the flight attendant Carina Widén and her colleagues.

The crew's first contact with the product is when the trolleys are being loaded on to the aircraft and placed into their specific compartments in the galley, which is the aircraft's "kitchen". See image 7. The manner in which the aircraft is loaded and the placement of the different trolleys and compartments vary between airlines, airplane and the layout of the aircraft's interior. For example on short distance flights the aircraft's interior layout is different and the galley is often much smaller than on the same aircraft that traffics a longer distance. The way the food is packed may also vary, for example on the Novair flight the ovens were pre-loaded with hot meals. So for the flight attendant to prepare the meals, the first step was to turn on the ovens and let the meals heat up. This way of handling the meals was essential for Novair in order to get the meals out and served in time during shorter flights to destinations around the Mediterranean. When the meals are entirely heated they are removed from the oven and placed in the containers which are stored in the trolleys. This task was mainly performed by simply sliding the tray out a few centimeters at the most and placing the hot meal in the container. The task became very smooth and time efficient due to the layout of the tray and that each container were placed closest to the door of the trolley.

When all meals in the trolleys are prepared the meals are served to the passengers,

with the exception of special meals which are prepared and served in advance. The trays used by Novair were designed to drag out one another, so when you pull out the first tray it would move the tray in the back up front so it easily could be reached next. This feature was successful most of the times and the back tray was released from the first tray when it came up front. With the incorrect technique or bad layout of the tableware you could end up pulling out both trays resulting in one falling to the cabin floor. Another incidence that could occur when serving the passengers was that the plastic seal of the dessert container could "pop" off and end up somewhere else. This was mainly due to poor design leading it to become difficult for the caterers to apply the seal correctly. It was also mentioned during the interview that the coffee cups used by Novair, designed by Helios, had a to narrow bottom diameter which made it hard to place the water and yoghurt containers properly in the cup. This impacted the tray layout negatively and made it harder to handle.

When the passengers finish their meals the trays are collected by the flight attendants and are placed back into the trolleys they first came from. When the trays are returned to the flight attendant the products on them have all changed place; it is often that all of the tableware products, plastic and paper waste is all over the tray. This may complicate the procedure of pushing the trays back into the trolley in their dedicated slots. Many passengers try to ordered their waste neatly in the different containers and cups to help the flight attendants. This may in some cases help the flight attendant while in other cases makes it harder for them. An example of when the passenger has been too helpful is when they have build a small pile of waste that exceeds the tray slot height in the trolley which makes it difficult for the flight attendant to fit the tray back in again. This results in that some trays have to be forced back in, making the trolley totally chaotic and disorganized. The trolleys often ended up looking like a trash bin with trays all over and waste just pushed in where there was space. This looked nowhere near the neat and structured trolleys which first came on board the flight.

3.6. THE PASSENGER

It is difficult as a passenger to imagine all the work put into making the airline meal for the flight, but in the end both the caterer and the airlines future are dependent on how well they satisfy the passenger.

Among different in-flight services the passengers value other aspects like a good frequent flyer scheme, a convenient schedule and fare price higher than the airline meals (Peter Jones, 2011, p. 55). Though a meal of low quality and poor presentation will affect the passenger's opinion of the airline and if this re-occurs several times it may cause the airline to loose passengers. Not serving meals on the flight may in many cases be better than serving a poor meal.

A method to ensure a medium to high level of passenger satisfaction is to serve branded meals or meals that include branded products. By using products the passengers recognize from their daily life or even their own refrigerator it will give them a stronger trust in the food and feel acquainted with the taste (Peter Jones, 2011, p. 92). For this to be really successful it requires the use of more premium or well known brands which the passengers associate with high quality and good taste. This, in many cases, is followed by a higher price per item compared to non branded or unknown brands. The strategy has been adopted by many airlines today; one specific example is United Airlines which both serve *Starbucks* coffee and *McDonald's Friendly Sky Meal* (Peter Jones, 2011, p. 94). Another example is the SAS breakfast kit which includes *God Morgon* orange juice, *Bregott* butter and *Arla* milk all well known brands among their native passengers. As seen in image 8 on the following page.

3.6.1. DO YOU LIKE IT?

A survey was carried out on the Novair flight from Gothenburg to Antalya asking the passengers about their attitude towards the waste produced around their airline meal. Fifty-eight of the dining passengers filled out the survey, twenty-eight men and thirty women. The age among the participating passengers ranged from 13 to 78 years and the average age was 43 years. The majority of the participants of the survey said they travel by air one to three times per year for leisure purpose. Less than one fourth said

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they traveled by air in their work. Half of the passengers said that they recycle more or less everything in their own household and the same passengers found it important that their flight is environmental friendly.

The findings of the survey showed that almost all passengers arranges their waste on the tray before it is collected by the flight attendant. Half of the participating passengers answered that they during their meal can find the excess packaging bothering or difficult to put away. When asked if they would be willing to assist the flight attendant by arranging the waste accordingly almost every passenger answered that they were in favour to assist to some extent. For detailed survey data see Appendix D Passenger Survey - Novair.

A recent controversy that arose among the public in New Zealand and Australia were that several airlines in the region, and globally, reused their plastic cutlery and tableware. Before it became known to the public, most passengers believed that all plastic cutlery used by the airlines were disposed after each use. When it was discovered that many airlines used reusable plastic cutlery the public responded with disgust, feeling it was unhealthy and filthy (New Zealand Herald, 2010).

3.7. FOOD SAFETY

A food hazard outbreak on an airplane can be devastating and affect more than hundred passengers and the crew. It is therefore important that the food is handled properly throughout the whole chain from caterer to passenger. At the caterer the food safety regulations are constantly controlled by food safety personnel whom are responsible for food quality control. They control and analyze the food and production environment to ensure that it meets the standards and that he food loaded on to the aircraft is correctly handled and safe to eat. To fully ensure high food safety it is important that the catering personnel and the airplane crew follows the food safety guidelines (Peter Jones, 2011, p. 136, 170, 173 & 177).

Reducing the Risk of Biological Hazards

» Good hygiene among personnel handling the food.
» The food is properly chilled and kept below 5° C.
» The meals are thoroughly heated above 70° C and kept at that temperature for at least 2 minutes.
» The meals are served within 15 minutes of reheating; temperature must not fall below 63° C.
» Meals not consumed must be destroyed.
» Chilled food can be saved for 48 hours if it is cold food and 72 hours if it is warm food.
» Use of commercial dishwashers which improve sanitation of tableware.
» The commercial dishwasher must reach above 80° C to meet set food safety regulations.
» Dishes flash dry at the end of the wash cycle, reducing food safety risks.

IDEATION

The ideation and concept development phase will initially transform the data collected from the pre-study in to tangible design goals and requirements. With structured guidelines the project is then ready to enter the ideation and brainstorming. To catalyze the brainstorming, similar products and innovative products were examined to find inspiration for the product ideation. With guidelines and inspiration the product ideation followed through numerous steps of sketching, prototypes and visualization. Due to the large quantity of early and diffuse concepts this part focuses mainly on following the final concept through the ideas and sketches that lead to it.

4.1. CONCEPT GUIDELINES

The concept development was initiated with a compilation of key product requirements and goals which were based on the pre-study. The compilation will guide the design process in the right direction to create a concept which satisfies the unique needs of the passengers, caterer, airline and environment. The concept should also be led in the direction that enables the product to capture and express what the next generation of airline tableware would look and feel like. The composed compilation below includes guidelines for the design, current issues and important industry standards.

Design Goals:

» Cup size that matches the water container.
» Follow the ATLAS trolley standard. (The trolley standard was selected in order to simplify the design process and does not favor any trolley standard over another)
» Account for international quarantine and biosecurity laws.
» Easy for different airlines to brand the product and give it their personal touch in order to differentiate them from other airlines.
» Possibilities for airlines to sell advertisement space on the product, in order to lower the cost of the meal.
» Minimize the use of disposable items.
» Possibility to customize the tableware according to the airlines different meals.
» Sustain at least 10-40 use cycles before it is disposed.
» Cutlery shall feel more genuine and not be associated with cheaper disposable alternatives.
» The tableware shall be adaptable so it can be used for both caterer prepared meals, branded meals and pre made food.
» Intuitive and recognizable design, but also with an innovative and modern touch to clearly differentiate the new airline tableware from others.
» Simplify collecting of the airline tableware after passengers have finished their meal.
» Optimize the product's materials to achieve good functionality, long life time, low environmental impact and low weight.
» Follow health regulations and recommendations.

4.1.1. CONCEPT FEATURES

The design goals were broken down to easily identify important concept features and those which should be avoided. A matrix was set up where each feature was evaluated against the caterer, airline, passenger and environment in order to understand how the different features affect each of them. It was important to include the environment together with the users in order to measure each features affect equally on both the environment and its users. The three most important features and the three least wanted features are summarized below, for the complete matrix see Appendix E Feature Matrix.

Must Have Features:

- » Compact design
- » Airline brand
- » Advertisement

To Be Avoided:

- » Disposable
- » Biodegradable
- » Cheap expression

The low scores on the disposable and biodegradable features are directly linked to the international quarantine and biosecurity laws; all food from international flights must be considered hazardous and therefore be combusted at special plants; see part 2, Pre-study, The Caterer, page 28. Therefore it is not possible to recycle or use any type of biodegradable materials yet, if the tableware is supposed to be used on international flights. This leaves only two viable options; disposable items which are combusted after each meal or reusable items which are washed and reused several times after each meal, 10-40 times. This resulted in a higher desire for reusable items which will lower the amount of the products disposed of after each airline meal. If disposable items are required then they should have as little CO_2 impact as possible

when combusted. Weight is also considered one of the most important features in order to lower the overall CO_2 impact. By lowering the total weight of the product or designing a smaller and more compact product it is possible to save weight by decreasing the amount of required trolleys to carry the same amount of airline meals.

4.1.2. INSPIRATION

To create a design that differentiates itself from mainstream airline tableware it is important to look for inspiration in nearby fields like product packaging solutions and modern ground-breaking products. Products that are efficiently and intelligently designed to minimize the environmental impact and continue being competitive on the market. See image 9 on the following page for inspiring products.

A. Smart Packaging

Chimney Charcoal is a neat example of how you easily can redesign the packaging and also add functionality to the packaging instead of just using it as a container for the content. In this case the smart packaging solution makes the product easier for the user to use, lowers the environmental impact by eliminating the use of lighter fluid and also leaves no waste products (Micheal DiChristina et al., 2012).

B. Simple Elegance

This egg carton is a take on how you can redesign the very classic egg packaging. The design is nothing extraordinary, though it delivers the eggs in a much more elegant and compact package compared to the original egg carton. The simple and compact packaging both requires less material and less space in the fridge and while transported (Otília Erdélyi, 2012).

C. Resourceful Design

The Nike Flyknit may be the next generation of shoes. By rethinking the whole process

IMAGE 9 (p. 59): Inspiration found in products like Nike footwear, egg cartons and innovative grill packaging

A

B

FRISS BIOTOJÁS

C

of creating a sports shoe Nike was able to come up with a technology and design that both made the shoe lighter, cheaper to manufacture and best of all it has almost zero waste products when manufactured (Fast Co. Design, 2012).

4.1.3. EARLY CONCEPT

The summary board, image 10, on the following page captures and visually summarize features and requirements that would represent a desirable design of an airline tableware. This could be seen as the first iteration of the airline tableware concept.

To quickly see how compact it was possible to create the design and still fulfill the necessary requirements like fitting into a ATLAS trolley a quick sketch using only squares was drawn of each product piece. The squares represent their approximate size in order to see how compact it was possible to fit everything on the tray and still be usable and fit in the trolley. See Appendix F Size Verification. The visualization showed that the minimum dimension of the base should be approximately 270 x 192 mm, which is similar the half size tray used today on ATLAS trolleys. See Appendix B ATLAS Tray. Together with the measurements and the summary board it was possible to get a brief picture of how the concept could be expressed verbally:

> *A lightweight and compact meal that is possible to seal and consist of reusable products. Each product should sustain a number of use cycles before they start loosing quality and look worn out. The meal should also in someway incorporate advertisement space as a way to reduce the cost of the meals.*

A verbal concept like this becomes a strong utility when continuing with the concept development as it becomes possible to quickly verify different concepts and see if they lack any aspects of the verbal concept.

LIGHTWEIGHT
COMPACT DESIGN
INTERNATIONAL QUARANTINE & BIOSECURITY LAWS
ATLAS TROLLEY LID
NON–TRADITIONAL TRAY
ADVERTISEMENT
REUSABLE
ORGANIZED LAYOUT
SENSE OF QUALITY

4.2. EXPLORING IDEAS

To continue the concept development and explore different possibilities almost endless brainstorming and sketching sessions laid out the foundation of how the airline tableware could be designed to fulfill the requirements and innovate the product. What makes tableware so special is that it consists of several products and therefore becomes a product of products. Therefore every product included in the airline tableware is a part of creating the whole experience and expression of the product. When designing such products it becomes important to look at the product as a whole before focusing individually on each product; you have to find the overall expression before giving each product their unique look.

The idea and concept exploration started out by trying to find a base profile that would encapsulate the other products in a simple and compact way that looked elegant. See image 12 in the following page. A few profiles that captured this type of expression and functionality was, the "lightly folded paper" (1), "pincer" (2), and "valley" (3) . See profiles below.
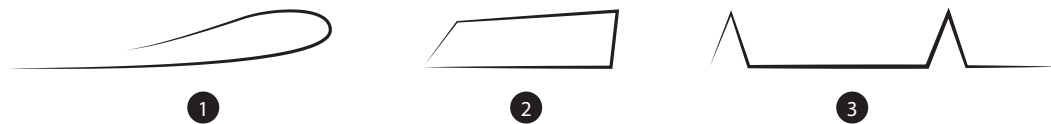
These profiles were worked into product concepts experimenting with solutions how to encapsulate the products and basically get a feeling of the overall expression the product has. The idea exploration of the different profiles can be seen in the summarized image on the following page. All ideas were continuously evaluated by using the design guidelines and summary board as a direction of what a "good" design would be. This helped capture the pros of each specific concept and of course also highlight features that should be avoided and did not work.

The greatest challenge for most concepts were to them compact and still fit all the required items. One key feature that was highlighted as positive during the early

PLATE.
SUGAR CANE FIBRE.

AIRLINE TRAY...

PICK

WRITE ON THE TRAY

BENT TRAY STYLE

CHEAP LUXURY.

MINIMA WAST AND STUFF ON TRAY

SAME SIZE, TWO TRAYS

SLICED TRAY.

EXTRAS.

STANDARD SIZE 40 x 25

CARTS

CLOSED

DOG FEADER

FOOD BOX

PACKAGED DRINKS. (TETRA

PLASTIC

PAPER

POWER

ARCHITECTURE.

PRETTY COOL

WATERY?!

GOOD

BUMP IN MIDDLE.

DIVIDE

BREAD.

TIGHT

SQUEEZE !!!!!

MAX HEIGHT

COFFEE.

TRAY

MENU

PLASTIC BASE.

TROLLEY

EXCLUSIVE?

CURVED OR STRAIGHTER?

FULL SIZE

NECESSITIES & CUTLERY

PAPER

MENU

ECO

PUSH

PUSH

KEEP

stages of idea exploration was the use of a paper cover as a lid or cover.

