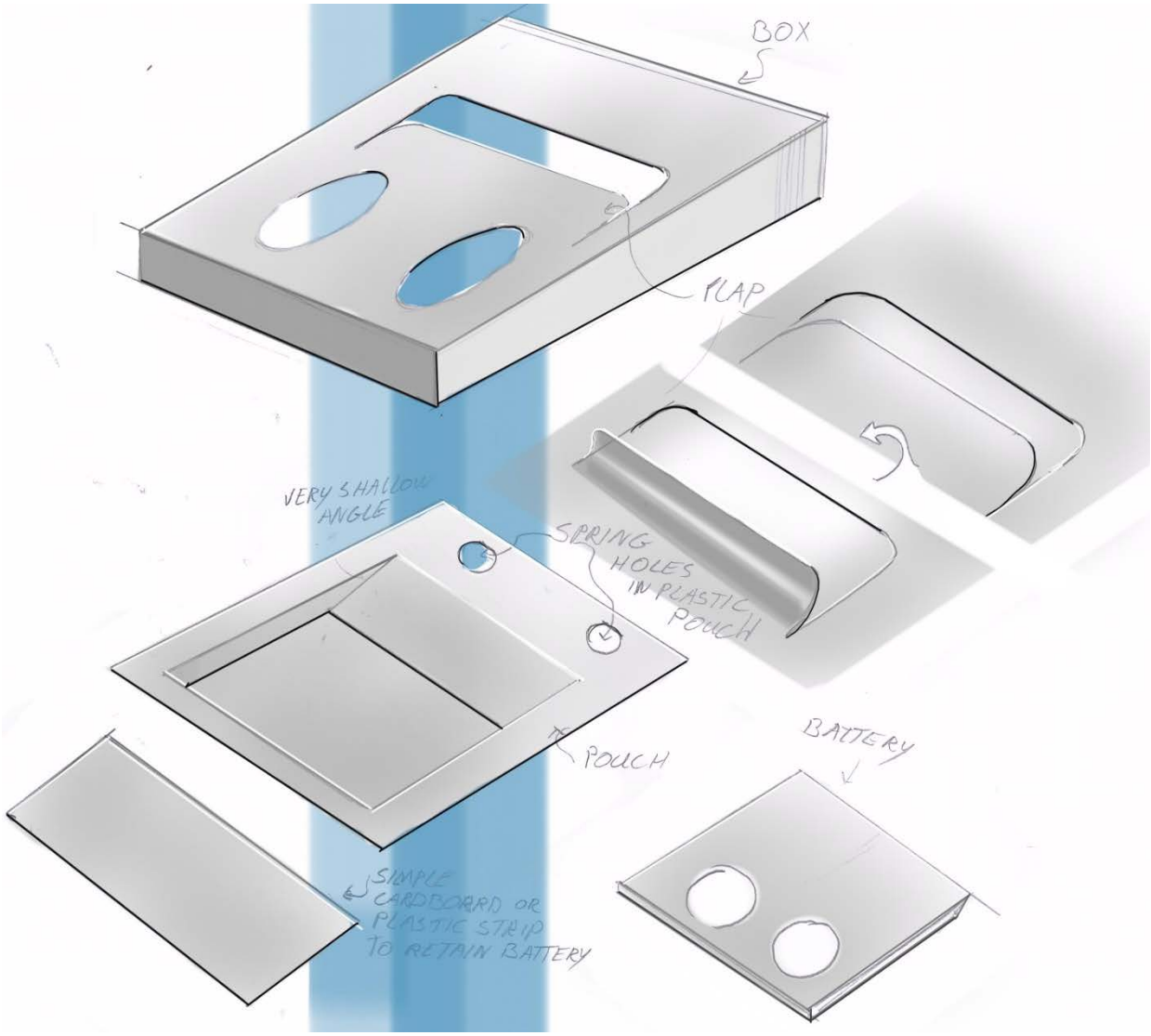
IMPOSSIBLE

TOWARDS GREENER FILMPACKS

FILM PACK REDESIGN TO ENABLE BATTERY REPLACEMENT



Ivo ten Brinck
Bachelor Industrial Design
University of Twente

Impossible B.V.
1-11-2013

IMPOSSIBLE

Information page

Title of the Bachelor Assignment
Film pack Redesign to enable battery replacement

Educational organization
University of Twente

Course
Industrial Design Engineering

Name and address of the company
Hoge Bothofstraat 46
7511 ZA Enschede
P.O. BOX 242 7500 AE Enschede
Netherlands

Exam committee
Examinator: Dr. Ir. H.J.M. Geijselaers
University tutor: Ir. H. Tragter
Company tutor: Ing. D. Lemmens

Student number
S1015230

Name of student
Ivo ten Brinck

IMPOSSIBLE

PREFACE

This report discusses the results of the Bachelor assignment performed by Ivo ten Brinck, student Industrial Design Engineering at the University of Twente. The Bachelor assignment is the final assignment of the Bachelor curriculum and aims at putting skills and knowledge gathered during the complete Bachelor curriculum into practice.

The assignment was formulated by Impossible B.V. in Enschede. Impossible produces film packs for Polaroid cameras. In 2008 Impossible acquired the licenses to activities abandoned by Polaroid.

The customers of Impossible asked for a more environment friendly version of the “instant film” Impossible produces. In the current Impossible film pack the battery which powers the camera is sealed in the disposable film cartridge. The goal in this project is to design a suitable solution to make batteries interchangeable between film packs so customers can re-use the battery several times. Furthermore the separation of the (plastic) cartridge and the battery enables a more efficient recycling system.

In order to get optimum results from this redesign cycle, Impossible is interested in introducing a rechargeable battery as well. For this to become reality the battery of course needs to be interchangeable.

ACKNOWLEDGMENT

Special thanks to
Ir. Hans Tragter for being my tutor at university while working on the project.
Dick Lemmens for being my tutor in the company while working on the project.
Nico Dikken because I shared his office for the last three months.
All other staff members at Impossible.

SAMENVATTING

De Bachelor Opdracht van Industrieel Ontwerpen is er op gericht de student kennis te laten maken met de praktijk van de technisch onderlegde ontwerper. Het is daarbij de bedoeling dat de student zich ongeveer drie maanden inzet bij een bedrijf om een opdracht die het bedrijf heeft opgesteld uit te voeren. Daarnaast is de bachelor opdracht een proeve van bekwaamheid voor de student. Na het voltooien van de opdracht moet duidelijk zijn dat de student tijdens zijn bachelor de benodigde vaardigheden van een Industrieel ontwerper heeft verzameld.

Impossible b.v. Impossible maakt fotopacks die geschikt zijn voor gebruik in Polaroid camera's Daarnaast ontwikkelt het bedrijf op dit moment een lijn camera's die met dezelfde "Polaroid" instant ontwikkeltechniek werken.

De filmpacks die Impossible produceert bestaan uit een achttal fotoframes, een darkslide die de foto's bedekt, een veer, een batterij en een accupouch/cardstock (waarin de batterij vastgehouden wordt). De filmpacks zijn 90 mm breed, bij een lengte van 111 mm een hoogte van 16 mm. De batterij heeft nog veel capaciteit over na het volschieten van één filmpack. Toch wordt het film pack na gebruik door veel consumenten als geheel weggegooid.

De vraag van Impossible is een herontwerp van de box zodat de accu gemakkelijk uit het pack gehaald kan worden. Het liefst voor hergebruik in een volgend film pack, maar anders als recyclebaar afval. Om verwisselbaarheid te kunnen bereiken moet de box, de houder van de batterij en de batterij zelf aangepast worden.

In de huidige packs zit de batterij vast op een rechthoekig stuk karton (de cardstock) dat nodig is bij de assemblage van de film packs. Dat is een zeer geschikte methode als de batterij moet blijven waar hij is. Echter is deze methode erg onpraktisch als deze er door de gebruiker uit moet kunnen worden gehaald. Daarom moet dus ook dit plaatje zo worden aangepast dat deze wel de batterij kan vasthouden als dat gewenst is, maar ook de batterij los kan laten.

Uiteraard moet niet alleen de zojuist beschreven cardstock worden aangepast maar ook het doosje. Om het echt heel simpel te houden: er moet een gat in de doos komen zodat de accu ook daadwerkelijk uit het filmpack kan worden gehaald.

Om de perfecte positie, vorm en formaat voor deze opening te vinden zijn er eerst verscheidene tekeningen gemaakt waarvan in overleg met de plantmanager van Impossible er een aantal zijn geselecteerd om in Solidworks, een 3D tekenprogramma, verder uit te werken. Tevens zijn er proefmodellen gemaakt door bestaande doosjes aan te passen, met het doel ze zo veel mogelijk op het conceptuele ontwerpen te doen lijken. Op basis van de gegevens die hier uit zijn gewonnen zijn verdere aanpassingen aan de box gemaakt in het 3D tekenprogramma en zijn er 3D-prints gemaakt van veelbelovende ontwerpen.

Om er zeker van te zijn dat de ontwerpen ook in serie produceerbaar zijn, zijn van de meest veelbelovende ontwerpen simulaties gemaakt van het spuitgietproces. Aan de hand van de inzichten die hieruit voortkwamen zijn wederom de ontwerpen bijgewerkt.

SUMMARY

The Bachelor Assignment of Industrial design aims to give the student a first taste of the real world of technical design. The student is obliged to work on this assignment at the assigning company for at least three months. The bachelor assignment is a test of competence for the student. After completing the assignment it must be clear that the student has met the standard of education the University of Twente sets for their students.

In this case the company is Impossible b.v. Impossible produces film packs for use in Polaroid camera's. Currently the company is also working on new camera's which will be able to use the same film packs. Though these film packs are very similar they do not contain a battery. Therefore, they are not suitable for the old Polaroid camera's. Packs for Polaroid camera's however are suitable for the new Impossible camera's.

The film packs Impossible produces consist out of eight photo frames, a dark slide which shields the photo frames from light, the photo frames, a spring, a battery and a pouch/cardstock (which holds the battery). A film pack is 90 mm wide, 111 mm long and has a height of16 mm. The battery still contains a lot of power after one film pack has been processed. Nevertheless many customers discard the film pack as a whole.

The request posed by Impossible is to redesign the film pack in a way that the battery at the least will be removable. This would make it easier to recycle the battery. However this would be a significant environmental improvement over the current design. Impossible requested the battery to be interchangeable between film packs. To reach interchange ability the box, the pouch and the battery itself must be adjusted.

In the current packs the battery is glued to a sheet of cardboard which is needed for the assembly. This is rather impractical if the battery has to be removable. Because of this the cardboard sheet must be changed to make it hold the battery during assembly and in the camera, but also be able to release the battery when the cartridge is empty. Obviously both the cardboard sheet and the box must be altered. In short: a hole must be made in the box in order to enable the battery to pass through.

To find the optimal position, shape and size of this opening several drawings have been made. In consultation with the plant manager at Impossible Enschede a number of sketches were selected to be worked out in detail in 3D software. Besides that a number of physical modifications were made by changing the current boxes to make them appear like the conceptual designs as much as possible. Based on the data derived from these initial concepts further design iterations have been made in the 3D software and 3D-prints have been made to actually hold and feel the physical concepts.

In order assure that the designs can actually be mass produced the most promising designs have been analyzed in Moldflow Adviser. This program helps to analyze the ability to produce an object through injection moulding. Using data from the injection moulding analysis, more adjustments have been made to the designs.

IMPOSSIBLE

INDEX

Information page 1
Preface 2
Acknowledgment 2
Samenvatting 3
Summary 4
Introduction 6
1. Project frame 7
2 Analysis and research 9
2.1 Current design of the film pack 9
2.2 Battery technology at a glance 11
2.3 Pressure sensitivity of photo frames 19
2.4 Light sensitivity 20
2.5 Camera and pack 21
2.6 Customer wishes 23
2.7 Demands and requirements 24
3 Idea phase 26
3.1 Brainstorm 26
3.2 Idea drawings 27
3.3 Morphological diagram 31
4 Concept phase 32
4.1 Proccesability 32
4.2 Concepts 35
4.3 Conclusions after first designmeeting 41
4.4 .Concept comparison 43
5 Concept realization 46
3.2 Battery redesign 49
3.3 Cardstock redesign 51
6 Prototyping 53
8 Conclusions reccomendations 56
9. references 57

Motivation

Impossible B.V. received customer complaints about the film packs they produce. Customers feel that the film packs are bad for the environment because the battery is sealed in and cannot be re-used.

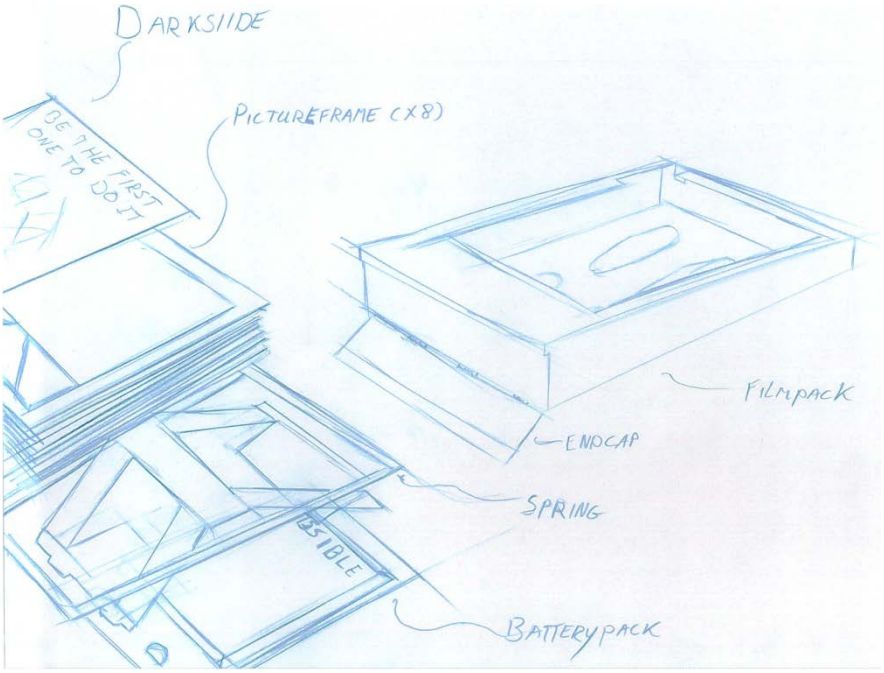
In the past Impossible tried to comply with the environmental wishes of their customers by taking back used batteries. Impossible would then check if they are suitable to be used again or have to be safely disposed of. Impossible had to stop this way of recycling because of regulatory problems. There is a need for another way to meet the regulations and the wishes of their customers.

Goal

The goal of the project is: Making it possible to easily remove a battery from a film pack. This will greatly help to recycle the batteries. The ultimate goal is to be able to place a battery from a discarded film pack in a new pack. In this way the first battery should be able to power up to 5 or even 8 film packs instead of just the one in the current situation.

Structure

In this report you will read about the company and the cause of the assignment in the first chapter. The research phase which forms the basis of the project is discussed in the second chapter. This chapter will be concluded with a set of requirements for the redesign. In the third chapter idea phase is discussed. After which the concept phase and the results thereof are paid attention to. The final product is presented and evaluated in chapters six and seven. In chapter eight a conclusion of the total project is shown.



FIGUUR 1 COMPONENTS IN THE PACK

1. PROJECT FRAME

Since the successful rise of cheap digital photography, instant ready photo technology became obsolete. The Polaroid and Kodak companies that used to dominate this market have since stopped the production of cameras and film. Nevertheless many of these cameras still exist and are used by enthusiasts and artists. The film production plant of the former Polaroid company is continued by Impossible B.V. in Enschede, the Netherlands.

Impossible had to re-create the instant photography technique because Polaroid had dragged its former suppliers down in its fall. Impossible did find new suppliers but could not get the exact same base products needed for the Polaroid formulas. They succeeded in this near impossible task in 2010 when they launched their first new film packs. While they had to re-invent the chemical composition for the film they still use the old design for the box containing the film. The current film pack is visible in figure 1.

Customers question the impact the film packs have on the environment. Impossible wants to lower its environmental footprint and keep their customers satisfied. This is the reason Impossible asked a student to redesign the film pack to make it more sustainable. Impossible wants the battery in the film pack to be interchangeable between film packs.

Impossible produces film packs for three kinds of Polaroid cameras and their own new camera concept. The redesign assignment targets “square format” film packs. These film packs are suitable for Polaroid 600 (figure 3) and SX-70 (figure 5) camera’s as well as for the Impossible camera concept (figure 6). The Polaroid Spectra cameras (figure 4) use a different shape of picture frames (figure 2) which are not targeted in this assignment. In the table on the next page is a compilation of the products discussed above.

FIGURE 2 SQUARE FORMAT FILM (5)

FIGURE 3 SPECTRA FILM (6)

IMPOSSIBLE FILM PACKS

FIGURE 4 POLAROID 600 CAMERA (1)

FIGURE 5 POLAROID SPECTA CAMERA (2)

FIGURE 6 POLAROID SX-70 CAMERA (3)

FIGURE 7 IMPOSSIBLE INSTANT LAB (4)

DIFFERENT PHOTO CAMERAS IMPOSSIBLE PRODUCES FILM PACKS FOR

The film packs discussed above are inserted in the bottom of the camera [step 1]. After which the camera ejects the dark slide which covers the film frames [step 2]. Now the film frames are ready to be exposed to the desired picture. At the push of the shutter button the first film frame rolls out carrying a picture [step3].

8 STEP 1

9 STEP 2

10 STEP 3

STEPS IN INSERTING A FILMPACK IN A CAMERA

2 ANALYSIS AND RESEARCH

In this chapter the research which forms the bases of the assignment will be described. A quick insight is given in what the Impossible filmpack is and which features it performs. A summary of research in battery technology is given, as well as an analysis on the light and pressure sensitivity of photo frames. This chapter will be concluded with a set of requirements and demands to which the redesign will have to conform.

2.1 CURRENT DESIGN OF THE FILM PACK

The first step in clarifying the redesign task is an analysis of the box itself. This will help to understand the functions of the parts and more important, it helps to know which parts may be discarded.

There are four main actions the box has to fulfil, to make these possible the box contains a number of features. The features are listed below and are visible in figure 11 and 12.

1. Contain: the box has to be capable of storing the targeted amount of picture frames. The current design is of the exact right size to house the frames, no changes can be made here. The bottom of the case is mostly closed except for the battery- and detection holes, the top is mostly open to allow pictures to be exposed to the desired image. To keep the pictures from falling out the box has an edge over the top. Also to close off the pack completely thus keeping the photo frames inside, the end cap is welded on the box.
2. Loading: The box has to be put in the camera to be able to actually make pictures. The film pack has to conform to very strict dimensions to make it possible to fit in all Polaroid cameras.
3. Energy: The film pack has to position the battery contact points exactly over the contact points in de camera.
4. Protect: The box must protect the film frames from light and pressure.

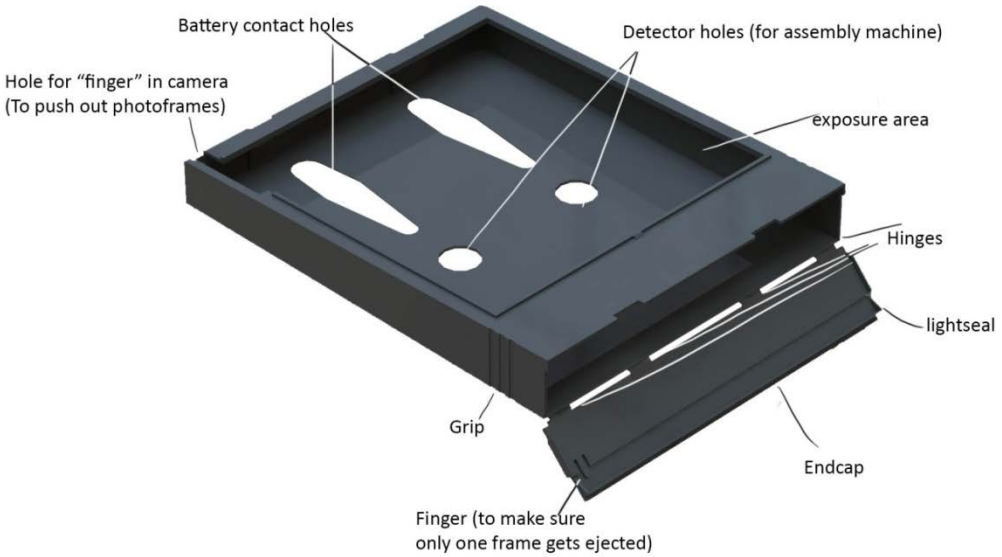


FIGURE 11 THE BOX WITH ITS FEATURES (FRONT)

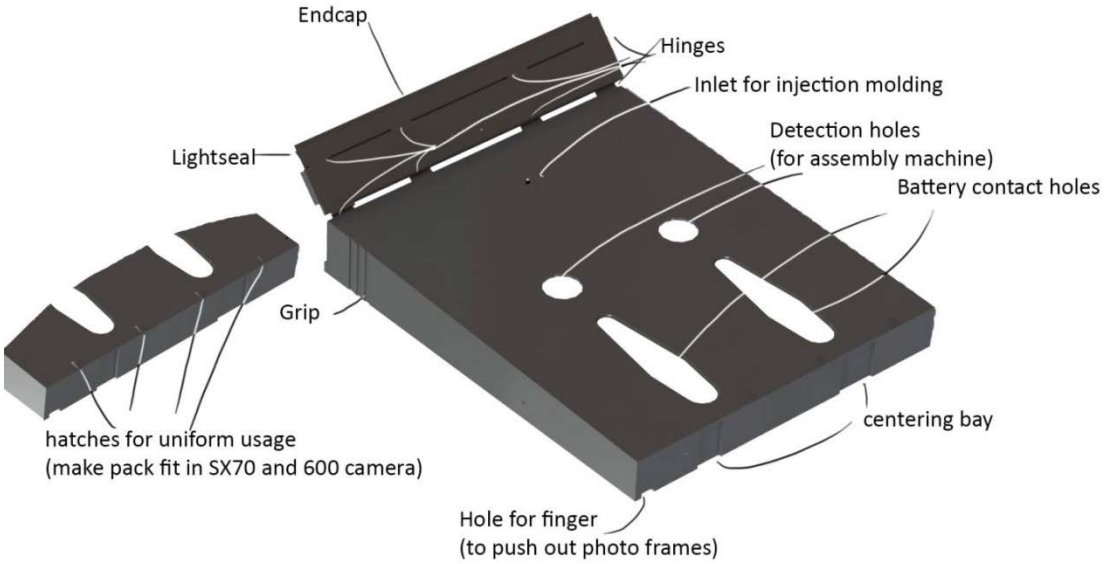


FIGURE 12 THE BOX WITH ITS FEATURES (BACK)

The main components an Impossible film pack consist out of are listed below. In figure 13 the numbered components are visible

1.	Box	Cassette in which all components are assembled. In figure 11 and 12 the components of the box are revealed.
2.	End cap	Welded to the box and acts as a “lid” to the filmpack
3.	Light seal	Attached to the end cap, covers the frame ejection opening in the end cap
4.	Card stock/battery pouch	Rectangular piece of cardboard: Contains battery and aids insertion of spring, photo frames and dark slide.
5.	Battery	Attached to the cardstock, delivers power to the camera.
6.	Spring	Provides upward pressure to the film frames to make sure the top film frame is in the focal plane.
7.	Photo frames	Negative and positive sheet and developer fluid.
8.	Dark slide	Covers the negative sheet of the pictures to prevent light leaks
9.	Pick slot skirt	Attached to the dark slide, covers the pick slot (where the finger pushes the picture frame to eject it)

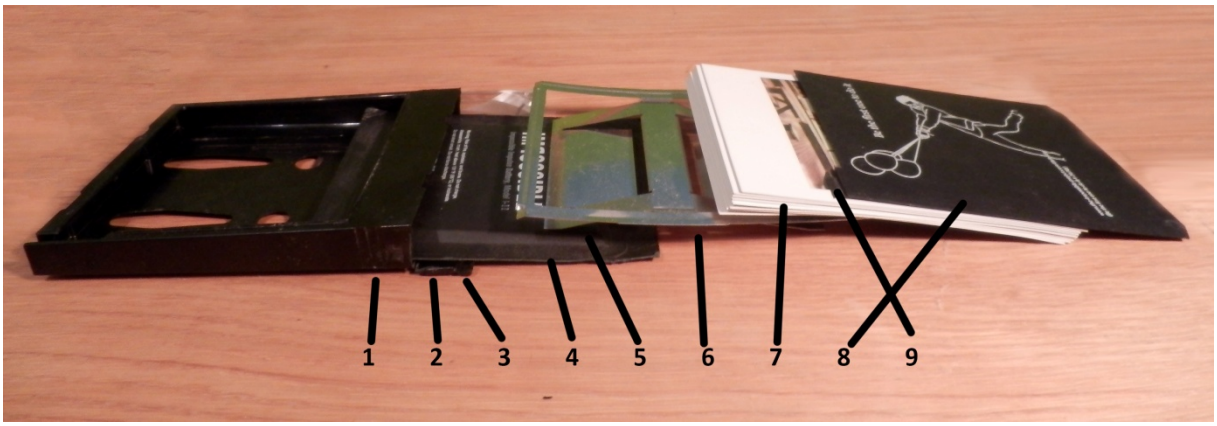


FIGURE 13 COMPONENTS IN THE IMPOSSIBLE FILM PACK

2.2 BATTERY TECHNOLOGY AT A GLANCE

Quite a lot of information about batteries was needed to get a sufficient grip of the problem. The first source that has been consulted is the internet. Besides the information from the internet a lot of knowledge about batteries was found in books Impossible owns. The old documents from the Polaroid times were also still available, which helped a lot in finding which kinds of battery are suitable for application in the film pack.

