Analysing the Double diamond design process through research & implementation

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Abstract

"Analysing the Double diamond design process through research & implementation" aims to clarify and discuss the Double diamond design process, its origin, use and usefulness in design today. The thesis also intends to discuss the position, skill-set and responsibilities designers are faced with when working for a start-up in comparison to a larger company. The Double diamond design process itself is viewed through the lens of a case study project with a small company/start-up called Eye Caramba Oy. As the Double diamond model originated through the study of design practices in large established compa-nies on a strategic level it was seen fit to balance that with its use on a small project and on a highly prac-tical level. As the Design council (the creators of the Double diamond design process) urge users to alter or modify the process to suit their projects there are a vast amount of process model variations available. For the case study an original process model was made based on a project example. This detailed model added a layer to the discussion regarding proper use and modification of the Double diamond design process. As discussions and subsequent conclusions were the result of comparing a small project with a vast pool of research, they should not be viewed as conclusive but rather as important discussions for young designers entering an ever-changing market.

Keywords Design process, Double diamond, case study

1.0 Introduction

1.1 Background and motivation

As an industrial designer leaving university or other studies and entering the job environment one is faced with a vast variety of places and scenarios in which to apply ones' skills. The design profession has a multitude of sections and sub-sections which can all apply to different work environments. As a designer for an automotive company for example the expectation on the designer may be to focus on form, expression, branding etc. while at a start-up the designer may be expected to know anything from surface treatment, photography, prototyping, user studies, materials, legislation, manufacturing methods and so on. This leaves the individual designer with the task of finding out what exactly is expected of him/her.

The Double Diamond design process is a widely known, taught and applied design process. It was created following a study of 11 large corporations and their internal design processes. This method will be applied and analysed in a case study. A concise overview of the Double Diamond design process will follow, as well as some examples of other processes both contemporary and historical. (Design Council, Desk study, 2007).

1.2 The case study

Eye Caramba Oy in Helsinki contacted Aalto regarding a potential project collaboration. The project will be explained and examined in full later in the report. As the case study project is limited to its context the results may be applicable and relevant mainly to designers within similar areas of design. The case study will include a discussion regarding the designer's position/role in a start-up, what can and should be expected of both company and designer.

As the role of the designer directly correlates to his/her skillset and methods these attributes will be viewed, analysed and discussed. the Double Diamond design process will also be viewed, analysed and discussed particularly regarding its use, applicability and suitability to this specific project.

1.3 Aims and goals

The thesis report aims to concisely explain the Double Diamond design process origin, idea, structure and usage. It (the report) should give the reader a clear understanding of the process model and how it can and should be used. The reader should understand the various phases and actions therein.

By applying the Double Diamond design process to a real project and analysing the outcomes further discussion on applicability, best-use and customisation can be had.

2.0 Thesis Literature review

Keywords: Double diamond design process, Design process, Design methods, Design management, best practice,

Case study working name: STROBO

> "If you can't describe what you are doing as a process, you don't know what you're doing."
>
> W. Edwards Deming. (Leanvlog, 2018)

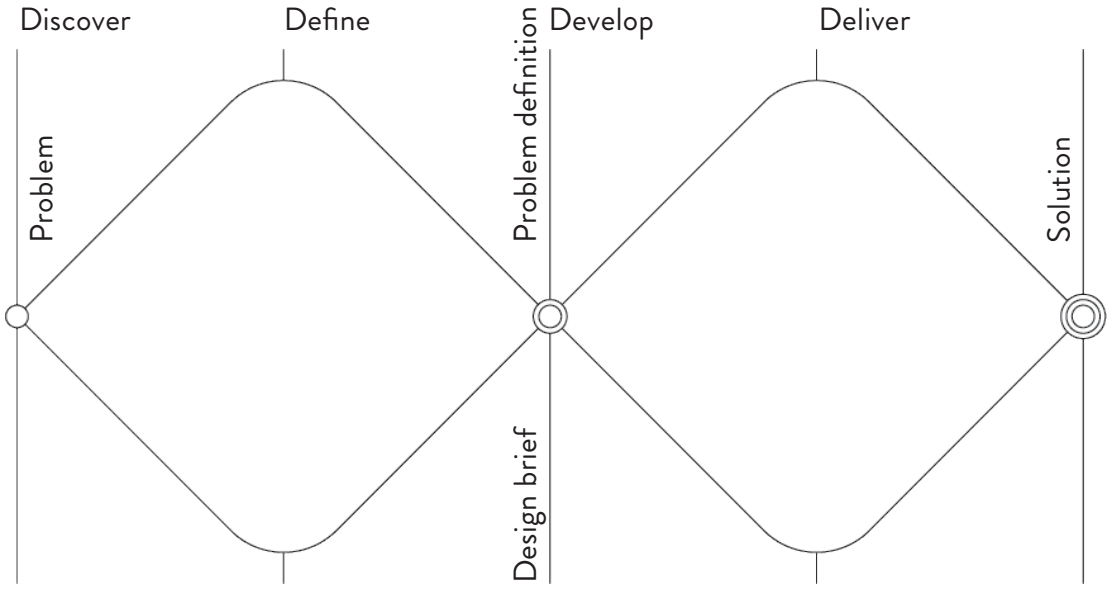
The following is a short overview of the evolution of design methods and processes focusing primarily on reviewing the aspects that formed the so-called Double Diamond design process both through historical examples, current trends and research. Simply put "[The design process is] the specific series of events, actions or methods by which a procedure or set of procedures are followed in order to achieve an intended purpose, goal or outcome." (Best, 2006). Or to put it in more philosophical terms the design process is the mapping and planning of the "means to an end".

"With the emergence of design methods came the mapping of the design process, generating models, formulae and diagrams that aimed to illustrate best practice. "(Design Council, Desk study, 2007).

The design process has been a topic of study and research for decades, and yet it seems no "holy grail" has been discovered. Various charts, graphs and structures have been generated in order to accurately categorize and simplify the steps taken throughout a design brief. In later years more emphasis has been put on the idea that there is no process model that could fit most cases and therefore be considered "standard" but rather that models must constantly be changed and adapted according to the specific characteristics of a brief or project. Best (Best, 2006) discusses this matter in the light of not only a vast variation in project characteristics and attributes but also a constantly changing context. No project is carried out in a vacuum, rather, all are influenced by changes in user preferences, market conditions etc. (Best, 2006). Clarkson and Eckert discuss a similar standpoint in which they believe that there are generic

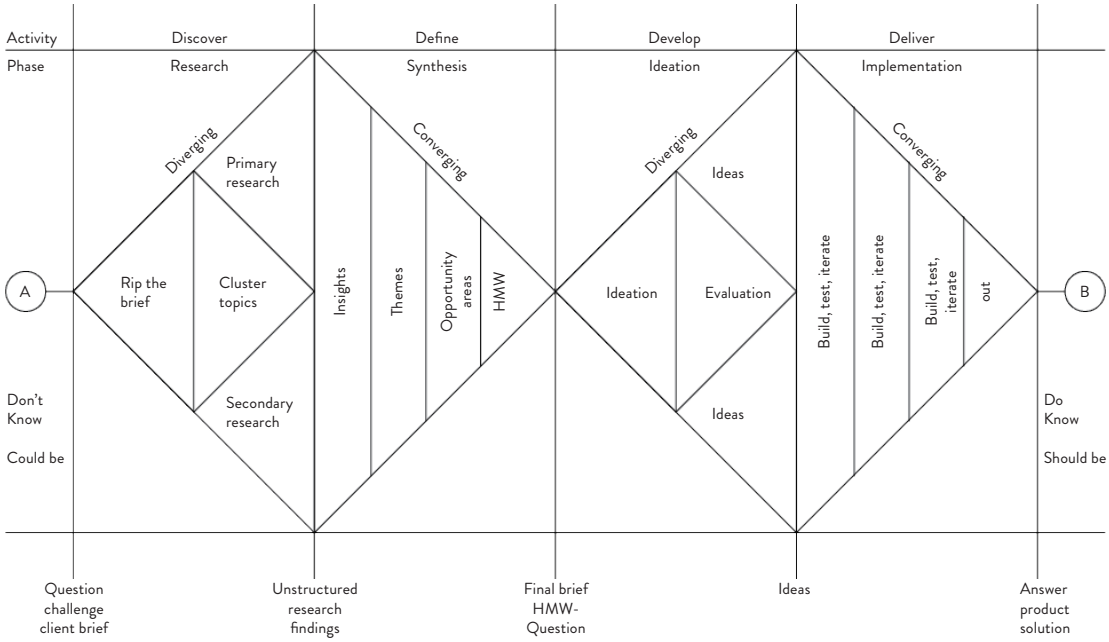
stages which could constitute a commonality between design processes. However, this does not remove the need for modification in accordance with the targeted problem or used needs. (Clarkson, P.J. and Eckert, C.M. 2005). The constant necessity for modification and customisation led Best to describe two categories of processes, the standardised and the customised. The standardised is more generic and vague as it must serve a large variety of purposes. It also tends to have more predictable outcomes. Customised is what happens when you take a standardised method and modify, change, specify or in any way alter it to be suitable to a specific project (Best, 2006).

The Double Diamond design process in the form created by the Design Council serves as a suitable example of a standardised method. This version is easily applicable to most projects as it follows a standard means of working through a project.