The second profile, "pincer", proved to be superior through the conceptual sketches, basically due to its use of space in the most optimal way. Though it lacked some of the elegance which many of the concepts based upon the first profile, "lightly folded paper", possessed. These profiles were therefore merged to try to capture the uniqueness of each profile without sacrificing any of the benefits. The result of combining the two profiles gave a new fourth profile with softer edges and a more arched take on the original "pincer" profile. Named there after, the "arched pincer". See image 13 below.

4.2.1. VERIFYING THE PROFILE

v The tilted top was shown to be ideal when fitting the items due to the height difference between the cup and the food containers. There were no issues with fitting the items and the container design actually gave a lot of extra space for the interior items, it could even be possible to shrink the container size.

IMAGE 13 (p. 64): Illustration of the proposed shape.
IMAGE 14 (p. 65): Early prototype of the concept for verification of the designs dimensions and form.

57
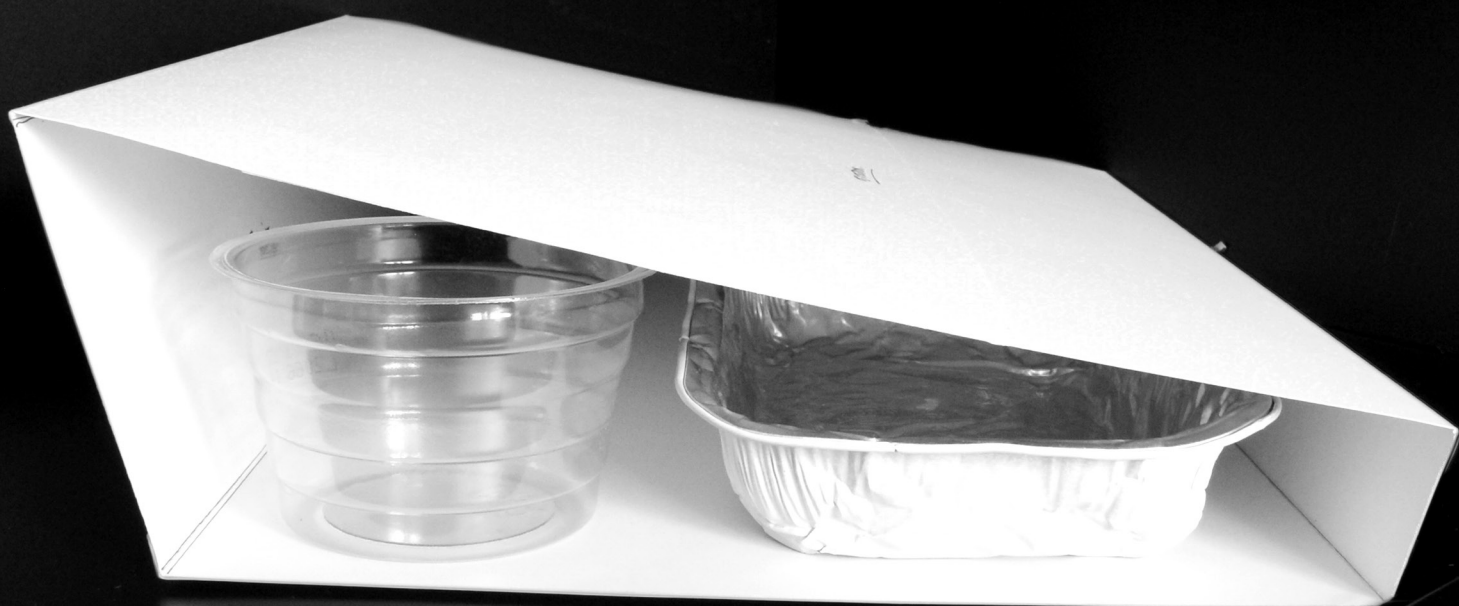
4.3. DEFINING THE CONCEPT

With the profile verified, the concept development followed with more sketching to define, remake, enhance and come up with a more solid design. See image 15 on following page. In this stage of the process typical features for the product started to emerge; for example a foldable paper cover, a solid plastic base, specific compartments for the cutlery and a base size of 270 x 192 mm.

The use of a paper cover both made the meal more structured and neat, for example when the passengers have finished their meal they can easily close it together while waiting for the flight attendant to collect it. The feature also simplifies for the airlines to brand their product by creating different prints and designs for the paper cover. This way smaller airlines do not need to invest as much into branding all of the interior products like the cup etc.

The idea with a paper cover is also that it divides the product in to an exterior and interior product. This way the exterior product will encapsulate the other products and give the product a solid and neat first impression. The interior products can therefore consist of branded products, pre-made food packages of paper or caterer prepared dishes served in containers and still give the same first impression. Though reusable products are always preferred.

The paper cover is also planned to be exchangeable, which enables the possibility to use different covers for the meals throughout the day and individual customization through print; you could for example add a menu, nutrition facts, advertisement, etc. For example a advertisement space of almost an A4 can be a valuable resource for many airlines to improve their flight's profit. On a long distance flight this can mean ads displayed to 250 or more passengers per meal served.

To continue the concept development and further define the product, the ideation and sketching focused on the interior products such as the cup, containers and cutlery. These products are equally important as the exterior product in order to create a fluent design language. They all have to be lightweight, serve their individual function, comfortable to use, express quality and look great together with the rest of the products.

IMAGE 15 (p. 67): Detailed product concept sketches of airline tableware and interior products.
IMAGE 16 (p. 68 & 69): Final concept visualization.

CONCEPT. ①
NEWS

FOLDABLE.

CHANGEABLE
COVER...
BRAND...
MEAL...
SEASON...

PAPER
MENU or
ECO FACTS

COMPARTMENT

CUTLERY +
NECESSITIES

MEAL + COFFEE
DESSERT + GLASS

OPEN

CLOSED

MENU / ECO

PLASTIC

PAPER

WRAP
TOGETHER

SLIDE IN
PAPER COVER

FLIP
ROTATE 180°

MENU
• SHRIMPS

• MASHED POTATOES

ECO

FLIP

MEAL

PLACE CAN INSIDE THE TUBE

NEWS PAPER STYLE

CLOSE

LATCH.

CUTLERY

2012 CUTLERY

BREAK

BREAK

BREAK

BREAK

KLEENEX

59

4.4. Concept Visualization

OPEN

CLOSE

Cutlery

PRODUCT
COMPARTMENT

Top

Front

Profile
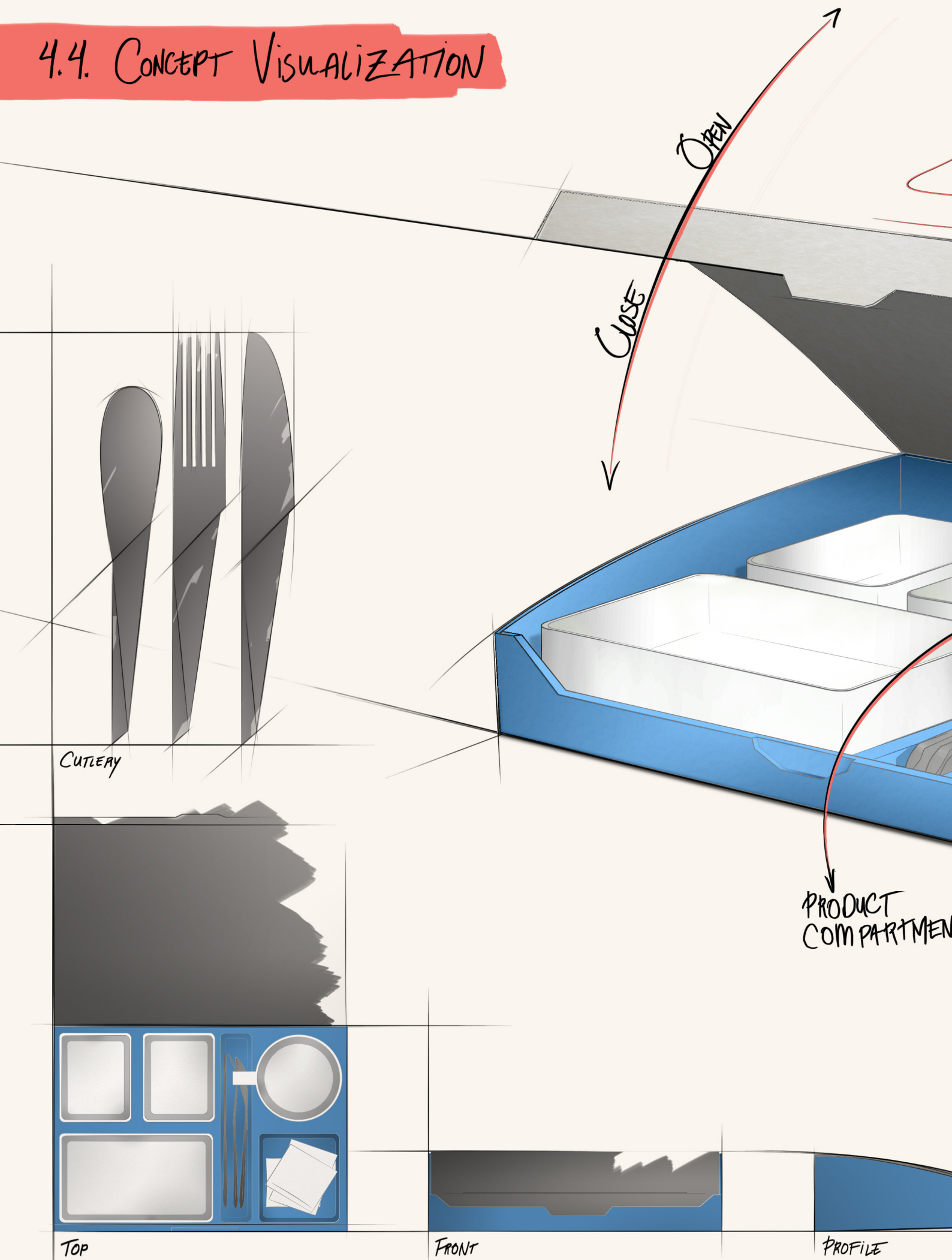
BRANDED
PAPER TOP

PULL TO EXCHANGE

80mm

192mm

PLASTIC BASE ♺

40mm

270mm

FINAL DESIGN

The final design phase will transform the concept defined at the end of the ideation and concept development phase in to a final product candidate. This phase of the project focuses on translating the final concept sketches to CAD models in order to verify, refine and present a final product. Through refinement of the CAD models a final product candidate emerges. With detailed CAD models of each product it becomes possible to create high realism 3D visualizations, drawings, simulations and detailed specifications of the final product. The following part focuses on presenting the whole product and each individual part by its function, material and design.

5.1. AIR DINNER

The product *Air Dinner* features a complete set of tableware specifically designed for airline meals. It consists of a tray, paper cover, coffee cup, large container, two small containers, fork, knife and a spoon. All the products are designed to fit into the tray in their specific compartments to create a neat and structured way which simplifies handling of the product for its users. An *Air Dinner* meal has the width of 270 mm, which is the slot width of an ATLAS trolley, a depth of 192 mm and a height of 53 mm. With these product dimensions it becomes possible to fit up to 52 trays, four trays per row; depending on the configuration of the trolley, its size and standard. This is twice as many trays compared to regular full size trays without compromising any of the products of a full size tray. Basically it is a full size tray in a half size format.

The overall design language of *Air Dinner* is affected by the trolley's dimensions and the importance of keeping the product as compact as possible in order to fit as many meals per trolley as possible. Therefore the overall design is predominantly based of squares in order to use the limited space as efficiently as possible. Despite the overall "square-esque" approach all products have been given a softer touch in order counteract the otherwise sharp edges, straight lines and formless feeling. The black and white line of the containers specifically enhance the softer corners of the design by giving it a sharp contrast which emphasizes the rounded corners. Due to its transparency more lines become visible which blurs the sharp corners of the square base. The color scheme is very neutral and discrete with mainly black and white except for the cover and necessities. It is important to use neutral and discreet colors in order to not influence the presentation of the food in a negative manner. The design and elegance of the tableware is instead enhanced through its details, patterns, lines and contrasts. All together *Air Dinner* creates an expression of a light, elegant, simple and appetizing airline tableware.

As seen in the image 17 on the following page the base of the tray consists of a transparent plastic with a flip-able paper cover. This will give an expression of new and alternative tray design compared to the standard airline tableware. The cover helps enclose the product and gives the exterior a compact and clean expression, while the transparency makes it feel light and airy. The synergy effect of these two

IMAGE 17 (p. 73): Digital visualization of the final design for *Air Dinner*; close-up and full view.

features creates a new airline tableware experience and the product as a whole receives a new level of detail and interaction. All of the products in image 17, except the paper top and the salt and pepper, are considered rotable items and are meant to be reused several times.

5.1.1. TRAY DESIGN

The tray is the base of the airline tableware and also the centerpiece of the product. It is designed to be robust and easy to use and at the same time remain very compact compared to other full size airline tableware. A digital visualization of the tray can be seen in the image 18 on the following page.