In this part of the research you will be reading about the properties that distinguish battery cells and a general explanation of what a battery actually is. After which the differences between primary and secondary (rechargeable) cells are discussed.

The batteries Impossible uses have to be capable of producing high amounts of energy in a short amount of time to charge the flash and process the film. The ability to do this is highly dependent of the internal resistance and the architecture in the battery.

When a customer uses a used battery to power a new pack Impossible wants to be sure the battery will be able to power the full pack. Therefore it is needed to test each battery before it is inserted in a new film pack. A number of solutions to know if the battery contains the desired amount of electric power are analyzed.

2.2.1 BATTERY CELL

The number of battery types is immense. All types of cells have been built differently and contain a wide variation of chemicals. To be able to compare batteries it is important to look at specific parameters of which the most important are listed below (Wieling)

Properties that distinguish different battery cells.	
Energy density	The amount of electrical power per unit of volume..
Weight	The amount of electrical power per gram of weight.
Lifetime	The amount of time a battery is capable of delivering the desired power output under normal circumstances. In de case of rechargeable batteries, this is mostly measured in the number of charge/ discharge cycles.
Shelf live	The time a battery can remain unused “on a shelf” and still deliver the desired power output. Batteries tend to lose 2% up to 20% of electric power each year of not being used.
Output in voltage	All batteries are a combination of various chemicals. Some react to give of a high voltage per cell some are lower. Batteries giving of lower voltages tend to have a longer lifetime and shelf live.
Safety	When short-circuited batteries can get very dangerous. They can actually explode or leak hazardous chemicals. High potential batteries tend to be more dangerous than batteries giving of lower amounts of energy because they can generate more heat in a short-circuit.
costs	Some batteries have fabulous characteristics in the above categories. These do come at a high price though
Peak power output	Some batteries are capable of producing a large amount of electrical energy in a very short time span. This characteristic is important for Impossible because the camera asks short bursts of energy instead of a gradual draw.
Operating temperature	Batteries work best in a bandwidth of temperatures. This bandwidth differs for different battery types.

2.2.2 PRIMARY CELLS VS. SECONDARY CELLS

An electrolytic cell (later battery cell) is a system that can convert chemical energy to electric energy. Because it can store chemical energy it can in a way accumulate electric energy and release it later on. A battery cell is composed of a number of electrochemical reagents. (Encyclopædia Britannica). ((Ph.D), 1992)

A primary cell, a non rechargeable cell uses chemical processes which are generally non reversible. This means a primary cell is ready for the scrap after its first, primary, use. A secondary cell or rechargeable cell uses chemical processes which are reversible. By applying a (higher) Voltage over the battery contacts, people can force the current to move the other way around, also making the chemicals go back to their original positions, ready to get discharged when needed.

As explained above, a primary cell can only be used once, while a secondary battery often can be used hundreds of times. At first glance it seems secondary batteries have a huge advantage. The question arises: why are primary cells still produced and sold in such large numbers?

The simple answer is: costs. Primary batteries are far cheaper to buy than secondary batteries. Primary batteries usually also have a much longer shelf life, some can be stored for up to ten years and still be used while most rechargeable batteries lose their power within a year or even a couple of weeks. Primary cells generally have a lower internal resistance, making it possible to draw higher currents. These characteristics are generalized but tend to hold up for most different battery types. (Dynabee, 2003) (batterijvergelijker)

2.2.3 PEAK POWER

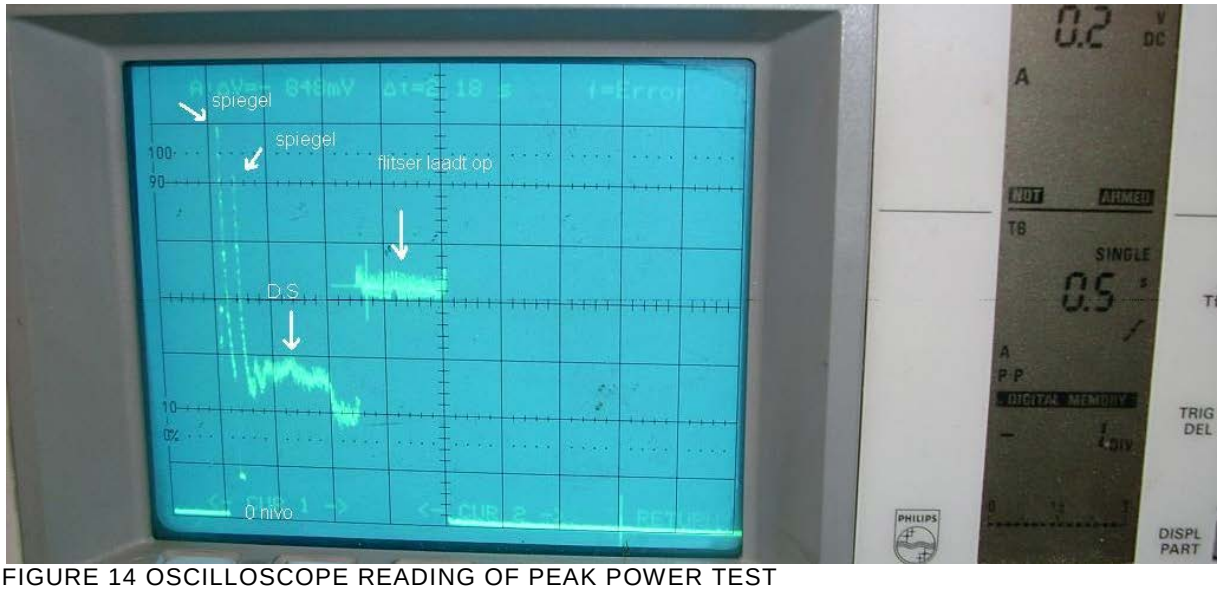


FIGURE 14 OSCILLOSCOPE READING OF PEAK POWER TEST

The maximum pulse discharge is the current at which the battery can be discharged for pulses of up to 30 seconds. Usually the battery manufacturer defines a limit in order to prevent excessive discharge rates that would damage the battery or reduce its capacity. The battery used in a Impossible film pack needs to have a high limit for the maximum pulse discharge. Because a high peek power surge is needed in Polaroid cameras to prime the flash before taking a picture.

Each pack contains 8 photo frames and a dark slide. This means that the motor in the camera must complete 9 eject cycles in each pack. The flash could be required to be primed up to 8 times for each pack. Figure 14 oscilloscope reading of peak power test shows the peak power surge at the ejection of the dark slide. The first two peaks in the oscilloscope reading are caused by mirror movements in the camera the second rise in the oscilloscope is accounted for by the actual ejection of the dark slide. The third and last peak in this reading is caused by charging the flash. This last peak typically lasts 4 to 5 seconds depending on the state of the battery.

2.2.4 SERIES OR PARALLEL CIRCUIT

A battery contains several electrochemical cells. These cells can be connected in series, or in parallel circuit, a combination of both is also possible. A parallel connection gives the same electrical potential (volts) as a single cell but is capable of delivering a higher current (amperage) A battery connected in series provides a higher electrical potential but at the same amount of current as a single cell. The series circuit simply adds the voltage of the cells together, this is the output potential. Many batteries in practical life are circuited in series, consider the 9V block in your fire alarm or the 12V battery in your car. In both series as parallel circuits the sum of the total accumulated energy equals the sum of the separate cells. (accudienst)

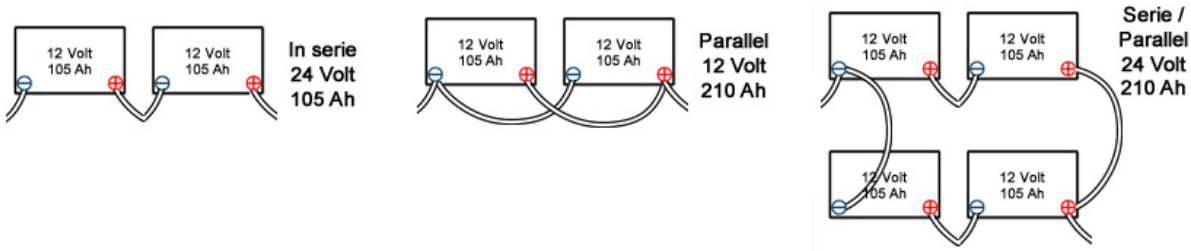


FIGURE 15 SCHEMATIC REPRESENTATION OF SERIES AND PARALLEL CIRCUITING

2.2.5 INTERNAL RESISTANCE

The internal resistance of a battery is a very hard thing understand, it is as the word suggests hidden inside the battery. When current is drawn from a battery it will have a lower electric potential (terminal voltage) than when there is no active circuit (open-circuit voltage). This effect is caused by the internal resistance, it creates a barrier for electrons to flow. This causes heat in the battery instead of delivering all the power to the appliance which needs it. The internal resistance of a battery can change due to aging of a battery and because of the number of charge/discharge cycles (batterijvergelijker)

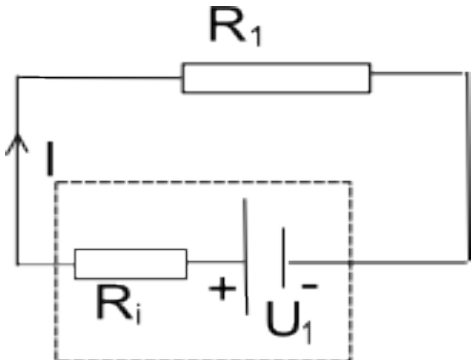


FIGURE 16 SCHEMATIC DRAWING OF AN INTERNAL (RI) AND A EXTERNAL (R1) RESISTANCE

When a battery is being discharged the internal resistance always plays its part. In the schematic drawing above, the internal resistance is called R_i and the external resistance is called R_1. At the moment energy is drawn from the battery a current is going round the circuit thus also going through R_i. The total electric potential is divided between the two “resistors”. which means less potential is going through R_1, the device that actually needs the power.

The current batteries used by Impossible have quite a high internal resistance which is just below 1Ω, the old Polapulse batteries produced by Polaroid only had an internal resistance of 0,5Ω.

The influence an internal resistance can have is shown below.
the external resistance (the camera) is set at $R_1 = 4\Omega$, the battery can deliver 6 volts of (closed circuit voltage) CCV

	Total resistance	Total current	Potential the internal resistor dissipates
R_{iold} = 0.5Ω	$R_{total} = R_{iold} + R_1$ $R_{total} = 0.5 + 4 = 4.5\Omega$	$I=U/R_{total}$ $I = 6/4.5 = 1.3333A$	$U_i = I * R = 1.333 * 0.5 = 0.666V$
R_{inew} = 1Ω	$R_{total} = R_{inew} + R_1$ $R_{total} = 1 + 4 = 5\Omega$	$I=U/R_{total}$ $I = 6/5 = 1.2A$	$U_i = I * R = 1.2 * 1 = 1.2V$

It becomes apparent that the current battery “loss” almost doubles compared to the old battery.

2.2.6 TESTING A BATTERY

Testing is designed to tell us things we want to know about individual cells and batteries. Some typical questions are:

- Is the battery fully charged?
- How much charge is left in the battery?
- Has there been any deterioration in performance since it was new/ since last time I used it?
- How long will it last at my typical load?

Although all cell parameters the design engineer may wish to measure can be quantified by direct measurement, this is not always convenient or possible . For example the amount of charge left in the battery, the State of Charge (SOC) can be determined by fully discharging the battery and measuring the energy output. This takes time, it wastes energy, each test cycle shortens the battery life and it may not be practical if the battery is in use. It would also be pointless for a primary cell.

Similarly, the remaining life of a secondary cell can be determined by continuously cycling it until it fails, but there's no point in knowing the cell life expectation if you have to destroy it to find out. This is known as the State of Health (SOH) of the battery. These tests are very suitable for testing a small number of batteries from a larger batch. With this information the engineer can make a viable prediction about the quality of the full batch. What is needed for testing a single battery are simple tests or measurements which can be used as an approximation to the desired parameter, an indirect measurement.

2.2.7 BATTERY TESTING

When Impossible will be marketing a “new and improved” version of their film pack, it will have to perform alike. While guaranteeing the life of the battery for one pack is rather safe. It is rather more of a risk to guarantee the battery will not fail when it is used several times.

Since the battery will be interchangeable between film packs in the near future, Impossible will have to find a way to at least give their customers the confidence to put a battery which essentially has already been used in their freshly bought new film pack. If the battery dies halfway the pack the customer risks losing a precious and costly film frame while having to take the pack out in order to change the battery. This would cause a large source of complaints and has to be avoided.

It is therefore of the greatest importance that customers trust the battery enough to put it in their pack. One of the easier ways to do this is to say the battery will last only three film packs. This is still far better than only using it once and will be quite safe. Though safe it will also allow for a lot of perfectly fine batteries going to waste and might let age old batteries pass, even though they might have gone flat just because of their elderly state.

To counteract this waste and to actually meet the requirements set at the beginning of the project a trustworthy measuring device is needed to test the batteries. If the battery goes below a measure of 5,8 Volt OCV the battery should not be used for a new film pack and be disposed of safely. Anything above that number should be fine if the pack is used up over the next month. If customers leave the pack in the camera for longer periods of time they should discard any battery measuring below 6,0V OCV because of shelf deterioration.

Not everyone, of safer to say, hardly anyone has a multimeter or a battery tester suitable for testing 6 Volt batteries. To make sure people who do not own one of the above meters can still know if their battery is adequate for powering the camera there will have to be some sort of Impossible battery tester. Either supplied with each battery or an extra accessory available on the web shop or at the Impossible Project spaces (The name for Impossible stores).

A battery tester could easily be modified to meet the voltage and internal resistance range the impossible batteries require. If designed nicely Impossible could sell these battery testers for up to €10,-. While not making anything obligatory to buy. If a customer rather uses his own multimeter, that would be perfectly fine.

The other option would be a “Duracell” style test strip which on a push at the contacts will glow yellow to its current state of charge. The user will not have to read a voltage level and think:”would that be enough to power my new film pack?” The designer could put markings on the tester like: “good as new”, “good”, “good for one month”, or “bad”.

2.2.8 HOW (DURACELL) TEST STRIP WORKS

A battery test strip is a dark strip incorporated in a battery or with a package of batteries. The moment each end is pressed against the poles, a part of the strip turns yellow. The length of the yellow portion of the strip depends on the condition of the battery. A Fresh battery will colour the full strip yellow, an older battery will not fill out the strip. At the back of the tester is a wedge-shaped piece of conducting material. The strip itself contains a liquid crystal which changes colour at approximately 46°C.

FIGURE 17 DURACELL BATTERY TESTER

When the user presses the ends of the conducting wedge against the poles of a battery a current will flow through the wedge. The current, given by Ohm's law, I = V/R, where R is the total resistance of the wedge. The resistance per unit length is not constant. It is higher in the narrower portion of the wedge and lower in the wider portion. The power dissipated per unit length is therefore largest in the narrowest portion of the wedge. In this area the wedge heats up most and will turn yellow easier than in the wider portion. A new battery produces a large enough current to even heat up the wide portion of the wedge and turn the liquid crystal above it yellow. As the battery gets lower on power, the current decreases and the length of the yellow portion decreases as only the narrow parts of the wedge get hot enough to turn the crystal above yellow (University of Tennesee).

This test uses an external resistor to heat up the crystals. This makes it very useful to test the actual amount of electrical power remaining in the battery. Since it is a passive tester it does use some energy to heat the strip. The exact amount of energy loss due to the test is hard to quantify because it changes with the amount of time the tester is pressed and the state of the battery. If only used before insertion into a new film pack the advantage of knowing the state of the battery would outweigh the disadvantage of energy loss.

2.2.9 BATTERY CHOICE

FIGURE 18 BATTERY USED BY IMPOSSIBLE

Impossible currently uses a Li-MnO_2 (Lithium Manganese Oxide) battery (See Appendix III). Consisting out of two cells which have been series circuited to deliver 6.2V of open circuit voltage (OCV) and 6.0V of closed circuit voltage (CCV). This difference in voltage is caused by the internal resistance. The battery has a capacity of 750 mAh and a maximum pulse discharge rate of 500 mA.

In the figure above the current battery is shown in its protective pouch which is glued to the card stock (1). To the right the battery stripped of its protective pouch. It is clearly visible that the battery consists out of two separate cells. The most right picture is the size the battery will take in the near future. It will have the same output voltage and capacity as the current battery (2).

Impossible has chosen Li-MnO_2 technology because this type of battery has a very high energy density making it possible to deliver large amounts of energy while being as small as it is (76 * 60 * 3mm). Li-MnO_2 batteries are known for delivering a very stable output voltage over their entire lifetime at a wide operating temperature range (-10 - 55°C). The typical self discharge rate of this type of battery is ≤2% per year if stored in recommended circumstances of <30°C and <75% humidity.

The research that has been conducted confirms that a Li-MnO_2 battery is a good choice for powering cameras. Though the current battery type is very well suitable the battery will have to shrink in size to be interchangeable. HCB (the Chinese battery manufacturer) has already promised to be able to shrink the battery to 58 * 58 * 2.2 mm. these are the dimensions which will be used to redesign the film pack.

2.3 PRESSURE SENSITIVITY OF PHOTO FRAMES

Impossible feared that changing a battery in a film pack would inflict damage to the picture frames. The pressure needed to push in a battery might cause visible defects. The old Polaroid picture frames were sensitive to pressure. Especially point concentrated loads could easily damage the picture frames. Because Impossible uses thicker positive and negative sheets which should make the new picture frames less susceptible to pressure.

Tests have been conducted to make sure this assumption of pressure not being a mayor issue is indeed correct. To test the sensitivity a weight of up to 4 kg was pushed on an area of 40mm^2. A credit card was used to concentrate this high stress on a small area. A calibrated two kilogram weight was used to push down on the frame for prolonged time. The credit card was pushed down manually on the photo frame on a set of scales to simulate higher pressure for shorter amounts of time.

After this abuse the picture frames were processed to a blue colour. The chemical which produces a blue colour is situated deepest in the sheets. Any damage inflicted in the tests should be visible when a frame is processed in this colour.

A total number of 15 photo frames were visually analyzed by the instrument technician at Impossible. He could not detect any pressure inflicted damage on any of the tested photo frames. In the figure below a number of the tested picture frames are shown.

Though pressure did not show on the pictures light leaks did become apparent, this is a mayor issue which has to be addressed carefully. Just the slightest bit of light getting to the photo frames will show on the picture as a white spot (see fig. 19).

The pod (the bag under the photo frames containing the development chemicals) remains just as sensitive to pressure as it always has been. It is made to break at the pressure generated by the rollers in the camera to ensure an even spread of developing fluid over the photo frame.

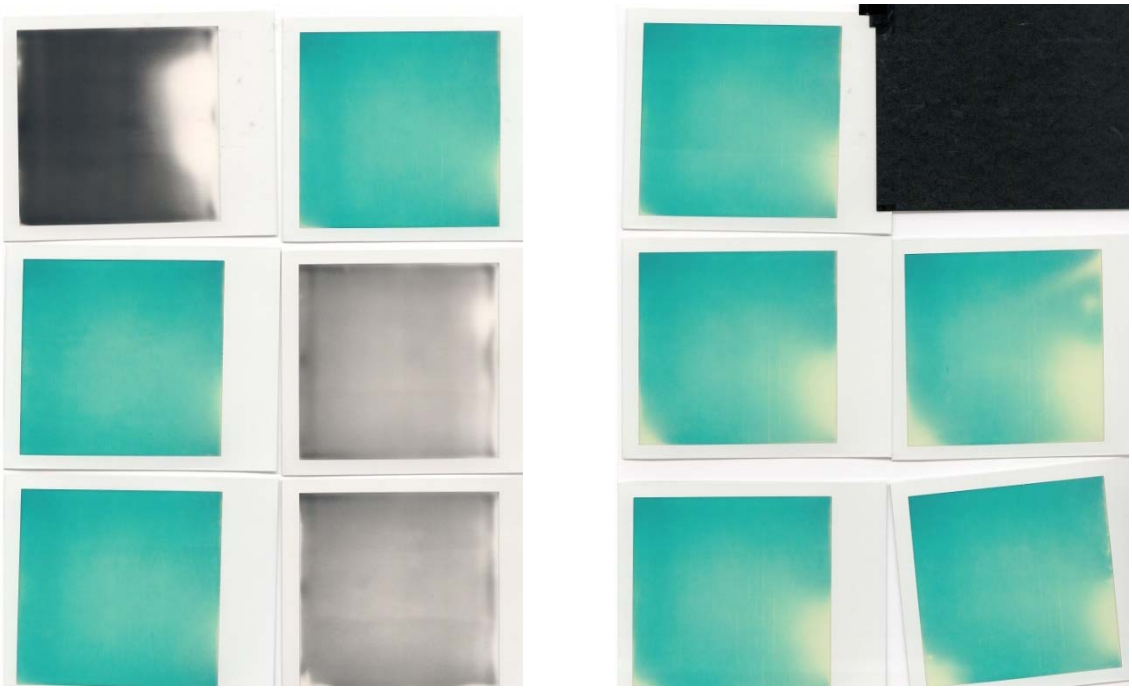


FIGURE 19 PRESSURE TESTING OF THE FRAMES

2.4 LIGHT SENSITIVITY

As told in the previous paragraph light is a mayor issue for Impossible photo frames. The photo frames need to be kept in the dark at all times before the picture is exposed. If light does get to the picture the negative will be pre-exposed and will only show a white spot at the place where it has been pre-exposed. This effect became clear in the pressure tests of which the scans are available above.