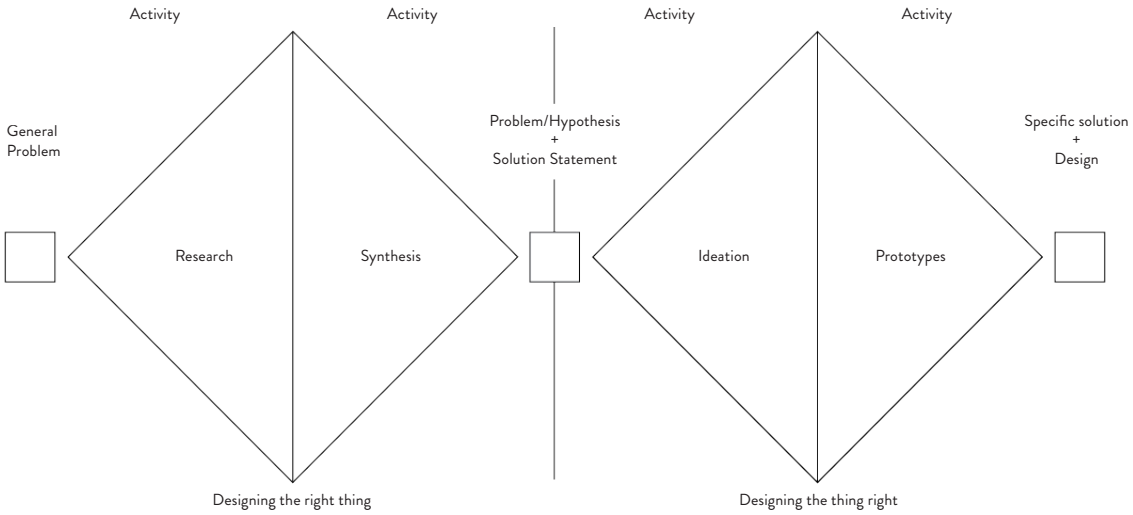
(DesignCouncil, 2018)

However, when applied to a project with specific characteristics it (Double Diamond process model) can take on a customised form specifically formed according to the project making it more useful. An example of such a customised model seen below from a project conducted by Sohaj Singh Brar in 2017. This customised Double Diamond model was created in order to clarify for the designer as well as other stakeholders what the designers' role was in the project as well as the actions needed to achieve the intended goal. The project was to create a new UX for buying circular tickets on the Indian Railway (Singh Brar, S. 2017). This model was used as inspiration in creating the customised Double Diamond model for the STROBO case study project.



(Singh Brar, S. 2017)

Not all customisations are that complex. In other cases, designers use the Double Diamond design process to showcase their personal method. In such cases the process is customised to show the designers' personal workflow and methods. An example of such a case is Product designer Natalie Rutiezer's customised Double Diamond process.



(Rutiezer, N. 2017)

Historically the recognition of the limitations of standardised methods has meant the transition from methods that assume a linear progression throughout a project to ones that assume many changes along the way. These changes are often handled through iterative loops, allowing the designer to adjust for changes as well as take steps back when necessary. The rapid evolution of society, business and technology suggests that an ideal methodology or process is unlikely to ever be achieved. “What matters therefore is that a flexible infrastructure is in place with the foresight and intelligence to respond quickly and appropriately to creative change (Design Council, Desk study, 2007).”

With all the complexity that follows the rapid movement of the world today design processes are required to consider factors such as technology (technological advancement), sustainability, legislation, safety, social responsibility and so on (Design Council, Desk study, 2007). In addition, the intended product, type, nature or position of design in a company can further impact the design process (Best, 2006).

It seems a hopeless feat to simplify the design process far enough to find a standard process. However, although it is agreed that there are no best practices, commonalities have been found across processes used which typically consist of four or five distinct phases (Design Council, Desk study, 2007). And on these commonalities the Double Diamond process was created.

3.0 The Double Diamond Design Process

General overview

The double diamond design process is a relatively new and well-known methodology. It was developed by the Design Council in 2005. An in-depth study of eleven global brands and the methods they use was conducted in 2007. The double diamond method was produced as "a simple graphical way of describing the design process.". (Design Council, 2007) The method consists of four phases beginning from an initial idea and ending with the delivery of a product or service (Design Council, 2007). Although the double diamond shape is meant to be generic throughout all projects the design council suggest that it be altered (or customised) to fit each individual project's needs and characteristics. These could be the aim of the project such as a product or service. They could also be more specific like whether the project is carried out in-house or together with third parties, suppliers, consultants etc. Each phase incorporates iterative loops in which exploration and testing can occur (Design Council, Desk study, 2007). The four phases of the Double Diamond design process are: Discover, Define, Develop and Deliver (Design Council, 2007).

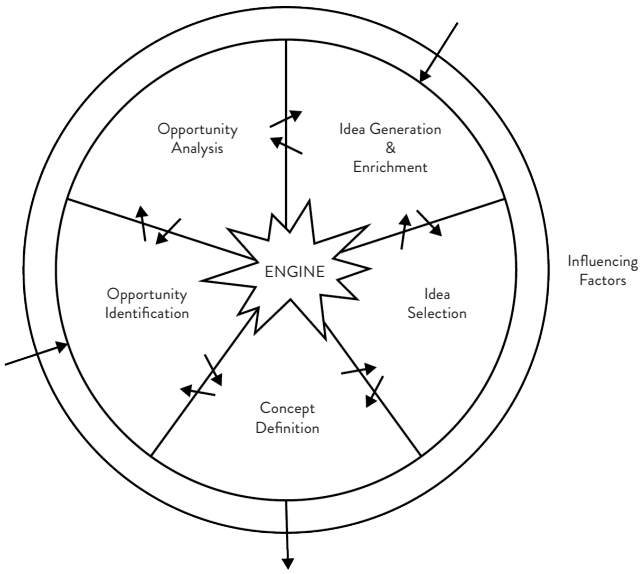
3.1 Discover

In the discovery phase an idea or user need must be established.

This initial quarter of the Double Diamond process, aptly named Discover is a phase in which the designer plays a key role. The actions taken in the Discover phase are meant to generate innovation and therefore involve a wide perspective and minimal formalisation. "in striving to enforce effectiveness, formalization also risks inhibiting innovation and flexibility (Frishammar, J. & Florén, H. 2010)." In this early stage the quality of work defines the degree of successful innovation and identified opportunities (Eschberger,T. 2018).

The actions and characteristics of the Double Diamonds' Discover and Define phase are seen in the study of front-end design. As this section of the design process always involves a large amount of uncertainty and change it has been referred to with terms like "fuzzy" or "spongy" front end. One key commonality between "fuzzy front end" and the early phases of the Double Diamond is that they are critical in defining the nature of the problem that is being addressed (Rhea 2003). As the divergence in thought and concept generation has unpredictable outcomes the early stages are characterised by uncertainty and are difficult to plan (Eschberger,T. 2018). This uncertain-

ty and lack of standardisation is noticeable not only between companies but between projects within the same company as well. Sequencing, overlapping and differences in duration are all factors that differ on a project to project basis (Frishammar, J. & Florén, H. 2010).



(Koen et al., 2001, Koen et al., 2002)

One method of uncovering new concepts or ideas that may be innovative as well as having a set market demand is studying the user. Establishing the user needs can be done in many ways including: market research, user research, information management and through design research groups. (Design Council, 2007) The Design Council refer to the phase as a "phase of divergent thought" (Design Council, 2007). This is to suggest that the designers, researchers or teams keep an as broad and open perspective as possible. This in turn should give the space to be creative and to be influenced by a multitude of sources resulting in a wide range of ideas, thoughts, questions etc. (Design Council, 2007).

Larger companies most often have teams or sectors dedicated to researching market trends, user needs and other potential opportunity areas. However, in recent years there has been an increase in start-up companies (Forbes, 2015) which are generally too small to dedicate significant revenue into research but must rather rely on other methods of discovering opportunities. In such situations the designer plays a large role. "... Discover phase as one of the most critical and the one which makes best use of the

designer's skills (Design Council, Desk study, 2007)."

In 2015 it was noted that the people starting start-up businesses because they wanted to had increased. These individuals called "opportunity entrepreneurs" were defined as people who were not unemployed or looking for work. In addition, there had been an increase in "Entrepreneurs starting new businesses because they saw market opportunities" (Kauffmann, 2015). One method through which start-ups and entrepreneurs are able to discover innovative ideas is crowdsourcing. Companies like Kickstarter and Indiegogo allow the start-up or individual to show their ideas to a large audience with almost no input of revenue. This not only gives an opportunity to gather initial funding but gives invaluable insight into the opinions of the core audience (Patel, 2016). This method allows for the potential end user to evaluate and give feedback on an idea from the very beginning of the design process.

"Entrepreneurs often get carried away with their business ideas and sink money into equipment, beta testing and expensive prototypes before they truly understand the market demand." (Patel, 2016)

"The outcome of the Discover stage of the design process is a project brief for a design project and signifies the practical start of the design process" (Design Council, 2007).

3.2 Define

In the define phase the needs, problems, ideas are focused toward end goals.

According to the report put out by the Design Council many large corporations have a similar stage (Define) with the examples of: Starbucks "Downtown", Whirlpool "Synthesis" and Microsoft "Ideate" (Design Council, 2007).

The first quarter of the Double diamond design method (Discover) ends in a brief which the Define stage then examines, evaluates, changes and refines into a project brief which is in line with corporate goals and interests. The material from the previous stage is "analysed and synthesised into a brief with actionable tasks related to new and existing product or service development" (Design Council, 2007).

Having found a problem or solution in the Discover stage the Define stage also focuses on the context in which the problem or solution resides, as well as the context of the company itself in undertaking the brief. Financial situation, investment and competing

products are but some factors that are considered. The Design Council puts emphasis on the importance of involving the whole team in this aspect, not least the designers (Design Council, 2007). However, in the case of a start-up hiring a single designer much of this research and consideration is conducted separately from the designer. In such cases knowledge of company finances, investments and market analyses are limited to the designer who acts merely within the parameters given by the employer. This gap in knowledge can and should be breached using good design management thereby allowing all parties to be fully informed. An important role that the Define stage plays is described by the Design Council as "a filter that allows designers to identify which idea has legs and should be pursued and developed" (Design Council, 2007).