The design of the tray is based on the dimensions of an ATLAS trolley tray slot and therefore has a width of 270 mm. The width of the tray is slightly narrower than the slot width of 276 mm which creates a small marginal on the sides to make it easier to slide in the tray. The depth of the tray is 192 mm and the height is 53 mm. These dimensions are partially defined by the interior products of the airline tableware but also the ATLAS trolley. The tray is divided into six different compartments that are specifically designed after their individual product. See image 19 below. Compartment one and two are used for desserts and starters while compartment three is used for the main dishes, the fourth for cutlery, the fifth for the coffee cup and the sixth is for necessities such as pepper, salt, refreshing towels etc.
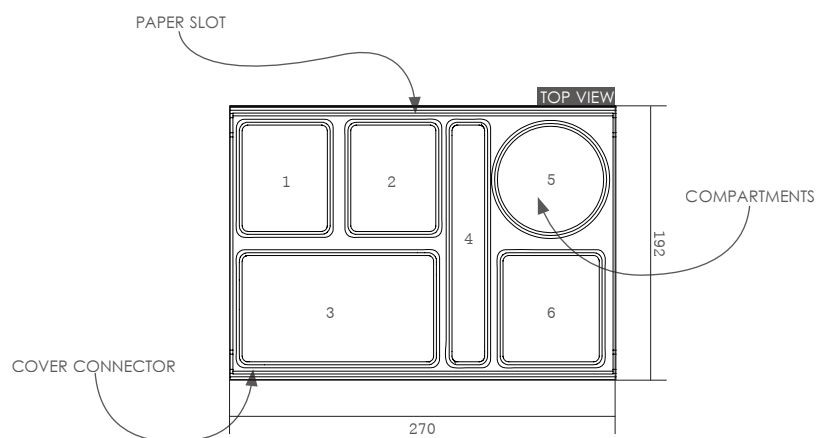
PAPER SLOT

TOP VIEW

COMPARTMENTS

COVER CONNECTOR

192

270
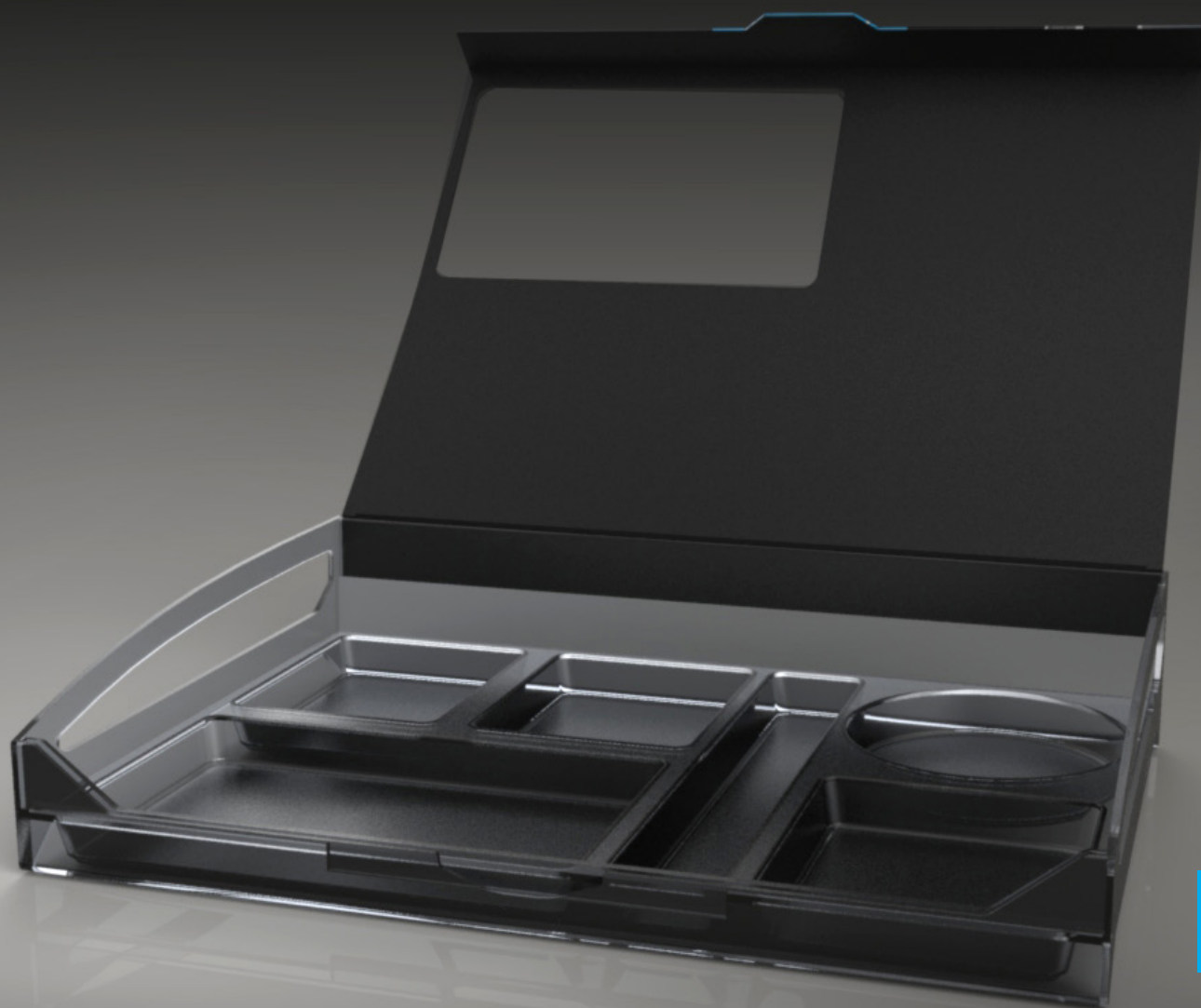
The tray consists of a lightweight design without any massive sections, the average material thickness of the tray is 2 mm. The thin material thickness is made possible through the tray's complex shape with compartments and strengthening elements. The materials thickness is an important factor in order reduce the weight compared to common flat trays. Based on the form factor and materials the simulated weight of the tray is 357 g which corresponds to the weight of the larger flat full size tray used today.

A slot for the paper cover is located at the back end of the tray. The slot is designed to hold the paper top together with the tray yet still be easy to replace. The front of the tray designed with a similar slot as in the back of the tray. What differs the from slot from the back slot is that it is designed to lock the paper cover in place when it is closed. This heals keep the meal sealed together when handled by the caterer and flight crew. By just pulling the paper cover upwards it will pop open and the user can open up the meal.

To ensure a high quality product which sustains several use cycles without loosing durability and surface finish it is important that the tray is manufactured in a durable material. In order to encourage recycling it is significant that the product is easy to recycle and fits the recycling system in society. Due to the trays transparent design it was important to find a suitable polymer with the required attributes of recycling, durability and appearance. Polyethylene terephthalate more known as PET was found to be a highly suitable alternative since it possesses the desired attributes of transparency, durability and temperature resistance along with being easy to recycle and easy to sterilize. See Appendix G Material Selection. PET recycling programs are established in many countries around the world, for example 48.3 % of all PET bottles in Europe are recycled (Wikipedia PET, 2012). These extensive recycling programs of PET will facilitate the adoption of PET in airline tableware's trays.

5.1.2. TABLEWARE DESIGN

The tableware consists of two small containers for starters and desserts, one large container for the main dish and a cup for coffee and tea. See image 20 on the following page for a digital visualization image of the tableware. All of the tableware is designed and dimensioned to fit their specific compartment in the tray and thereby create a compact and well presented meal. They are all designed to be durable and used as *rotable* items, and therefore be able to be reused several times before disposed of. The materials, colors and forms are all selected to enhance the desired robust, clean and elegant feeling to ensure that the passengers feel comfortable and pleased while eating their meal.

The material selection, in Appendix 7, showed both that Polypropylene (PP) and Acrylonitrile butadiene styrene (ABS) were suitable materials for the tableware and are common in commercial tableware and other household products. They are both recyclable, tough and have similar CO_2 emission levels during the production of the material. The main advantage of ABS compared to PP is its aesthetic attributes like multiple coloring possibilities, high detail molds and more exclusive surface finish, while PP has higher thermal resistance. The aesthetic features of ABS makes it more fitting for the sought style of the product and is therefore selected as the material for the tableware. The main concern with ABS is that it does not age that well; overtime the material looses its high surface finish and elegance. This will not likely be an issue for the tableware due to its short lifespan of 10 to 40 washes before it is worn out.

Cup

As mentioned in the pre-study, the cup is the most widely spread tableware across the meals provided by the airlines. Therefore the cup was designed to feel special and unique among the rest of the tableware. By decorating the lower part of the cup with a pattern of black and white horizontal stripes made it differentiate itself from the containers single striped bottom. To keep the tableware unified a single black stripe decorates the top interior of the cup to create harmony with the exterior bottom

IMAGE 20 (p. 78): Digital visualization of the cup, small container and large container.

69

stripes and the containers interior stripe. The cup is designed with a rather large ear to provide a good grip when using the index finger and the thumb to hold the cup. The dimensions of the cup are Ø 81 mm at the top and Ø 66 mm at the bottom. It has a height of 50 mm and an ear that stretches out 22 mm, is 18 mm wide and 30 mm high. See image 21 below.
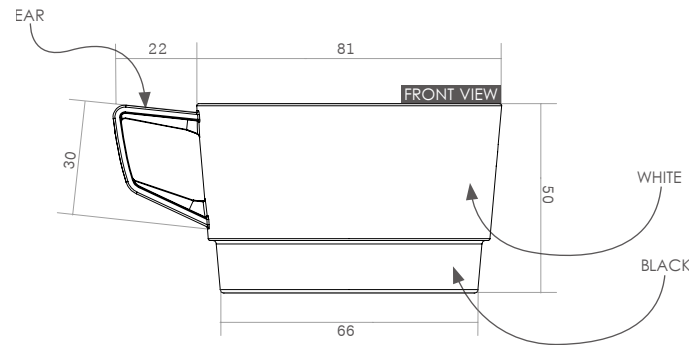
Small Container

The small container is designed to hold the side dishes, like desserts and starters. It is approximately half the size of the large container were the longest edge is the same as the shortest on the large container to create a harmony between the containers. Unlike the cup, the lower part of the container is black with just a single white stripe to provide it with a more discreet touch. In resemblance with the other products of the tableware, the top interior is decorated with a black horizontal stripe around the whole inside of the container. The small container is designed to enable usage both while positioned in the tray and while for example, holding it in ones hand. The small container has a 55 x 70 mm bottom and a 63 x 78 mm top, the height of it is 34 mm. See image 22 below for dimensions.

IMAGE 21 (p. 79): Product illustration of the cup.
IMAGE 22 (p. 79): Product illustration of the small container.
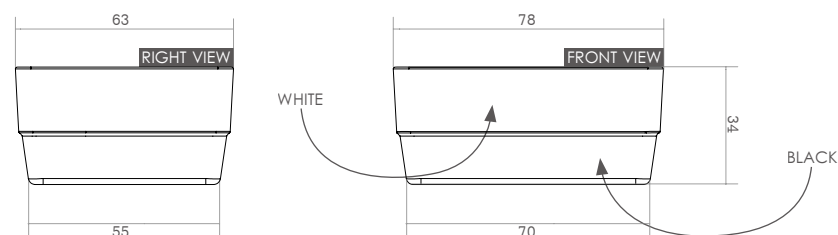
Large Container

The large container is designed with compliance to the small container and therefore it also possesses the horizontal white line at the bottom and the interior black line at the top. It is designed with the passengers diverse ways of eating in mind and may therefore be used both in the tray or while holding it the hand. The main difference between the large and the small container is the dimensions. The large container has a 70 x 130 mm bottom and a 78 x 138 mm top, the height of the container is 34 mm. See image 23 below.
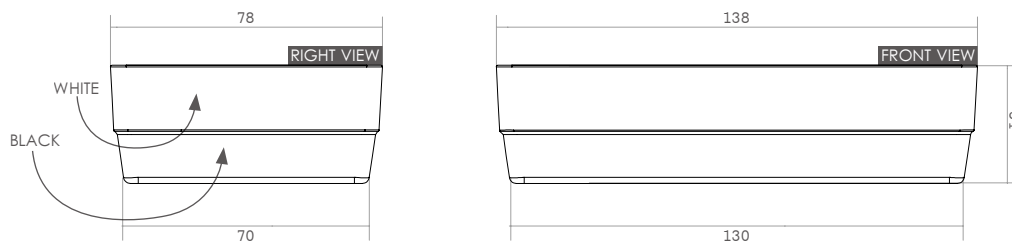
5.1.3. CUTLERY

The focus of the cutlery design was to create lightweight plastic cutlery that would be durable and elegant and not be associated with cheaper plastic cutlery. The cutlery series consists of a fork, knife and spoon which all have been given similar dimensions; See image 24 below.
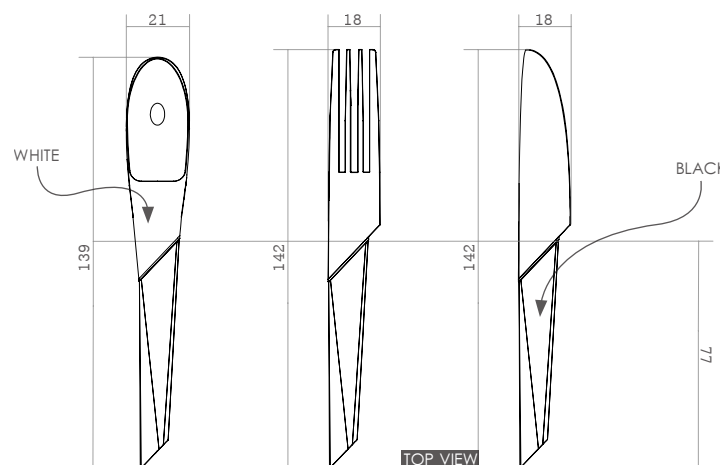
IMAGE 23 (p. 80): Product illustration of the large container.
IMAGE 24 (p. 80): Product illustration of the cutlery.
IMAGE 25 (p. 81): Digital visualization of the knife, spoon and fork for *Air Dinner in different angles*.

In order to assign the cutlery's desired durable, elegant and non-cheap expression and level of quality it was important that they kept the same quality as the rest of *Air Dinner*. In addition, it was found important that the cutlery would not be associated with cheaper disposable alternatives. This was achieved through giving the cutlery a high level of detail and cuts to make the cutlery stand out and feel unique. The handle was emphasized by a distinct cut and a matte black color in order to give the passenger a feeling of more conventional cutlery. The strong contrast between the handle and the top provides and intuitive way of describing for the user how to grip the cutlery for best use. The handle has been given a differentiated and more robust structure to make it more grip friendly and embrace the genuine feeling of the cutlery. The top consists of a white glossy smooth surface which feels sterile and gives an elegant look. See image 25. The cutlery is produced in the same material as the containers, ABS.

5.1.4. BRANDING & ADVERTISEMENT

The exchangeable paper cover makes *Air Dinner* unique amongst its competitors. The feature adds both a direct functionality to the airline tableware by holding the products together and an indirect functionality, custom graphics and design. This room for customization makes it easy for the airline to brand their product and give it a unique touch by simply designing their own cover. Another benefit for the airline is the possibility for the airline to more visually diversify their meals. For example by adding different covers that correspond to the meal like vegetarian, seafood, meat, special meal, etc, they can create n unique feeling to every meal. See image 26 on the following page for examples of covers.

The paper cover is not only limited to expressing the airlines brand, it could be seen as an alternative source of income. The easy exchangeable paper cover is an ideal channel for in-flight advertisement. This could be realized in several different manners; the airline could for example have a branded cover and sell ad-space on the inside, the whole cover is an ad-space where the airline is only present through a small logo or the meal could be sponsored. Independent of how it is executed, advertisement space the size of an A4 on the airline meal is a great asset for the airline.

IMAGE 26 (p. 83): Digital visualization of the paper covers and how they are removed/connected to the tray.
IMAGE 27 (p. 83): *Air Dinner* onboard an airplane. and how the passenger would experience the product.

5.2. THE BENEFITS OF AIR DINNER

Air Dinner is designed in a manner that benefit all users and the environment in some extent; to make the user's interaction with the product easier and reduce the environmental impact of the airline tableware. The following paragraphs highlights both how the product *Air Dinner* has improved the different users' interaction with the product and how it has reduced the CO_2 emissions during its life cycle.

5.2.1. IMPROVED USER INTERACTION

Caterer

Air Dinner is first and foremost designed to enhance the recycling capabilities of the product. Therefore the caterer is an important user because of their contact with the "waste" product. The dedicated compartments together with the paper cover makes *Air Dinner*'s waste inside more structured and easier to handle when returned to the caterer. The caterer can organize their workflow based on clearing the compartments of *Air Dinner*. The more structured and efficient their workflow can become the easier it will be to take care of the returning products and waste accordingly; reusable, disposable or recyclable. This feature alone can be a strong motivator and catalyst for the caterers to start taking care of the waste responsibly.

Air Dinner is designed to make it easy to "re-brand" the product on the go. This is achieved through exchangeable paper covers which can be customized based on the airline and the specific meal. A branding approach like this will enable the caterer to keep a base stock of trays, containers and cutlery together with a stock of paper covers for the different meals and airlines they serve. The caterer can therefore prepare their meals in advance instead of having to wait for the airlines specifically branded tableware to be delivered to them for cleaning and preparing. The tableware later delivered to caterer will then be cleaned and returned to their stock. This will create a more flexible workflow for the caterer which may reduces the preparation time for the meals and minimize delays.