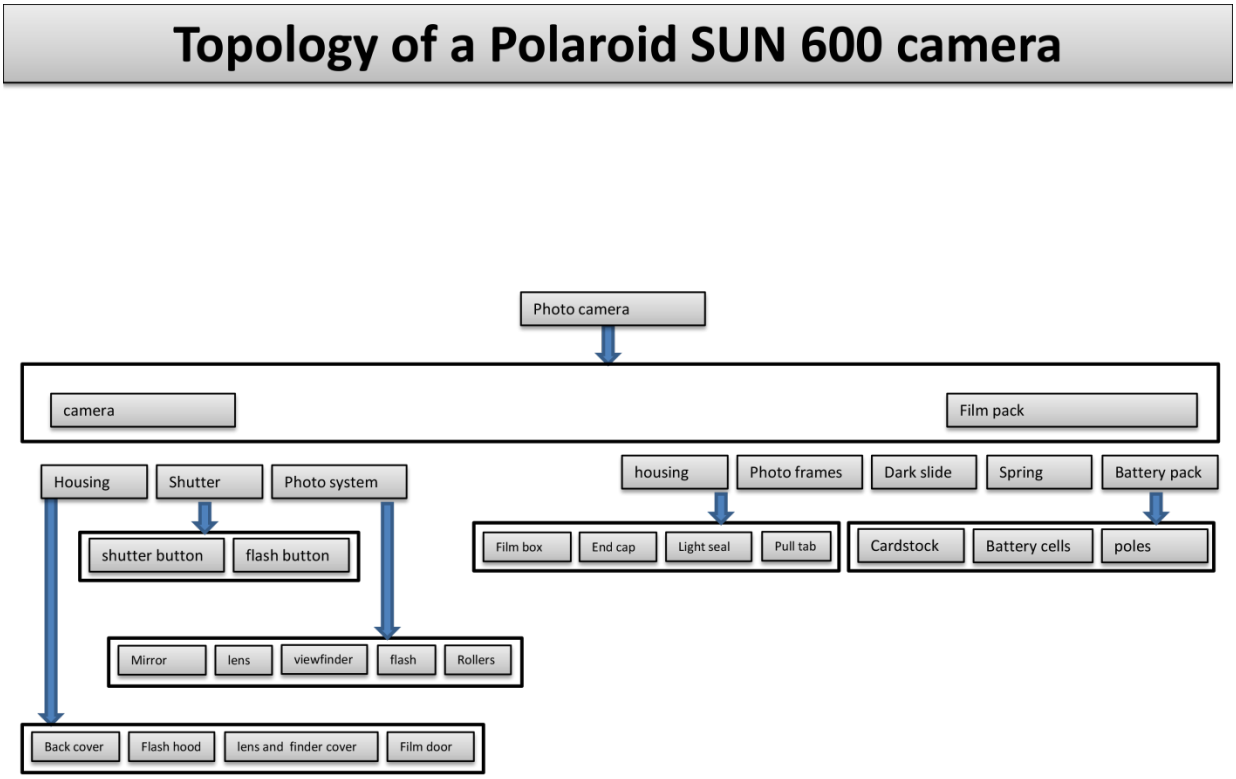
To avoid light leaks the box containing the stack of photo frames has to be sealed very carefully. Since the pictures have to be exposed when a picture is taken, the pack cannot be moulded as a closed box but has to be open on the top side to allow light to get to the negative at the desired moment. To make sure light only gets to the picture when the moment is due Impossible uses a cardboard sheet; the “dark slide” to cover the photo frames in the film pack. Once the film pack is inserted in a Polaroid camera, or new Impossible camera, the first sheet the camera detects will be ejected. This means that when the film pack is inserted in the camera it will be ready to shoot pictures directly afterwards.

The film pack also has holes in the bottom to allow the battery contacts to touch the camera contacts, so the camera can get its power supply. Next to the two battery contact holes are two other holes for detection in the assembly machine. These help the assembly machine recognize the kind of film pack. Though this feature is still present it is not relevant in the current situation, for Impossible has changed the pack assembly procedure relative to the way Polaroid used to fill the film packs.

In the Polaroid days film packs for “600” camera’s and “SX-70” cameras were slightly different so they would not fit in the wrong kind of camera. Polaroid made this precaution because “600” camera’s use a much higher (600) ASA value then SX-70 cameras (100) to process the picture. Impossible felt that this limited the freedom of its customers and countered the problem by introducing special filters that can be clicked on top of the film pack. This freedom is much appreciated by the artists that use Impossible film.

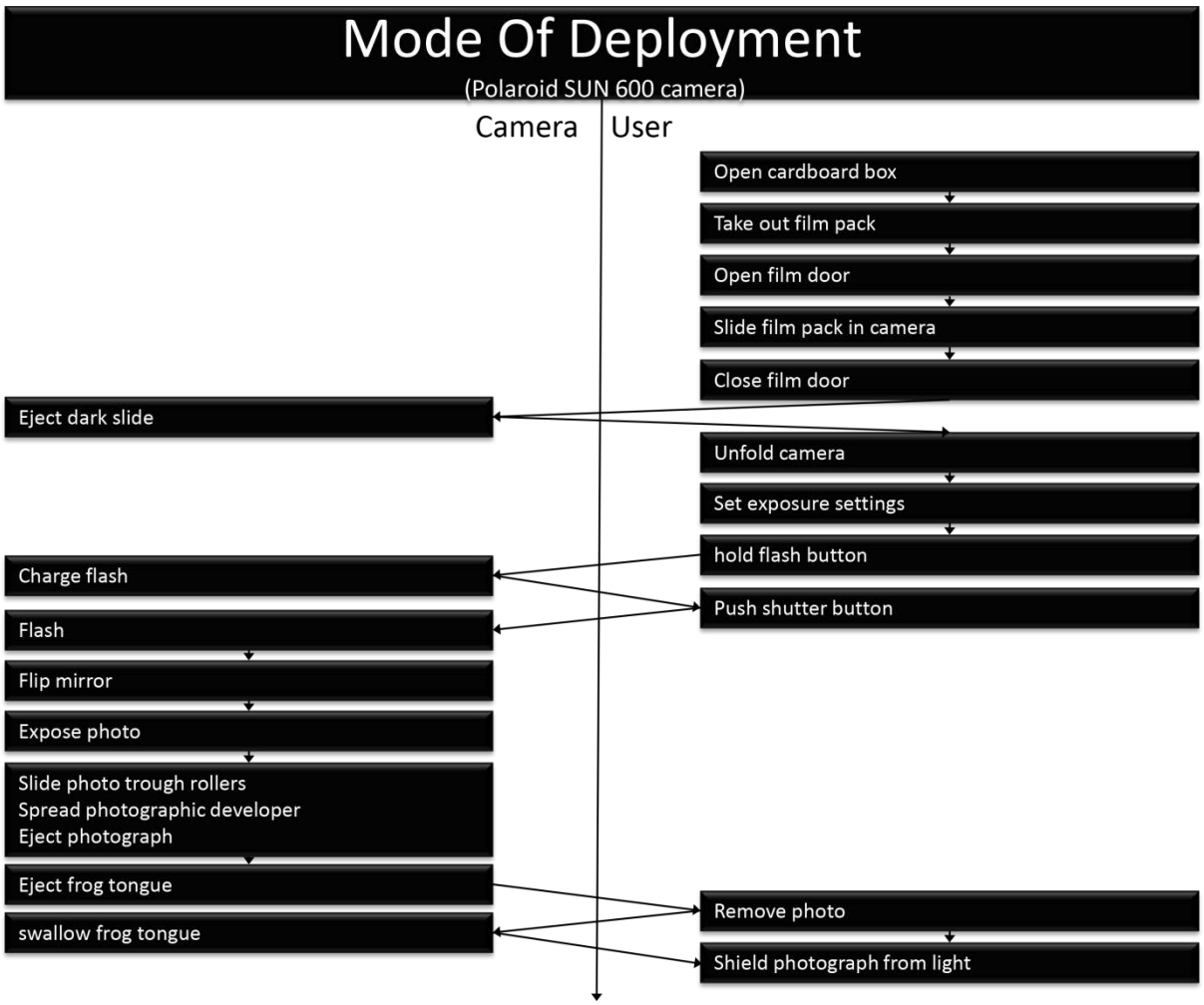
2.5 CAMERA AND PACK

In designing a film pack for a camera it is important to know where components in the camera are placed. To be able to easily see the hierarchy of components a topological diagram was devised (see fig. 20). The system was divided into two groups; Camera and film pack. With this it becomes very clear where components ought to be placed relative to each other.



FIGUUR 20 TOPOLOGY OF A POLAROID SUN 600 CAMERA

To make the user interaction with the camera and film pack comprehensible within seconds a mode of deployment has been formulated(see fig. 20). This is a chronologically ordered overview of the actions the user and the components have to perform.



FIGUUR 21 MODE OF DEPLOYMENT IN A POLAROID 600 CAMERA

2.6 CUSTOMER WISHES

This redesign assignment was commissioned because Impossible felt their customers were unhappy with the environmental impact impossible film packs have. When asked about the details the customer analysis produced, Impossible B.V. could not formulate a clear answer.

Since this redesign should be as comprehensive as possible it makes sense to ask customers about their wishes or even demands they have regarding the film packs. For the formulation of these wishes and demands a survey was carried out on the internet Te target as much customers as possible it was posted on several photo blogs and discussion sites. Also Impossibles Flickr channel and the Impossible support page were searched for customer concerns and problems regarding the battery. A compilation of these concerns and problems is in appendix II.

In the survey the following questions were posed. In appendix I the full survey is included.

	Yes	no
1. When using your filmpack have you ever encountered battery problems? (Dead battery straight away or after a few frames)	15	12
2. Did you ever try to change the battery on your Impossible filmpack?	10	17
3. Did you ever take the battery out of your Impossible filmpack for better recycling?	22	5
4. Would you consider buying separate batteries for Impossible film packs if available?(given that you'll be able to buy film packs without a battery)	20	7
5. If Impossible would produce a rechargeable battery would you consider buying it?	24	4
6. How many film packs do you use up each month? (if less give an estimate in decimals)	average usage: 124,5/26 = 4,61	
7. Any tips, recommendations or complaints about the filmpack?		

Both the survey and the compilations of concerns and problems showed that Impossibles customers were generally indeed interested in an interchangeable battery. The survey did reveal though that most customers would not except a rise in costs following an introduction of a possible redesign.

Also the survey shows more customers would like to buy a rechargeable battery re-use the primary battery. This might be caused by the unawareness of customers that the battery would indeed be capable of powering up to 5 or more film packs. It is recommended though that Impossible would do a comprehensive research in the possible introduction of a rechargeable battery.

2.7 DEMANDS AND REQUIREMENTS

Based on the results that have been established in the research and analysis phase a set of demands and requirements is assembled.

	Performances	
1.1	Battery insertion	Less than five seconds
1.2	Battery must be detachable	Less than five seconds
1.3	Battery may never stop while photographing	Minimal voltage at insert: 6V
1.4	The filmpack must be lightproof	
1.5	Force required to eject photo frame may not increase	
1.6	Operating life of battery	Minimum of 5 film packs
1.7	In camera shelf life of battery	May not change due to redesign

	Geometry	
2.1	Outer dimensions of box	See drawing 758242_11_SH02 (Appendix V)
2.2	Inner dimensions of box	See drawing 758242_11_SH02 (Appendix V)
2.3	Battery contacts must be at specific location in the box	22.5 mm off back 27,6 mm off side (Appendix V)
2.4	Geometry of pack must make sure battery will not fall out of the pack	Provide sufficient force to keep battery clamped
2.5	Pack must provide sufficient protection to pressure on pods	
2.6	Redesigned pack must be usable for both Polaroid camera's and Impossible FPU	

	safety	
3.1	Sharp edges	The user may not come into contact with any Sharp edges
3.2	Electricity	When used in a normal way the battery may never cause a short circuit.
3.3	Chemicals	When used in a normal way the user may never get into contact with chemicals used to process the film or battery chemicals

	Production	
4.1	Use of existing moulds	Only small adjustments, keep 3 mm away from cooling canals

4.2	Use of existing machines	Forming of the box may not require more force than current design (120MPa injection pressure)
4.3	Use of same material	Nova Innovene S-3207 (Polystyrene) (Appendix IV)
4.4	Processability: Assembly	No large modifications in partial and final insertion of the filmpack (battery/ cardstock, spring, frames and dark slide).
4.5	Processability: Injection moulding	Cycle time <10 seconds
4.6	Welding of end cap	Processes must remain unaltered (Dimensions of end cap and box may not change)

	(Cognitive) Ergonomics	
5.1	It must be clear how to hold the pack while placing the battery	
5.2	It must be clear how to hold the filmpack while inserting in camera	Grip
5.3	It must be clear how to hold the filmpack while taking out of camera	Pull tab
5.4	Pushing the battery in the pack and taking it out may not require much force	No more than 20 N of pushing/pulling power required.
	Positioning of the battery must be clear and unambiguous	

Nr.	**Wish**	**Quantification**
6.1	No manual is needed to understand the procedure of changing the battery	Understood within five seconds
6.2	Operating life of battery	Minimum of 8 film packs
6.3	Rechargeable battery	As option
6.4	Ninth frame in filmpack	
6.5	Smaller battery	
6.6	Battery tester	Incorporated in or with new battery

The most important demands are summed up below.

- The pack must be designed in a way the battery can be taken out of the pack easily, but cannot fall out.
- The battery must be placed in a way that the battery contacts can make a proper connection with the camera.
- The pack must be designed in a way that it will fit in a Polaroid camera and it will hold the film frames.
- The way the battery should be placed must be clear.

3 IDEA PHASE

This chapter will show ideas and possibilities to make a film pack which enables interchangeability of the battery.

3.1 BRAINSTORM

In order to come up with a large number of different ideas a brainstorm is a very suitable process. A brainstorm is a way to open the mind of the designer, all ideas that came to mind were written down in mind maps. In figure 22 a example is shown.

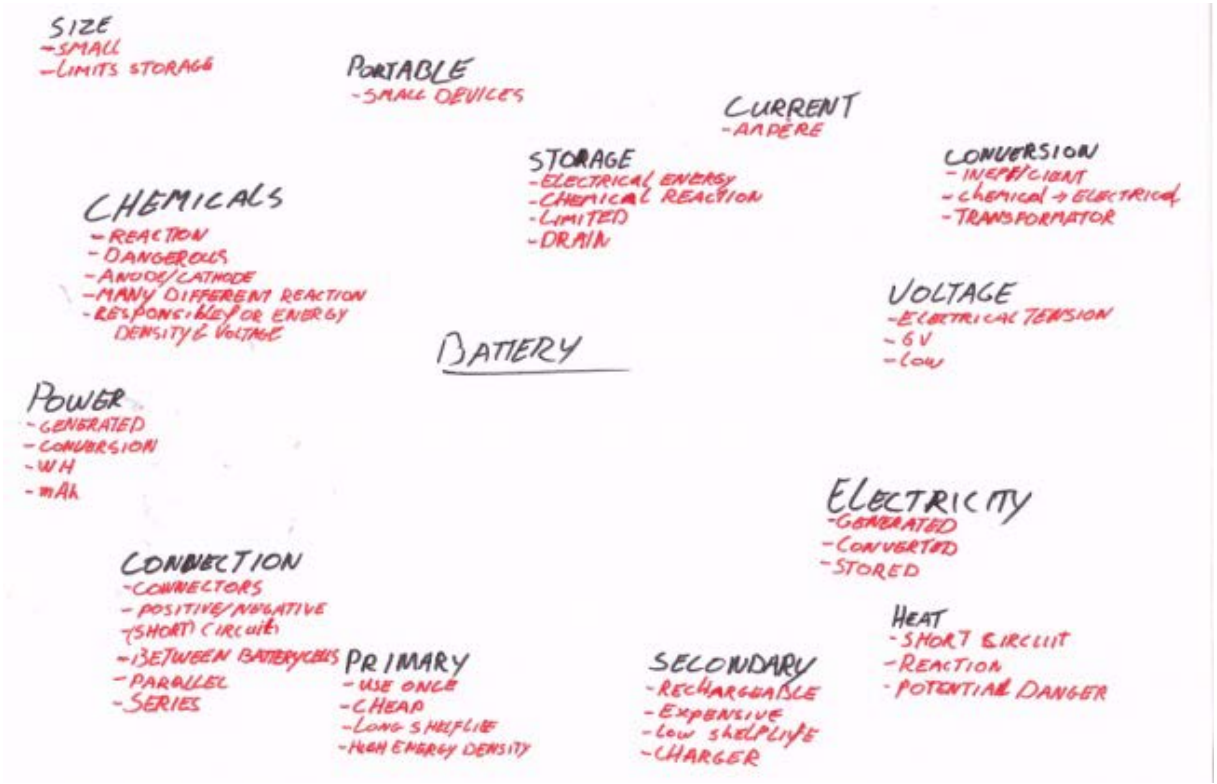


FIGURE 22 MINDMAP BATTERY

3.2 IDEA DRAWINGS

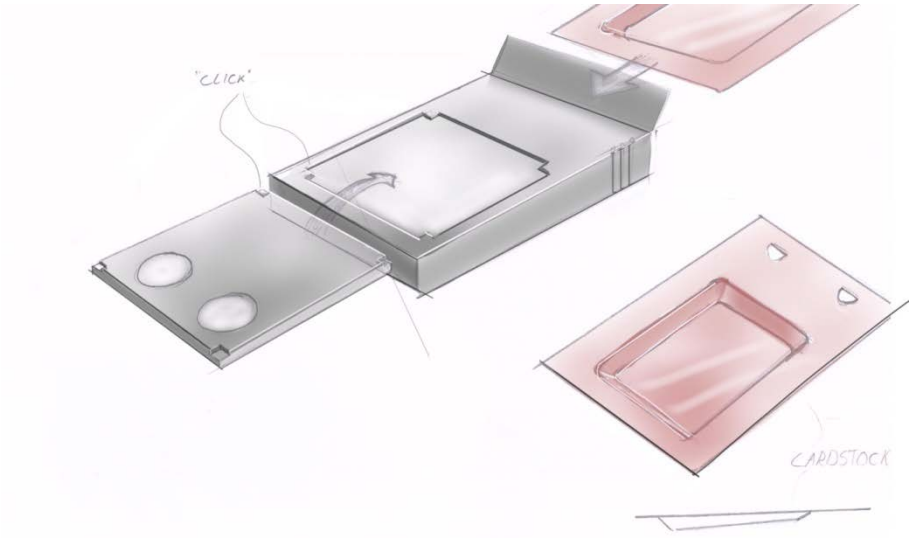


FIGURE 23 IDEA ONE

Idea one: The first idea makes interchange ability of the battery possible by providing a large hole in the back of the pack. This will make it very easy to click in a battery.

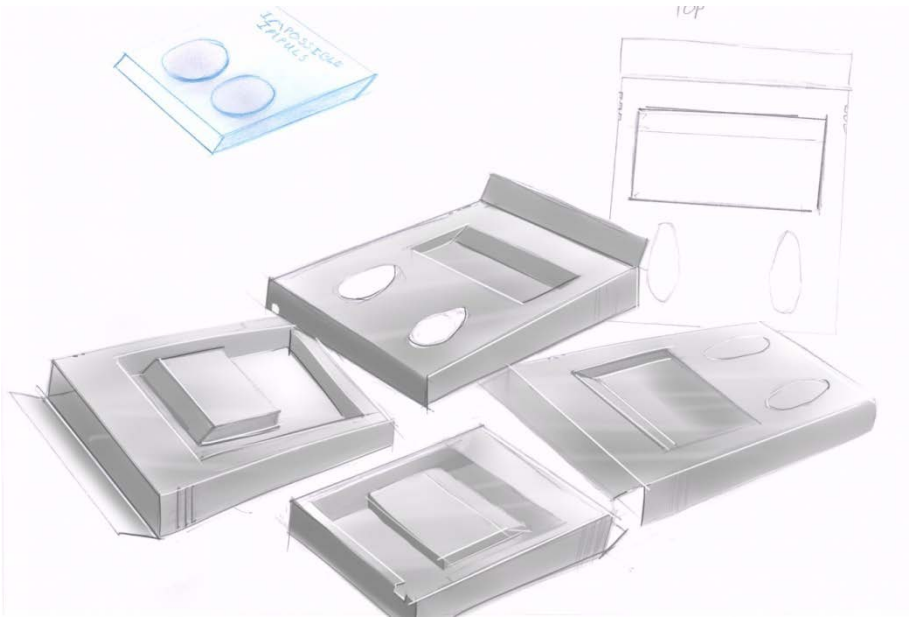


FIGURE 24 IDEA TWO

Idea two: The second idea has a hole in the back of the pack and a portion of plastic guiding the battery to its desired position. This idea would probably create problems in the assembly machine. The card stock must be able to slide in the pack, in this idea it would be obstructed by the raised inside of the pack. This concept will not be pursued in the rest of the design process.

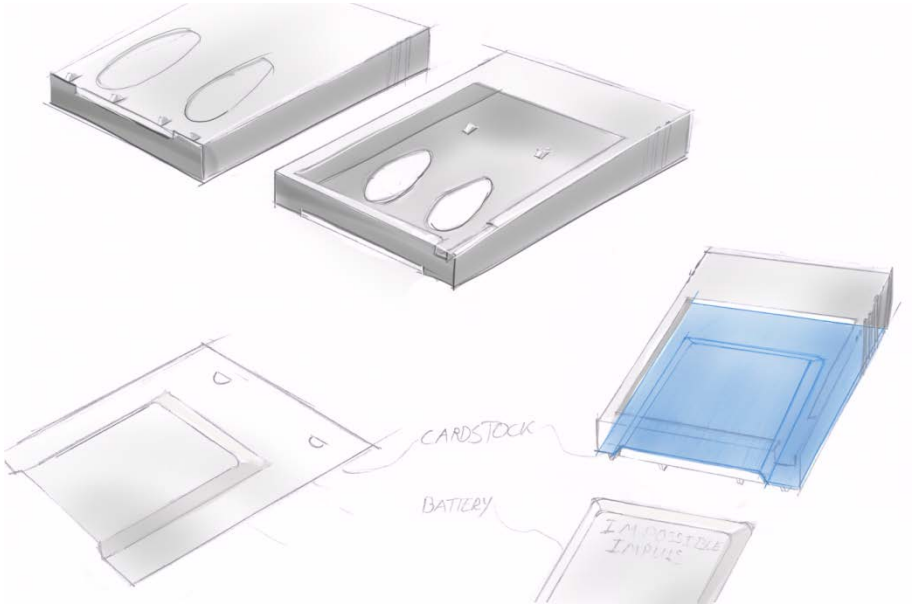


FIGURE 25 IDEA THREE

Idea three: The third idea is designed so the battery can slide in from the bottom of the pack. It only changes a very small part of the pack, therefore it will not have a large impact on the rigidity of the pack.

The bottom of the pack is packed very tight with the eight photo frames, the cardstock and the dark slide. This would not leave room for a hole through which the battery can slide into the pack. This idea was not investigated any further.