The Design Council also emphasises the importance, and often neglected value in having regular discussions between various departments involving engineering, manufacture, branding, materials experts, research teams and designers. In larger companies such as those described in the report, initial ideas for products are evaluated against established manufacturing methods and branding (Design Council, 2007). "Cooperation among functions and departments also creates legitimacy for a new concept and facilitates the subsequent development phase. (Frishammar, J. & Florén, H. 2010)." Start-up companies are often new to the market as previously mentioned and are therefore unlikely to have established or pre-existing manufacturing facilities. This means that an idea generated by a start-up is generally less limited in terms of possible manufacturing methods. Bruce and Morris discuss the possible pros and cons having third party involvement. They reason that some of the potential problems having third party involvement are "accessibility, familiarity and control (Design Council, Desk study, 2007). However, some advantages include added insights as well as reduced cost. (Bruce, M., Morris, B. 1994). In such cases the manufacture experts may be the staff working at the designated factory, meaning that early stage involvement may not be possible. In other cases, the initial expertise regarding manufacture comes from the designer until the concept has reached a stage where it can be brought to manufacture.

In the Define stage designers use a variety of methods to define what ideas, solutions or approaches would best serve the project problem or opportunity. Some such methods involve: paper prototyping, scenarios, brainstorming, sketching and quick and dirty prototyping (Design Council, 2007).

Optimising the brief through using management tools is a key part of the Define stage. Through the use of management tools, a team is able to accomplish two things: firstly, ensure that all aspects of the project have been considered. Secondly, to avoid any

problems that may arise at later stages. The resulting material is used as a foundation to allow go/no-go decisions to be made (Design Council, 2007).

Although risk management often involves taking steps to avoid changes at later stages some companies have a rather contrary philosophy. Some software companies including Yahoo consider changes throughout the development to be inevitable and work with methods that allow changes to happen as "quick, cheap and painless as possible" (Design Council, 2007). Although the STROBO project never intended to progress using Yahoo's (and other software companies) philosophy as the budget was limited much of the work was done in a rough state using various "quick and dirty" methods such as paper prototyping, 3D printing and other forms of mock-ups. In addition, due to the designer's relationship to the company there were many changes and challenges along the way. These aspects will be discussed in a later section.

The end of the Define stage is explained to be a pivoting point where a project either receives approval and backing or is killed. However, the methods of presenting the project vary greatly with many formal and non-formal examples. It was mentioned that in the company Alessi and BskyB the CEO was closely involved in the go/no-go decision making (Design Council, 2007). This form of approval, and the effects of such a structure had significant impact on the STROBO project.

"In practice, the Define stage ends in a project go-ahead through corporate level sign –off" (Design Council, 2007).

3.3 Develop

This phase and third quarter of the design process is intended for development, iteration and testing (Design Council, 2007).

Following the official sign-off the project is now ready to be developed using such design methods as brainstorming, visualisation, prototyping, testing and scenarios (Design Council, 2007). The project is at this stage focused on producing the product or service agreed upon in the previous two stages. Although the methods may be similar across the stages the intent has changed and there is little room for exploration.

In the develop stage it is common to work closely in a multi-disciplinary team involving members from a wide range of professional sectors such as: engineering, materials specialists, marketing and manufacturers (Design Council, 2007). The project becomes

a diverse team effort. In larger companies such as the eleven from the Design Council report such teams are likely to be primarily in-house, with third parties weighing in on specialist areas. However, in smaller businesses and start-ups these experts from various disciplines must be consulted with through third parties. While large companies are likely to be slower in progressing through the first two stages (Discover & Define) they have an advantage in being able to quickly, often and effectively consult with experts from various fields through in-house multi-disciplinary teams. This advantage can lead to faster and safer (less likely to hit big problems) development.

At this stage of the design process visual design management tools become essential. These tools are used both as organisers as well as communications. The teams rely on tools such as roadmaps and spreadsheets to keep track of every new development. Sketching, rendering & prototyping (both functional and visual) are used to inform internal stakeholders of the progress (Design Council, 2007).

"... the principle of the development phase is to prototype and iterate the concept to get it as close to an end product or service as possible." (Design Council, 2007).

bringing an idea or concept into the physical world is not only a great way to communicate the concept but also often reveals mistakes, flaws or aspects which may not have been considered. "Technically, new product development (NPD) projects often fail at the end of a development process (Frishammar, J. & Florén, H. 2010)." For this reason, some companies enter into the three-dimensional world fairly quickly through techniques such as paper prototyping and "quick and dirty" prototyping. One such company is the UK based Dyson. Dyson is known in the design world for their extensive use of "advanced" cardboard mock-ups. They use these early mock-ups to both communicate and test various concepts. Having settled on one or sometimes a few concepts they make so called "breadboard prototypes". These prototypes show one or several of the functions of the end product without worrying about the looks. These breadboard prototypes range from a single switch to a full assembly. The prototypes are refined further using CAD software and rapid prototyping before initiating manufacture (MisterRolls, 2010).

Other companies such as Seat have incorporated more recent technology to visualise the concepts at an early stage. Visualising through virtual reality (VR) is supposed to have reduced the number of physical prototypes needed to be made prior to launch by 30%, as well as significantly reducing manufacturing time. These techniques allow for decisions to be made quicker and more efficiently (SEAT, 2018). Despite these benefits the automotive industry at large holds onto traditional clay model making. A reason

mentioned is the importance of keeping the “human touch” referring to the forms and aesthetic of the clay model as music or art, unquantifiable but noticeable (Wilson, M. 2015)

Toward the end of the Develop stage companies engage in communication with factories and manufacturers as well as third parties related to bringing the product or service into manufacture. The product or service is also tested at this stage and users are often involved in the testing (Design Council, 2007).

3.4 Deliver

“... concept is taken through final testing, signed-off, produced and launched” (Design Council, 2007).

Finalisation of the product or service, production and launch belong to this final phase of the design process. Although evaluation very much belongs throughout the development of a service or product it is particularly noted in the “Deliver” phase. Having put products into production testing can be done both in the factory as well as in the intended environment. (Design Council, 2007).

During the process of launching a product the process now involves such parties as marketing, packaging and brand sectors. In larger corporations’ instructions are produced to assure that the brand is consistent in all representing countries. In the case of Starbucks this document is called Siren’s Eye (Design Council, 2007).

At the end of the Deliver stage feedback in various forms, and for various reasons become important. Design teams require feedback of successful products or services in order to gain weight in a company. This feedback is also used in order to identify any problems, opportunities or new ideas which could feed into the next generation of products.

3.5 Summary

As the value of design became noticed during industrialisation design methods began to be formed. Initially these processes were linear suggesting a step-by-step progression through a project but in later years process models evolved to incorporate iterative loops and steps back. This evolution made process models more applicable and realistic toward projects. Managing for changes and expecting complications along the way led in particular software companies to use process models which aided in rapid

alteration of even core project features.

Another development toward applicability for real-life projects was viewing process models as fluid and mouldable to the specific characteristics of a project. This development led to processes being seen as either standard or customised and customisation has become generally encouraged.

Through observing companies' processes as well as researching the history and evolution of design processes the DesignCouncil developed the Double Diamond design process. It has four phases, many of which have strong commonalities with similar models both historical and contemporary. The phases (Discover, Define, Develop and Deliver) have their distinct actions and purposes but depending on the nature of the project it is applied to vast overlapping can occur, particularly in the early phases.

This process model is being taught in many Universities and is used in many companies both for specific projects as well as to visualise the company or individual designers preferred methods. It (the Double Diamond design process) has been customised in innumerous ways to fit a multitude of vastly dissimilar projects and continues to be developed.

Although no "holy grail" of design processes has emerged despite the continuous study and development of the topic these processes continue to evolve. Perhaps the words of Heraclitus ring true in the field of design processes "the only thing that is constant is change".

> "The history of design is one of constant evolution. "
> (Design Council, Desk study, 2007).

4.0 Case study

Keywords: Photography light, videography, cell phone peripherals, product development, prototyping, design process

The next section will focus on the chosen case study project of designing a powerbank light for cellphone photography. The project working title was STROBO coming from the product name suggestion Strobocop. Strobocop was a name intended to combine the strobe light function of the product with the well-known sci-fi character Robocop in a humorous way. As the project was carried out in a small company, or start-up there were no regulating brand management teams or sectors. This made decision

making quick and easy.

The project began with a meeting with the CEO and co-founder of Eyecaramba Oy Arto Ekman. This meeting set up the desired outcome of the project as it was seen at that point as well as the context in which the designed product would operate.

4.1 BlackEye

Blackeye is a company founded in 2013. In 2017 it was one of the founders, Arto Ekman who brought the brief to Aalto University. He remained project leader throughout and was the one making final decisions. Blackeye aim to provide phone attachments which are universal to all smartphones. These attachments aid in creating photography and videography content with higher quality and range. Their first product was a clip-on lens. (blackeye, 2019)

4.2 The Brief

The initial brief was left intentionally vague. The product concept was based on observations made by the company and a keen understanding of its target market. As a product it was intended to branch the company into a new sector within the category of photography and videography lighting.

The idea was to combine two much used products in cell phone photography, namely the flash/continuous light and the power bank. By combining these products, the idea was to allow users to create higher quality content in low light places for longer periods of time.

The generic target audience for Blackeye is an outdoorsy photography/videography enthusiast. Their skill ranges between beginner and mid-level professional. High level professionals tend to use phone-specific attachments such as the Moment lenses. As Blackeye aims to remain universal making such specifically allocated devices falls outside of their brand identity. Their target audience are young people on the move, meaning their devices also need to be tough enough to stand higher levels of wear and tear. Prior to the STROBO project no blackeye products contained electronics.

4.3 Documentation

Throughout the project a logbook was scrupulously kept. Photos and videos were also taken in order to further document the process. Sketches, renders, CAD models and

physical models were archived.

4.4 Collaboration and communication

As the company was small each individual played some part in the project. The main contacts/influencers were Arto Ekman (then CEO), Paavo Tamminen and Leo Tynkkynen. Paavo is the creative director who works with everything from in-store stands to interfaces. He is a key stakeholder in the overall design of the branding. Leo is the marketing manager who is responsible for most of what is shown about the company publicly.