Airline

Optimizations on the caterers end of the product are directly beneficially for the airline in form higher efficiency and less delays which result in greater profit margins. The exchangeable paper covers enables the airline to update their styling and look of their airline tableware depending on season, type of meal etc. This possibility will help keep the product new and fresh without the need of changing the whole tableware. The airline may also benefit from the usage of paper covers in another perspective, namely that the meals can be sponsored and the covers may contain advertisement. These possibilities will reduce the cost of the airline meal.

The new tray design makes the entire product more intact and easy to handle for the flight crew when serving and collecting the meal. The paper covers also benefit the crew when collecting the meals by keeping all the waste and products in one place not being worried of waste falling off the tray or getting dislocated when pushed into the trolley.

Passenger

The compact design of *Air Dinner* does not just help save space in the trolleys but also saves space on the passengers tray table. The tray tables in economy class are dimensioned in compliance to the full size trays, so the design of *Air Dinner* will enable plenty of extra space for the passenger to use. Even though the meal is designed to be more compact it will give a more spacious feeling for the passenger while seated. The paper cover will also make it easy for the passenger to keep the products and waste from the meal together when finished. By returning all the containers, cups, waste, etc to their original positions the meal can easily be closed and put to the side of the tray table. This gives the passenger flexibility and make them not feel limited by a tray covering their table until it is collected later.

The paper cover of *Air Dinner* helps communicate with the passenger and provide them with a pleasant, informative and welcoming experience when served their meal. The use of covers based on the different meals served make them stand out more from

each other and give the passenger a more exclusive feeling to their choice of meal. The cover together with the transparent tray creates a sort of mystique around the meal, the passenger can glimpse the meal but needs to interact with it to uncover it fully. This can also be said for the interior of the tray where the containers and cup is lowered into the tray and their design is fully uncovered when the passenger interacts with the product. The experience of uncovering and exploring the meal together with the modern, simplistic and high quality of the products it will give the passenger a new, exclusive and more interesting airplane dining experience.

EVALUATION

In the evaluation during the end of phase three, the final design of *Air Dinner* was evaluated to identify flaws in the design. The evaluations are based upon *Quality dimensions of goods;* reliability, performance, maintainability, environmental impact, appearance, flawlessness, safety and durability (Bo Bergman, Bengt Klefsjö, 2010, p. 31). In this particular case the most important factors, based on the set requirements and goals for the product, for evaluation are; performance, environmental impact, appearance, flawlessness and of course durability. These factors are evaluated both through computer simulations and user focus groups. The focus group evaluations are more concentrated on the soft values of the product whereas the simulations help evaluate hard values of the product such as environmental impact, durability and manufacturability.

6.1. AESTHETICS & INTERACTION

To be able to properly evaluate the aesthetics, dimensions and user interaction with the product it was necessary to create a detailed prototype. Rapid prototyping was used to create the base of *Air Dinner*; the tray, cup, containers and cutlery. These were then refined through handcraft in order to achieve a high level of realism when it comes to the material perception, tactile feeling and aesthetics. These factors of realism were of great importance in order to receive qualitative input from the focus group.

6.1.1. PRIMARY–USER IMPRESSIONS

In order to evaluate the product experience and perception based aspects of the product a group of primary users got together to interact, feel, use and "imaginary-dine" out of the product prototype. After exploring the prototype the participants were asked to rate the airline tableware as a whole and each product individually. Aspects that were rated are among other; product aesthetics, dimensions, quality, uniqueness, reusability and dining experience. See image 28 for a radar chart summarizing the participants experience of *Air Dinner* within the different categories. For further details see Appendix J Focus Group Questionnaire for further details.

The overall product experience of the airline tableware among the participants was very satisfying. The airline tableware was evaluated based on the participants' previous experiences with airline tableware and were asked to score if they experienced *Air Dinner* as above or below average. Overall, *Air Dinner* scored above average to much above average in aesthetics, quality, dimensions, dining experience and reusable to name a few of the aspects. This was persistent throughout each of *Air Dinner*'s products with the exception of the cutlery. The cutlery were rated below average and much below average in dimensions, reusable, simple and quality. They were found weak and the participants all together thought that there was no to a minimal of a difference between the quality of the cutlery compared to disposable cutlery. The dimensions were off on especially the spoon and the fork, the fork had a too short handle while the bowl of the spoon could have been larger and maybe deeper according to the participants. The participants were also in consent questioning why the cutlery was

AESTHETICS

DIMENSIONS

QUALITY

DINING EXPERIENCE

INTUITIVE

UNIQUE

MODERN

SIMPLE

REUSABLE

4,00
3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00

AIR DINNER
TRAY
CUTLERY
CUP
CONTAINERS
PAPER COVER
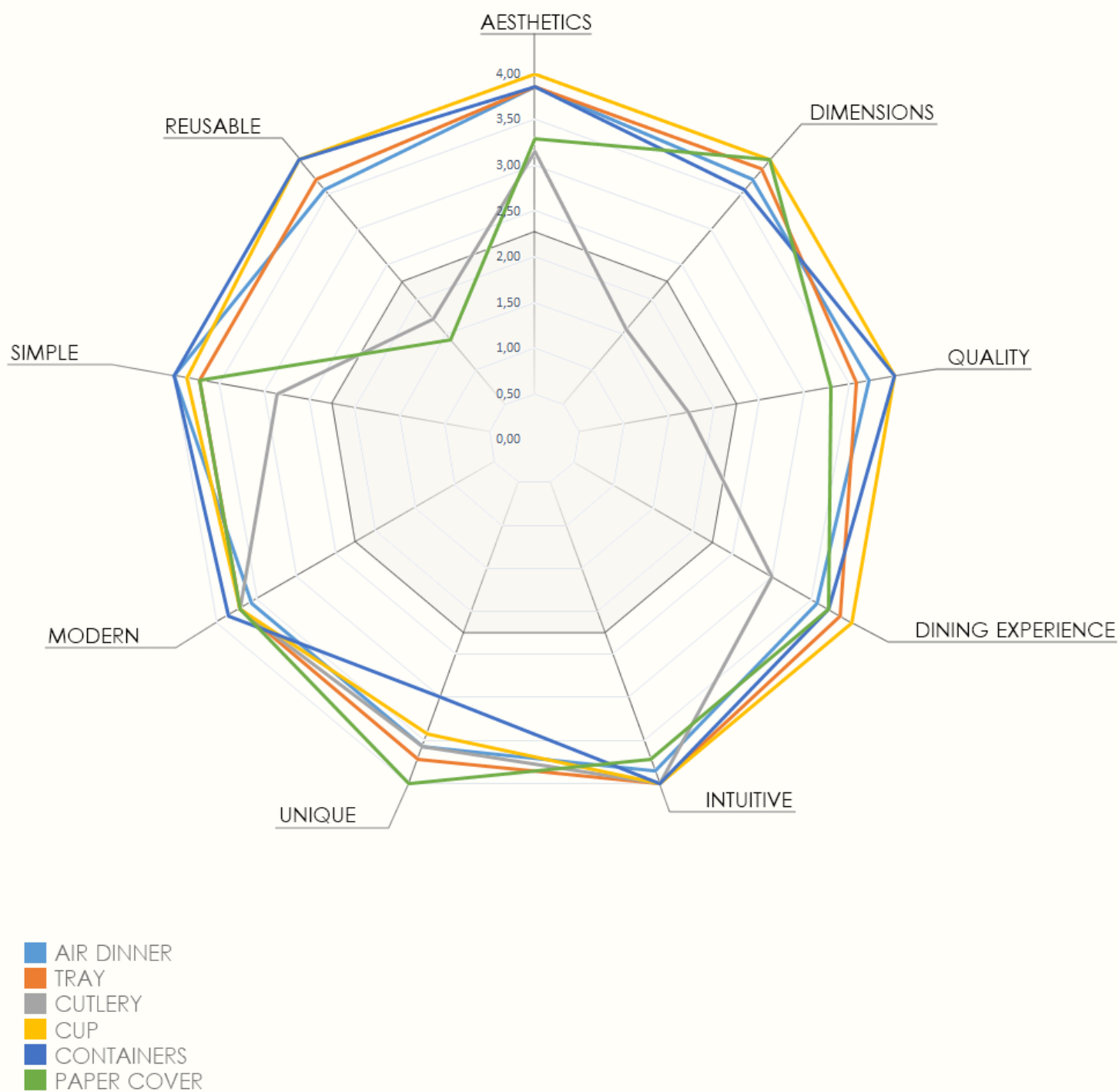
left without some kind of line of white detail similar to rest of the tableware.

The most outstanding product of the airline tableware was the cup which was praised among the participants and scored much above average in all aspects. It was experienced as very robust and durable, grip friendly, exclusive and very porcelain-ish in style and tactile feeling. The multiple line pattern on the cup was very appreciated and was said to add an extra dimension to the whole experience and that it made the cup unique but still a part of the product family. One participant commented for example that if the cup would have had a single line as the containers it would have become too much of repetition and could have destroyed the exclusive feeling of the products.

The containers were all found to be above average, they had the same sense of quality and durability as the cup and were found to match to overall aesthetics of the airline tableware design. The most questionable aspect of the containers were the size of the small container, the participants could not agree on whether the containers were a bit to small or of a decent size.

The tray together with the paper cover was experienced as unique and interesting out of a dining experience point of view. The participants found that the cover added an extra dimension to the dining experience and product, though there were some difference among the participants whether the cover should be of paper or in plastic incorporated into the tray itself. The reason a plastic cover was discussed was if using plastic would give a more sturdy and long lasting impression of the airline tableware. In the prototype shown to the participants, the tray was solid black while the final design 3D renders have a transparent tray. The participants were asked which of the two they preferred and if they had different expressions. The solid black tray was experienced as somewhat more elegant and exclusive while the transparent tray was experienced as more unique and light.

6.2. ENVIRONMENTAL IMPACT

The overall environmental impact of *Air Dinner* was simulated in order to understand the affect it may have and which segments that are the largest contributors. The simulations were based upon the products being produced in Asia and then shipped to Europe where they were assembled before delivered to the caterer and/or airline. The simulations show the emissions based upon the current design and materials selection of *Air Dinner,* but also comparisons with alternative materials selection, current disposable products and current reusable products. See table 1 Material Variations below for more detailed description of the different simulations and materials selection. The scenarios simulated are the products CO_2 emissions and

TRAY	
🟦	AIR DINNER (USE 30 TIMES)
🟪	COMMERCIAL TRAYS (USE 30 TIMES)
🟩	ALTERNATIVE MATERIAL (USE 30 TIMES)
LARGE CONTAINER	
🟪	AIR DINNER (REUSABLE 30 TIMES)
⬜	COMMERCIAL DISPOSABLE CONTAINERS (USE 1 TIME)
COFFEE CUP	
🟪	AIR DINNER (USE 30 TIMES)
⬜	COMMERCIAL DISPOSABLE CUP (USE 1 TIME)
KNIFE	
🟦	AIR DINNER (REUSABLE 30 TIMES)
🟩	COMMERCIAL DISPOSABLE KNIFES (USE 1 TIMES)
⬛	COMMERCIAL EXCLUSIVE KNIFES (USE 365 TIMES)

🟫 STEEL
🟪 ABS
🟦 PET
⬜ PAPER
🟩 PS

energy consumption in the areas of end of life, transportation, material and all three together (total). The data presented in image 29 on the following page shows the results from the simulations of each of the different product scenarios. The data represents a life cycle of 365 days. During this period it is estimated that the disposable items are used once a day and then disposed, meaning 365 products will be manufactured and disposed of during the 365 day scenario. *Air Dinner* is designed to sustain up to 40 use cycles, in this simulation it was therefore estimated that each product of *Air Dinner*

TABLE 1 (p. 92): Material variations used for the environmental impact simulations and evaluation.

IMAGE 29 (p. 94): Simulation of CO_2 *Emissions and energy consumption over 365 days of product use.*

CO² EMISSIONS (kg CO²)

	END OF LIFE			TRANSPORTATION			MATERIAL			TOTAL		
TRAY	0,301	1,1	1,5	0,167	0,127	1,20	13	7,7	11	13,5	8,9	12,6
CONTAINER	3,5		0,367	0,136		0,029	2,3		2,7	5,94		3,1
KNIFE	0,199	6,2	0,193	0,014	0,892	0,021	3	42	2	3,2	49,1	2,2
CUP	1,9		0,398	0,086		0,019	1,5		1,7	3,49		2,12

ENERGY CONSUMPTION (MJ)

	END OF LIFE			TRANSPORTATION			MATERIAL			TOTAL		
TRAY	0,215	0,817	1,1	2,1	1,6	1,5	350	250	270	352	252	273
CONTAINER	2,6		0,263	1,7		0,365	37		66	41,3		66,6
KNIFE	2,8	4,4	0,138	0,169	8,6	0,269	30	1400	48	33	1413	48,4
CUP	1,4		0,304	1,1		0,232	24		42	26,5		42,5

sustained 30 use cycles before they were disposed. The end of life scenario is based upon an average recycle, landfill and combustion ratio across the European countries.

In image 29 on the previous page it is possible to observe that the results strongly point towards a lower environmental impact when using reusable products like *Air Dinner*. In comparison, a common disposable knife consumes 29 times more energy than the knife of *Air Dinner*. The difference between the other products of *Air Dinner* compared with common airline tableware alternatives show a more marginal difference. For example both the cup and the large container show a greater energy consumption compared to disposable paper alternatives, though the total CO_2 emissions for those products are still lower for *Air Dinner*. Another questionable material selection of *Air Dinner* is the one for the tray, the current material selection is PET which showed to be the least favorable in the evaluation both emission and energy wise. The common airline trays in ABS showed somewhat lower results compared to *Air Dinner*. The material that scored the lowest of all three was PS, by using a PS based tray it could be possible to reduce the tray's CO_2 emissions by 34 % compared to the proposed PET based tray. For further details see Appendix H Material Analysis.

Another interesting aspect is that the stainless steel knife compared to the reusable *Air Dinner* knife showed an overall similar total emissions and energy consumption. Though factors such as weight and increased airline fuel emissions are not accounted for and may therefore give the reusable plastic cutlery an upper hand emissions wise.

6.3. DESIGN & MANUFACTURING

6.3.1. DESIGN

Due to the tray being the largest contributor to CO_2 emissions its design was evaluated more thoroughly in order to identify potential improvement areas which would help the product become more environmental sustainable. Most notable was that some segments of the tray had an unnecessary large material thickness, more specifically the front and back of the tray. For a detailed image of the analysis results see Appendix I Design Evaluation. Proposed design improvements can be found in the discussion chapter 6, section *6.1.1. Design Improvements*.

6.3.2. DIMENSIONS

In connection to the focus group the dimensions and proportions of *Air Dinner* were examined in order to evaluate the design and if any of the products were incorrectly dimensioned. Incorrect dimensions would impact the usability and perception of the product. The dimensions were evaluated based upon observations during the focus group and photo-documentation. See image 30 Photo-documentation of a user holding and interacting with the products of *Air Dinner*.