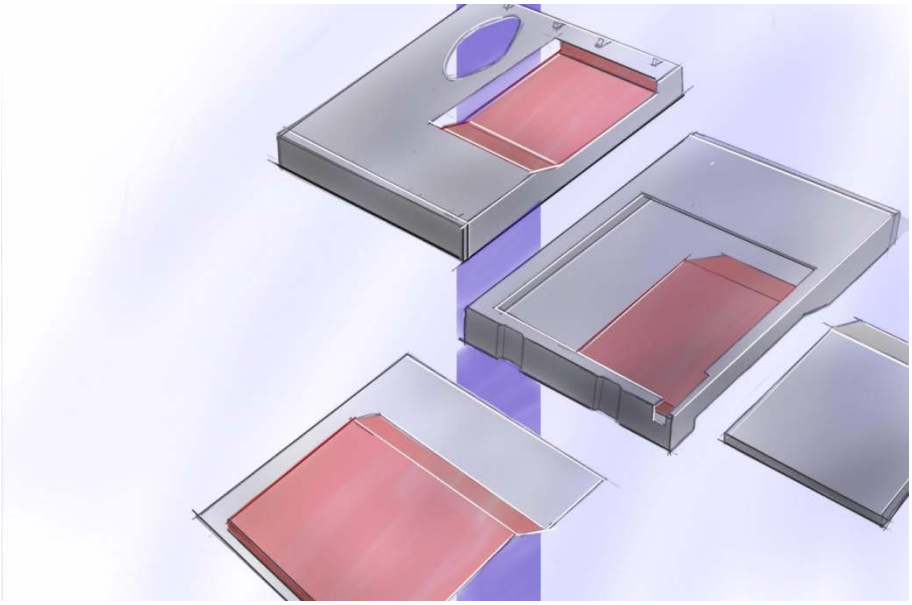


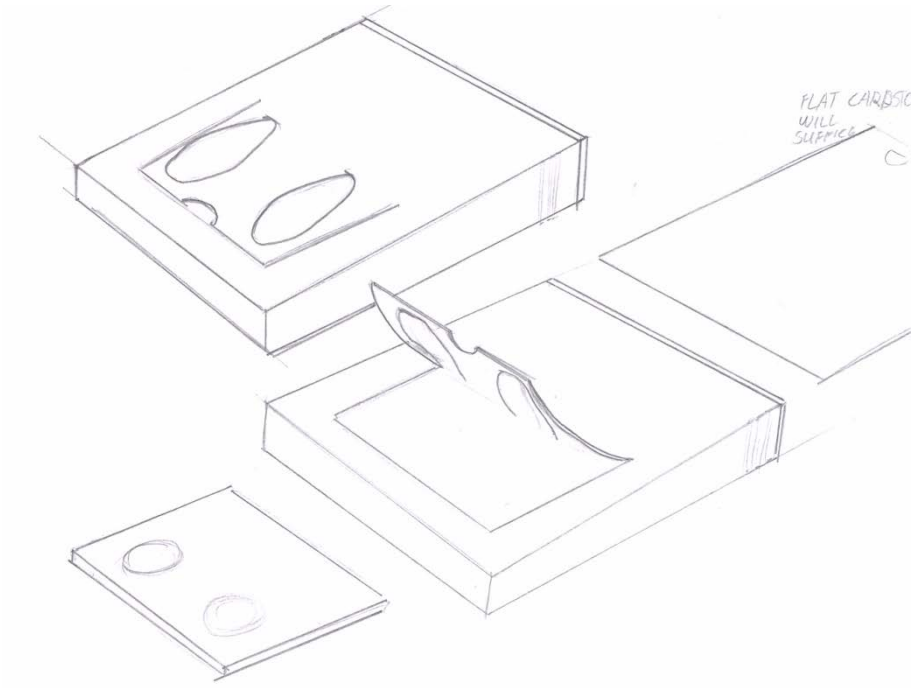
FIGURE 26 IDEA FOUR

Idea four: The fourth idea is based on a sliding principle. The battery would slide in from the side of the pack. To make sure the battery would actually fit in the pack a plastic guide for the battery is implemented. Together with the modified cardstock this would direct the battery to the desired position. This idea would probably create problems in the assembly machine. The card stock must be able to slide in the pack, in this idea it would be obstructed by the plastic guide of the pack. This concept will not be pursued in the rest of the design process.

FIGURE 27 IDEA FIVE

Idea five: The fifth idea is designed so the battery will slide in from the side. The back of the pack is partially lowered so it can assure a perfect light seal.

To be able to clamp the battery the pack would have to have negative angles. This would not be injection mouldable. It would also cause problems on the assembly machine since the cardstock would catch on the negative angle when it slid in



FIGUUR 28 IDEA SIX

Idea six: The sixth idea provides access to the box true a flap in the back of the box. Because this flap closes after changing the battery it still contributes to the rigidity of the film pack.

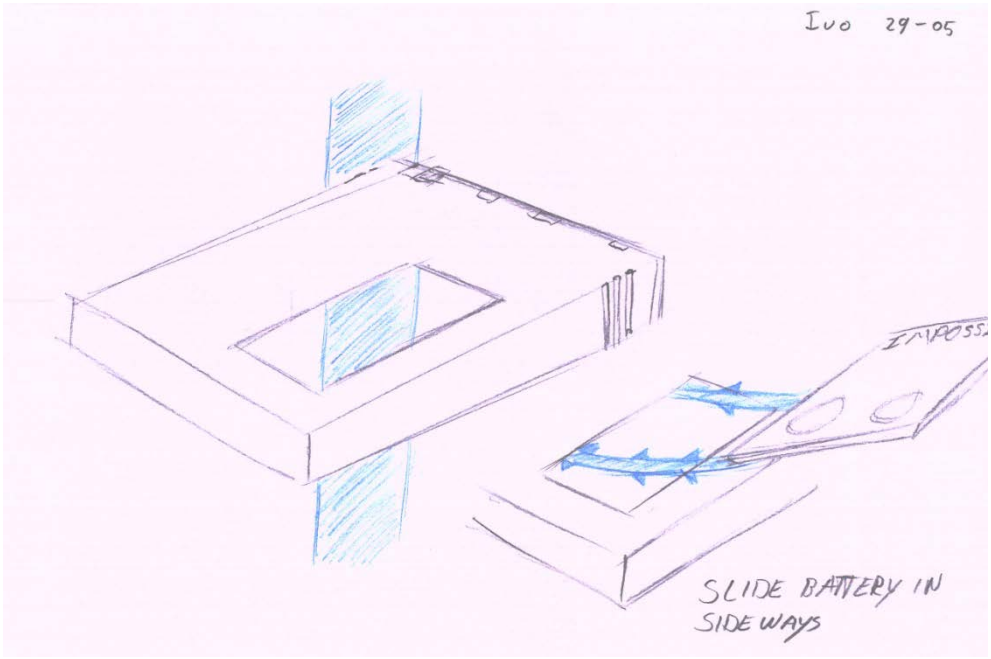


FIGURE 29 IDEA SEVEN

Idea seven: The seventh idea relies on sliding in the battery from the back of the box. In this idea not only the insertion of the battery would be easy, but also the removal of the battery would be quite effortless because the battery is within reach at all times.

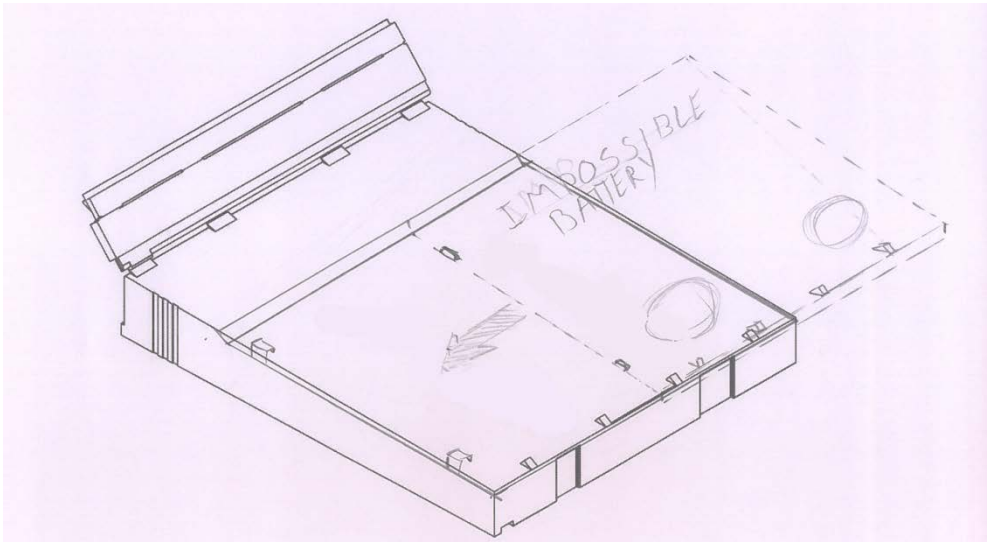


FIGURE 30 IDEA EIGHT

Idea eight: The eighth idea seals of the complete back of the box. The battery clicks onto the back of the box in special clasps. This idea assures the box to be light proof on the back. The closed back provides a suitable space to explain the battery changing procedure.

This idea would probably create problems in the assembly machine. The card stock must be able to slide into the pack, in this idea it would be obstructed by the lowered back of the box. This concept will not be pursued in the rest of the design process.

3.3 MORPHOLOGICAL DIAGRAM

The newly found ideas need to be grouped so they can be assessed later on this helps the designer to get a grip on the design process. In this case the ideas were grouped in a morphological diagram (see fig. 31). In a diagram like this it is possible to “walk” different routes, combining the solutions in different categories.

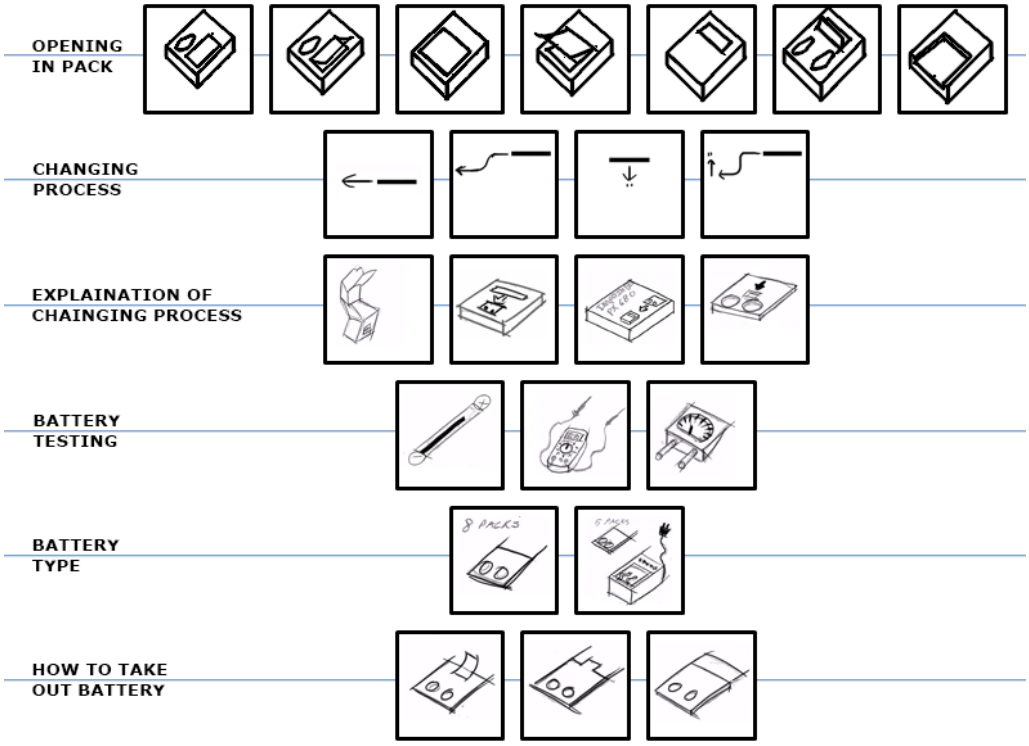


FIGURE 31 MORPHOLOGICAL DIAGRAM

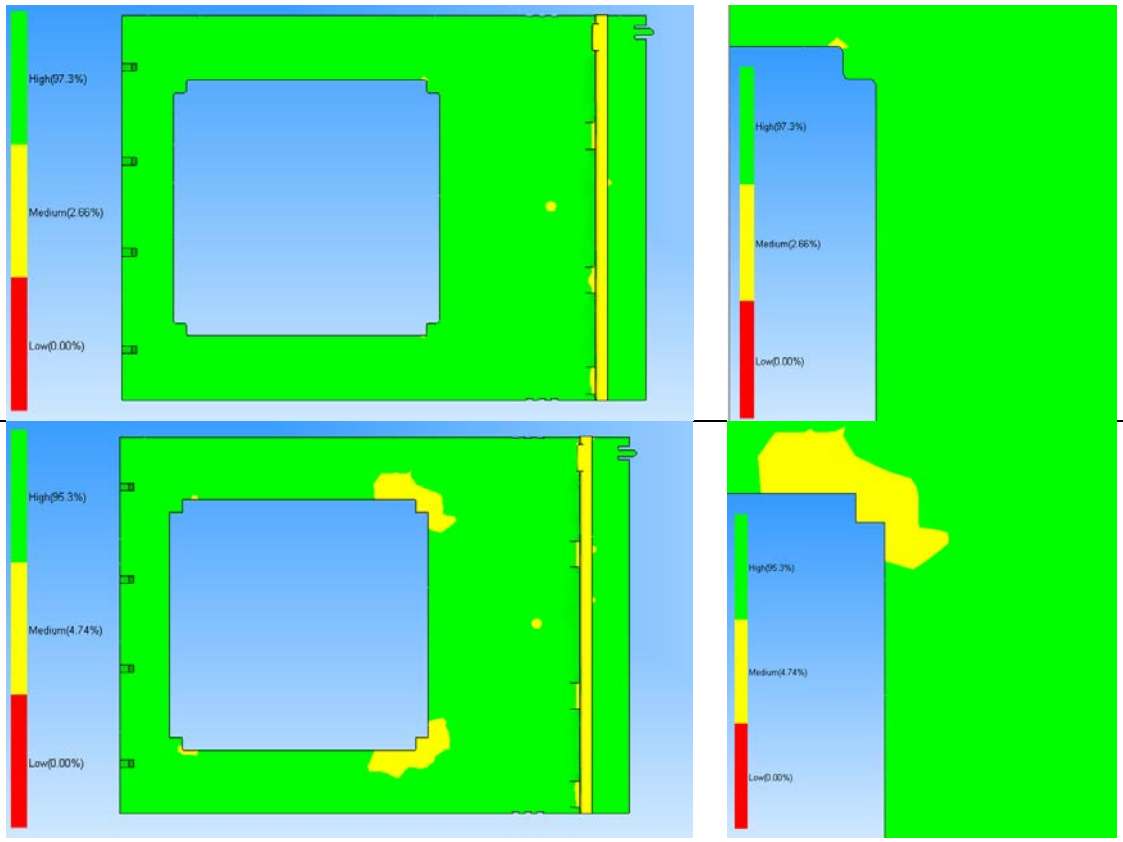
4 CONCEPT PHASE

In this chapter the acquired data which of the analysis and the idea phase is put into practical use. In this concept phase the ideas that were conceived in the brainstorm sessions and in the idea phase are sorted to find the most promising concepts. Not only the most promising for the end customer, but, and perhaps even more important, the most promising for process ability.

4.1 PROCCESABILITY

The pack will have to be manufactured using the injection moulding machines at Impossible. It will be moulded using modified old moulds that Impossible already owns. This limits the freedom for the designer considerately, but at the same time makes the project interesting. Injection moulding is a very peculiar process, all kinds of parameters can have enormous influences on the quality or even in the ability to make the product at all.

At the utmost importance for injection moulding is the taper of the product. For when this is slightly off the product will not be able to get out of the cast. It is also very important not to block the stream of molten plastic with barriers in the flow runners. Of course it is virtually impossible to remove these all together, for you would get a solid box. But making them and their impact as small as possible is. This means that angles at 90° or less should be avoided anywhere in the product. A filleted corner will make for a much better fill of the box.



FIGUUR 32 90° ANGLE VS FILLETED ANGLE

Before sending a design to the toolmaker it is important that the design is checked for imperfections which might slow down the injection moulding or would cause quality issues. To make sure none of these problems occur a mould flow analysis is made of each design proposal. In these mould flow analyses some problems became apparent and were dealt with accordingly.

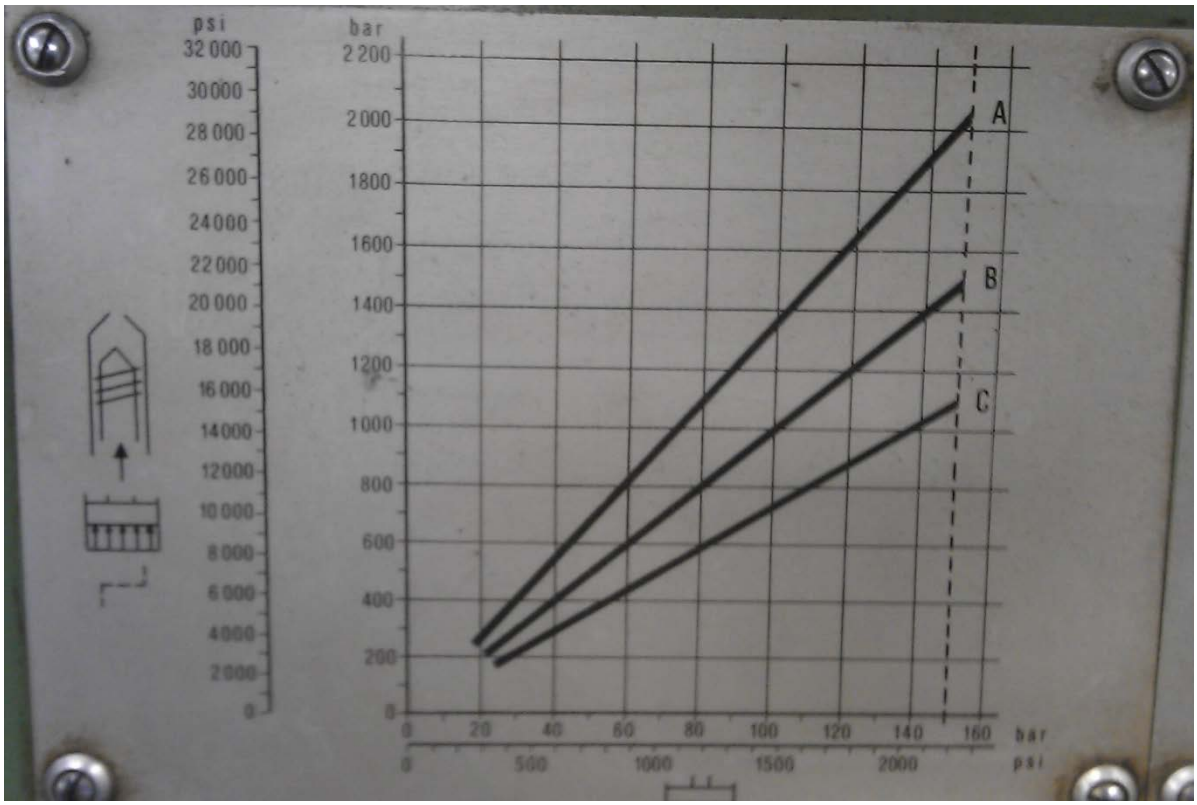
The material used in injection moulding is, a very large factor in how the product turns out. Some questions have to be asked; what is the melting point, what is its glass temperature and most important; what is the melt flow rate (MFR) of the material? In this case the MFR lies around 15 $^{g}/_{10min}$. Alas the company which made the specific polystyrene composition stopped its business. It is therefore very hard to get the exact parameters when making a mould flow analysis in Autodesk Moldflow Advisor.

The material used at Impossible is a mixture of polystyrene, a tiny bit of polyethylene and a number of other additives. The Moldflow Advisor database does not contain the specific material type for two reasons, one: the material was specifically made for Polaroid, and two, the company has stopped production shortly after Polaroid did.

After some correspondence with Autodesk (Moldflow Advisors maker) a slightly different material with great resemblance to the Nova Innovene S3207 material was chosen. This material is called styrolution 546N. Styrolution took over production when Nova Innovene stopped. They make plastics that are loosely based on the old products.

When starting to make the mould flow analysis some non design related problems occurred with the filling of the part. After some research the problem was found in a wrong pressure setting. The injection moulding expert at Impossible told the pressure was 120 bar, which translates to 12 MPa, this pressure was hardly enough to distribute the plastic for over two centimetres.

Though this 120 bar was not an incorrect statement, it was the pressure that the hydraulic ram created. The actual injection pressure is the hydraulic ram pressure multiplied by its intensification ratio, in this case 1:10 (the B in figure 33), which follows from the difference in surface area of the hydraulic ram and the much smaller extrusion screw. This makes for a injection pressure of 120 MPa.



FIGUUR 33 INTENSIFICATION RATIO DEMAG 240 INJECTION MOLDING MACHINE

With the correct injection pressure set and the (mostly) correct material set the analysis could be made. The original, unaltered, has been analyzed as a benchmark, this box filled out nicely but did form some small air traps. Next to that it does have some areas that Moldflow Adviser sees as potential quality issues at the places where the wall thickness of the box was higher.

Moldflow Adviser does give its user a very detailed insight if the model is possible to be injection moulded. In spite of this fact I would recommend Impossible to let VDB Dollwin or another toolmaker make an analysis based on the mould instead of the model. This will probably be a safer way to find out if the part is mouldable since these professionals will account for shrinkage and other changes in the mould.

4.2 CONCEPTS

CONCEPT 1

Concept 1 is quite a large iteration on the standard box, even though only one thing actually changed. It has a large cut-out in the back of the box where the battery can be clicked in.

Advantages:

1. Uncomplicated change of the mould for production on the injection moulding machine.
2. This concept requires far less plastic than the standard box (10895 mm^3 Vs. 13158 mm^3).
3. Battery clicks in easily.

Disadvantages:

1. Expected problems in assembly machine, it is very likely that the cardstock will snag on the edge of the cut-out, if this were to happen the whole machine must be stopped to resolve the problem.
2. In contrary to putting the battery in it is rather hard to take it out since there is far less outward pressure when the photo frames have been ejected.
3. The box is quite weak in twisting direction, in itself that not too much of a problem since it will not have to deal with twisting forces, but it might feel a little flimsy, which is not a “quality” Impossible searches in their product.
4. This concept requires a special ridged battery case to make the click possible

CONCEPT 2

Concept 2 has a cut-out at the back of the box orientated on the side of the box making it possible to slide in a battery from the side. It will then be clamped by the piece of plastic where no cut-out has been made.

Advantages:

1. No problems to be expected in changing the mould.
2. Small probability of holdups in the assembly machine because the cardstock will be guided by the plastic that is left.
3. The battery will be clamped properly.
4. Pushing in a battery is very easy for the customer because of the large cut-out.
5. No expected problems in rigidity.

Disadvantages:

1. It is debatable if the box will keep the photographic material completely shielded of light when a less subtle person is changing the battery.
2. Asymmetrical design might cause quality issues.

CONCEPT 3

Concept 3 has a cut-out in the back of the box orientated on the side of the box. If bears great resemblance to concept 2, only differing in the size of the cut-out, the larger cut-out makes it easier to put the battery in the pack and reduces the pressure exerted on the photo frames

Advantages:

1. Easy modification to the mould
2. Easy access for the battery with a minimum of exerted pressure on the photo frames
3. Reduces pressure on photo frames.

Disadvantages:

1. Small amount of plastic keeping battery in the box.
2. The battery might twist when the pack is empty.
3. Cardstock might snag on the edge of the cut-out.
4. It is debatable if the box will keep the photographic material completely shielded of light when a less subtle person is changing the battery.
5. Asymmetrical design might cause quality issues.

CONCEPT 4

Concept 4 is fully closed. The battery will not be placed in the box but be clamped on the bottom of the box

Advantages:

1. No light leaks from the battery side of the film pack.
2. Hardly any force is needed to place the battery.
3. No point concentrated load is exerted on the photo frames.
4. Very easy to place the battery

Disadvantages:

1. Very hard to change to mould for it requires a lot of extra material on the cavity and a cut in the core, both of which heavily effect the cooling quality of the mould.
2. Requires a complete redesign of the battery to make it fit.
3. Needs more plastic than the other concepts.
4. Hard to make the box hold the battery.
5. Problems at the assembly machine because of the ledge inside of the box.

CONCEPT 5

Concept 5 has an incision at the bottom of the back and two slices running up to the middle of the pack. This allows a portion of the back to “flip open” when pulled. When the flap is flipped open the battery can be inserted or removed.

Advantages:

1. Easy modification to the mould.
2. Will not catch in the camera when taking the pack out.
3. Easy insertion of the battery.