During the project communication was quick and informal between designer and CEO meaning that decisions and actions could be handled quickly. Both designer and CEO had outside contacts that were brought in to the project at various stages creating a network between parties. As an example, communication with the factory in China was done via Blackeyes' contact on site. Electronics prototyping was handled initially through the designers' contact.

Communication was handled largely through: phone call, messenger, email and skype. Face-to-face meetings were also frequent. Most of the design work was done on Aalto Campus and not at the company premises.

4.5 Initial research, investigation & preparation

Limited experience and prior knowledge in the field of luminaire design made initial research and preparation crucial. In larger companies' sectors and groups are generally dedicated to various areas of expertise such as materials experts and market researchers. In a small company such as Blackeye the designer is expected to know or learn the necessary information. The following topics were investigated during the first few weeks of the project in order to quickly advance.

4.6 Inspiration and competition

One of the first steps was to investigate current products in targeted field as well as related areas. Inspiration was drawn from spotlights, flashlights, studio lights and more. As initial concepts targeted the outdoors community aspects such as solar panels and flash lights were interesting secondary functions.

Competitive products were selected, acquired, deconstructed and analysed. The

competitive products were all from the targeted market but varied greatly in technical complexity, size and price.

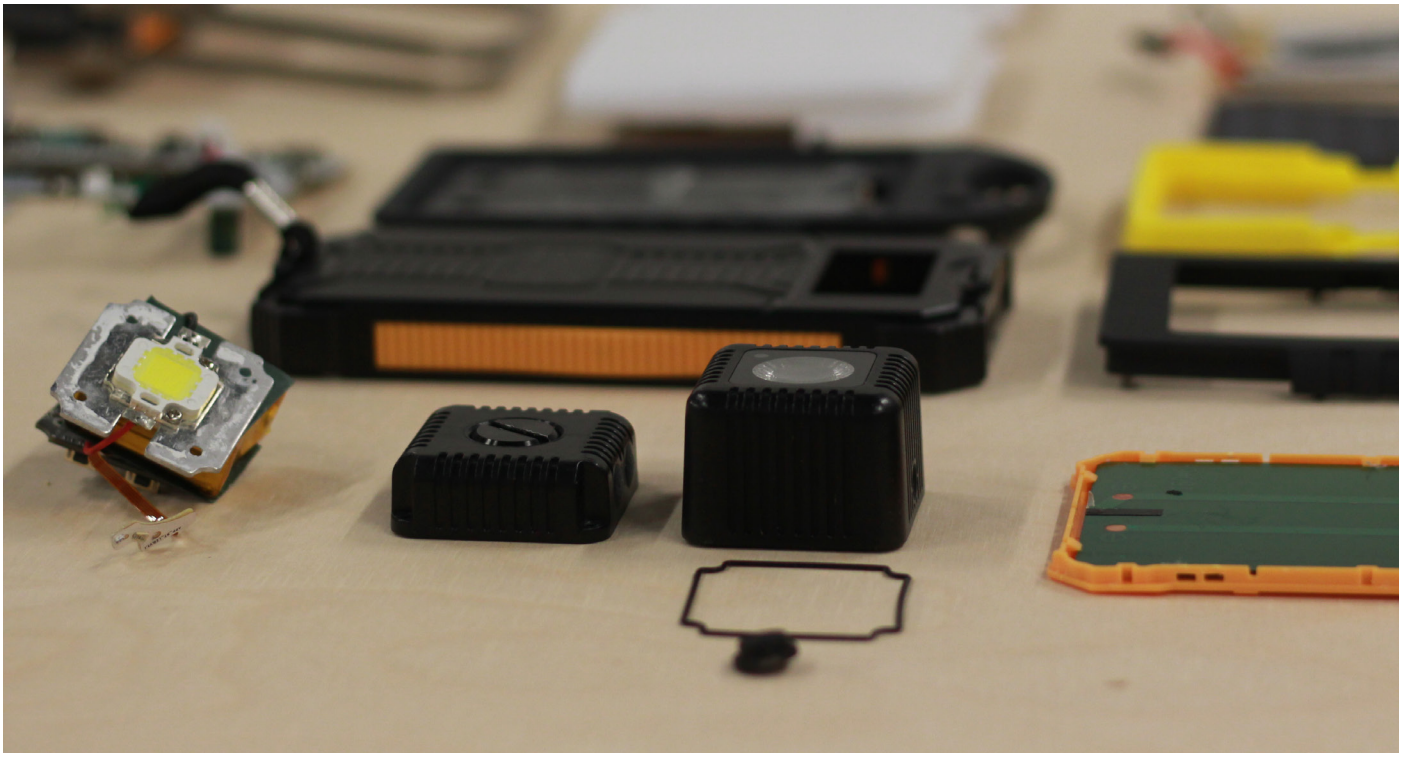
Acquired competitive products were evaluated and examined prior to be disassembled for further analysis. Some aspects such as incremental increasing of light were tested as well as means of diffusing the light. Touch points such as buttons, straps, handles, fixtures and charging points were particularly noted throughout the process. Consideration was also given to product durability and resistance to water and dirt. This was done through investigating structural elements, in particular where exterior bodies joined. In these cases, overlapping and sealing elements were of special interest. Form-factors also play a role in sealing and were also considered.

Product use of materials, particularly pertaining to joints and functions such as dampening shock, absorbing heat or diffusing light were evaluated. One powerbank used a silicone rim around the exterior to seal a joint between to plastic sides. This was designed as a visual element which unbeknownst to the user served the purpose of making the device both more shock absorbent in the case of dropping, but also more dirt and water resistant. In other cases, the sealing part was concealed in the interior or left out entirely. Other examples of interesting use of materials was the Lumecube which is constructed almost entirely in aluminium. This was done both to remove as much heat as possible from the LED meaning it could shine brighter for longer without over-heating or damaging the LED chip. The structure also meant that the device was very durable. The USB charging point was concealed under a threaded lid with a rubber O-ring seal. These where but some of the findings to show examples of the value of evaluating and studying the market in which the designed product will enter.

4.7 Questionnaire

As advanced user research was impossible for numerous reasons a questionnaire was sent to a small selected group of people who represented the anticipated target audience. This was done in order to gain insights as well as possibly confirming expected needs of the target group.

Although Blackeye had a pre-defined target audience and had already gone through phases of determining target audience needs, they found it interesting to validate these through a qualitative questionnaire. It was also believed that this questionnaire could potentially yield some small insights or inspirations for the product which could add value. A small prize in the form of a Blackeye product was given to a randomly selected contributor to the research.



4.8 Requirements & Standards

In order to source a factory which could deliver the best product investigation into standards and requirements common to the product specific field was necessary. Arto was in charge of travelling to inspect factories and had to have sufficient knowledge which fell on the designer to prepare.

Multiple common standards are self-certified by the factories which means that an external quality control sector is necessary to assure that products hold to the claimed standards. Research into the most common standards for similar products was conducted.

As many of the common standards such as CE, RoHS and UN/DOT 38.3 are self-certified it is necessary to have a third-party quality control unit which takes legal responsibility for these quality factors to be upheld by the factory. This is a common way for the company to deflect responsibility of potential product failure from the core company. This also means that the selected third-party companies must comply to certain standards such as ISO and IEC 17025.

Research into requirements for obtaining these standards was also done including detailed descriptions of tests such as (but not limited to) free-fall, moulded case tests and short-circuit tests. These examples are for obtaining IEC 62133, end device standard.

Deciding on what IP standards the final product would adhere to also affected the overall design and was therefore good to get acquainted with early on in the project.

4.9 BOM (bill-of-materials) lists

An initial bill of materials was generated in order to have material for the factory to make estimations. The materials changed throughout the project and as such the BOM list had to be changed and updated as the concept developed. Only at the end of the project could a fully accurate BOM list be made.

Multiple meetings affected the materials definition. These meetings were between designer and client, designer and materials experts as well as between client and factories.