The evaluation showed similar design faults as the ones that emerged during the focus group session. The cutlery, mainly the handle, is approximately 1 cm too short and therefore they seem under dimensioned and are perceived to be difficult to interact with. The under dimensioned design of the cutlery also makes the cutlery feel less durable and are perceived as disposable rather than reusable. Even though the cutlery proved to be to small the overall design was grip friendly and fit the hand easily with its distinct handle and edge which divides the handle from the top.

The containers both prove to be easy to handle, grip and hold on to. They comfortably fit the user's palm. Same goes for the cup which easily could be gripped in different way while keeping a tight and comfortable grip of it. The diameter as well as the ear were both correctly dimensioned and gave good stability to the users.

IMAGE 30 (p. 97): *Photo-documentation of Air Dinner's dimensions in relation to a user holding the products.*
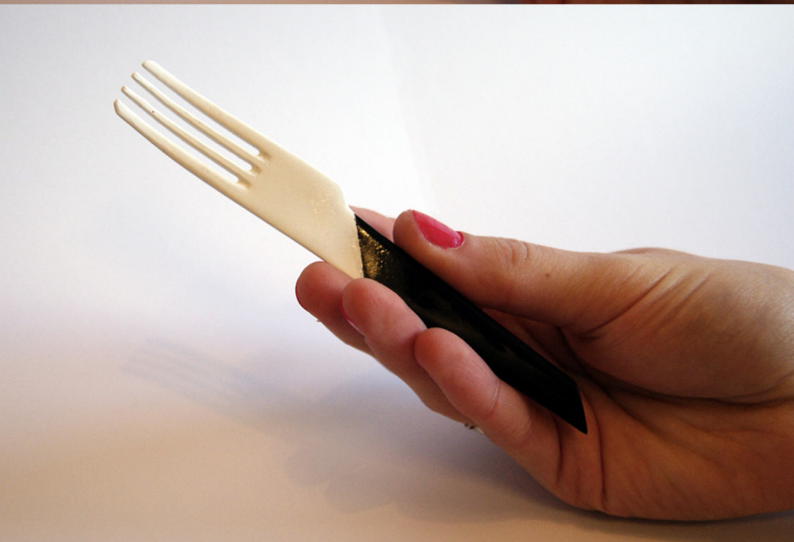
6.3.3. MANUFACTURING

Injection molding would be a suitable manufacturing method based upon the design of *Air Dinner* and the materials it is composed of. Due to the detailed CAD models developed of *Air Dinner* it became possible to evaluate the design with regards to manufacturability and build quality. Each of the products were evaluated to identify potential weaknesses which could either affect manufacturing of the product or the durability of it. The evaluations are based upon simulations of the CAD models in Solidworks. Detailed results of the simulations can be found in Appendix 9 Design Evaluation.

The evaluation showed that the design of the cutlery had areas which would potentially affect both the manufacturing and the durability of the product. The weaknesses of the design are potentially due to the under dimensioning which also became obvious during the focus group session. The simulation also shows that the weak areas are due to a material thickness which is much lower than the suitable 2 mm for injection molding, the cutlery showed a material thickness of less than 0.5 mm in the most critical areas.

The containers, both the large and small container, showed no major weaknesses that could affect the manufacturing and the product durability. The only potential design flaw of the small container is that the corner of the edges may have a too narrow radius which could affect the manufacturing of the product. The cup showed a similar weakness as the small container, the top radius of the edge of the cup may be to narrow and sharp which could affect the manufacturability of the product.

The tray showed no areas of major weakness, though there were several questionable areas which could be improved in order to assure the product manufacturability and durability.

All of the identified design faults previously mentioned are of a simpler kind and will not require any major redesign of *Air Dinner*.

DISCUSSION

The project as a whole reached the set goals within the time span of master thesis and has presented a viable product candidate mature enough to proceed through testing and evaluation in its real environment.

Process

In order move rapidly through the product development process and reach the set goals for the master thesis, the early concept evaluation and decision making relied on subjective assessment. The lack of hard data for the concept decisions is compensated by the faster process resulting in earlier testing of the product candidate. An approach like this yields a greater risk than a more objective approach with hard facts that underlie the concept decisions and progress in the project. Therefore it is important to know when which approach is most appropriate. In this particular case where the product is rather small and non-technical it becomes less expensive to prototype, test, evaluate and redesign final product candidates. Even though the increased risk of the first product candidate being flawed, the subjective concept approach will faster and more time efficiently yield a market ready product due to the earlier extensive testing the product is subject to. The more advanced the product is, the more weight should be put on using objective data oriented methods throughout the concept development.

Methods

As mentioned above the project's methods, especially in the earlier phases, have had a subjective focus which are either based upon data gathered from users or conclusions made by the author from for example observations in combination with interviews. Some of the key features of the final design, *Air Dinner*, are therefore not based upon any proven fault or missing features among the current airline tableware design. Features like the exchangeable paper cover are solely based upon the author's perception and interpretation of the product. It could be discussed if the project should have followed

a more traditional structure where a handful of concepts are evaluated in the middle of the project and a final concept is selected based upon more objective evaluation methods, like a Pugh Matrix. In this project most of the objective evaluations have been performed in the end of the project directed towards the final design proposal, *Air Dinner*. It is difficult to say which approach would have yielded what result, or even maybe the same. In this case the more subjective approach enabled the project reach much further which resulted in a much more mature final product; a functional and accurate prototype of the final design ready for intensive testing and evaluation.

As the focus of the master thesis was to develop a more sustainable airline tableware in a rather short period of time other aspects of the product had to be researched more briefly, like the deeper studies of the current product usability etc. Many of the methods used focused on identifying the environmental weaknesses of the current products and find ways to improve the airline tableware environmental wise.

Afterwards, mainly during the evaluation of the prototype these sacrifices in the area of usability research surfaced. This became evident in the design of the cutlery, during the ideation and design phases of the project the size of the cutlery were pushed to the minimal limit in order to achieve light weight cutlery. This could have been avoided by adding more usability research into the first phase. In short, the methods should have been more equally divided into research in sustainability and usability. Though as time is often of the essence during a project and the focus of this project was the environmental aspects of the product it was a "necessary-evil" to focus the methods and research on sustainability aspects in order reach a satisfying depth in the final design of the product.

Participants

The interviews, observations, survey, focus groups and usability testing were all performed in a Swedish context which could have an impact on the results and would for sure benefit from more international input. The working procedures habits among passengers, airlines and caterers may differ internationally and as the airline industry

is global it is important to account for these aspects in this kind of project, especially if the product is further developed. The survey itself was performed on a charter airline which represents a small group of the user group passengers. The majority of the participants were what most would consider non-frequent flyers as they traveled by air once a year. However, most of the participants had been traveling by air for the last ten years. What is also worth considering is that the charter airlines have a distinct different focus than focus then regular airlines. They are strongly holiday focused, meaning that the flight is a part of the whole holiday experience that they sell to the passenger. According to the airline themselves, they tend by this approach to add a little extra to the meals and service to please the passengers and give them a good start and end of their holiday. Therefore to verify the data gathered from the survey, the survey should also be conducted on at least one regular airline in order to compare the results and capture a wider spectrum of the user group passengers.

Dimensions & Design

The final prototype of *Air Dinner* was the real test to observe if the slimmed down and compact airline tableware design would fulfil the requirements in terms of usability, durability and style. Even though CAD, sketches and paper prototypes are of great help it is often hard to predict and estimate exactly how the final design would be as a physical product. A concept that seems good on paper and on screen may be awfully bad in reality, but often the more refined the visual work is in both the digital and physical space it becomes easier to grasp and understand the design of the product. For *Air Dinner* the final prototype gave a really good and thorough insight of the product and also enabled the author to present a tangible product when discussing the design and result of the master thesis.

Overall it could be said that the design and dimensioning of *Air Dinner* is satisfying, the available volume is efficiently utilized by the different products and during the focus group session none of the participants felt that it felt cramped and tightly packed. Though as mentioned in the dimensions evaluation, the design of the cutlery was rather flawed, they were by all means under dimensioned and is the one item

that out of usability concerns has to be improved in order for the product to become successful. During the focus group session it was also discussed that the small container was marginally to small and would probably not be negatively affected by increased dimensions. There is also space on the tray for the enlargement of the small container without affecting the overall design and therefore it would be worth considering.

Material Selection

The evaluation of *Air Dinner* showed that it may be possible to reduce the environmental impact by changing the material of the tray from the proposed PET to PS. As PS showed such reduced emissions both compared with ABS and PET it could be a possible alternative to explore if the whole product could be designed in PS. This would improve the recycling possibilities even more compared to the current material selection of *Air Dinner*.

If PS would sustain the same amount of use cycles as the other two materials it would definitely be a more preferable alternative both emissions wise and the ease of recycling the whole product as one.

The best approach to further study the material selection and improve it is by running three identical prototypes of each material side by side through a set of use cycles. Afterwards it would be possible to evaluate and identify the strengths and weaknesses among the materials.

Environmental Impact

It is complicated to calculate the environmental impact of an airline meal due to the large amount of circumstantial and country specific factors that affect the airline meal industry. Some countries have a wide spread recycling program while other depend on landfills. Also factors like how the waste water is treated from the dishwashers at the caterer can have a great impact on the product's environmental impact. These

factors are very important; but worth noting is that these factors can be assumed to have a similar impact independent of how the airline tableware is designed. Therefore, these circumstantial factors are not directly linked to the product, meaning that the solution to these factors are somewhat outside the product's reach. However, these factors are nevertheless part of the product's total environmental impact throughout its life-cycle and should be investigated.

In order to examine the airline tableware's environmental impact it is important to focus on factors that are directly connected to its design; such as the form, weight and material. These are the factors that were used when calculating the environmental impact for the product in this master thesis. Therefore the calculated values are not an accurate representation of the total environmental impact and only represent a part of it; the part which is possible to influence and change through different design decisions.

As there are probably ten thousand or more varieties when it comes to airline tableware it is of course extremely difficult to examine the whole spectrum of meals and their individual environmental impact. Therefore the evaluations have been first and foremost based on the material selection and number of times the product is used before it is disposed of. This will give a brief understanding of how the different materials and behaviors will affect the environment compared to another. The negative aspect of doing a kind of product generalization and categorization like this is that the product's unique design and features are not part of the evaluation. A resourceful design may have as positive of an impact on the environment as a better material selection. Though as none of the airline tableware has been evaluated in how their design impacts the environment it is safe to say that the evaluations are on rather similar terms and does not favor one or another. But the design aspect of the product still remains and would be interesting to research and evaluate to see how they affect the environmental impact. This leads to the fact that in order to identify a truly sustainable airline tableware design factors as these need to be accounted for in the long run.

7.1. CONCLUSION

The master thesis as a whole reached the desired depth sought in the design and development of the product. It also shows, like mentioned in the introduction to the thesis, that the airline meal industry has been lagging behind in the development of sustainable and environmental friendlier airline tableware. This thesis shows that it is possible to develop airline tableware that have less CO_2 emissions compared to many tableware used today by airlines around the world. If a master thesis can show that there is room for improvements within the product range offered today, it is definitely an area which could be improved both design and environmental wise if resources were shifted towards it.

As for the project itself the product *Air Dinner* showed some minor flaws in the design, but overall the design of *Air Dinner* delivered satisfying usability, reduced environmental impact and a touch of uniqueness. A good step in the right direction.

7.1.1. DESIGN IMPROVEMENTS

With a few flaws in the design hindering the product from reaching a more final state they become important to address in order to continue the work with the product and ultimately reach a production ready product. The following are the design improvement which are of most concern:

» Redesign the tray to have the thickness of all its surfaces in order to reduces the weight, material consumption and possibly improve the durability of the design.
» Increase the dimensions of the small container by approximately half a centimeter in depth.
» Increase the length of the cutlery by one centimeter, or almost the full length of the tray cutlery compartment.
» Enlarge the bowl size of the spoon.
» Shorten the head of the fork and reduce the amount of tines on the fork to three in order to increase the durability of them.

7.1.2. FURTHER WORK

The next step in the process would be to continue the iterative process and do further research, evaluation, refinements and realization of the *Air Dinner*. More extensive usability research could add another level of uniqueness and interaction which could take the product to the next level. The following areas would benefit from further research and development:

» Usability research to explore possible design improvements which could strengthen the product's competitiveness.
» Environmental analysis incorporating operational emissions such as fuel and waste products.
» Product trials in an airline and caterer environment. Letting the product run through a series of use cycles testing the design towards all three users; caterer, airline and passenger.
» Deeper material evaluation and research in order to further explore the pros and cons with a PS, ABS and/or PET based product. A suitable approach would be to run three identical prototypes of each material through 30 or more use cycles and after evaluate them.

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Images & Tables

Image 1: An airline meal after a passenger has finished it. *Photography,* Rikard Rehnmark.

Image 2: The products included in an airline meal. *Illustration,* Rikard Rehnmark.

Image 3: Tablet showing KLM's airline meal pre-order page. *Photography,* Rikard Rehnmark.

Image 4: Atlas trolley dimensions and how the meals are organized. *Illustration,* Rikard Rehnmark.

Image 5: The airline meal out of a caterers point-of-view. *Photography,* Rikard Rehnmark.

Image 6: Galley of Novair's Airbus 321-200. *Photography,* Rikard Rehnmark.

Image 7: How the airline meal can look like for the passenger. *Photography,* Rikard Rehnmark.