Disadvantages:

1. Might snag on the spring when the pack is inserted in the camera.
2. Cardstock might snag at the edge of the cut-out at assembly.
3. Hard to make a complete fill because the flap is at the bottom, where the injection pressure gets lower
4. Hard to get the battery at exactly the right spot.

CONCEPT 6

Concept 6 has a fairly small cut-out at the top of the back. The battery can slide in and out via this hole.

Advantages:

1. Symmetrical design makes it easier to injection mould.
2. The cut-out is situated at the top, this makes it easier to slide the battery to its desired location.
3. Small change to the mould.

Disadvantages:

1. Cut-out is very close to injection point, this changes the flow of plastic drastically.
2. The cardstock might snag at the edge of the cut-out at the assembly machine (though it is expected to be far less of a problem than in concept 1.
3. The battery might be hard to take out.

4.3 CONCLUSIONS AFTER FIRST DESIGNMEETING

In a design meeting the six concepts were discussed in a group of six employees of Impossible B.V. First the Solidworks drawings and mould flow analysis' were shown. Also a prototype was made of all designs these were all tested on ease of insertion.

In the design meeting a suggestion was made to combine a concept with a cut-out and a flap. Because the box with the flap was very sturdy and gave the present people a feel of safety but it was hard to change the battery, while the cut-out provided the easiest insertion procedure.

Two different approaches in combining these conceptual directions were investigated. First a pack in which the access to the pack was situated to the side was made. The second approach was to provide access to the pack from the top.

CONCEPT 2.1

Concept 2.1 is actually a combination of concept 2 and concept 5. It has a cut-out and a flap to make the entry of the battery easier while not having a large hole which weakens the structure.

Advantages:

1. Only small changes to the mould.
2. no problems to be expected at assembly.

Disadvantages:

1. Asymmetrical design makes the plastic spread in an uneven way, this might weaken the structure.
2. It is very hard to push in /pull out the battery because of the small hole.
3. Hard to get the battery at the desired position.

CONCEPT 2.2

Concept 2.2 uses the same kind of combination as concept 2.1 does but at a different location and size. It combines concept 5 and concept 6. The hole from concept 6 gives a clear message to the customer that it is possible to take out the battery, the flap from concept 5 makes this action easier by creating more space to take out the battery.

Advantages:

1. Needs only small changes to the mould.
2. The flap makes the hole smaller, reducing changes of snagging in assembly.
3. easy excess for the battery.
4. Easy to get the battery at its desired position.
5. Symmetrical shape, making problems in injection moulding less likely.

Disadvantages:

1. cut-out is very close to the ingot. Making the flow of the plastic follow a different path.
2. The flap might point inwards making it likely the cardstock will catch in assembly.

4.4 .CONCEPT COMPARISON

Since all concepts listed above have their own pros and cons it is important to compare them on a variety of points. In the diagram below the concepts are scored in a range of different important features. These features are lifted from the program of demands and requirements in chapter 2 (analysis and research). The demands and requirements have been written in a way that makes comparing the concepts easier (see fig. 34 and 35). The features used to score the concepts are:

Mould adjustments	The amount of effort needed to change the mould. Adding a lot of material and/or deep cuts is very hard because of the cooling in the mould.
Injection moulding process adjustments	Will the cycle time change? Is it possible to automate the process?
Assembly adjustments	Assembly is a very particular process in the production of film packs small changes can lead to large costs in time.
Taper	Does the redesign accommodate easy ejection from the injection moulding machine?
Costs	Large changes in the mould, longer cycle times, possible holdups in assembly, use of more plastic will all costs the company money.
Customer experience	The expected overall feel for the customer
Easy to use	Ease of changing the battery
Force required	The amount of force a person has to use to push in/ take out the battery. Must be a compromise between ease of use and being sure the battery will not fall out of the pack.
Speed of changing	The time it takes the customer to take out the battery from and old pack and insert it in their new pack.
Understand ability	Do customers understand the procedure of changing the battery? Preferable without need of a manual.
Image (green)	The way the new design is perceived by the customer. Use of less plastic and ease to recycle/reuse the battery.
Usability of current material	Impossible uses a very specific composition of polystyrene and other additives to assure the pack blocks all light.
Safety	The way the pack protects the customer from sharp edges and the chemicals used in developing the photo and the battery chemicals.
Suited for FPU also	The FPU (film processing unit) has a slightly different setup then the old Polaroid cameras. Impossible wants the new redesign to work in both times of cameras.
Lightproof	It is of the utmost importance that the pack shields the photo frames from light.
Certainty of battery contact	The battery must touch the contact points in the camera power the camera.

Diagram legend	
++	Very good
+	Good
o	Mediocre
-	Not so good
--	Quite bad

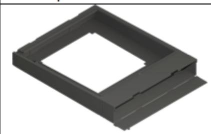
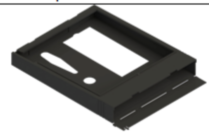
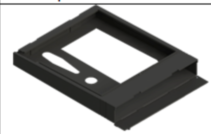
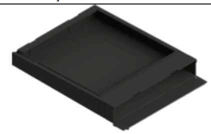
	Current design	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6
							
Mold adjustments	++	+	+	-	-	+	+
Injection molding proces adjustments	++	+	+	-	-	+	+
Assembly adjustments	++	+	++	o	o	++	++
Taper	+	+	+	o	-	o	+
Costs	o	+	+	o	o	+	+
Customer experience	o	+	+	+	+	++	++
Easy to use	++	+	+	+	+	++	++
Force required	++	+	+	++	+	-	++
Speed of changing	--	++	+	++	+	o	+
Understandability	++	++	+	++	-	-	++
Image (green)	--	++	++	++	+	+	+
Usability of current material	++	++	++	++	++	++	++
Safety	+	+	+	+	++	+	+
Suited for FPU also	++	-	+	+	++	+	+
Lightproof	+	-	o	+	++	+	o
Certainty of battery contact	+	o	+	+	-	+	+
Total	16	15	18	14	8	14	21

FIGURE 34 CONCEPT COMPARISON

In figure 35 the first six concepts were compared and scored. In figure 35 the concepts that have been designed after the design meeting are scored. It becomes very clear that concept 2.1 where the battery is inserted via a cut-out and flap combination on the side of the back scores much lower than concept 2.2. Concept 2.2 scores particularly high in user friendliness.

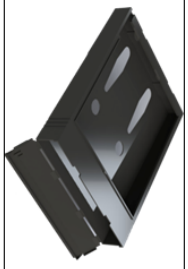
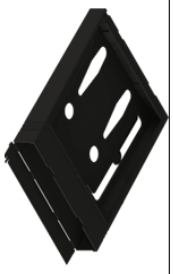
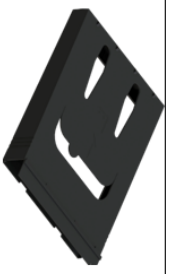
	Current design	Concept 2.1	Concept 2.2
			
Mold adjustments	++	+	+
Injection molding proces adjustments	++	+	+
Assembly adjustments	++	++	++
Taper	+	+	+
Costs	o	+	+
Customer experience	o	-	++
Easy to use	++	--	++
Force required	++	--	++
Speed of changing	--	--	+
Understandability	++	++	++
Image (green)	--	+	+
Usability of current material	++	++	++
Safety	+	+	+
Suited for FPU also	++	++	+
Lightproof	+	+	+
Certainty of battery contact	+	+	+
Total	16	9	22

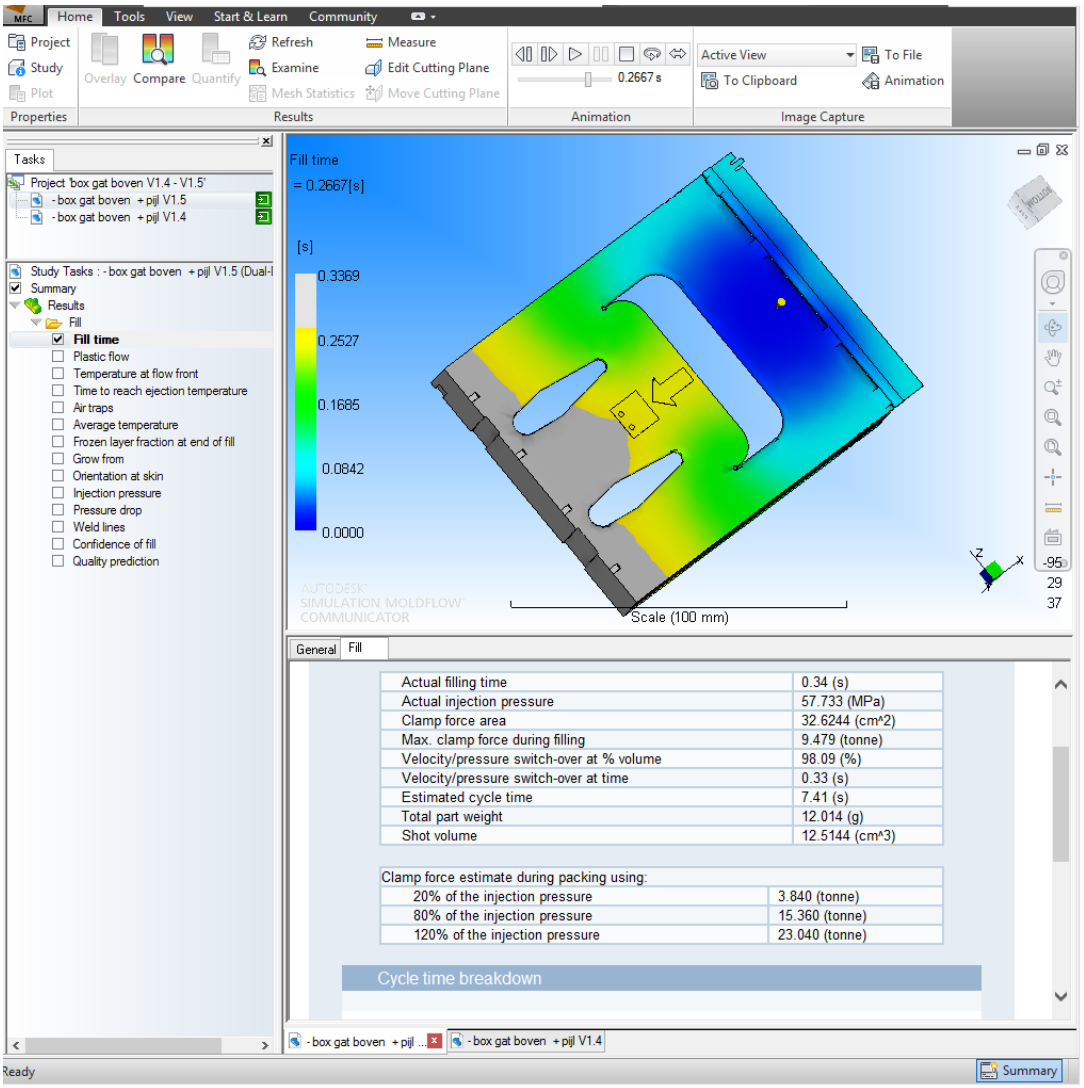
FIGURE 35 CONCEPT COMPARISON 2

Concept 2.2 was chosen to work out to a proper prototype. This choice was made because this concept scored highest on the list of disadvantages / advantages. Overall it has the highest probability to succeed.

Based at this concept 2.2 various minor alterations were made. Not only on paper or on the computer but real film packs were changed to make prototypes. Some different radii were tested as well as the specific location of the hole and the length of the flap. With these models battery insertion and exertion was tested. The best results were found with a cut-out radius of 8 mm, a hole size of 15 * 62 mm and a flap size of 10 * 61 mm. The hole in the best scoring prototype is located 30 mm from the top of the box and 13.5 mm from both sides of the box. (see appendix V)

FIGURE 36 TESTBOX WITH BEST PROPORTIONS

It requires only small changes to the mould. These changes are possible to implement according to a specialist at toolmaker VDB Dollwin and the injection moulding experts at Impossible. To be sure the molten plastic would flow through the mould in the best possible way a mould flow analysis was made using simulation software called Moldflow Advisor.



FIGUUR 37 MOLDFLOW ADVISER CALCULATING THE CONCEPT

Moldflow Adviser did calculate the forming of some air traps. Air traps are a problem because of two reasons. First: where there is an air trap there is no plastic this would considerately weaken the box. Second and perhaps even more important: air traps might cause burns in the mould. As the air is compressed after the insertion of the molten plastic it gets very hot and might get to the combustion temperature of the plastic. This could result in boxes with an imperfect surface or even holes in the box.

Moldflow Adviser also finds these air traps in the original shape of the box (see fig. 38). In the past Polaroid had some problems with burns in their film packs. Some moulds would cause air traps while others worked fine. This problem was overcome by drilling a hole at a very specific place in these moulds while the other moulds remained unaltered. This might explain why Moldflow Adviser finds the air traps. Another explanation might be that there could be a fault in the Solidworks model of the box.

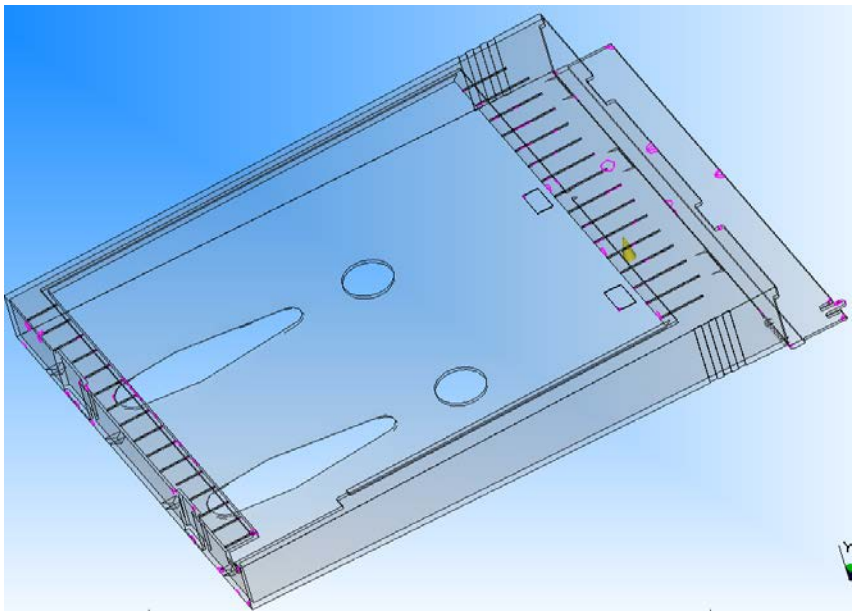


FIGURE 38 PINK AREA'S ARE AIR TRAPS IN THE ORIGINAL DESIGN

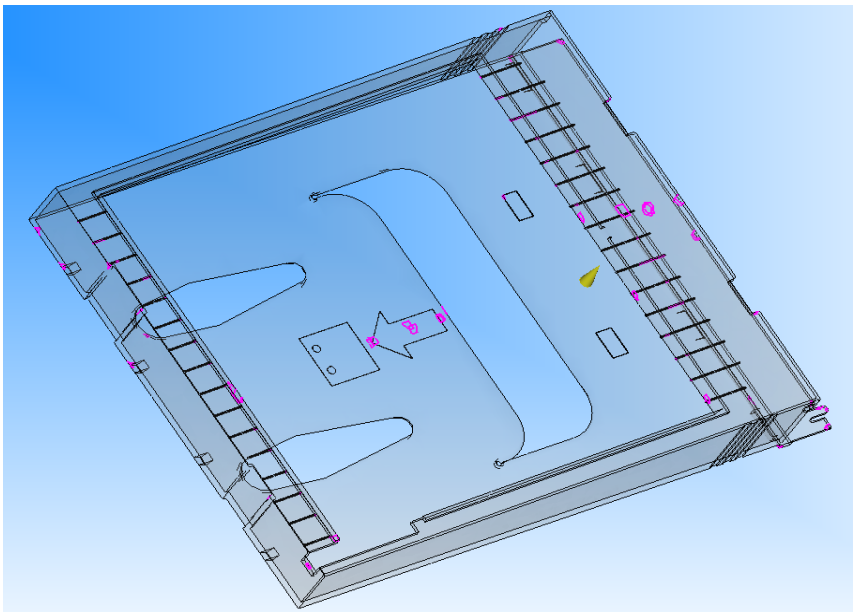


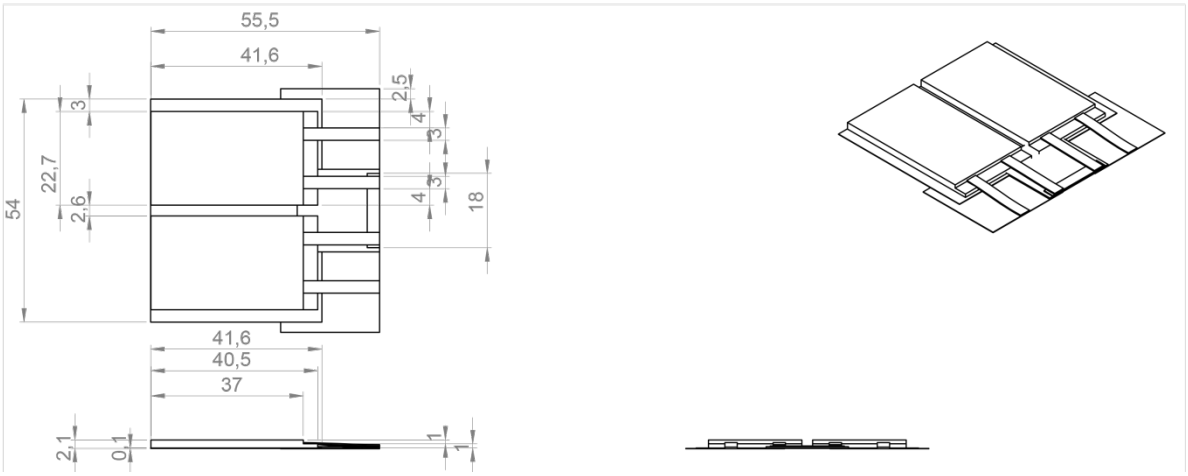
FIGURE 39 PINK AREA'S ARE AIR TRAPS IN REDESIGNED FILM PACK

The redesign does change the locations of these air traps (see fig. 38 and 39), this might bring forward new problems. Either way it is recommended that Impossible will have an expert look at these problems before they make the alterations in the moulds. This expert might be able to pinpoint the problem in the software model or in the real physical moulds.

5.2 BATTERY REDESIGN

In the current situation the battery is contained in a battery pouch which is glued to the card stock. To reach interchangeability it is needed to redesign the way the battery is contained.

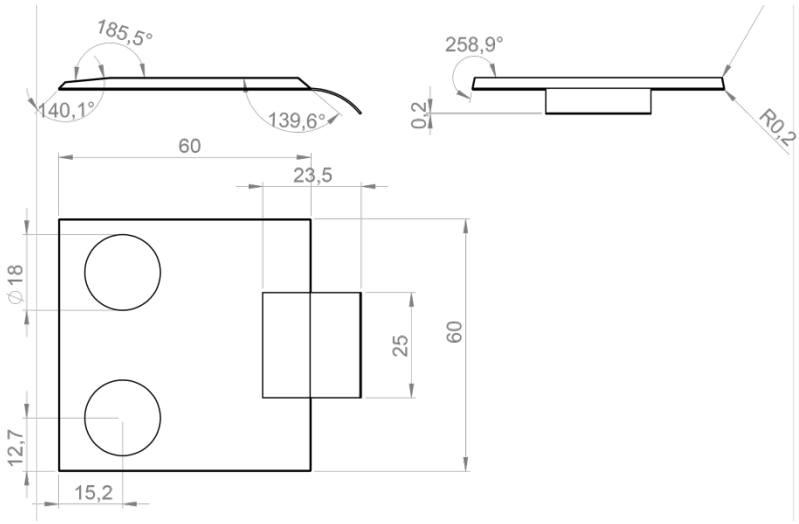
The battery will take a new shape in the redesigned pack. It will still be a Li-MnO_2 battery like the one that is used by Impossible in the current situation. To be able to reach interchangeability the battery will have to get smaller. The HCB, the battery supplier, assured it is able to accomplish this and make a battery which measures only 59 * 55.5 * 2.1 mm like you can see in the figure below, instead of the current 76 * 60 * 2.1 mm. This size has been used in the redesign.



FIGUUR 40 BATTERY SIZE USED IN REDESIGN

At the insertion of the battery in a film pack the user on the battery pushes down with a force of up to 25 N. The battery will have to be strong enough to withstand this force without being damaged. This is very important because batteries contain dangerous chemicals. To assure the battery can be handled safely it will have its own protective plastic case.

This protective case will be 3 mm high, 60 mm wide and have length of 60 mm as is visible in the drawing below. The polystyrene plastic which makes up this pouch will have a thickness of 0.3 mm and will be produced using vacuum forming. The pouch consists of a cover and a lid in which holes for the contact points are made. The pouch will have to be glued or welded when the battery is inserted to ensure the pouch cannot open.



FIGUUR 41SIZE AND SHAPE OF THE BATTERY POUCH

In figure 41 five renders are visible. These show the shape the battery case will take. The front of the case has an angle of 140.1° to make guide battery insertion. The back of the pack has a angle of 139.6° to help sliding the battery out of the pack.

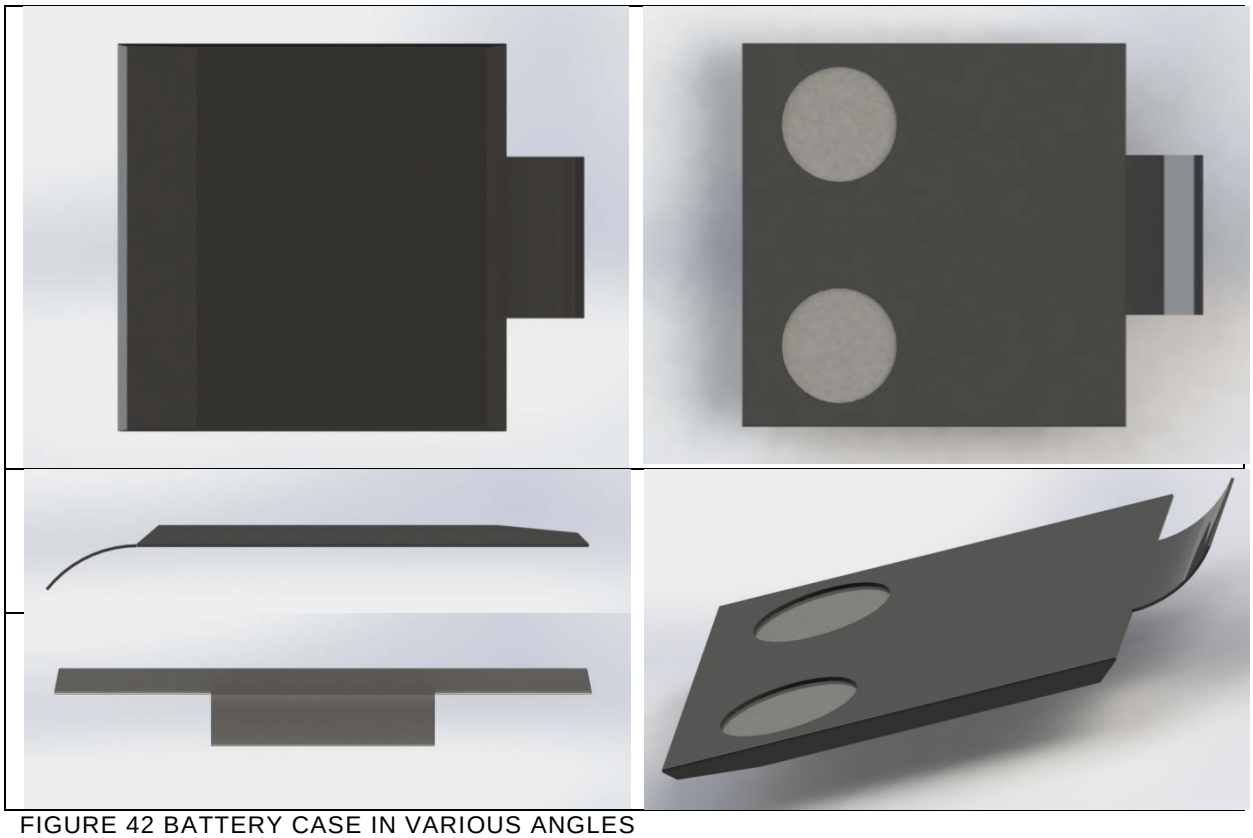


FIGURE 42 BATTERY CASE IN VARIOUS ANGLES

5.2 CARDSTOCK REDESIGN

In the current situation the battery is glued to and covered by the card stock/ battery pouch. After the redesign these components will be separated. In the last section the new battery pouch has been discussed. In this segment the redesign of the cardstock will get attention.