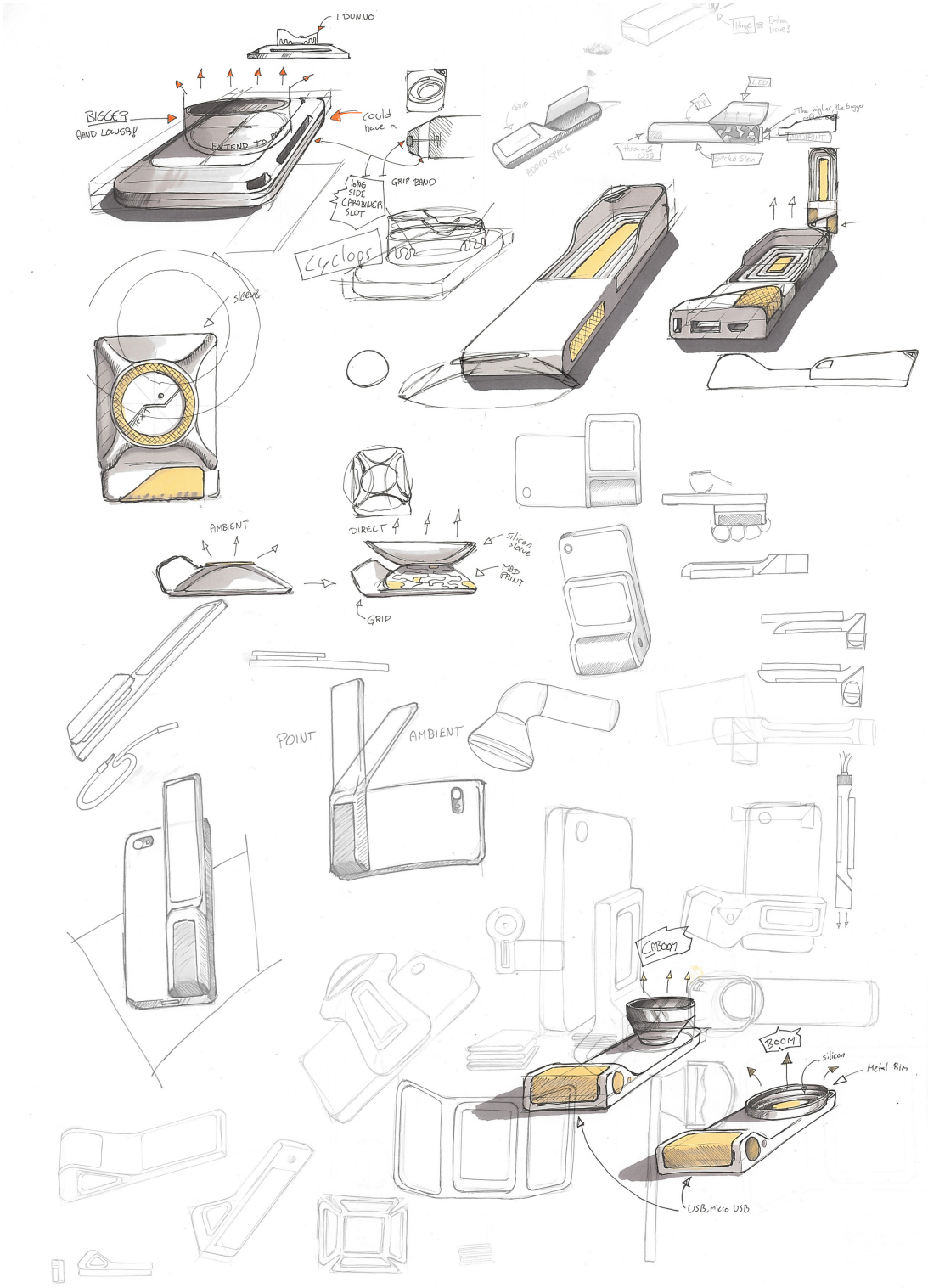
4.10 Initial concepts

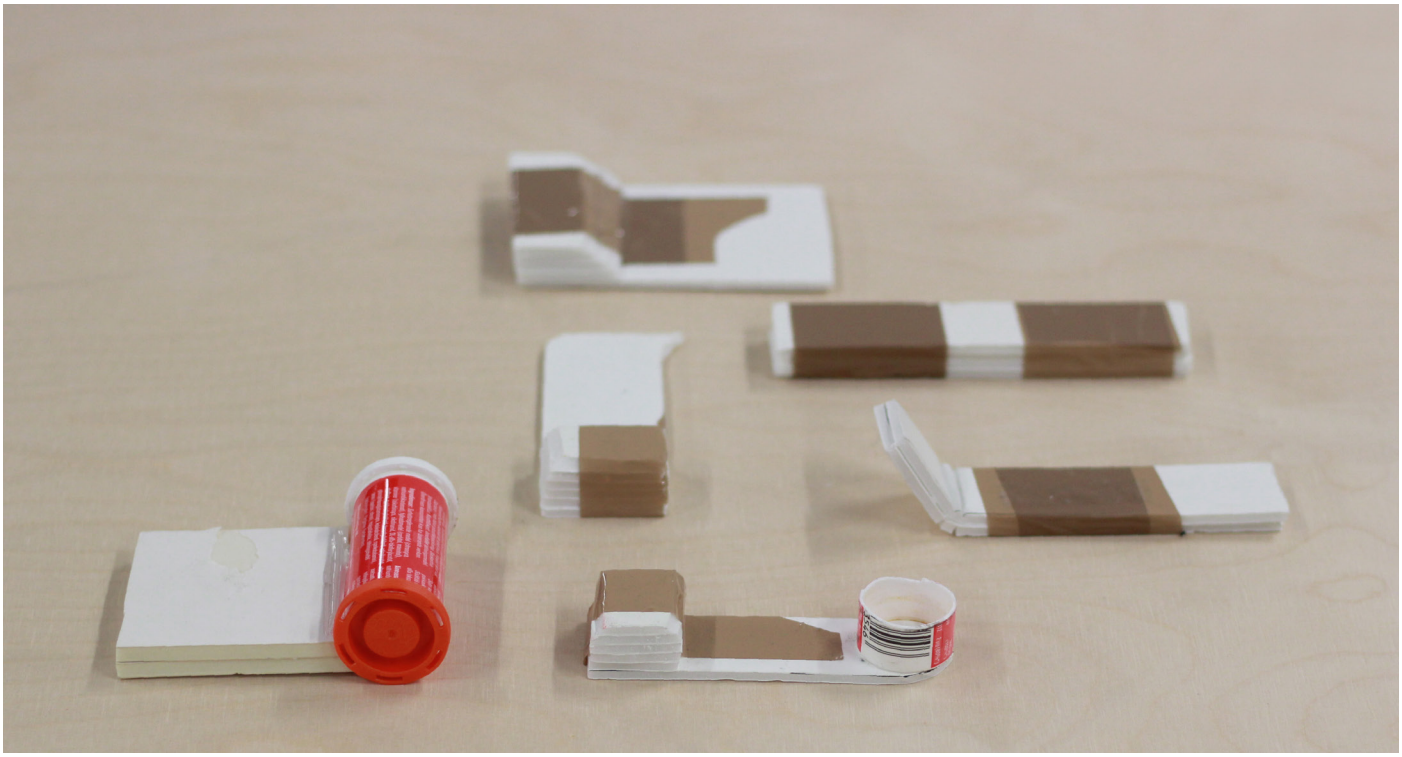
Having evaluated the market and studied key features in similar products it was time to develop as many concepts as possible. This was part of the first quarter of the double diamond design process to discover all possible ideas and solutions for the problem. Naturally this stage was worked on in parallel with initial research and competitive product evaluation, as with many of the stages described there is overlapping.

The initial three concepts were generated within days of the project beginning. Sketches, crude CAD mock-ups and renders were made to represent the idea of each concept.

Introducing CAD and rendering this early in the project may have laid the groundwork for a slower project development as it set the bar for the standard of concept representation. In companies it is good practice to gage the clients receiving the material and what attitude they hold to the level of early to mid-stage design concept generation. In many cases a crude sketch could save hours of work if more refined techniques are superfluous. However, it is also true that in many cases the initial work of the designer may be set against the work of competing designers or design agencies in which case the work needs to meet those demands if the designer wishes to retain the commission.

Having submitted three concepts a fourth concept was developed which resembled one of the initial three, but with an additional function, namely a flip-up silicone casing. Below the casing was a print which only became visible when flipped up. This idea was the beginning of main theme throughout the concept development and prototyping.





4.11 Initial prototyping

Early prototyping was done quick and dirty. The prototypes were made in a matter of minutes using only scrap, foam core, hot glue and tape. As a method this is incredibly efficient to quickly visualise and "feel" the product. It also allows the designer to evaluate size and proportions before wasting much time on form development. Later in the project the prototypes became more advanced and developed, but at the cost of being bound by gate-stages and thereby difficult to change.

Through evaluating the prototypes, sketches and rough renders three designs were chosen to be presented. The project timeline required that the first diamond (the expansion and contraction of ideas and concepts) would be completed within two weeks of the project starting point. This meant that doing things quickly was essential. However, this also meant that there was a lack in careful thought and consideration in the early stages.

4.12 Finding a direction

“Sleeve”: collapsible silicone reflector intended to offset diffuser panel for softer lighting.

Within a month of the project beginning a concept with a USP had been set (unique selling point). Factories in China had been visited and investigation into the topics: materials, LEDs, legal requirements & standards and standards of charging units were required of the designer.

Little time was taken to consider the risks of the concept and any necessary backup plan in the eventuality that the design USP would fail.

The USP was a collapsible silicone reflector which would have a diffuser mounted on the top and would thus allow the diffuser to be offset from the device. This would cause the light to be changeable in softness depending on the distance between the diffuser and light source. The idea came through the research of camping gear as at this time the concept was intended to be aimed in part at the outdoors market. In camping gear collapsible crockery is common.

The existence of similar products (collapsible silicone cups, bowls etc.) led the team to believe in the feasibility of the concept. The feasibility was however not to the designer’s knowledge put against time and money constraints.

4.13 Inspiration & mood

The commissioning company branding was at the core of the design aesthetic. As a company they promote outdoor activity, sports and traveling. Initial concepts were heavily visually aimed at the outdoor market and the “tough” products market. As the project progressed the target market was refined which in turn toned down the features of the concept making it more appealing to the larger market demographic. As the core Blackeye products are universal in their application it was considered that the STROBO product too could be more widely applied.

4.14 Materials

As the market of photography luminaires is saturated it was important to find areas of differentiation in which the concept could compete. One such area is materials quality. As Blackeye are known for high build quality it was established early to have aluminium as a key material. Although this material can be cut or cast into any number of forms it was considered important to keep it basic in order to keep the material feeling natural. Removing heat from the LEDs was an important factor as the batteries and electronics can get damaged if over-heated. Aluminium was going to be used as a passive heatsink.

Other materials were established through consulting materials experts who could give advice regarding strength and durability. The final lower structure material was throughout the project set as a PC-ABS blend. This material combination is often used in such products as cell phones as it is fairly inexpensive as well as durable and flexible. Later in the project the team at Blackeye decided to make the whole body apart from the electronics and diffuser aluminium.

A particular material was considered for the backside of the device. This material was called gecko-skin and was a rubber-like material with adhesive properties which allowed it to fasten to almost any surface without leaving residue behind and without becoming permanently fixed. This functionality was very appealing and the gecko-skin was part of the main concept until very late in the project. It was sourced and tested. After thorough testing it was evaluated and was dropped from the concept as the adhesion was proven to drop quite quickly risking breakage of the device and displeased customers.