APPENDIX

A. TIME PLAN

B. ATLAS TRAY

C. ATLAS TROLLEY

D. PASSENGER SURVEY – NOVAIR

E. FEATURE MATRIX

F. SIZE VERIFICATION

G. MATERIAL SELECTION

H. MATERIAL ANALYSIS

I. DESIGN EVALUATION

J. FOCUS GROUP QUESTIONNAIRE

A. TIME PLAN

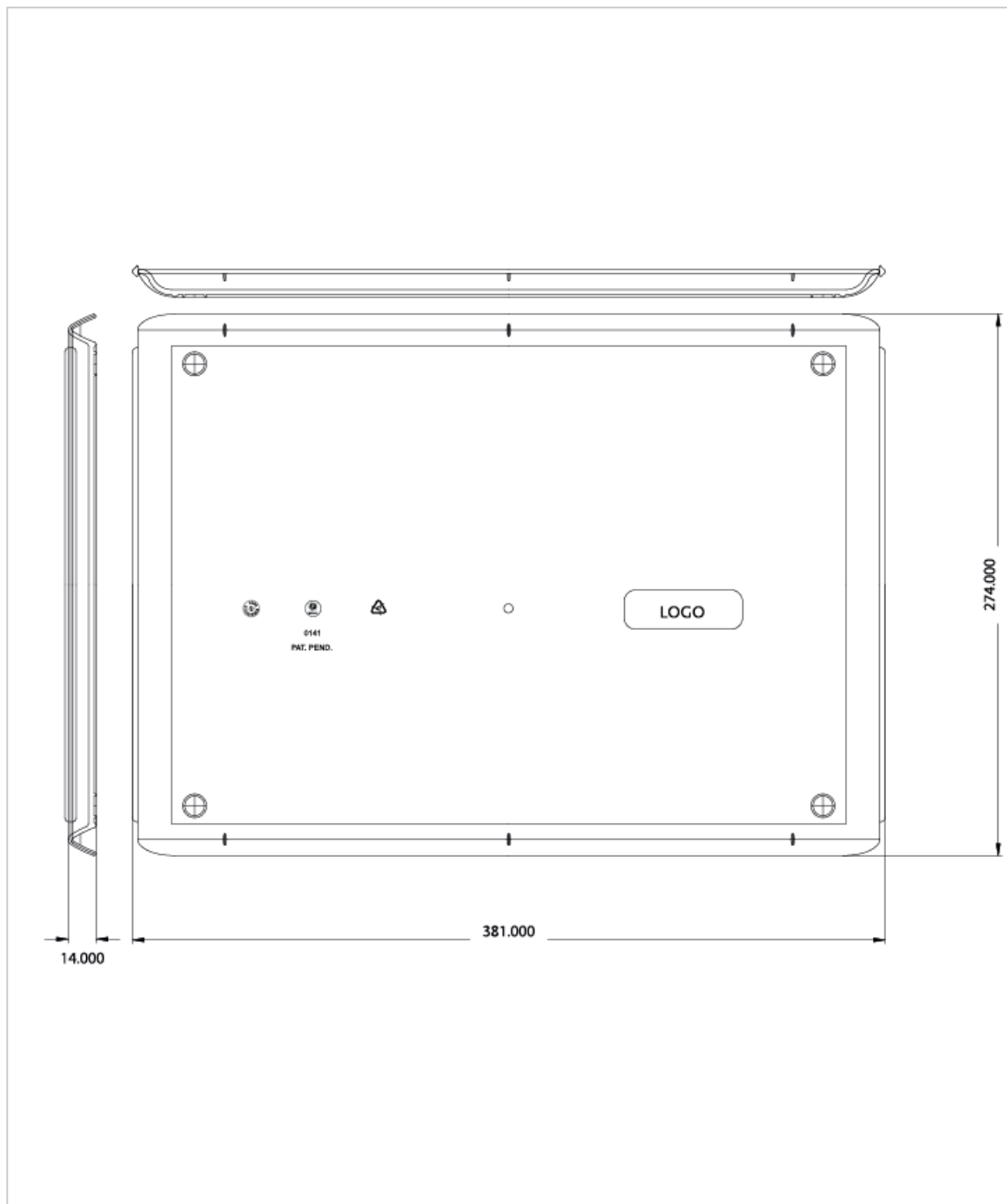| ID		Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1			Pre-Report	8 days	2/1/12	2/10/12		
2			**Phase 1**	**23 days**	**2/13/12**	**3/14/12**	**1**	
3			Background & Knowledge Gaining	5 days	2/13/12	2/17/12		Reading
4			Market Research	9 days	2/13/12	2/23/12		Study
5			Industry Regulations and Standards	4 days	2/20/12	2/23/12	3	Reading
6			User Studies	4 days	2/20/12	3/2/12	3	Meeting
7			User Scenarios and the Product	4 days	3/2/12	3/8/12	5,4,6	Visualization
8			Material Research	12 days	2/24/12	3/12/12	4	Study
9			Phase 1 Summary	2 days	3/13/12	3/14/12	5,8,6,7	Documentation
10			**Phase 2**	**28 days**	**3/15/12**	**4/23/12**	**2**	
11			**First Stage**	**8 days**	**3/15/12**	**3/26/12**		
12			Concept Generation (Quantity > Quality)	4 days	3/15/12	3/20/12		Ideation
13			First Stage Concept Visualization	4 days	3/15/12	3/20/12		Visualization
14			First Stage Prototypes	3 days	3/15/12	3/19/12		Prototyping
15			User Feedback	1 day	3/21/12	3/21/12	12,13,14	Study
16			Concept Evaluation	2 days	3/22/12	3/23/12	15	Evaluation
17			Selection of Concepts	3 days	3/22/12	3/26/12		Documentation
18			**Second Stage**	**8 days**	**3/27/12**	**4/5/12**	**11**	
19			Refining Concepts (Quality / Quantity)	4 days	3/27/12	3/30/12		Ideation
20			Second Stage Concept Visualization	4 days	3/27/12	3/30/12		Visualization
21			Second Stage Prototypes	3 days	3/27/12	3/29/12		Prototyping
22			User Feedback	1 day	4/2/12	4/2/12	21,20,19	Study
23			Concept Evaluation	2 days	4/3/12	4/4/12	22	Evaluation
24			Selection of Concepts	3 days	4/3/12	4/5/12	22	Documentation
25			**Third Stage**	**7 days**	**4/6/12**	**4/16/12**	**18**	
26			Finalizing Concept (Quality > Quantity)	7 days	4/6/12	4/16/12		Ideation
27			Third Stage Concept Visualization	7 days	4/6/12	4/16/12		Visualization
28			Third Stage Prototypes	7 days	4/6/12	4/16/12		Prototyping
29			Preperations for Midterm Presentation	5 days	4/17/12	4/23/12	28,27,26	Summary
30			Midterm Presentation	0 days	4/23/12	4/23/12	29	Presentation
31			**Phase 3**	**16 days?**	**4/24/12**	**5/15/12**	**10**	
32			User Feedback	1 day?	4/24/12	4/24/12		Study
33			Evaluation & Selection of Final Concepts	5 days	4/25/12	5/1/12	32	Evaluation
34			Refining Concept/s (Final)	5 days	5/2/12	5/8/12	33	Ideation
35			Concept Visualization	10 days	5/2/12	5/15/12	33	Visualization
36			Concept Prototype	10 days	5/2/12	5/15/12	33	Prototyping
37			Final Concept/s Complete	0 days	5/15/12	5/15/12	36,35,34	Documentation
38			**Phase 4**	**22 days**	**5/16/12**	**6/14/12**	**31**	
39			Compiling Documentation & Work	2 days	5/16/12	5/17/12		Documentation
40			First Draft	12 days	5/18/12	6/4/12	39	Documentation
41			Second Draft	5 days	6/5/12	6/11/12	40	Documentation
42			Final Report	3 days	6/12/12	6/14/12	41	Documentation
43			Preperations for Final Presentation	15 days	5/18/12	6/7/12	39	Summary
44			Final Presentation	3 days	6/8/12	6/12/12	43	Presentation
45			Project Deadline	0 days	6/15/12	6/15/12	38,44,42	

B. ATLAS TRAY

CUSTOMER ARTWORK

274.000

LOGO

0141
PAT. PEND.

381.000

14.000

CLIENT	SIZES PRODUCT IN MM. LENGTH 381 WIDTH 274 HEIGHT 14	SCALE 50%	ARTWORK LOGO EMBOSSED	SIGNATURE
ARTICLE ROTABLE TRAY 1/1 ATLAS 'WHITE LILY'	SIZES LOGOPLUG IN MM. LENGTH 60 WIDTH 20 RADIUS 6	MATERIAL ABS COLOURS MATERIAL ...	DATE ...	HELIOS
ARTICLE NUMBER 0141...				

C. ATLAS TROLLEY
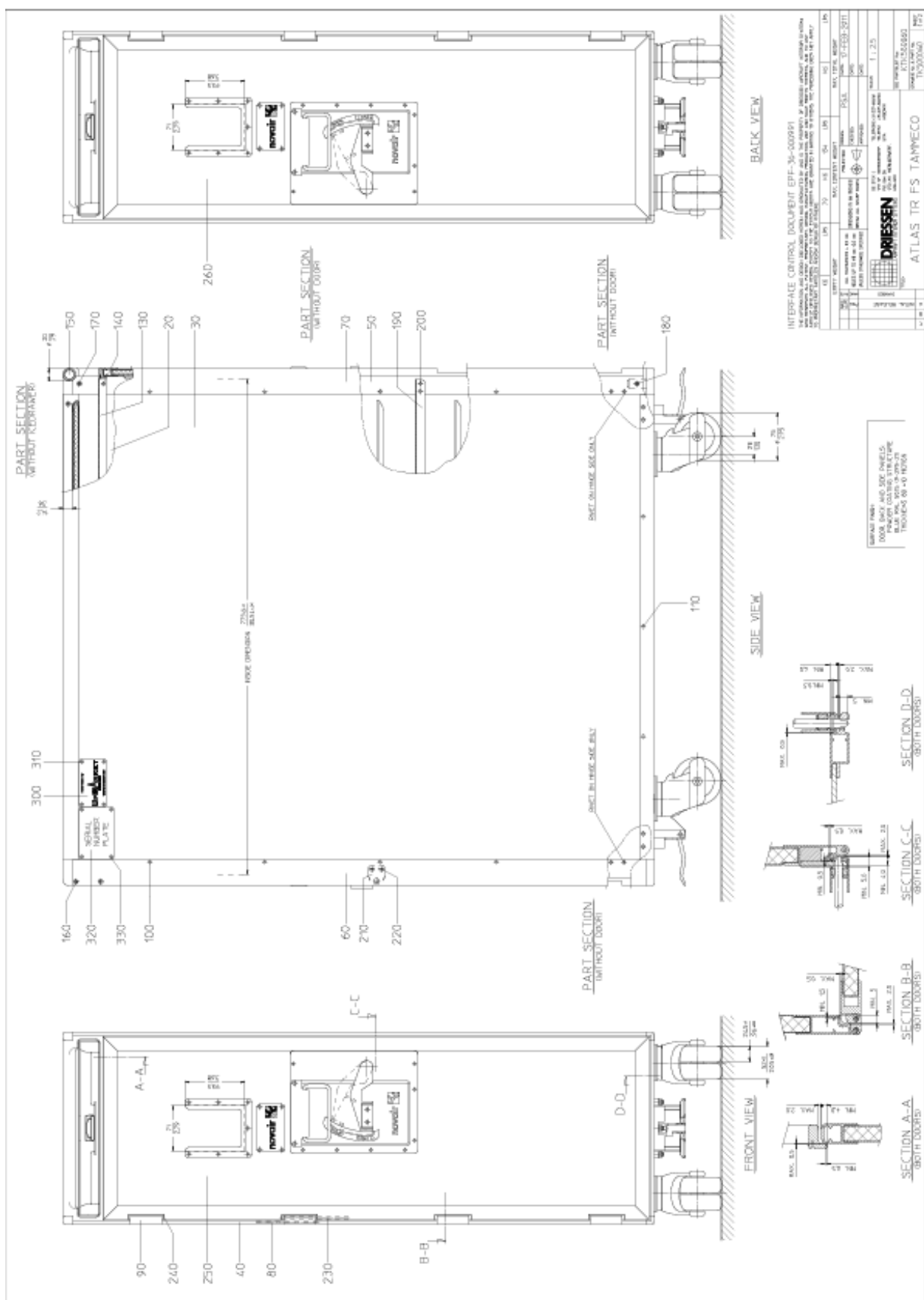
D. PASSENGER SURVEY – NOVAIR

Fråga	n					
Ålder 43	Man 28	Kvinna 30	Första flyg 1986			
Hur många gånger reser du med flyg i ditt arbete per år (tur och retur)?	58	Aldrig 45	1 till 3 — 8	4 till 6 — 5	6 till 8 — 0	fler 8 — 0
Hur många gånger reser du med flyg på semester per år (tur och retur)?	58	Aldrig 3	1 till 3 — 50	4 till 6 — 3	6 till 8 — 1	fler 8 — 1
När du reser med flyg på semester är det övervägande charter eller reguljärflyg?	58	Charter 50	Reguljärt 8			
Inom vilken region flyger du mest i?	58	Norden 2	Europa 41	Utanför EU 15		
Har du upplevt det skräp som uppstår efter en flygmåltid som i vägen eller störande?	58	Alltid 9	Aldrig 20	Ibland 29		
Brukar du på samla ihop skräpet efter flygmåltiden för att underlätta när det senare ska samlas in av personalen?	58	Alltid 51	Aldrig 0	Ibland 7		
Skulle du kunna tänka dig att hjälpa till att sortera skräp efter måltiden, innan det samlas in, om möjligheten fanns?	58	Ja 48	Nej 2	Delvis 8		
Är det viktigt för dig att din flygresa genomförs på ett miljövänligt sätt?	58	Ja 37	Nej 6	Saksamma 15		
Är det viktigt för dig att det serveras mat under din flygresa?	58	Ja 46	Nej 4	Saksamma 8		
Källsorterar ni i ert hushåll?	58	Ja 36	Nej 5	Delvis 17		

E. FEATURE MATRIX

Feature	USERS				Summary
	Caterer	Airline	Pax	Envir.	
advertisement	2	2	1	0	5
brandable	2	2	1	0	5
compact	2	2	0	1	5
light weight	1	2	0	2	5
new design	1	2	1	1	5
recycle	0	1	1	2	4
easy to use	1	1	1	1	4
reusable	1	1	2	0	4
plastic	0	0	0	2	2
paper	0	1	0	0	1
metal	0	0	-2	2	1
biodegradable	-2	1	-2	2	-1
disposable	0	0	0	-2	-2
cheap	-1	0	-2	0	-3

F. SIZE VERIFICATION

Dessert

Main dish

Appetizer

Cutlery

Cup

270 mm

190 mm

G. MATERIAL SELECTION

H. MATERIAL ANALYSIS

LARGE CONTAINER - PAPER

Carbon Footprint

Material:	2.3 kg CO_2
Manufacturing:	0.00 kg CO_2
Transportation:	0.136 kg CO_2
End of Life:	3.5 kg CO_2

5.9 kg CO_2

Total Energy Consumed

Material:	37 MJ
Manufacturing:	0.00 MJ
Transportation:	1.7 MJ
End of Life:	2.6 MJ

42 MJ

LARGE CONTAINER - ABS

Carbon Footprint

Material:	2.7 kg CO_2
Manufacturing:	1.6 kg CO_2
Transportation:	0.029 kg CO_2
End of Life:	0.367 kg CO_2

4.7 kg CO_2

Total Energy Consumed

Material:	66 MJ
Manufacturing:	16 MJ
Transportation:	0.365 MJ
End of Life:	0.263 MJ

82 MJ

CUP - ABS

Carbon Footprint

Material:	1.7 kg CO_2
Manufacturing:	1.0 kg CO_2
Transportation:	0.019 kg CO_2
End of Life:	0.398 kg CO_2

3.1 kg CO_2

Total Energy Consumed

Material:	42 MJ
Manufacturing:	10 MJ
Transportation:	0.232 MJ
End of Life:	0.304 MJ

52 MJ

CUP - PAPER

Carbon Footprint

Material:	1.5 kg CO_2
Manufacturing:	0.00 kg CO_2
Transportation:	0.086 kg CO_2
End of Life:	1.9 kg CO_2

3.4 kg CO_2

Total Energy Consumed

Material:	24 MJ
Manufacturing:	0.00 MJ
Transportation:	1.1 MJ
End of Life:	1.4 MJ

26 MJ

KNIFE – ABS

Carbon Footprint

Material:	2.0 kg CO_2
Manufacturing:	1.2 kg CO_2
Transportation:	0.021 kg CO_2
End of Life:	0.193 kg CO_2

3.4 kg CO_2

Total Energy Consumed

Material:	48 MJ
Manufacturing:	12 MJ
Transportation:	0.269 MJ
End of Life:	0.138 MJ