The cardstock will still have to perform its old task in assembly, guiding the dark slide, spring and picture frames and into the pack. In the holding of the battery its function has changed. It now is responsible of assuring the battery to make contact with the camera contact points.

Impossible does not want to be limited to producing film pack without battery. They also want to be able to offer “starterpacks” in which the battery is delivered with the pack. Therefore the new cardstock must be suitable for assembly with and without a battery. This means that the cardstock will have to be able to hold a battery. While it also needs to be open to be able to take the battery out or push one in.

The new cardstock is a vacuum formed polystyrene part, this material is chosen because the Impossible film pack is also produced out of polystyrene. Using the same material makes recycling of the plastic easier. Impossible has positive experience with polystyrene, the current battery pouch is made from polystyrene. The cardstock is composed out of two polystyrene parts, first: the vacuum formed part with a cavity for the battery. Second: a strip in which two holes are made to allow for battery contact. This strip holds the battery, while still being open so the battery can be slid in and out of the pack. The redesigned card stock is visible in figure 43.

FIGURE 43 CARD STOCK REDESIGN

5.3 CONCLUSION

The end result of the redesign is shown below in figure 44 and 45. In figure 44 the cut-out and flap that accommodate battery interchangeability are clearly visible. Figure 45 shows the film pack in its assembled state. In Appendix VI more renders are added, the workshop drawings are in Appendix V.

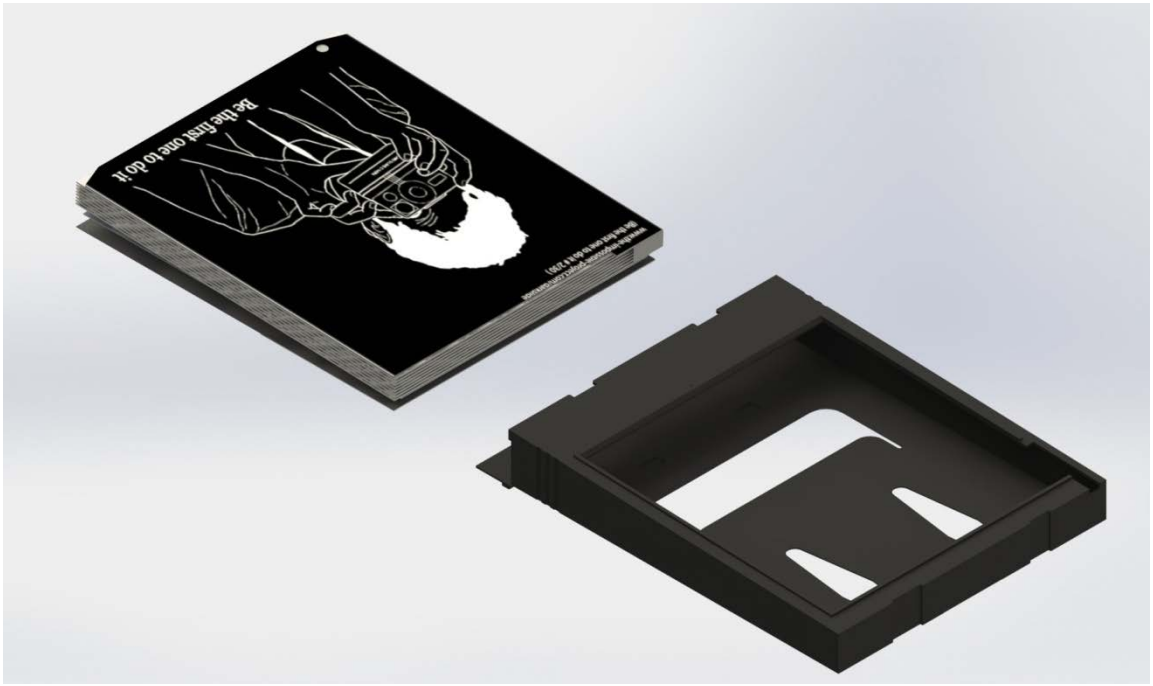


FIGURE 44 REDESIGNED FILM PACK BEFORE ASSEMBLY

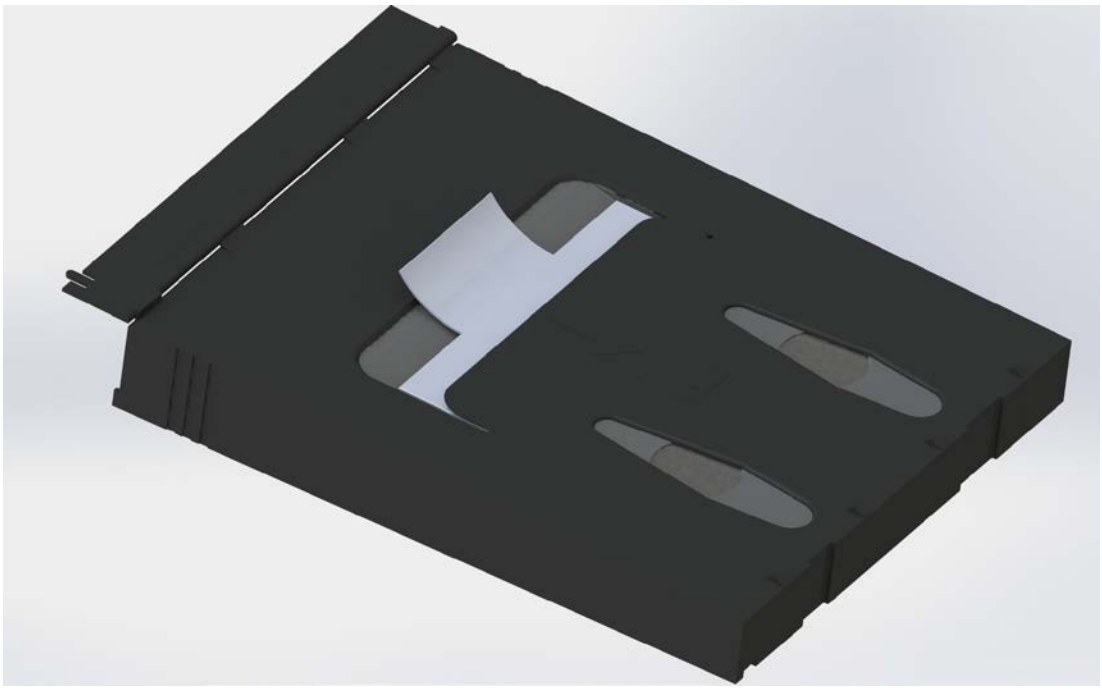


FIGURE 45 REDESIGNED FILM PACK ASSEMBLED

6 PROTOTYPING

To prototype the new design three different methods where used to get the desired model. The first approach was changing existing film packs. The second approach to making a new cardstock/battery cover was by vacuum forming. The third, 3D-printing, will be addressed below.

6.1 VACUUM FORMING

In the vacuum forming process PET plastic was used. This plastic is very suitable to vacuum form because of its thermoplastic behaviour. Its glass temperature is reached as low as 67,9° C (up till 79,9 ˚C for different compounds), while its melting temperature is reached at 212 to 265 ˚C. This makes the material able to deform while not risking melting or changing its characteristics. (CES edupack, 2013)

FIGURE 46 PROTOTYPES MADE USING VACUUM FORMING

To make a vacuum formed model (fig. 44) one first has to make a negative model of the cast. The heated plastic is “sucked” over this negative model to create the final vacuum formed product. When no negative model is readily available one will have to be made. The way the University of Twente usually does this is by carving a block of foam to the desired shape (left in fig. 44). In this case the foam was milled in cooperation with Peter Bolscher, he is the chief of the model workshop at the University of Twente.

6.2 ALTERING EXISTING FILM PACKS

The fastest way of prototyping in this case was to change existing parts. Using a Stanley knive and some glue models of the original film pack were altered to look like the concept that was tested. This method of prototyping has been used to test every concept. In Figure 45 a random selection of handmade prototypes is shown.

FIGURE 47 ALTERED ORIGINAL FILM PACKS AND CARD STOCKS

6.3 3D-PRINTING AT SHAPEWAYS

Shapeways is a Dutch company operating worldwide to offer cheap and qualitative 3D-prints. They are very well known in the world of 3D-printing and have good press. They can print all kinds of materials with methods differing as much as the materials.

Their basic and most used material is called “Strong White and Flexible” (fig. 46) it is a secret compound of nylon plastic. The method in printing Strong White and Flexible is called selective laser sintering, known better as the abbreviation SLS. In selective laser sintering a laser heats a plastic powder to melt it together to a very strong new whole. This process is done layer by layer, a new layer of plastic powder is added after each melting cycle.

Shapeways offers their customers an option to polish the model they printed. This does make a very large difference to the model. The polished version is very smooth and has far less friction if rubbed together. This is important when the box is filled with its contents, especially the cardstock and the spring are hard to fit in when the friction is too high.

FIGURE 48 PROTOTYPES MADE USING 3D PRINTING

8 CONCLUSIONS RECCOMENDATIONS

General goal

The main goal of redesigning the Impossible film pack to enable battery replacement was met using a design structure that is taught at the University of Twente. The process started with an analysis of the company, the current product and of course a research into the actual problem.

Multiple possible solutions were designed to solve the problem Impossible posed. The best concept was chosen to be worked out in greater detail.

Technical aspects

The redesign has been checked in regard of the process ability. Moldflow simulations showed the design would be injection mouldable but might show some quality issues. An expert opinion would be desirable here, especially because the quality issues were mostly found in portions of the film pack that have not been altered. Since the moulds will have to be adjusted to accommodate for the new design of the pack already it would be interesting to research possibilities of modifying the mould in a way that the general design would be of an even higher quality.

The assembly of the pack is one of the most important aspects of producing the film pack. If there are problems in this phase it will at the least prove to be a large bottleneck in the production. A assembly problem could damage a large batch of picture frames. Manual insertion tests on a prototype did not reveal any reasons to worry, but it is strongly recommended that Impossible would perform assembly machine tests with a number of prototypes before starting the actual production of the redesigned film pack.

Customer satisfaction

A thorough consumer test should be conducted. In order to know if the consumer wishes were satisfied It is recommended to commission a consumer panel to test the prototype before market introduction.

9. REFERENCES

(Ph.D), S. B. (1992). *The Polaroid Flat Cell A zinc/manganese dioxide system.* Massachusetts: Polaroid corporation Waltham.

accudienst. (n.d.). *www.accudienst.nl.* Retrieved 05 2013, from accudienst: http://www.accudienst.nl/h/354-hoe-schakel-je-accus-parallel-in-serie-of-serie-parallel.html

batterijvergelijker. (n.d.). interne weerstand. *http://www.batterijvergelijker.nl/uploads/images/theorie/schema04.png* .

batterijvergelijker. (n.d.). *inwendige-weerstand.* Retrieved 05 2013, from Batterijvergelijker: http://www.batterijvergelijker.nl/index.php?page=inwendige-weerstand

batterijvergelijker. (n.d.). *wegwerp-vs-oplaadbaar.* Retrieved 05 2013, from http://www.batterijvergelijker.nl/: http://www.batterijvergelijker.nl/index.php?page=wegwerp-vs-oplaadbaar

Bootic. (n.d.). *impossible-instant-lab-for-iphone-and-ipod-touch-prints.* Retrieved 10 2013, from http://www.bootic.com: http://www.bootic.com/impossible/electronics/communications/telephony/mobile-phone-accessories/impossible-instant-lab-for-iphone-and-ipod-touch-prints

Butitta, A. *Polaroid Spectra AF.* http://www.flickr.com/photos/aperture_lag/3782194471/, Madison, WI, United States.

Cburnett. *Polaroid_SX-70.jpg.* Wikipedia.com, http://en.wikipedia.org/wiki/File:Polaroid_SX-70.jpg.

CES edupack. (2013). Polyethylene terephthalate (PET). Granta.

Dynabee. (2003). *Wikipedia.* Retrieved 05 2013, from Wikipedia: http://en.wikipedia.org/wiki/Secondary_cell

Ediot. (n.d.). *Camera Ediot.* Retrieved 10 2013, from http://camera.ediot.com: http://camera.ediot.com/polaroid-600-business-edition/

Encyclopædia Britannica. (n.d.). *Encyclopædia Britannica.* Retrieved 05 2013, from http://www.britannica.com/EBchecked/topic/183162/electrolytic-cell

Encyclopædia Britannica. (n.d.). *Encyclopædia Britannica.* Retrieved 2013, from Encyclopædia Britannica: http://www.britannica.com/EBchecked/topic/56126/battery

Gatchell, M. *Polaroid SX-70.* Wikicomons, http://www.flickr.com/photos/gatchell/3795892866/.

MIT Electric Vehicle Team. (n.d.). Retrieved 05 2013, from http://web.mit.edu: http://web.mit.edu/evt/summary_battery_specifications.pdf

mpoweruk. (n.d.). *http://www.mpoweruk.com/testing.htm.* Retrieved 05 2013, from http://www.mpoweruk.com: http://www.mpoweruk.com/testing.htm

Mpoweruk. (n.d.). *http://www.mpoweruk.com/testing.htm.* Retrieved 05 2013, from http://www.mpoweruk.com: http://www.mpoweruk.com/testing.htm

Polaroid. (n.d.). *75-years.* Retrieved 07 2013, from http://www.polaroid.com: http://www.polaroid.com/75-years

Stillman, D. *what-do-prototypes-prototype/.* Design Gym, http://www.servicedesignnyc.com/essays/what-do-prototypes-prototype/.

Teske, T. *Polaroid spectra In Camera Double Exposure in Spectra Film Pack Holder.* http://tiffanyteske.blogspot.nl/.

University of Tennesee. (n.d.). Retrieved 05 2013, from http://web.utk.edu: http://web.utk.edu/~cnattras/Physics221Spring2013/modules/m12/battery%20tester.htm

unknown. *IMG_4426.jpg.* http://www.bluecorpse.com/wp-content/uploads/2013/09/IMG_4426.jpg, repairs.

Wieling, A. J. (n.d.). *http://www.mbva.nl/.* Retrieved 05 2013, from modelbouwvereniging Alblasserdam: http://www.mbva.nl/Accu_en_Lader.pdf

IMPOSSIBLE

APPENDIX

I. Consumer research - survey 60
II. Consumer research - customer concerns. 62
III. Battery specifics 65
IV. Material specifics 67
V. Workshop drawings 68
VI. Renders 76

IMPOSSIBLE

I. CONSUMER RESEARCH - SURVEY

Vraag:	When using your filmpack have you ever encountered batteryproblems? (Dead battery straight away or after a few frames)	Did you ever try to change the battery on your Impossible filmpack?	Did you ever take the battery out of your Impossible filmpack for better recycling?	Would you consider buying separate batteries for Impossible filmpacks if available (given that you'll be able to buy filmpacks without a battery)	If Impossible would produce a recharable battery would you consider buying it?	How many filmpacks do you use up each month? (if less just go for some estimate in decimals)	Any tips, recommendations or complaints about the filmpack? (I can't help you if your photo's don't come out the way you want, you'll need to contact actual empolyees for that.
Respondent 1	Yes, but not with Impossible film. Only with expired Polaroid film	It's easier to take out all the unexposed photo's (in the dark) en transfer them to another filmpack with a working battery :-)	Yes, when Impossible had the recycle program.	No, only if they would offer a rechargeable battery.	Yes	1	Rechargeable battery would be great.
Respondent 2	Never	Yes	Always	Sure!	No doubt	2	
Respondent 3	yes	no	no	yes	yes	3	write film name on it. not cryptic batch-code, but an easy to read name, like "Impossible PC 100 Silver Shade Cool".
Respondent 4	Of course.	While not impossible, its not easy enough when trying to save $3/shot films.	They are always 100% dead before I toss them.	If its easy to swap the battery inside the camera, sure.	See -4	4 to 5	Id like to be able to keep films stored well past expiration and still get an image...while not a perfect one, ANY image is better than nothing.
Respondent 5	in the cold, yeah sometimes. but maybe just a hand full. i shoot a lot of film, and it dosnt happen much. but it can.	yes, if it was dead.	yes, or course. in europe we can send them in and get a discount code in return, for the online shop, and i think this program is super.	no i wold never buy batteries.	no, their cameras they producing have a battery in them, whats the point of making another battery?	i estimate at least 15.	no the film pack is fine. there isnt much to do but just leave the battery out once the new cameras and gear comes from the impossible project.
Respondent 6	Only very occasionally and only on the older packs	No	Yes	Maybe. It would depend on cost, both in terms of the battery and the film packs.	Yes maybe. It would need to have quite a long life once charged and a long life in terms of the number of times you could charge it. Other things like the charger unit and the cost of purchasing these would also need to be considered	10-20 per month on average	No not really. Then again the only problems I've really had related to the Gold Frame packs and I didn't have too many of these.
Respondent 7	no	no	yes	not unless I get a new TIP camera	yes	1 or 2	
Respondent 8	Never.	Never.	Never. I use them long after for testing cameras or give packs to a friend who fixes SX-70s	I would not. I would always be able to use old pack in case of dead battery.	They will produce it for their TIP back camera. It's already in production as far as i've understood.	3-4 packs	1) Ejection problems due to the bending of the film. & 2) Fast drying of the film pods on room temperature while film is still sealed in the box.
Respondent 9	no	no	yes	yes	yes	1	no
Respondent 10	No. But the battery did run out of amps three or four shots after the last frame. It would only half-cycle the camera, making me wonder if it was broken.	I hooked up an external power-supply to the soldered contact points on the underside of an SX-70. Underneath the leather.	Yes.	If I wasn't forced to purchase 20e disposable batteries from IP instead.	Yes. Alternatively, sell rechargable watch cell batteries, and an adaptor (spacer) to charge them in standard AA/AAA Ni-Mh chargers that most people have. Customers then don't have to repurchase another rechargable system, and IP gets to cut costs by only selling batteries.	.5	Nope. I cannot see any other major design flaws.
Respondent 11	yes	no, but I did swap the pictures to another filmpack	yes	no, that means normally less reliability. As it would not eradicate battery problems, it still can go "empty" before the pictures end.a good recycling program would be very welcomed though.	not really the polaroid system was quite pleasant, its "integral" film packs, you don't worry, you just insert the film pack and it should be it. only it.nunless that would take the price down for at least 4€ per pack.	1.5 film packs perhaps, i still have some original film packs from polaroid, so not all of them are IMPOSSIBLE	
Respondent 12	Not with any IMPOSSIBLE films.	NOPE	I did in the beginning, but then there was no US recycling program, so I stopped.	Only if they were re-chargeable, otherwise I'd probably transfer a battery pack from an old pack to a batteryless pack.	Yup. If the cost was reasonable and the battery-less pack was cheaper than current packs	5 to 10	If you can work magic, how about something that keeps the film pack cool in camera? It might be IMPOSSIBLE.
Respondent 13	yes	no	yes	yes if this decrease the cost or increase frames per pack	refer to Q4	3 and above	nope not at all, since they are designed by polaroid.
Respondent 14	No.	No.	Yes.	Yes provided there was an easy way of testing the battery prior to use. Cost would be another factor but in principle the ability to re-use a battery would be a good idea.	Yes.	2 - 3 packs a month I also use Fuji peel-apart film.	The film is still expensive compared to old Polaroid material and you get 20% less frames. I would like to see Impossible go to 10 exposure film packs at the same cost. Impossible needs to solve the brown divot problem and the opacification layer of their film.
Respondent 15	No. I mostly use SX-70 cameras with the mint flashbar, so there's not much power drawn from the battery.	No	Yes. In Los Angeles County there is a free recycling center.	Absolutely. The PZ film cartridges almost snap right back together.	Yes oh yes oh yes	5 to 10	

IMPOSSIBLE

Vraag:	When using your filmpack have you ever encountered batteryproblems? (Dead battery straight away or after a few frames)	Did you ever try to change the battery on your Impossible filmpack?	Did you ever take the battery out of your Impossible filmpack for better recycling?	Would you consider buying separate batteries for Impossible filmpacks if available (given that you'll be able to buy filmpacks without a battery)	If Impossible would produce a recharable battery would you consider buying it?	How many filmpacks do you use up each month? (if less just go for some estimate in decimals)	Any tips, recommendations or complaints about the filmpack? (I can't help you if your photo's don't come out the way you want, you'll need to contact actual empolyees for that.
Respondent 16	this of course happend; solution fill good Film in a different cartridge in the dark - quite fiddly	no never did	yes and send them back to be recycled	why not	i definetly would	maybe 10 packs	I feel uncomfortable with the fact that so many parts are made of non recyclable material. Maybe there is some way to produce at least the housing of the pack maybe from cardboard for e.g.
Respondent 17							
respondent 18	no	no	yes	yes	yes	,5	
respondent 19	No	No	Not the Impossible ones, but I did years ago with Polaroid ones.	If they were good value for money and reliable	Would we have to buy a charger too?	I only shoot once or twice per year.	I think they kind of have it right with the integral battery I'm afraid. I can't think of how to get around this one.
respondent 20	Yes. Dozens of times.	Yes.	No. I keep all my film packs.	Yes.	Yes.	5 to 10	They're harder to remove film and insert into empty cartridges than the old Polaroid packs. I think the plastic is more fragile.
respondent 21	No, I haven't.	No.	Yes, but mostly I just keep them for testing purposes. I have piles of used cartridges.	Yes, that's definitely a good idea! I can't quite see why Land and co. originally designed SX-70 filmpack like this, with the batteries and all.	Yes, definitely.	Just about one, or less. Say 0.8 packs.	No real problems this far, so no complaints either.
respondent 22	Very rarely. Usually on a very old pack of film or a pack that I started and took a long time to finish	Yes	Yes	Yes	Yes	4	I'd love to see a rechargeable one. I hate the negative impact the batteries have on the environment. I'd love it if the packs potentially had more film.
respondent 23	Yes	No	Yes	Yes	Yes	2	
respondent 24	Only in some earlier films and more often, the earlier PZ films.	I have never reached the point where I needed to actually change the battery in a pack with film still in it. I have, however, powered the camera with an external battery to finish the film with mixed results.	I re-purpose all of my batteries and use them until they are completely drained, then dispose of them properly through a local program.	If the batteries are the same as the current batteries in the non-serviceable packs, or are at least interchangeable so as to allow one to use the batteries saved from the current packs, that would be a great step towards making the actual film more affordable at it's bottom line.	In the event that this became a reality and batteries became a separate component, a rechargeable battery would make perfect sense and once I were to run out of the current batteries, I would buy one in a heartbeat.	I have so many cameras, I can go through up to 5 or 10 packs of Impossible film alone in a month's time, depending on what I have going on. That isn't counting the Fuji pack film and old Polaroid stock I shoot from time to time.	I would love to see the film pack grow a little room for a couple more frames, but I know that it's more of an issue with the film materials than the pack itself. It would also be nice to see if there would be a way to make re-inserting a darkslide a little easier. I have inadvertently inserted it below the top frame only to wind up wasting a frame for no reason and have done this more than once. I realize it's not a normal circumstance, but as this film has become what it is and has changed the way we use these cameras, I find myself needing to swap out packs sometimes and I know there are others having the same fight. Anything that would help to get the darkslide back in place- the right place, that is- would be a tremendous help.
respondent 25	yes, with old or early TIP films on separate occations.	no, but I did transfer the film to a functioning filmpack	OFCOURSE!!!!!!!!!!!!!! it would be good if this was easier though, seems like one could cut oneself on the metal spring.	yes	yes	0,5	would be cool if the side facing out had a battery slot to insert small betteries, you could still change in the middle of the pack when it is still in the camera.
respondent 26	I've only had battery problems if the pack has been left in the camera for a very long time.	No.	No.	No.	No.	About 10.	
respondent 27	one time.	no, it's very difficult to eject the pictures from film pack (must be made with no light)	yes	no. A polaroid film pack = (for me) a fresh film + fresh battery	no	6 - 8 packs	no complaints. They are fully compatible with my polaroid devices. Don't change something. IP must use this money to produce a new instant camera.
respondent 28	yes (only in older packs that have been stored in the fridge)	no	yes	yes	yes	1	
yes	15	10	22	20	24	avarage usage: 124,5/26 = 4,61	
no	12	17	5	7	4		

II. CONSUMER RESEARCH - CUSTOMER CONCERNS.

will_shelter says:
What I would like to see is a cartridge with very thin rechargeable battery that you buy once (with a charging unit that tells you how many shots the charged battery can handle) and use with another film cartridge that you can slide on top?
Could be nice, less trash and maybe without a disposable battery the film might become slightly less expensive. Just a thought.
source: http://www.flickr.com/groups/polapremium/discuss/72157624090609196/
found 13-5-2013

Instant Integral says:
I really dont care about the battery, i use the old ones in my polaroid radio and then when they die i use the holder as a frame. Plus if they did a rechargeable one it would prolly make the film even more expensive.
source: http://www.flickr.com/groups/polapremium/discuss/72157624090609196/
found 13-5-2013

Ronaldus...Dus! says:
Any news on the upcoming battery-recycling program?
I believe you at TIP still use the old Polaroid-battery stock, that must eventually drie up at some moment.
As of now I am storing my empty PX and Polaroid packs for this project, in an old shoebox..(or is fridge better?),.but haven't seen any news about this for some time now..
Are you guys interested in collecting the empty packs for recycling , or should we throw them in the garbage as I id for some time....
Maybe one new filled PX pack for every 10 or so empty packs sent back?? eh eh??
source: http://www.flickr.com/groups/polapremium/discuss/72157624869550912/
found 13-5-2013

I would be happy to sent my batteries back!
j berd 45 says:
But I was wondering if I cold just send them in without the envelope from TIP? like, what's your address TIP?
Source: http://www.flickr.com/groups/polapremium/discuss/72157626020193196/Found 22-05-2013

recycle polaroid cartridges

ampelgrun says:
Hi, I would like to ask how do you recycle your empty cartridges of tz or px film. Do you take out the battery and take it to corresponding battery garbage can? The remaining would go under plastic.
What do you do?
Source: http://www.flickr.com/groups/polapremium/discuss/72157624547009688/
Found 22-05-2013

-lili says:
I'm not sure how this works and whether I should have created a new discussion topic. I believe my pack of PX70 ran out of batteries in the middle of shooting. I'm using an SX70 with no sonar and no flash so I know the battery wasn't sucked through those functions.