4.15 Proof of concept sleeve

The main USP of the concept in the early stages was the so-called sleeve, a silicone collapsible reflector carrying the diffuser panel. Despite having clear functional references in the form of silicone camping cups, measuring cups etc. it was still important to investigate the validity and manufacturability of the so-called sleeve.

Many of the early concepts contained some version of the already proven round collapsible cup. However, the team felt strongly that this form was not ideal and therefore moved forward with a rectangular form with curved edges. Meeting documentation shows that the decision to move toward a top-view Iphone 5 form factor was made 27.04.2017. This decision meant that the sleeve could no longer be round and would therefore need to be tested and validated.

The tests began with the close study of similar products, the discussion of material properties and mechanical movement studies.

4.16 3D Print tests

As mould manufacture is very costly and time-consuming alternative methods of capturing the movements and characteristics of the silicone sleeve were being investigated. As current 3D printers are able to print elastomers (Stratasys/Objet tango black) it was thought that prototyping could be initiated using this method. The evaluation of the sleeve through the Tango black material started small and escalated. Initial prints were cross sections of the anticipated form. As elastomers are flexible it was an additional challenge defining the ideal state in which to print the parts. It was established that the sleeve had to be printed in its extended state in order to have any success.

Following the cross sections prints were made replicating the existing silicone cups. This was done to evaluate the validity of testing using the 3D printing method. Although these prints had nowhere near as much rigidity in either collapsed or extended state the part moved in the same manner proving that this method was valid for initial tests.

Prototypes were then made using similar cross sections but with final form. The initial test was a complete failure as the long sides in extended state moved uniformly and collapsed. In order to counter this movement many tests were printed using multi-material printing. By incorporating rims along the folding edges in the Objet material Vero white it was believed that the long sides may hold their form. These tests were inconclusive as it was impossible keep separate the rims from the elastomer in such a thin print. This resulted in a more ridged form which no longer could fold as the attached rims would be forced to rotate around own axis. Had this test been conducted using vacuum casting for the sleeve and thin steel inserts it is very possible, if not likely to have succeeded.

4.17 Silicone in 3D print mould

Rather than try to make the rimmed concept work the decision was made to move forward to testing with silicone. In order to speed up the process of mould making whilst keeping the cost down a mould was designed for 3D printing. Due to the small tolerance in the fold sections of the silicone sleeve a very accurate print had to be made. With a thickness of 0.2mm the print material selection added severely to the print

expense. In order to cut costs, excess material was removed from around the mould. In order to see the flow of silicone through the mould it was printed in a semi-clear material. The idea was to cast multiple pieces using silicone with different hardness's. This would be done by adding silicone oil to the two-part silicone mix in a controlled and documented manner. However, the first cast proved that the mould could not withstand the pressure of de-moulding and it was broken entirely.

4.18 Silicone in CNC mould

The decision was made by Blackeye that due to time and money constraints one attempt at making a CNC milled mould would be made. The results would define whether or not the sleeve concept would proceed. Alternatively, the concept would proceed without the sleeve application and with minimal changes in the lighting units.

The mould was milled from a material combination of aluminium and plastic. This material gave similar properties to aluminium but the dust created by the CNC milling process was much less harmful to the CNC ventialtions system.

The mould was built using a male and female part and capped off with clear acrylic sheets. This would, like the 3D print allow for the silicone to be visible as it moved through the mould. Wood dowels held the parts in place and nuts and bolts secured them. In order to reduce flashing (the material that exceeds the boundaries of the mould and is removed in post-processing) additional clamps were added. The mould was treated with mould-remove wax betweed casts which made mould removal easier.

As with the 3D printed mould silicone hardnesses could be tested using silicone oil.

4.19 Proof of concept lighting

The lighting design changed a lot throughout the project and multiple prototypes and tests were created. An internal meeting on 15.06.17 clarified that Blackeye wanted a “looks-like” and “works-like” prototype to be made. This decision followed the decision not to have a final PCB made by the factory until after launch on Indiegogo or Kickstarter. This meant that the responsibility of creating the PCB which was to be used for initial marketing fell on commissioned designer. Usability and functionality were also a core concern when testing prototypes.

Initial tests were done by the designer. However, it was clear early on that this approach was inefficient in terms of time and resources. Therefore, as third-party contractors were deemed too costly the designer was required to find assistance to guide through the prototyping process.

Friday 30.06.17 there was a meeting with the Electroshop in Aalto campus Otaniemi. This meeting was to discuss the project needs and see whether they could assist in making a mock-up circuit.

4.20 Strobe functions

The working title Strobocop, later STROBO came from the desired strobe light function which would serve as an effect both for warning/ indicating, self-defence and novelty. Consideration was taken to using exterior elements such as light or sound to determine the nature of the strobe function.

4.21 Colours

The main concept initially contained one single COB LED. This LED could be custom made for the final product and could be shaped to desired size and shape. The shape was restricted by the internal dimensions of the sleeve. Later prototypes contained a strip light using RGBW LEDs. The RGBW LEDs could be used for effects in photography and videography by making changing colour and brightness features possible. When the “sleeve” element was discontinued the lighting element changed to a LED panel.

4.22 Sensors/ Flash

In addition to continuous video light the device was intended to flash simultaneously

with the phone camera. This feature was discussed but not tested. The options based on the market and competitive products research was that either a light sensor or Bluetooth could be used to set off the flash at the right time. A light sensor would make the device act as a slave flash. This feature is restricted by distance to the main flash, i.e. the phone. Some phone flashes also flash in sequences which could cause a problem.

The other option was using Bluetooth and an application on the phone to time the flash. This feature requires the software to act appropriately according to the phone in use. Software issues could cause future costs.

4.23 Mechanical design

Designing, testing and evaluating mechanical features and fittings where a large part of the second diamond process. As the product contained for the larger part of the project a flexible component there was much focus on its (the sleeve) attachment to the body of the product. In addition the sleeve had to hold a rim and diffuser panel which added another set of rather difficult materal and part combinations.

The main body of the component was designed to be manufactured in a combination of ABS and PC. Much consideration was given to assembly and hiding external fixtures. Although the final concept removed all rubber elements most of the concepts incorporated both rubber grips along the rims as well as a gecko-skin back. The grips would be made using a two-shot injection mould and the gecko-skin would be applied by machine or, in later stages left optional for user to apply themselves.

4.24 3D printing

Throughout the mechanical design process concepts were tested using 3D printing. These models proved invaluable as they could quicky show the assembly process as well as any potential problem areas. Tolerances could be evaluated to a degree taking into consideration the restrictions of printing accuracy.

The outer rim which was to carry the light diffuser was intended to be manufactured in aluminium. This unit was tested at length, beginnin with 3D printed models in various plastics as well as steel prints and later CNC machined rims were made and tested.

Prints were at several points brought to factories as references making them a clear means of communication.

4.25 App

From the initial brief the product was intended to be accompanied by an app. The app would be used to control the products finer functions as well as allow for expansion of product functionality through the usage of multiple units at once. Remote control also allows the device to be stripped of many buttons leaving only the essentials. The user is still able to access the finer settings via the app.

Early concepts for the STROBO included either a COB LED or a RGBW (red, green, blue, white) LED strip. The RGBW LED would allow the user to use colour effects which would in turn broaden the diverse production possibilities. Once multiple devices could be controlled through the app photographers would be able to create creative effects.

Paavo created multiple wireframes and look-like mock-ups for the app. Several third parties where contacted for creating the app and a rough functional mock-up was made by the factory in China.

Following the completed contractual obligation of the designer the app was removed from the concept and replaced by a small OLED screen on the back. At this point the device no longer had a sleeve and the LEDs were changed to only be adjustable to light temperature (i.e. no colours only light “warmth” measured in Kelvin). At this point the final details were being handled by the factory directly.

4.26 Design patent

On 18.05.17 Blackeye CEO and commissioned designer attended a scheduled meeting with the patent attorneys at Papula Nevimpat in Helsinki. This initial meeting was to discuss the various steps and options which could be taken in order to file for a patent.

The desired outcome was to acquire a patent for one of the core features of the intended product prior to displaying it to the factory in China. The main features were the sleeve or the combination of power bank and photography light.

In addition to the patents Blackeye wished to acquire a design patent. A design patent would entail the whole design and would tie down most of the features at once. Despite not giving the same degree of protection as a conventional patent would the design patent serves the same purpose.

A list of required material and forms for the design patent was given and a novelty search was ordered in which the attorneys would conduct a search to find if any similar patents existed that may cause a dispute. The results of this novelty search came in the form of a research report. The report showed multiple patents with similar attributes which could cause the patent application to fail. Due to this report the patent application was cancelled. The design patent was still in progress.

On 13.09.17 files were sent to Papula Nevimpat for the design patent. These files were basic dxf files of the assembled product along with specific descriptions of various aspects and elements.

4.27 (Failure)

18.08.17, the key USP (unique selling point) of the entire project was cancelled by the team at Blackeye. The product would continue to be finalised without the silicone sleeve.

This decision was made after 3d print mould casting and CNC milled mould casting had both yielded unusable prototypes. The concept was proven through existing products but the difficulty in generating a functioning prototype led the team to fear greater issues if brought to the Chinese factory. Other factors were time and money. As the project timeline had already been extended and relatively large amounts of revenue had been used to get to that point it was considered that the amount of time and money required to get the sleeve to work would be disproportionate to the added value of the feature.

From a design perspective this led to the question of what aesthetic features would remain and how the design would change. It was established that the design would remain almost identical to how it looked with a collapsed sleeve. Minor adjustments would be made on the exterior but much had to be done for the interior fittings. As the sleeve no longer occupied a large section of the top surface the design changed to having a large LED panel covering the top.

4.28 Hydro-dipping and surface treatments

Since the initial sleeve concept, the final product was intended to incorporate some form of graphical element. This element was chosen by the creative director and confirmed by the whole team. The graphic was an internally made colourful pattern known internally as “acid print”. As the concept was developed this print along with a variety of supplementary prints were applied.