60 MJ

KNIFE – PS Hi

Carbon Footprint

Material:	42 kg CO_2
Manufacturing:	38 kg CO_2
Transportation:	0.692 kg CO_2
End of Life:	6.2 kg CO_2

87 kg CO_2

Total Energy Consumed

Material:	1400 MJ
Manufacturing:	370 MJ
Transportation:	8.6 MJ
End of Life:	4.4 MJ

1700 MJ

KNIFE – STAINLESS STEEL

Carbon Footprint

Material:	3.0 kg CO_2
Manufacturing:	0.279 kg CO_2
Transportation:	0.014 kg CO_2
End of Life:	0.199 kg CO_2

3.5 kg CO_2

Total Energy Consumed

Material:	30 MJ
Manufacturing:	2.8 MJ
Transportation:	0.169 MJ
End of Life:	2.8 MJ

35 MJ

TRAY – ABS

Carbon Footprint

Material:	11 kg CO_2
Manufacturing:	6.5 kg CO_2
Transportation:	0.120 kg CO_2
End of Life:	1.5 kg CO_2

19 kg CO_2

Total Energy Consumed

Material:	270 MJ
Manufacturing:	65 MJ
Transportation:	1.5 MJ
End of Life:	1.1 MJ

340 MJ

TRAY – PET

Carbon Footprint

Material:	13 kg CO_2
Manufacturing:	9.1 kg CO_2
Transportation:	0.167 kg CO_2
End of Life:	0.301 kg CO_2

22 kg CO_2

Total Energy Consumed

Material:	350 MJ
Manufacturing:	90 MJ
Transportation:	2.1 MJ
End of Life:	0.215 MJ

440 MJ

TRAY – PS Hi

Carbon Footprint

Material:	7.7 kg CO_2
Manufacturing:	6.9 kg CO_2
Transportation:	0.127 kg CO_2
End of Life:	1.1 kg CO_2

16 kg CO_2

Total Energy Consumed

Material:	250 MJ
Manufacturing:	69 MJ
Transportation:	1.6 MJ
End of Life:	0.817 MJ

320 MJ

I. DESIGN EVALUATION

>2.0mm

<0.5mm

Incorrect edge

Area of weakness

Incorrect radius/edge

Area of weakness

Area of weakness
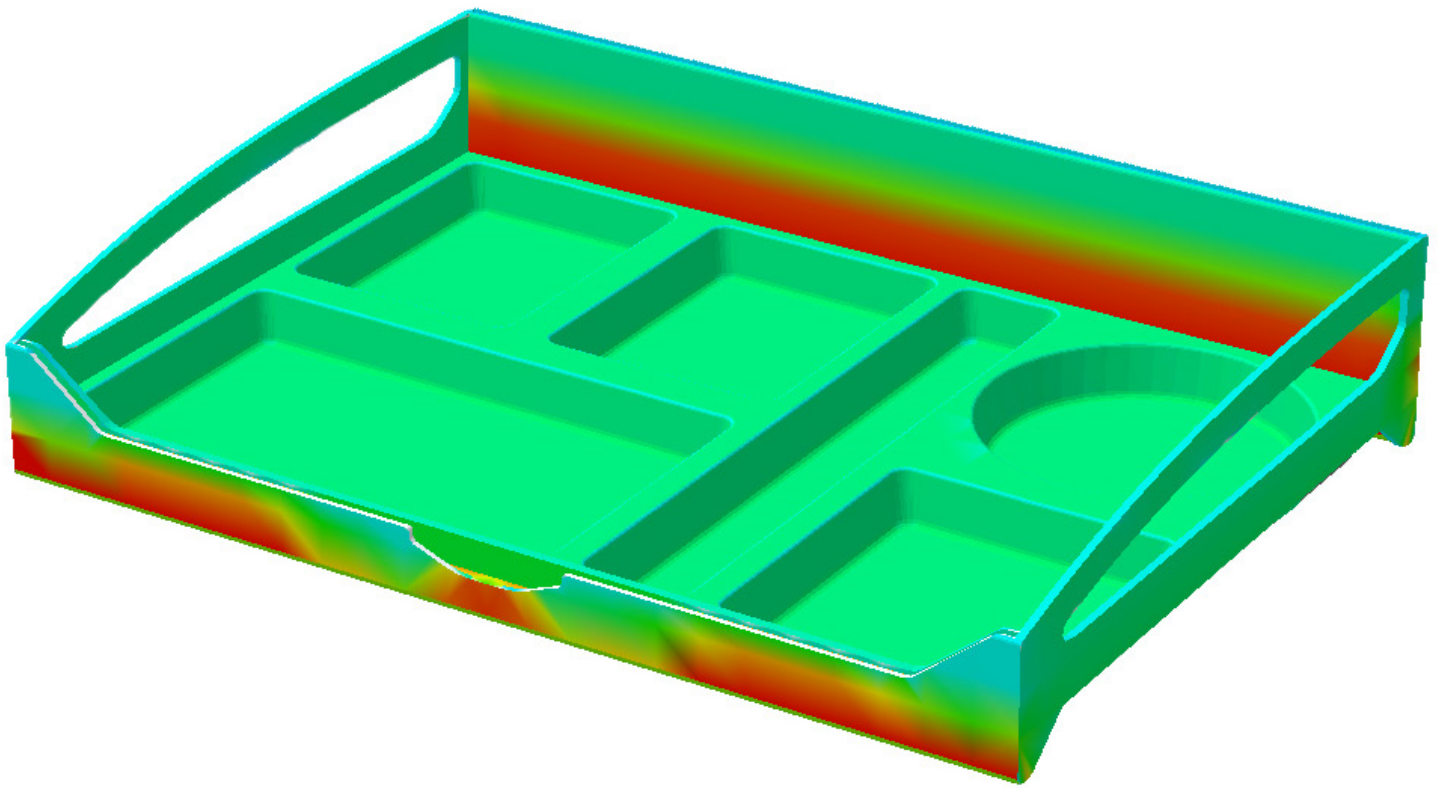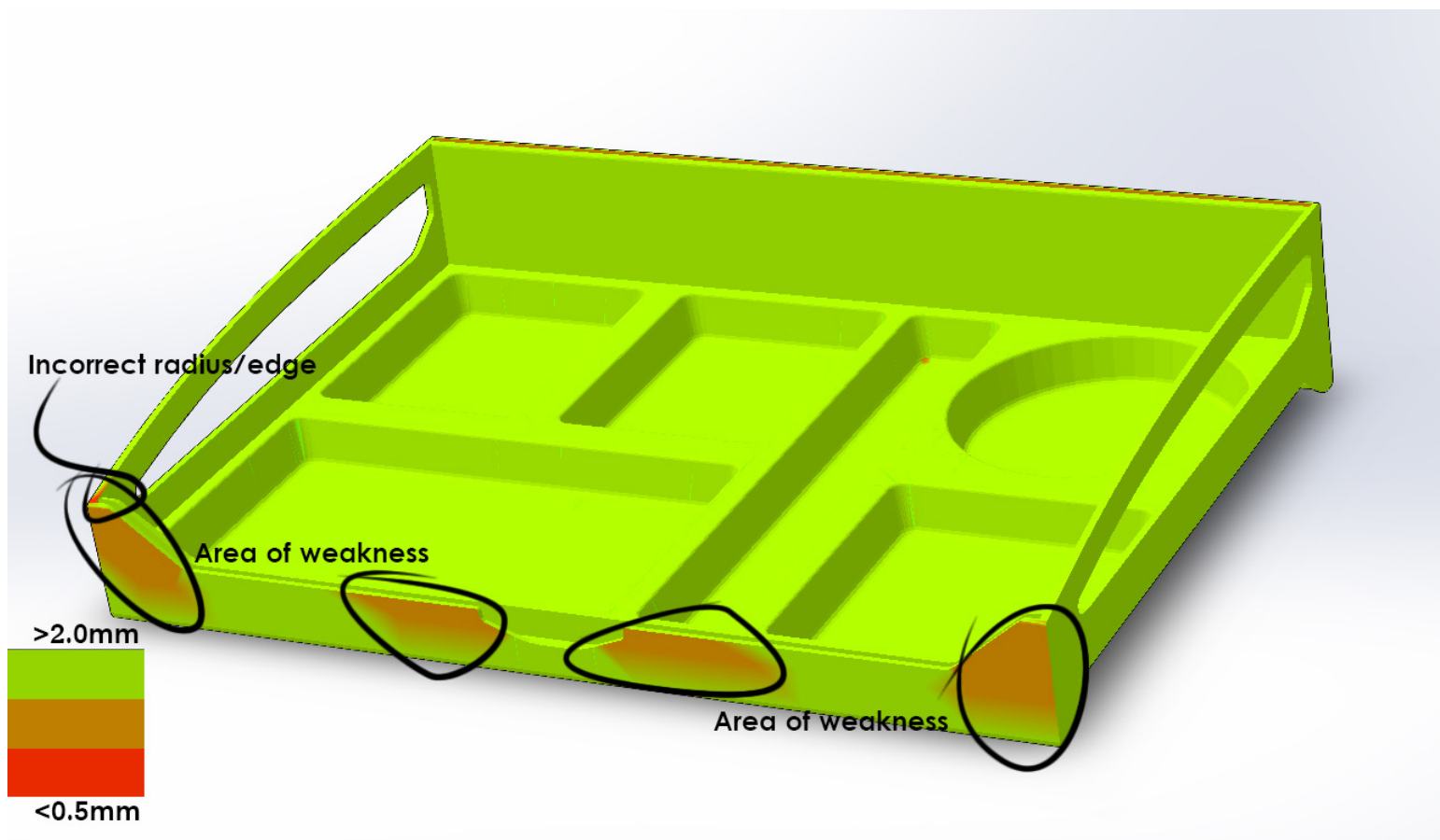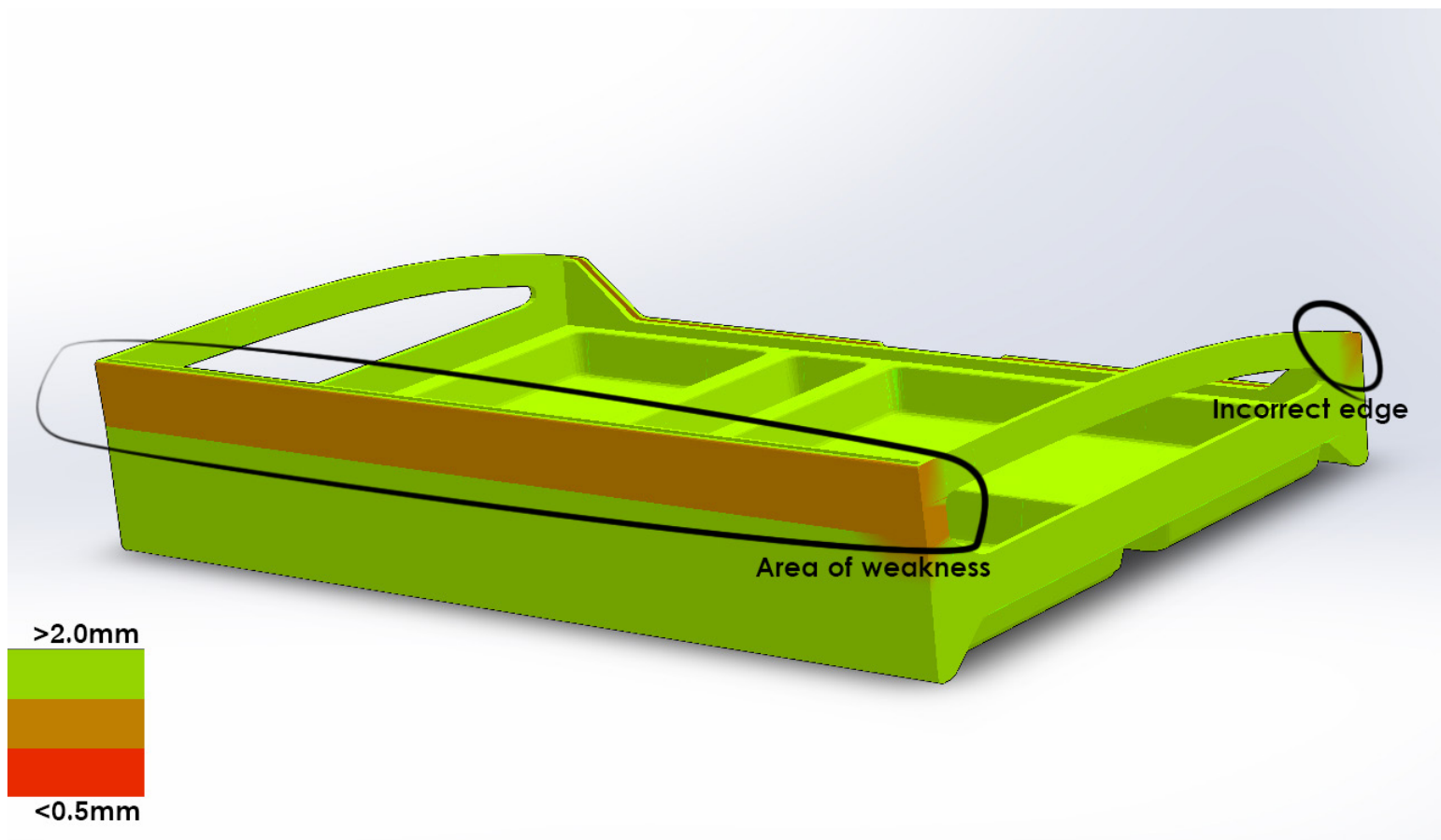
>2.0mm

<0.5mm
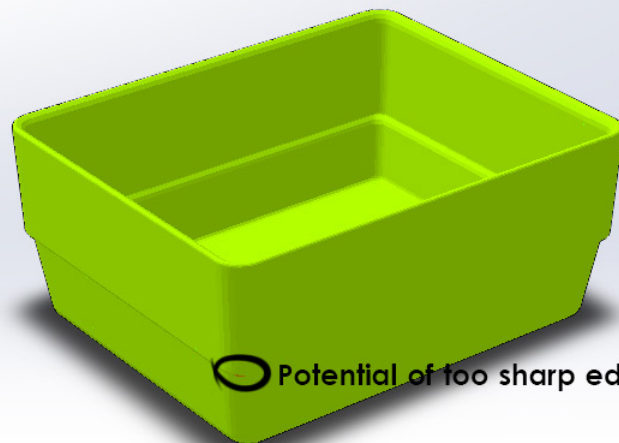
No direct design factors that may affect the manufacturing
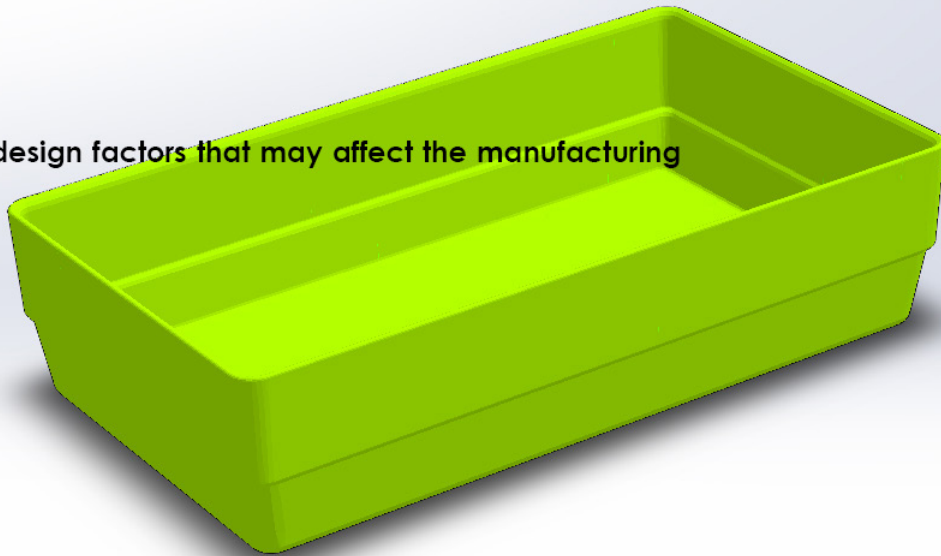
>2.0mm