I took a photo and after the shutter fired, the mirror stuck in the up position. Mind you, I took four successful photos a few days prior and two photos immediately before attempting the shot where my camera fell asleep. I opened the film pack door and shut it and nothing happened. So last resort, I put the dark slide in and took the pack out halfway to "reset" it (I guess) and put it back in. Closed the door and still nothing. Mirror still stuck. This time I took the pack out entirely, closed the door, opened it, put pack back in, closed door, and every thing that was left in my pack shot out: dark slide and the last two shots I had left which came out blank or just roller smudged really. :(

So yeah, was that a battery issue? Just need to know because while I'd hate to think I'd have to use an entire film pack in one day, I may resort to that if that means I can get 8 successful shots before the battery runs out...
source: http://www.flickr.com/groups/polapremium/discuss/72157624869550912/
found 15-5-2013

Jeesibean says:
hey everyone. Wondering if anybody has any suggestions for me!
I have an sx-70 one step that I got from ebay a few weeks ago. The first pack I film i used worked fine, no battery complications. Then the next pack stopped working after the first shot - the darkslide ejected, but when I pressed the button nothing would happen. I slid the battery from the previous pack underneath, and that did the trick. Everything worked fine after that. That pack was a px-100 colourshade cool made in 04/12

Now I have a pack of colourshade px-680 made in 02/2012 with an ND filter, and thae same thing happened - the battery appears to have quite after the second shot. I tried sliding the old battery underneath again, but it doesn't work. I tried sliding the battery from the most recent pack as well, but no luck. I've taken the pack out about 5 times and re-inserted it with/without the ND filter and nothing is working, though the darkslide does eject. Does anybody have any suggestions? I do not have an empty pack with a working battery to transfer the film to, so thats out. Any help would be appreciated!
Source: http://www.flickr.com/groups/polapremium/discuss/72157630265116612/
found 15-5-2013
SX-70 dark slide not ejecting

Simrat Sawhney
posted this on August 13, 2010 03:30
Hey everyone! I am very new to this forum and absolutely new to the world of Polaroid. I just bought an SX-70 off eBay purely on a whim. I have no experience of using SLRs but I loved the vintage effect of an SX-70 and bought one on eBay. I also bought the Impossible Project PX100 First Flush film. I loaded the film in the camera as per my understanding from YouTube videos. However, the camera did not eject / spit out the black card on closing the film compartment as it was supposed to.
There was no sound when I put the film in and closed the film compartment. Nothing is happening and no sound is made when I press the red button. Is the film dead? I can see pretty clearly through the lens and the bellows seem to be in good shape.
What could be the problem? Why did it not spit out the black card? Please help me!!! I am really dying to use my SX-70 but don't know how to make it work.
Do you think my film is useless now? Will it be a waste of a film if I have to take it out because it'll be exposed to light or is it fine if the black slide hasn't come out yet?
Please help! Thank you so much in advance!!
Source: http://support.the-impossible-project.com/entries/237487-SX-70-dark-slide-not-ejecting
found 17-5-2013

Dead Batteries?
Al Higgins
posted this on January 24, 2011 22:31
Hi guys, wondering if this has popped up before...
I loaded in a box of PX70 Colour Shade into my SX70, managed to get out the first 3 frames no problem, the camera stopped halfway through the third. I kinda guessed what the problem was when everything died, so I took out the film that was in there, and popped in a second box... I got the first photo out, and the battery died with the mirror down and aperture blades closed. :-
I tried both films in my girlfriends SX70 and no response from either.
Is this any way common? The photos I got look great, but I've only gotten 4 frames from what should have been 16, which I'm a bit disappointed about - And out of pocket!
Source: http://support.the-impossible-project.com/entries/412914-Dead-Batteries-
Found 17-5-2013
dead battery, now what?

jojonas~ says:
so I was thinking of rummaging through my stuff to find an old empty pack with still juice in thebattery and go into the dakroom to move over the polaroids (it is an original polaroid 600 pack).
any tips on how to handle everything in a good manner? I'd hate to accidentaly destroy the film :/
Source: http://www.flickr.com/groups/polapremium/discuss/72157631916214659/
found 22-05-2013
calong2009 says:
Is anyone experiencing weak or dead batteries in their color shade packs. I emailed Impossible Project and they immediately sent out a new pack of the MILK edition. WONDERFUL!! But this weekend two of the three packs I used had either a very weak battery (photo would not eject) or a dead battery by the 6th shot. I know it is not the cameras because I used other films (fade to black and silver shade) and this was not happening.
Source: http://www.flickr.com/groups/polapremium/discuss/72157625390934812
found 22-5-2013
my minolta says:
Okay I am tired of this happening... I get a new pack of film, put in my camera (pronto b) and take a picture and it turns out fine. Next day, I go to take a picture to find that the batteries are dead. This happens almost every time! Is it my camera that just eats up the batteries while I'm not even using it? Or is this just what happens when you don't shoot the whole pack in a day?

Also, since this happened today, I switched the film into another cartridge with working batteries and when I took

a picture the film only ejected halfway. I'm not sure if the picture was taken or if the film just didn't come out completely. Can someone please help me out here?? I don't want to waste any frames from a $30 pack of film anymore!!!
Source: http://www.flickr.com/groups/polapremium/discuss/72157629754080647/
found 22-05-2013

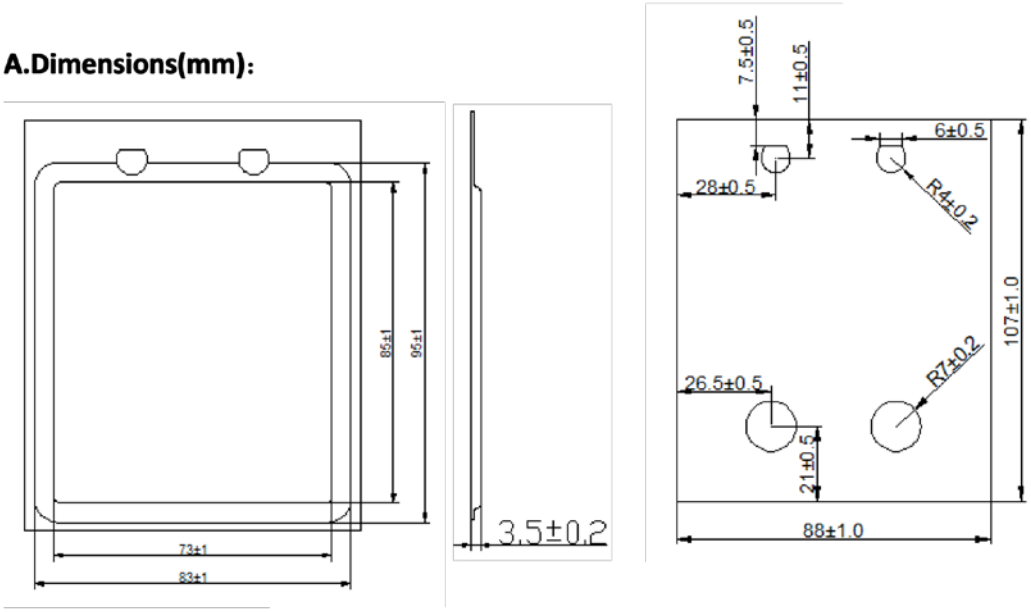
jworldboy says:
I posted this issue over at the Polaroid and Polaroid SX-70 forums. An SX-70 was passed along to me recently which needed some work. Part of the long door was broken. After fixing it, I stopped by TIP NYC shop this weekend and bought a pack of PX100 Silver Shade FF to try to even see if the camera would work. Long story short, I had to clean the contacts and eventually got some shots off but not without some issues. The entire ordeal is documented in the thread link
www.flickr.com/groups/polaroid_/discuss/72157625769745790/
I am thinking the issue can be a weak battery in the cartridge. Would TIP be able to mail me an empty cartridge with good battery power if I pay for the shipping so I can test out the camera and make sure the battery is or is not the issue?
Source: http://www.flickr.com/groups/polapremium/discuss/72157625801876476/
Found 22-5-2013

Cris Rose says:
So far i've only put 2 packs through the camera, it's working fine in all other respects, but after about a week, it's drained the battery in the film pack dry.
I'm not using flash on the photos, but the most shots i've got from a pack is 4.
Could it be because i'm leaving it unfolded between uses? Am i meant to fold it flat when it's not in use?
Any pointers would be appreciated :)
Source: http://www.flickr.com/groups/polapremium/discuss/72157626780453984/
Found 22-05-2013

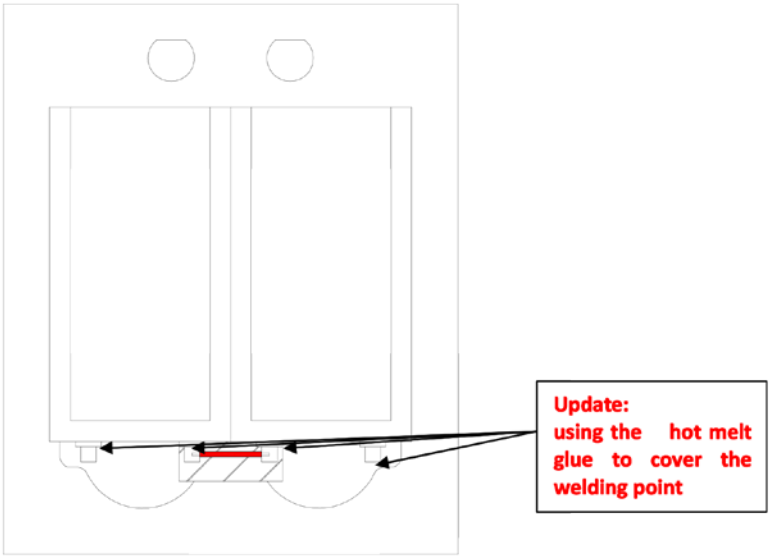
Ryan Kemp Analoge Fotografie says:
I've already sent TIP an e-mail regarding this issue, I'm just curious to see what the TIP employees and fellow Impossibleers have to say. I ordered 2 packs of Gold Frame 680 for my newly aquired slr680. I put the first pack into the camera, the dark slide shoots out perfectly, but everytime I try to take a shot, the shutter closes but nothing else happens. The only possible problem could be the pack has low juice in the battery. I just received the film 2 days ago. I've put 2 other packs of film in the camera, and they fire properly. I've even just put the other pack of Gold Frame I received with the defective pack into the camera, and it yields beautiful photographs without a problem thus far. Anyone else ever have issues like this with "brand new" instant film?
Source: http://www.flickr.com/groups/polapremium/discuss/72157629161945347/
Found 22-05-2013

2CP225040N Specification

A.Dimensions(mm):



B.Interior:



C、Specification:

N.O.	Item	Property	Remark
1	Model	2CP225040N	CP225040N in series
2	Nominal voltage	6.0V	
3	Open voltage	≥6.2V	
4	Nominal capicity	750mAh	At 23±2℃discharge at constant current 1mA until 4.0V cut off,Battery capacity depending on temperature and discharge currents and cutoff voltage changes.
5	Maximum continuous current	200mA	At 23±2℃ the battery can discharge at least the max conti-nuous discharge value which rated capacity 50% can permit until 4.0v
6	Maximum pulse discharge current	500mA	At 23±2℃,battery discharge duration for 3 seconds and stand 27 seconds, it can discharge at least the max pulse discharge 500mA value which rated capacity 50% can permit.
7	Operating temperature	-10~55℃	Any unknown information please contact with HCB
8	Storage condition	≤30℃ ≤75%RH	Stored the battery under recommends condition to make sure ≤30℃effectively battery's performance, the storage temperature or ≤75%RH humidity too high will increase battery's self-discharge rate and reduce battery's storage life.
9	Weight	≤25g	
10	Self-discharge rate	≤2%	Out of the recommended condition, the self-discharge rate may increase.

D、List :

N.O.	meterial	Property	remark
1	Battery	CP225040N	
2	Cardboard	L107mm×W88mm	Black
3	Plastic cover	L95mm×W83mm	
4	Connecter	ϕ24mm	Steel with nickel
5	Double-sided tape with hole	L20mm×W30mm	
6	Double-sided tape	W20	
7	Wire	28#1007 15mm	Red
8	hot melt glue		

HCB Battery Co.,Ltd Tech Department

2011-01-19

Partnumber: 1F6792

Polystyrene S-3207

Material additives:

- .5% Polyethelene

Physical characteristics:

Sample specimens prepared by Injection Molding Process

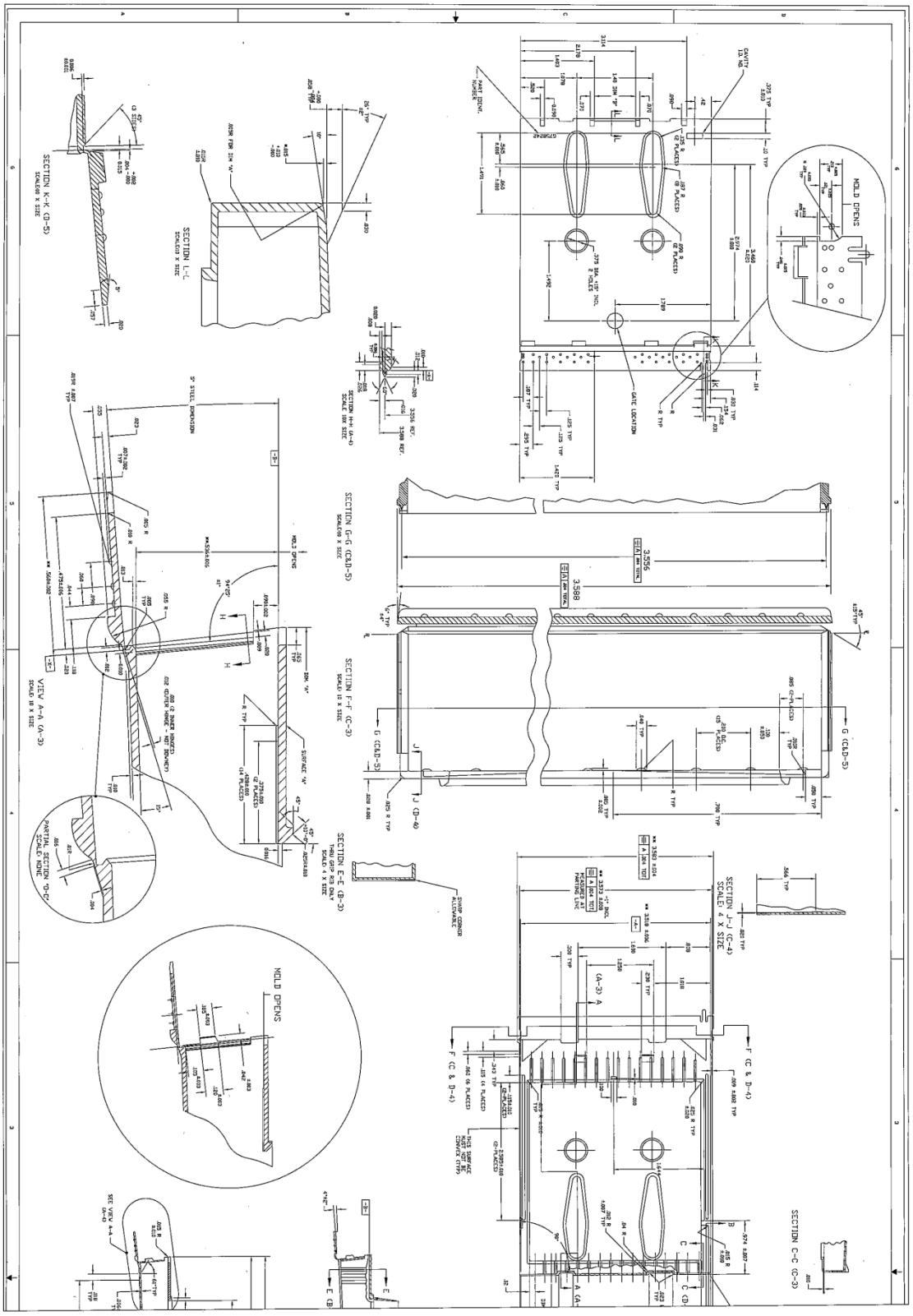
	Characteristic	*Unit*	*Spec*	*Range*	*Test Method*
A1.1	**Tensile Properties -** *Type-I Tensile Bars*				ASTM D-638
	A1.1.1 Tensile Yield Stress	PSI	4300	± 400 Tensile Tester 2.0-inches/minute	Crosshead speed of Universal
A1.2	**Izod Impact -** Notched RT	1/8-inch ft-lbs/inch	1.1	± 0.4	ASTM D-256
A1.3	**Melt Flow Rate** (Non-Additive)	minutes	13.0	± 3.0	ASTM-D-1238
A1.4	**Pellet Size** – approx. 3.5x3.5 mm				

A2 OPTICAL PROPERTIES - OPTICAL DENSITY

When used for injection molding of film hardware parts, the content of the specified black carbon grade shall be adequate to protect photosensitive components from exposure to light. An optical opacity requirement is such that there is no light transmission through a 15-mil thickness film.

V. WORKSHOP DRAWINGS

The original box drawing by Polaroid rather detailed and is therefore spread over two pages.