Through researching common methods within manufacture for applying graphics to aluminium hydro dipping was investigated. This method places a film with the graphic on a bed of water. Using various chemicals this film becomes fluid enough to form around a three-dimensional object whilst remaining on the surface of the water. The name hydro-dipping refers to the action taken when applying the print to the part. This is done by slowly submerging the part into the bed of water whilst rotating it in order for the film to cover all intended areas.

There are many means of having custom prints made in large scale but for prototyping proved to be challenging. To replicate the effect a method called water-transfer-print was used. This method has similarities to hydro-dipping but rather than submerging the part onto the print the print is taken from the water and draped over the part. The film proved to have significantly fewer flexible attributes to the hydro-dip film.

4.29 Ending the project

At the end of September 2017, the official project commission ended. As there had been so many changes during the project, and with so many things still unclear it was unanimously decided that the internal fittings and fixtures would be designed by the factory in China. As the PCB was not finalised at this point there was no reason to CAD final fixtures and fittings. The factory would be able to finish the product details on-site quickly and cheap. The final outlook was set as well as key features, physical and digital user interfaces and materials.

Development continued without external input and some major changes were made at later stages among which the app was dropped and replaced with a small OLED screen on the back of the device. The designer was still on commission on an hourly task-by-task basis and these decisions were made openly following discussion.

4.30 Visual stage breakdown

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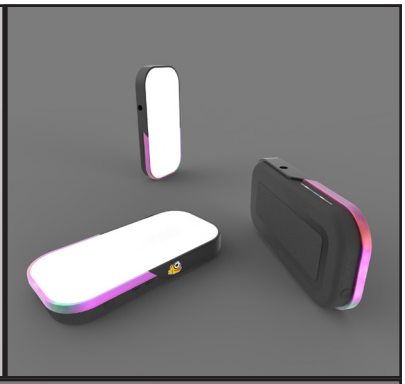

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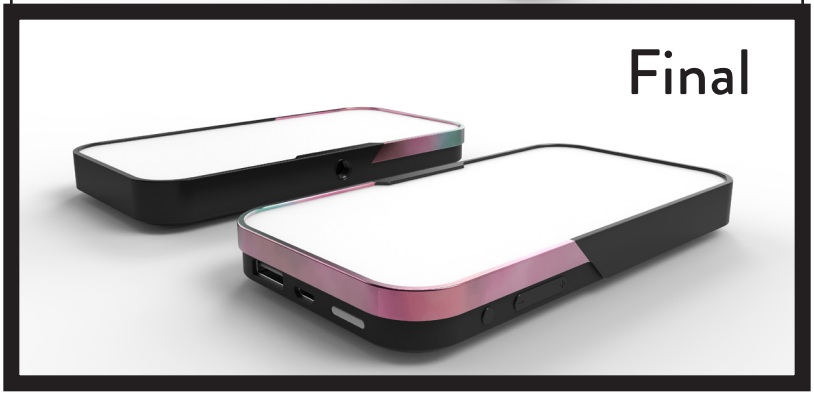


5.0 Role of designer

Designer role: Market researcher, materials expert, standards and certificates advisor, model maker, electronics expert, mechanical designer and industrial designer.

5.1 Skills and knowledge

The process of developing the STROBO showed the requirement for an extremely versatile, multidisciplinary designer who is willing to take on challenges far out of the standard designer tasks.

As seen from studying larger companies the norm is that in the development of a new product it is not uncommon that a team is formed with experts from various fields and sectors such as: materials, manufacture, marketing, legal, branding, design etc. In the case of a small company or start-up it seems that not only are many of these roles occupied by a single individual but many roles may be missing. This structure can come to force the commissioned designer to act as either a supplement for these through taking on tasks outside their field, or else as an intermediary acting as the communicator between the company and third parties. The designer must judge and decide in these situations which cases to take on and which to hand over to third-parties. In the STROBO project the designer was required to study the process of acquiring patents. In addition to this multiple third parties were involved in the form of legal advisors and agencies.

In the case of taking on additional roles, much time and effort is placed on finding correct sources to inform and aid in decision making. Much time is placed on study which is costly to the commissioner but valuable to the designer. In the end the designer who is not an employee of the firm gains valuable knowledge and experience to further broaden their expertise. Such a designer will in time gain a broader knowledge base rather than specialising in a specific companies' processes and requirements. Such a designer will also in time gain a network of third-party contacts which could aid small companies which haven't developed such a network yet (such as start-ups and entrepreneurs).

Similar attributes may be said of designers working within design agencies with a broad client base. However, many such design agencies employ designers from various fields creating a support network in any given project.

5.2 Decision making and progress

In the case of the STROBO project the designer was able to weigh in on decisions as an advisor but all major decisions were made by the company internally. Most major decisions were made internally and reported to the designer through the CEO/project leader.

Things that affect design decisions ultimately affect the process.
During the STROBO project the double diamond design process was used to structure a plan for the commissioned designer. This plan was in accordance with the commissioning companies estimated plan for the design. As the project progressed decisions, actions and other influences affected that trajectory. The commissioned designer was responsible for delivering content according to agreements and the company was in charge of the overall project (including marketing and launch materials etc.). As the project contained elements of risk, the design decisions made by the company ultimately steered the project progress and the commissioned designer acted accordingly. Throughout the second diamond specifics for the end product, as well as general outlook were changing. This caused a multitude of iterative loops which set the project back several months.

5.3 Use of Double diamond in project

The double diamond design process model has been used in many and various ways since it was released with varied specificity. There are arguments for and against adding detail to the model. However, the design council made it clear that the model is intended to be modified toward the specific project at hand. When initiating the project one of the first steps was to create a double diamond model based on Dan Nessler's "double diamond revamped" (Nessler D. 2016). This model used the basic double diamond model as a base, but added detailed stages within. These stages were based on anticipated steps, choices and dates and therefore presented a rather falsely clear linear project trajectory.

It was considered that testing the limits of the usability of a more detailed double diamond structure would yield more fruit than sticking to the intentionally vague model presented by the design council. As it were, one learns more from failure than success. Had the model been analysed based on the design councils' model there would be considerably less detail to glean as it expands and contracts all the while considering iterative loops throughout the process. It is in its original form a very true to life model of how projects tent to progress.

When starting out a project it is impossible to foresee the “iterative loops”, i.e. rethinking, failure, outside influences or anything else that may cause the project to take steps back. Due to this any initial model will assume linear actions following sequentially. In fact actions are being repeated constantly throughout the project and steps like CAD modelling may take on different forms such as “concept modelling” and “technical drawing”. Similarly sketching can mean concept sketching or sketching for marketing material, it all depends. This suggests that the details may be better served in a different structure or model.

Iterative loops are a normal part of any project and should not be considered failures in and of themselves as only through reiterating concepts and ideas can a design be refined into really good design. However, when pursuing a concept with unknown complexities such as new materials, new manufacturing methods or others it would be recommendable to take steps to reduce or acknowledge the risk involved and lay down plans for multiple eventualities as well as taking available revenue and time for the project into consideration. This was one learning outcome from the STROBO project.

Retrospectively it would have likely added greater value and less risk had the designer presented the process to the commissioner showing that the first diamond needs to match the second in size and value. The project moved forward with enthusiasm and probably didn’t exhaust all the possibilities as the double diamond model suggests. By pursuing an idea early on the risk was increased.

5.4 Learning outcomes

5.5 CAD & Rendering

CAD modelling was used from very early stages and all the way through the STROBO project. It was initially used for quick forms and renders. However, this method of conveying an idea is time consuming and may lead the client/commissioner to believe a concept is more finished than it actually is. It was shown that development using “quick and dirty” methods to test forms and functions as far into the project as possible creates a development with more fluidity and fast progression as each element is tested and either accepted or rejected prior to any major work. However, knowing the commissioner is important as this kind of development is not always accepted or appreciated. In the STROBO project it would have served the purpose greatly to interact more with the commissioner throughout the project through “quick and dirty” workshops in which brainstorming could occur.