<0.5mm

Potential of too sharp edges or small radius

>2.0mm

<0.5mm

>2.0mm

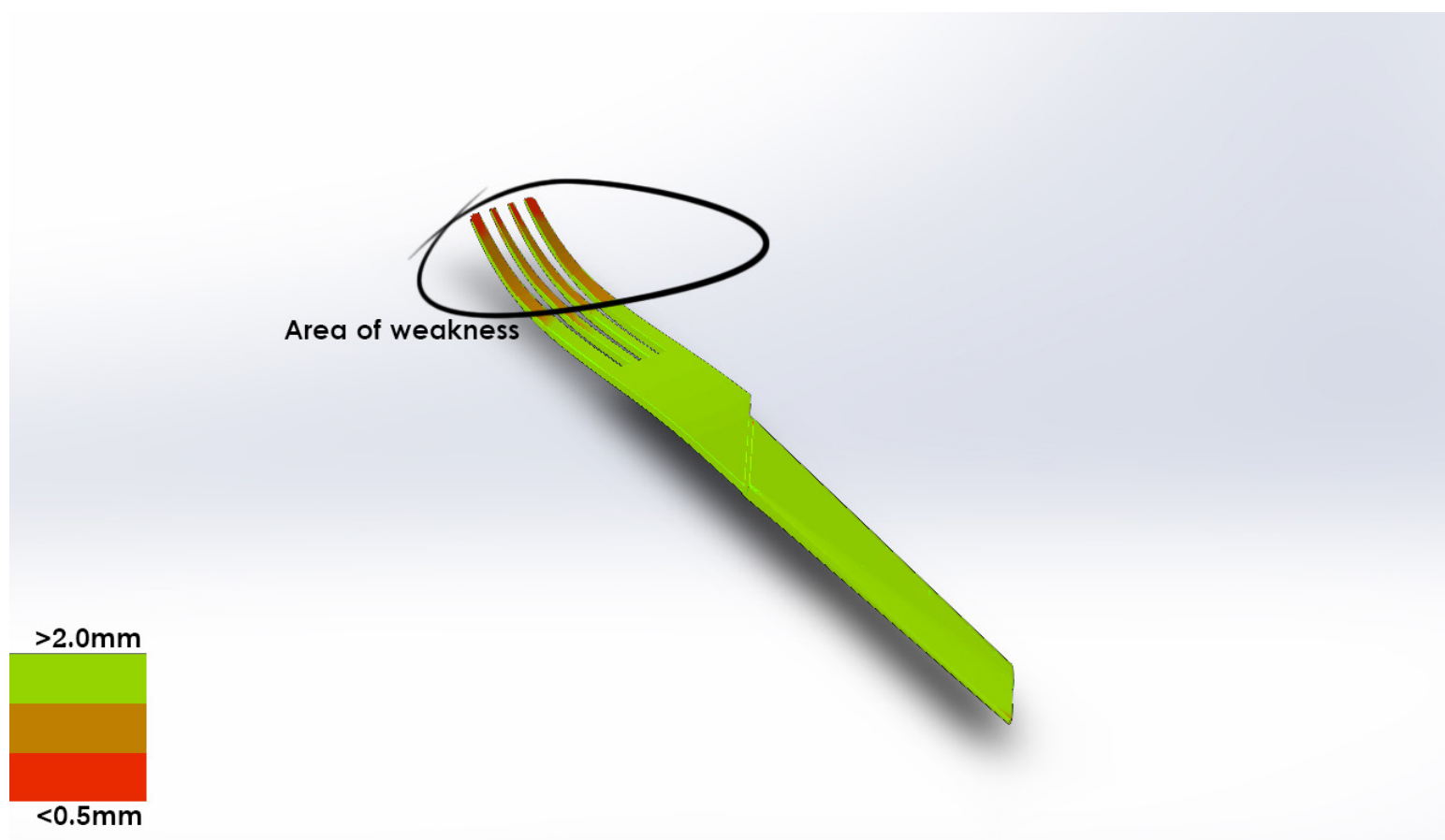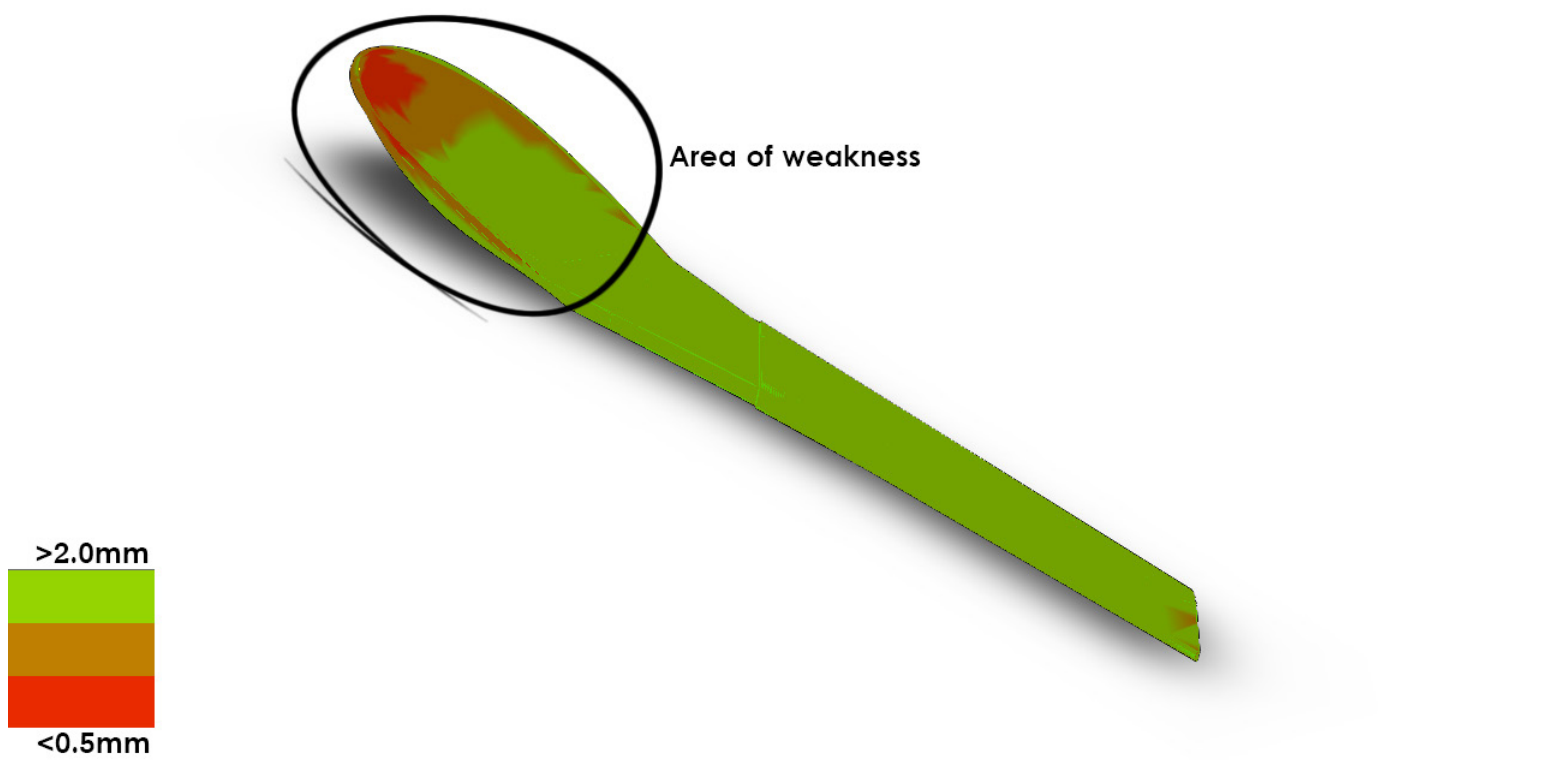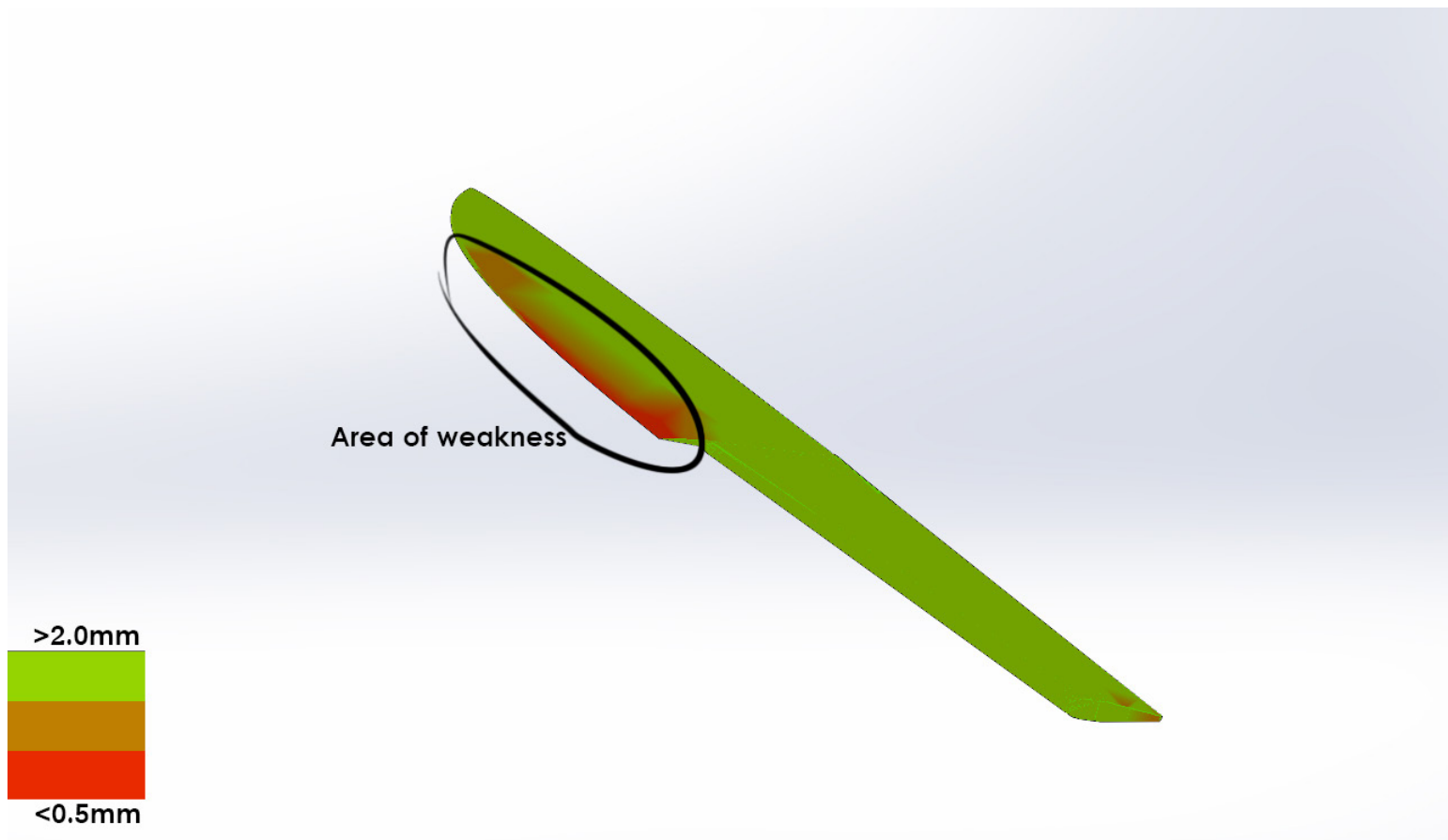<0.5mm

Too sharp edges or small radius

Area of weakness

>2.0mm

<0.5mm

>2.0mm

<0.5mm

Area of weakness

>2.0mm

<0.5mm

Area of weakness

J. FOCUS GROUP QUESTIONNAIRE

Air Dinner	Much below average ->			<-Much above average	Average
Aesthetics	1	2	3	4	3,86
Dimensions	1	2	3	4	3,71
Quality	1	2	3	4	3,71
Dining Experience	1	2	3	4	3,57
Intuitive	1	2	3	4	3,86
Personal/Unique	1	2	3	4	3,57
Modern	1	2	3	4	3,57
Simple	1	2	3	4	4,00
Reusable	1	2	3	4	3,57
Paper Cover	1	2	3	4	3,71
Tray					
Aesthetics	1	2	3	4	3,86
Dimensions	1	2	3	4	3,86
Quality	1	2	3	4	3,57
Dining Experience	1	2	3	4	3,86
Intuitive	1	2	3	4	4,00
Personal/Unique	1	2	3	4	3,71
Modern	1	2	3	4	3,71
Simple	1	2	3	4	3,71
Reusable	1	2	3	4	3,71
Cutlery					
Aesthetics	1	2	3	4	3,14
Dimensions	1	2	3	4	1,57
Quality	1	2	3	4	1,71
Dining Experience	1	2	3	4	3,00
Intuitive	1	2	3	4	4,00
Personal/Unique	1	2	3	4	3,57
Modern	1	2	3	4	3,71
Simple	1	2	3	4	2,86
Reusable	1	2	3	4	1,71
Cup					
Aesthetics	1	2	3	4	4,00
Dimensions	1	2	3	4	4,00
Quality	1	2	3	4	4,00
Dining Experience	1	2	3	4	4,00
Intuitive	1	2	3	4	4,00
Personal/Unique	1	2	3	4	3,43
Modern	1	2	3	4	3,71
Simple	1	2	3	4	3,86
Reusable	1	2	3	4	4,00
Plates/Containers					
Aesthetics	1	2	3	4	3,86
Dimensions	1	2	3	4	3,57
Quality	1	2	3	4	4,00
Dining Experience	1	2	3	4	3,71
Intuitive	1	2	3	4	4,00
Personal/Unique	1	2	3	4	3,00
Modern	1	2	3	4	3,86
Simple	1	2	3	4	4,00
Reusable	1	2	3	4	4,00
Paper Cover					
Aesthetics	1	2	3	4	3,29
Dimensions	1	2	3	4	4,00
Quality	1	2	3	4	3,29
Dining Experience	1	2	3	4	3,71
Intuitive	1	2	3	4	3,71
Personal/Unique	1	2	3	4	4,00
Modern	1	2	3	4	3,71
Simple	1	2	3	4	3,71
Reusable	1	2	3	4	1,43