FIGUUR 49 ORIGINAL BOX DRAWING BY POLAROID LEFT PAGE

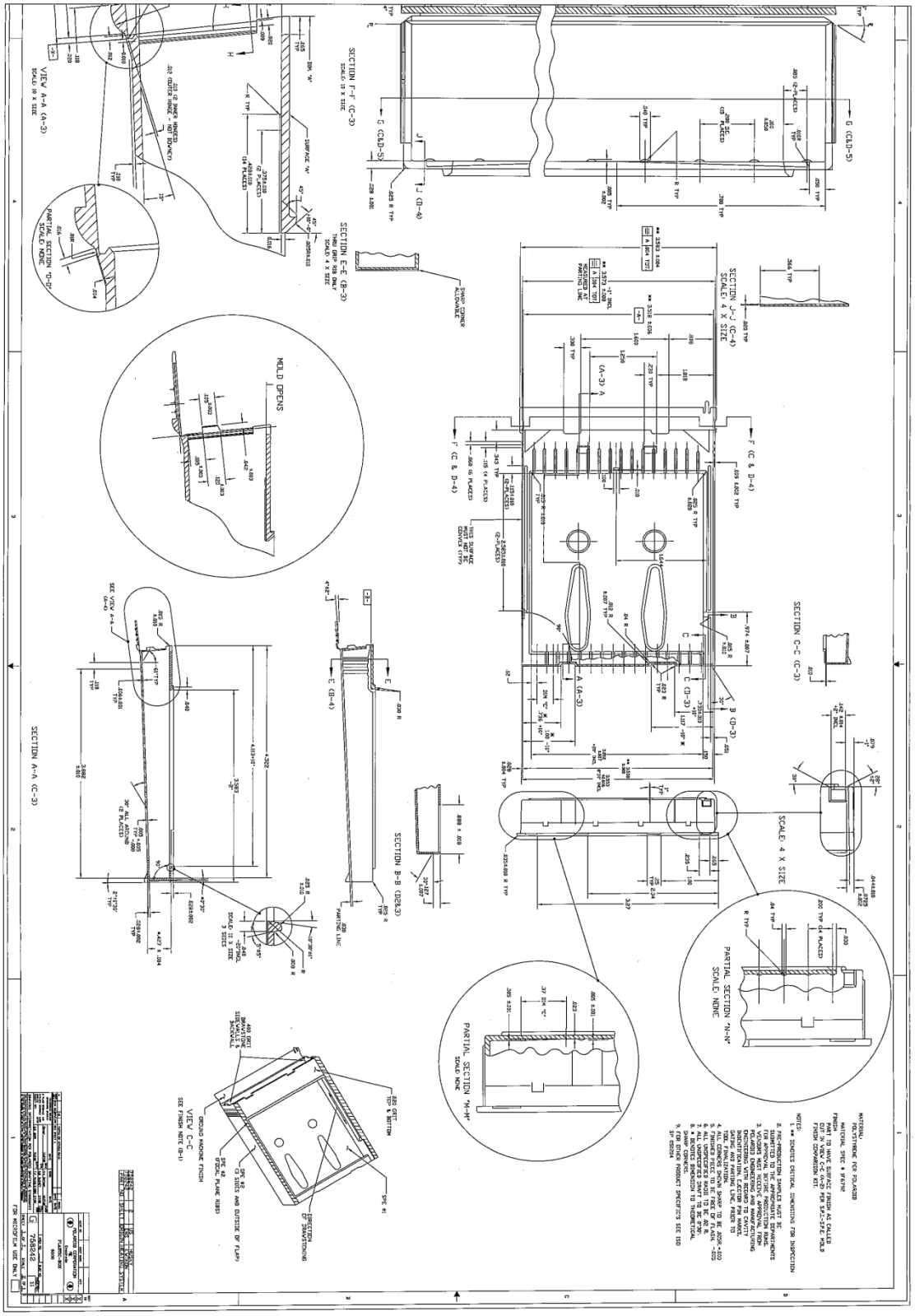


FIGURE 50 ORIGINAL BOX DRAWING BY POLAROID RIGHT SIDE

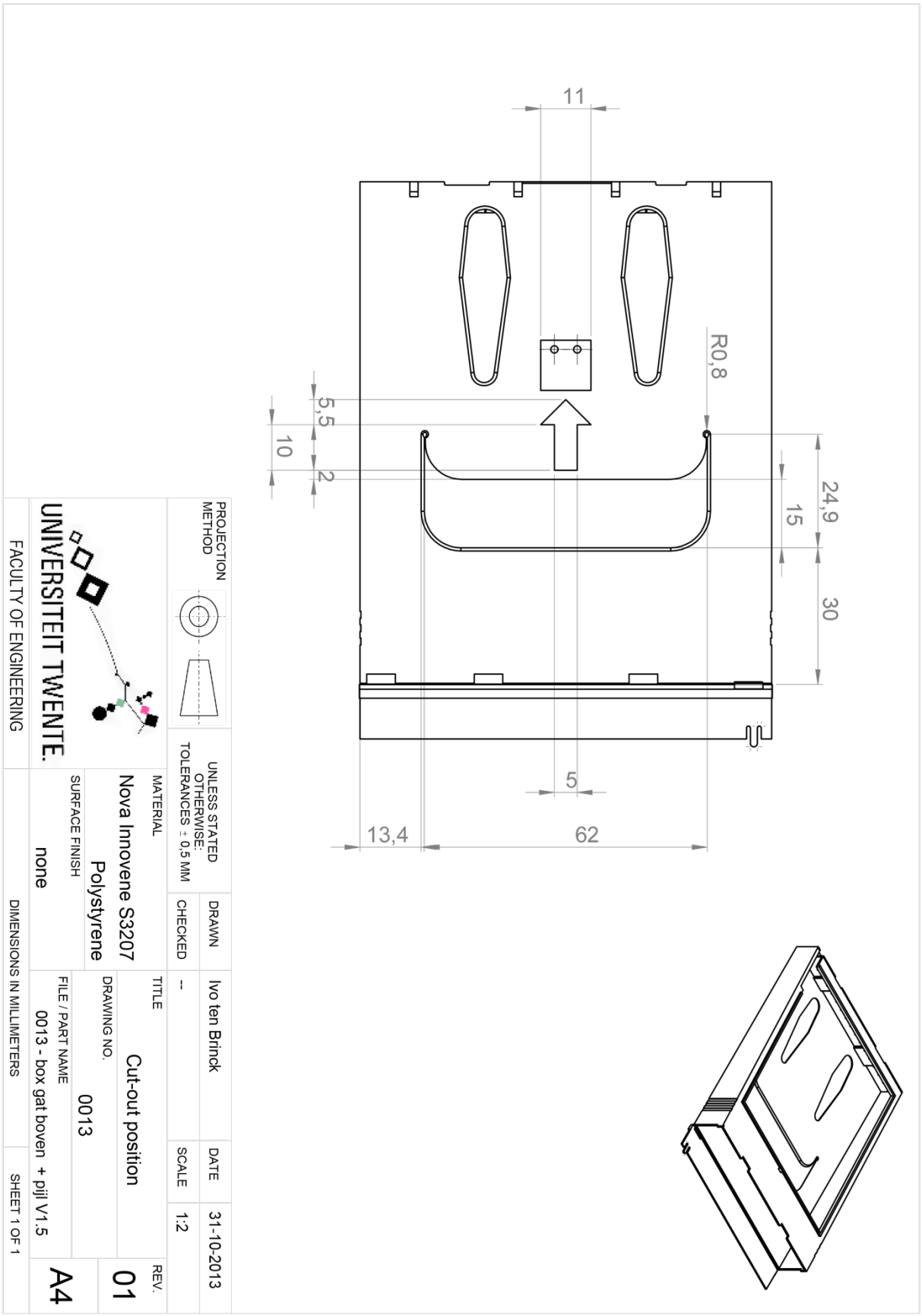


FIGURE 51 CUT-OUT DIMENSIONS AND LOCATION

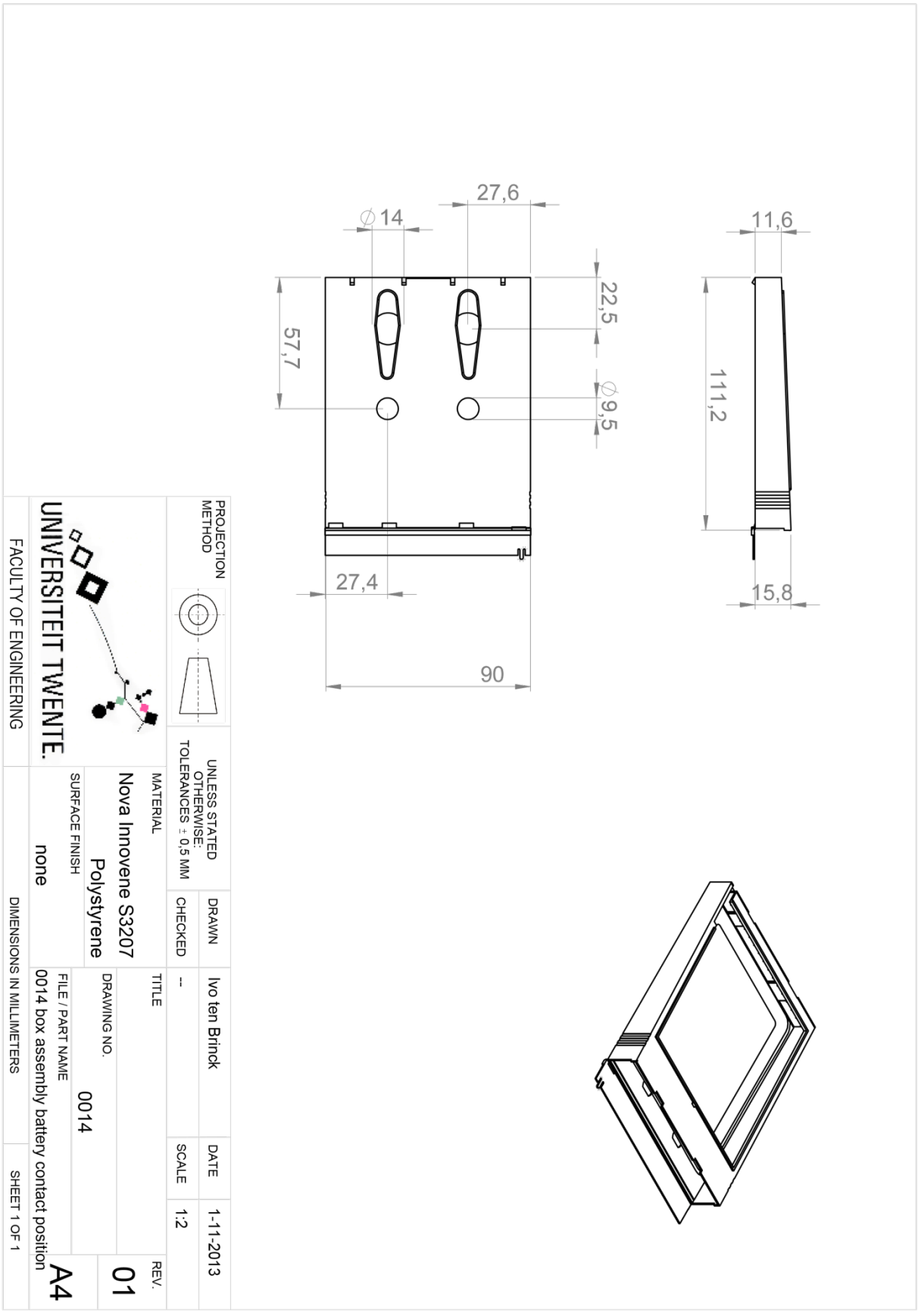


FIGURE 52 BATTERY CONTACT LOCATION

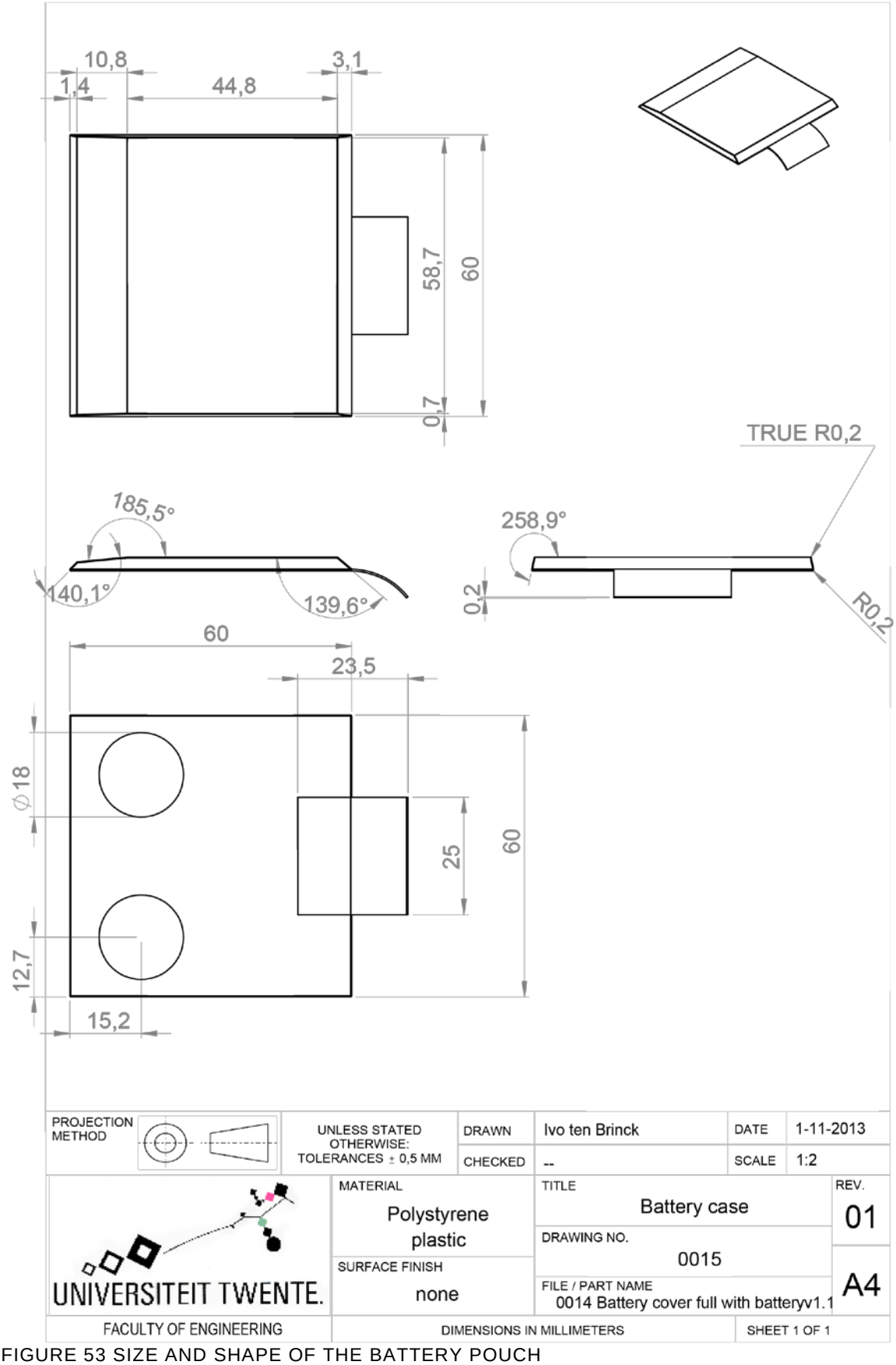


FIGURE 53 SIZE AND SHAPE OF THE BATTERY POUCH

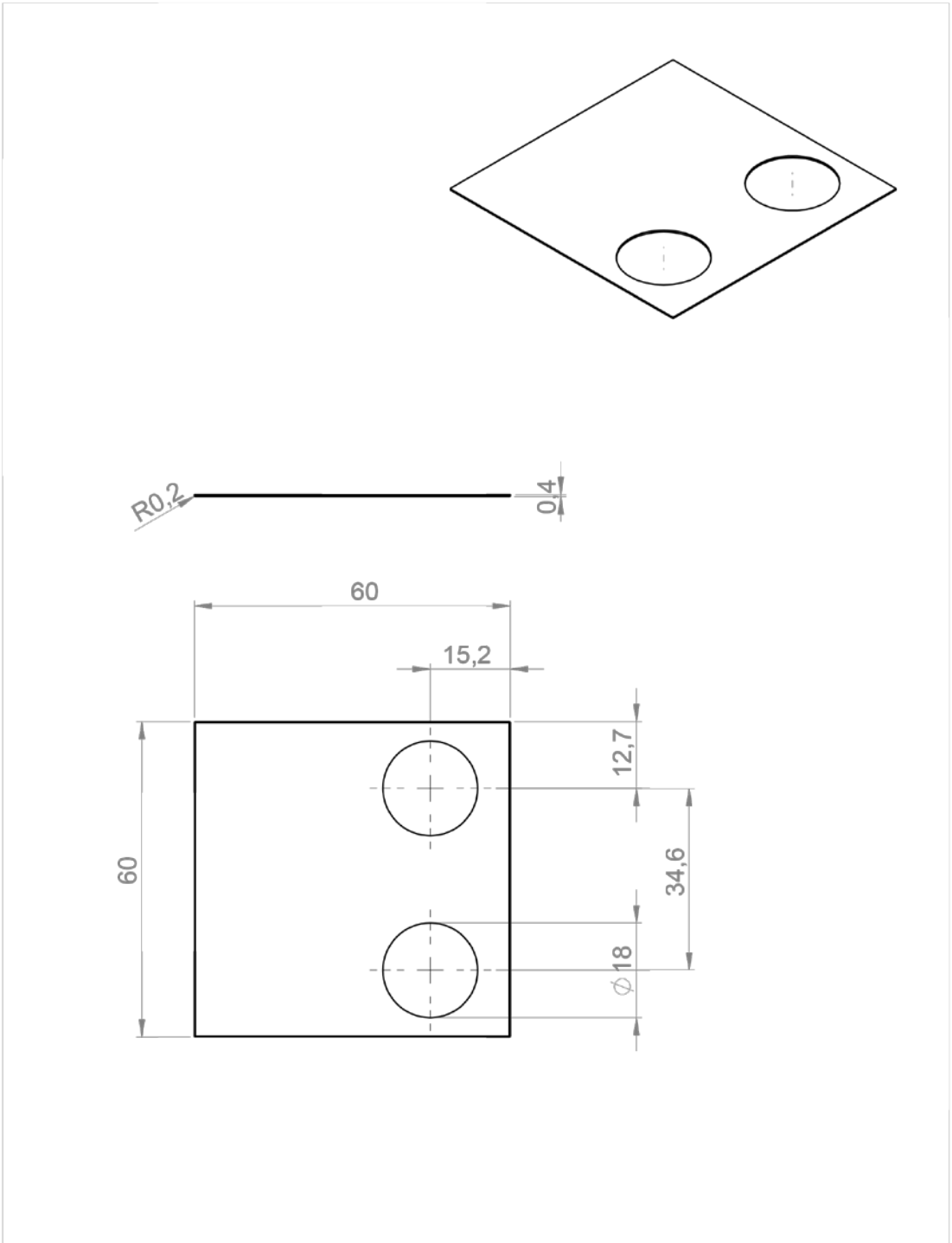


FIGURE 54 BATTERY POUCH LID

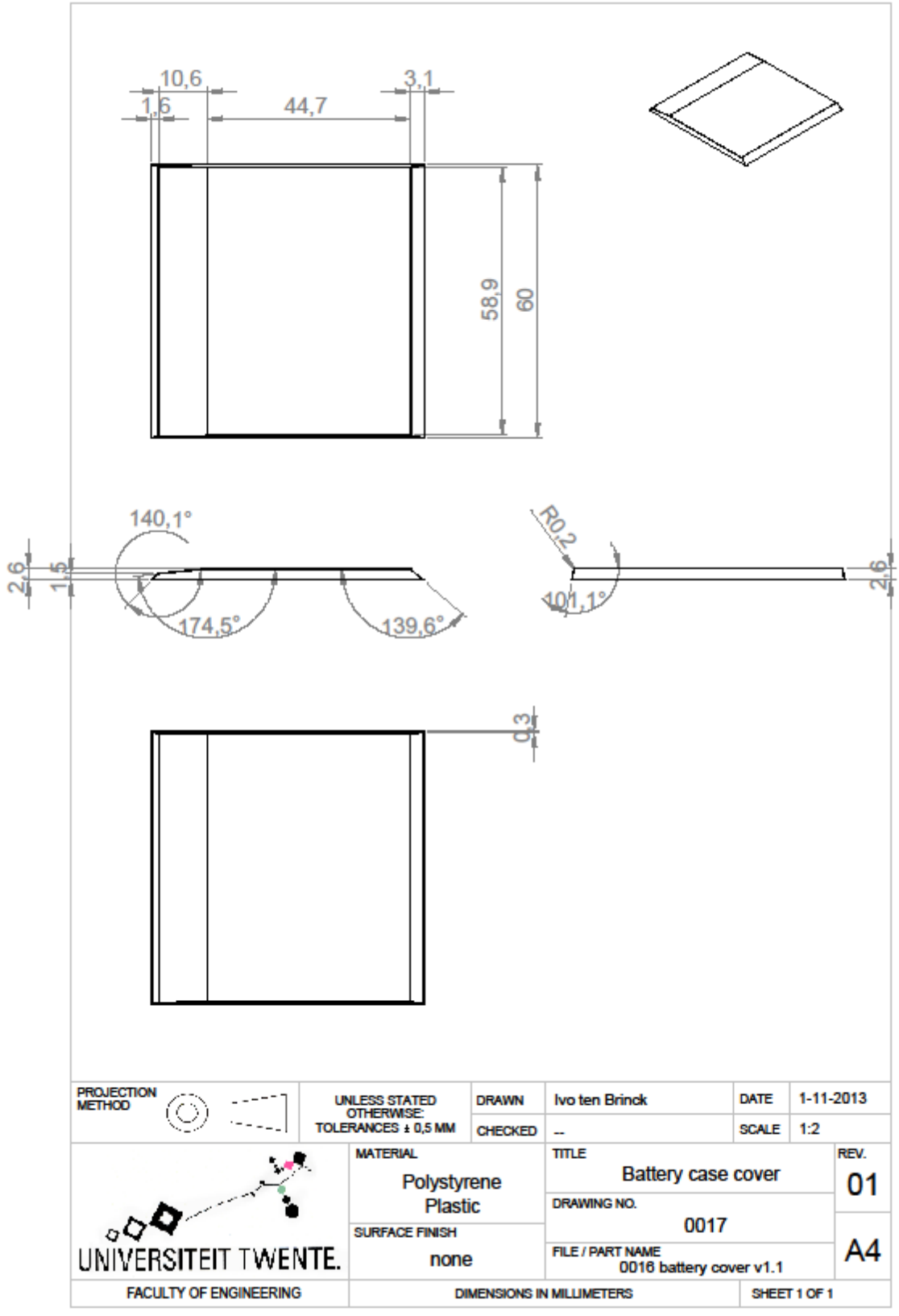


FIGURE 55 BATTERY POUCH COVER

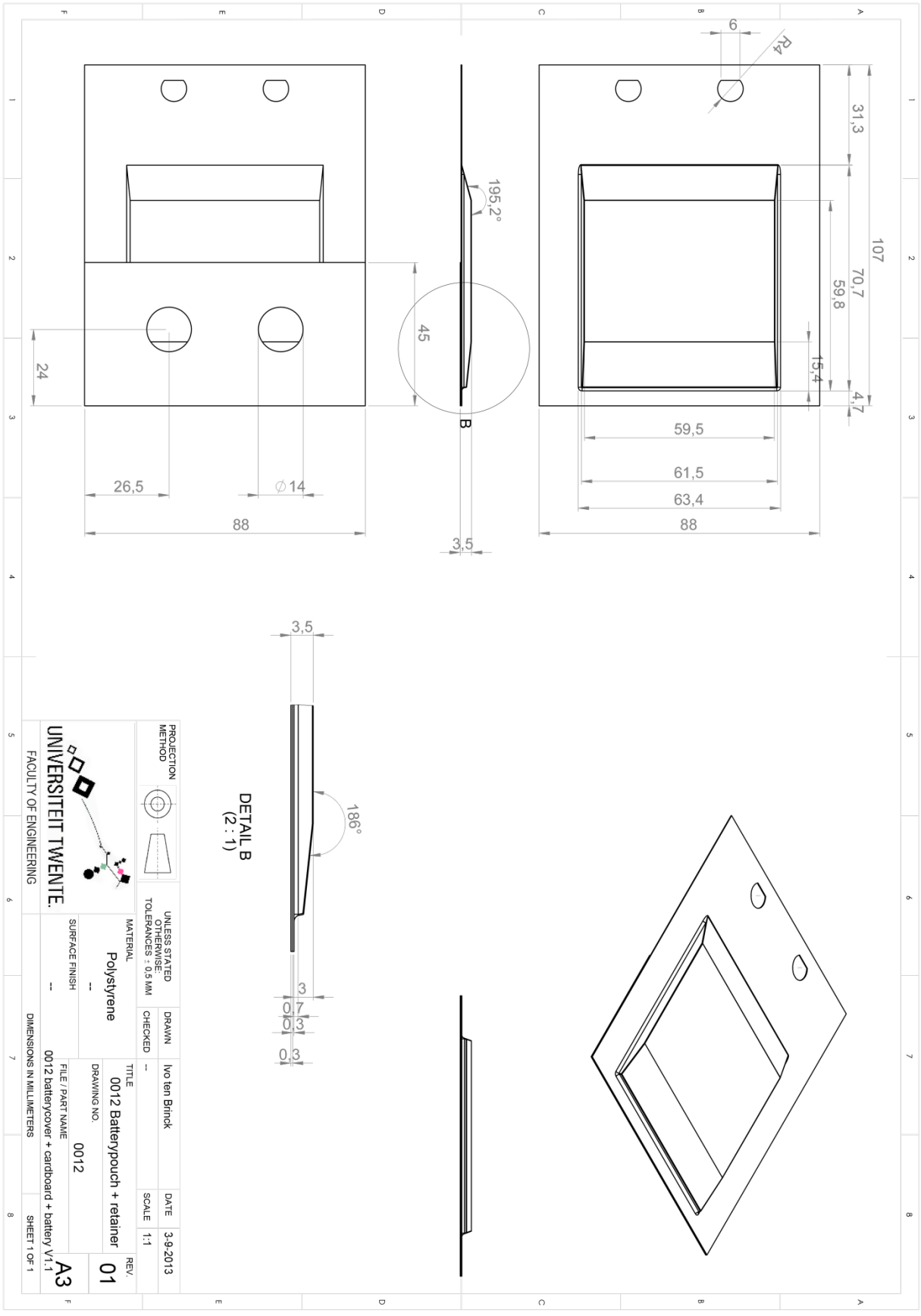


FIGURE 56 CARD STOCK

VI. RENDERS