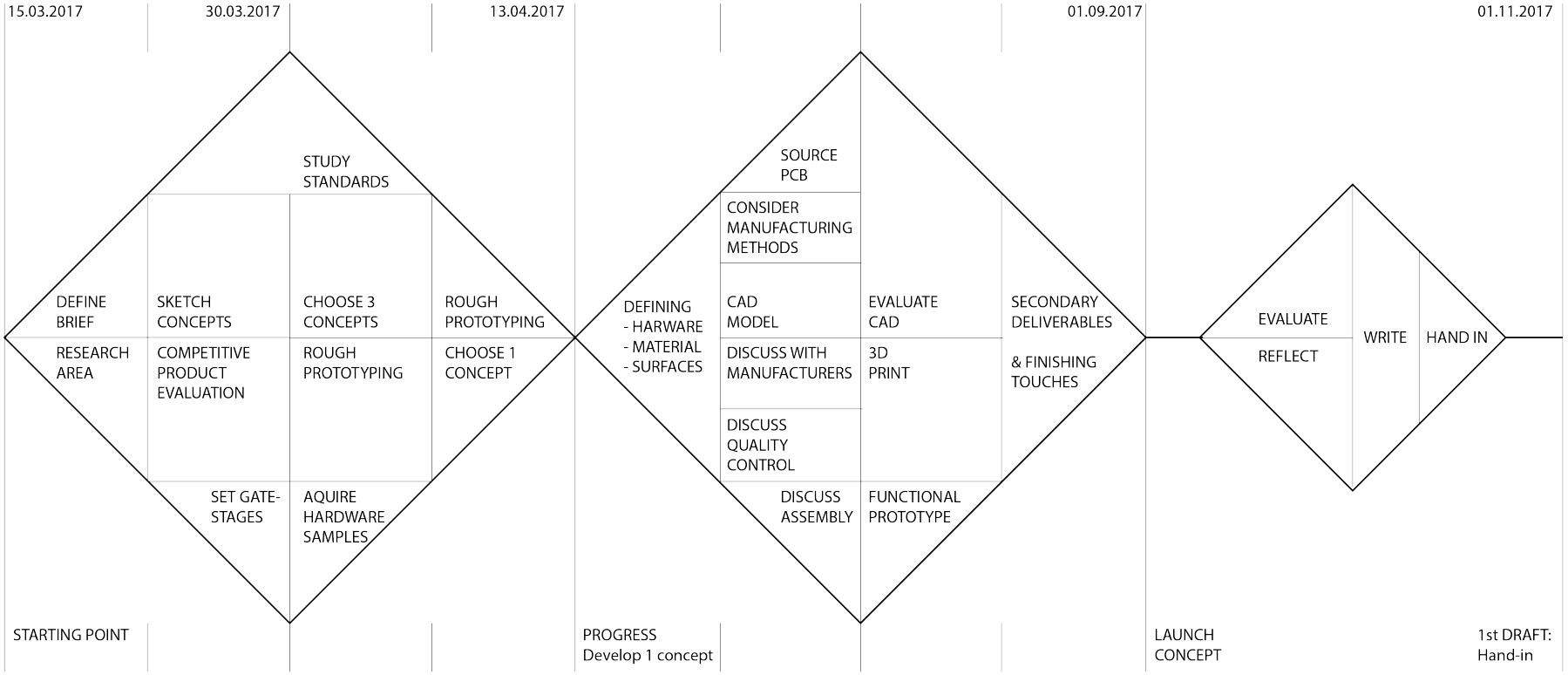
5.6 Analysing risk

The brief was given with certain aspects such as target market/audience set. The basic functions were established based on observation and research conducted by the commissioner. The problems which the product would target were also established. These pre-established boundaries helped in quickly moving into concept development however more time should have been spent understanding how the commissioner reached these conclusions and boundaries so that the designer would have a more solid base for designing concepts. In the STROBO project the boundaries were set but not explained and issues were solved as they came in regard to target audience needs.

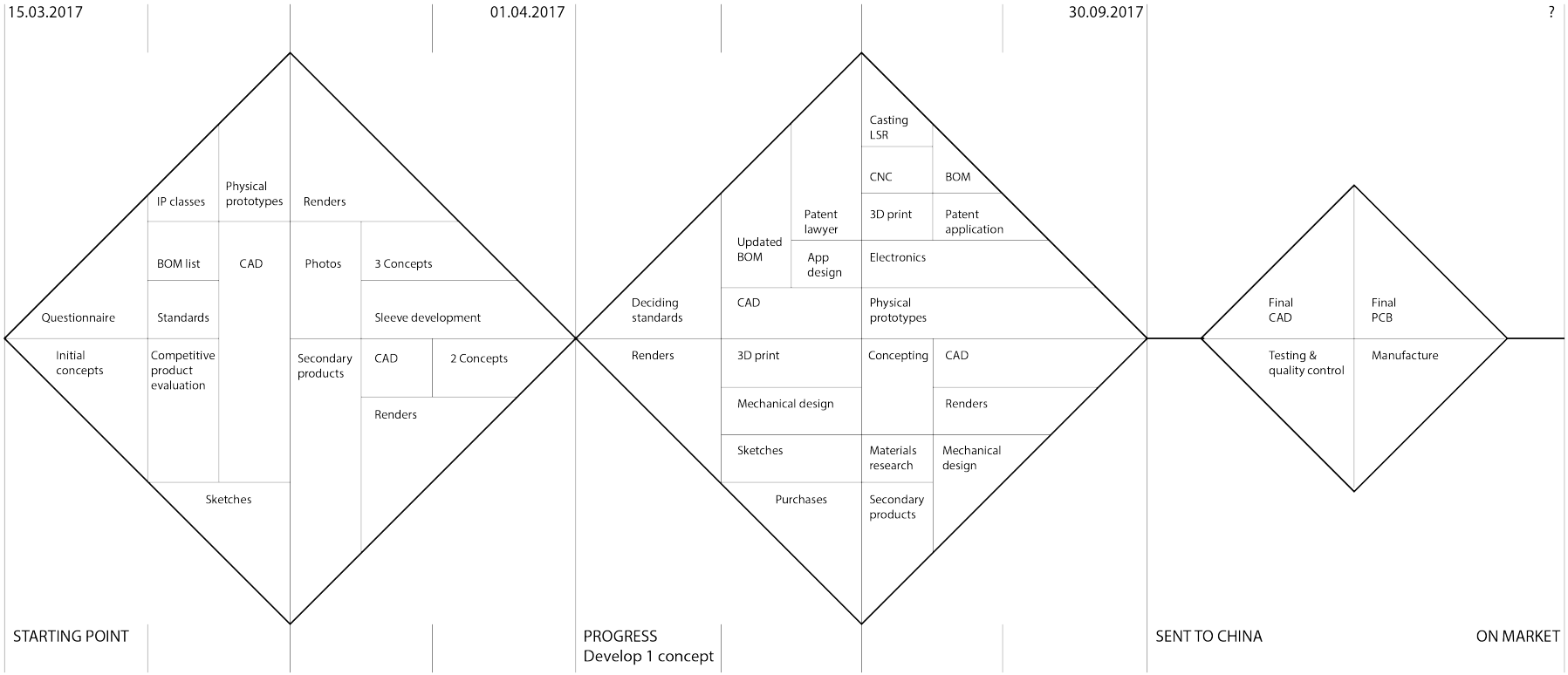
5.7 Quick and dirty

This method is a cornerstone in the design process as it allows to quickly and cheaply test features and forms in the early stages of design development. The method has been greatly promoted by the company Dyson who make many of their early models and mock-ups using paper, cardboard, foam or wood. Various features such as hinges can quickly be tested to validate the design intent. The STROBO project served to both validate the use of quick and dirty methods as well as define how this method should be applied. In addition to over-reaching with CAD and rendering development it would also have been beneficial to remove as much detail as possible at the early stages of prototype development. Also, certain aspects could have been prototyped separately rather than in the context of the product concept. There is greater value in a very rough physical prototype over a fairly polished digital one.

Planned project progression



Actual project progression



6.0 Conclusion

The value of the double diamond design process is undeniable. As it is fundamentally built upon the practices of leading companies with strong design methodologies it has a strong foundation when adjusted and applied properly to an organisation on a systemic level.

One attribute which might be key to the systemic approach's success is repeatability. Each of the studied companies is large enough to have established sectors for each aspect of the design process as well as a hierarchical chain of command. The products launched by such companies are generally related to, or developments of their previous products which means that similar process stages and issues can be assumed.

In contrast when working for a small company as a commissioned designer there is no established process nor is the company necessarily aware of potential issues down the line. Experts are not directly involved but are consulted on a question by question basis and are therefore not in a position to evaluate and warn of possible risks. In these scenarios the Double diamond may serve better as a concept which the designer can consider in order to successfully develop a concept or product.

6.1 Equal weight

Through the learning experience of the STROBO project the value of spending as much time and effort in the first diamond as the second became clear. Most, if not all of the issues discovered in the second diamond phase could potentially have been avoided if proper consideration and evaluation had taken place in the first diamond. In the STROBO project excitement, cost constraints and time constraints caused more costly and damaging issues in the second diamond development phase. This was as a result of discovering a novel idea and moving forward without properly evaluating the time, cost and risks involved with developing it.

6.2 Designer involvement

As the designer was commissioned for this project much of the managerial responsibilities which could have improved the project process where contained within the client company. This disconnect between design and company makes clarity in communication and responsibility a key attribute for success.

Some possible solutions for this would be to make the commissioned designer fully immersed in the client company with full transparency of information. This, however, may seem risky for some start-ups which rely on the secrecy of their invention. Another solution would be to have a high level of risk assessment for each stage of the design to ensure that the decisions and directions taken don't involve too high risks further on in the process. This is a potentially an issue from the client's side as small companies and start-ups often rely on novel or innovative ideas to compete with larger companies. Novelty comes in many forms but in many cases involves doing something differently from before. Therefore, novelty and risk often go hand-in-hand. In cases where the novelty is derived by taking existing products, parts or ideas and applying them to a new scenario risk is lowered as the company can rely on the validity of earlier products success in development.

6.3 Detail in the process

Through the STROBO project the value of adding detail in the process was evaluated. In this case however there was an issue of assuming a linear progression which the makers of the Double diamond design process never intended. As the original process design contained innumerable iterative loops it is practically impossible to assume steps as such loops may affect steps before or after. If an iterative loop occurs as a result of a failure in developing part of the concept this failure may cause the design to move back to a previous stage as well as alter the later stages which may have relied on the failed detail in the concept.

Basically, the Double diamond design process as a concept becomes more vulnerable the more it is saturated with detail. When a highly saturated Double diamond model encounters a problem a butterfly affect takes place which changes multiple steps along the way and essentially restructures the model. If each iterative loop requires a restructuring of the model then what value does this model serve as it is unreliable.

As seen through the research leading up to the making of the Double diamond there is value in making a corporate structure based on the Double diamond. In such cases details can through resources and practise fine tune the structure to accommodate corporate needs.

6.4 Value of the idea

In its core the double diamond is an idea which encourages the designer to expand in possibilities to find all possible issues, solutions or innovations (discover). The idea is intended for the designer to shed any restrictions and give space to innovate freely prior to examining and evaluating the options. This idea could be internalised by every designer and would ensure that they don't allow extensive knowledge of material behaviour, manufacturing methods etc. to hinder them from freely innovating in early stages of design. It would also allow them to restrain such innovation once certain key points of product development have passed.

In its core the Double diamond design process is a valuable and insightful idea which leads designers and companies on a well-founded and proven path throughout the design process.

7.0 Acknowledgements

I would like to extend a special thanks to the great people at Blackeye (Eyecaramba oy), and in particular Arto Ekman for giving me the chance to go on this journey of product development.

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Lastly, I would like to thank my Wife Sara. Without her love and support this project could not have come to fruition.

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