AEQUITAS

Design of a cyborg NERF blaster for children with physical disabilities.

Graduation project by Tim Tietze


Hasbro


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Master thesis

Design of a cyborg NERF blaster for children with physical disabilities.
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Executive Summary

This graduation report aimed towards the vision „ Transform the needs of the minority into the wishes of the majority“.

Children with physical disabilities face the issue to be excluded from the toy world of the able-bodied children. Toys with small buttons, heavyweight or the need of two hands for operating are examples which let children with physical disabilities experience failure. Alternative toys are mostly just suiting their abilities but forget about their actual needs. These needs are for example group play, rebellious play and active play. Further, these alternatives lack when it comes to pop culture topics or an aesthetic outer appearance.

This insight showed the opportunity to create a toy for the mass market which takes inspiration from the abilities and needs of children with physical disabilities.

The project was executed in cooperation with the toy brand Hasbro. Thus, it was possible to base the project on one of their products called NERF blaster. These toy blasters shoot non-harmful soft foam darts. This toy was chosen since it offers team play, active play, role play, rebellious play as well as it covers pop-cultural topics. Thus it is a perfect candidate to cover the needs of children with physical disabilities.

The project was executed in the following steps:

Analysis

At the start of the project knowledge regarding the topic of physical disabilities, inclusion and the toy itself needed to be gathered. To gain this knowledge, a literature research was conducted. Further, a school for children with physical disabilities was visited as well as a basketball wheelchair club, a trade fair for rehabilitation products and an occupational therapist.
The research concluded with the insight of how a blaster could support the inclusion of children with physical disabilities. Also, a universal criterion was defined which tries to summarise the various kinds of physical disabilities.

Direction forming

The insights taken from the analysis phase were translated into inspirational guidelines. A matrix was created which combines three determined abilities with the tasks needed to operate a blaster. By using multiple “how-to” questions, different ideas to operate a blaster were generated. Promising ideas were clustered and visualised. Two loops of expert evaluation lead to one final direction.

Concept Development

The core elements of the concept direction were defined to set a focus for the upcoming steps. Necessary measurements of the to-be-designed toy were determined to create reference points. By using CAD modelling, sketching and rough mock-ups, the defined core elements were further developed.

Company Visit

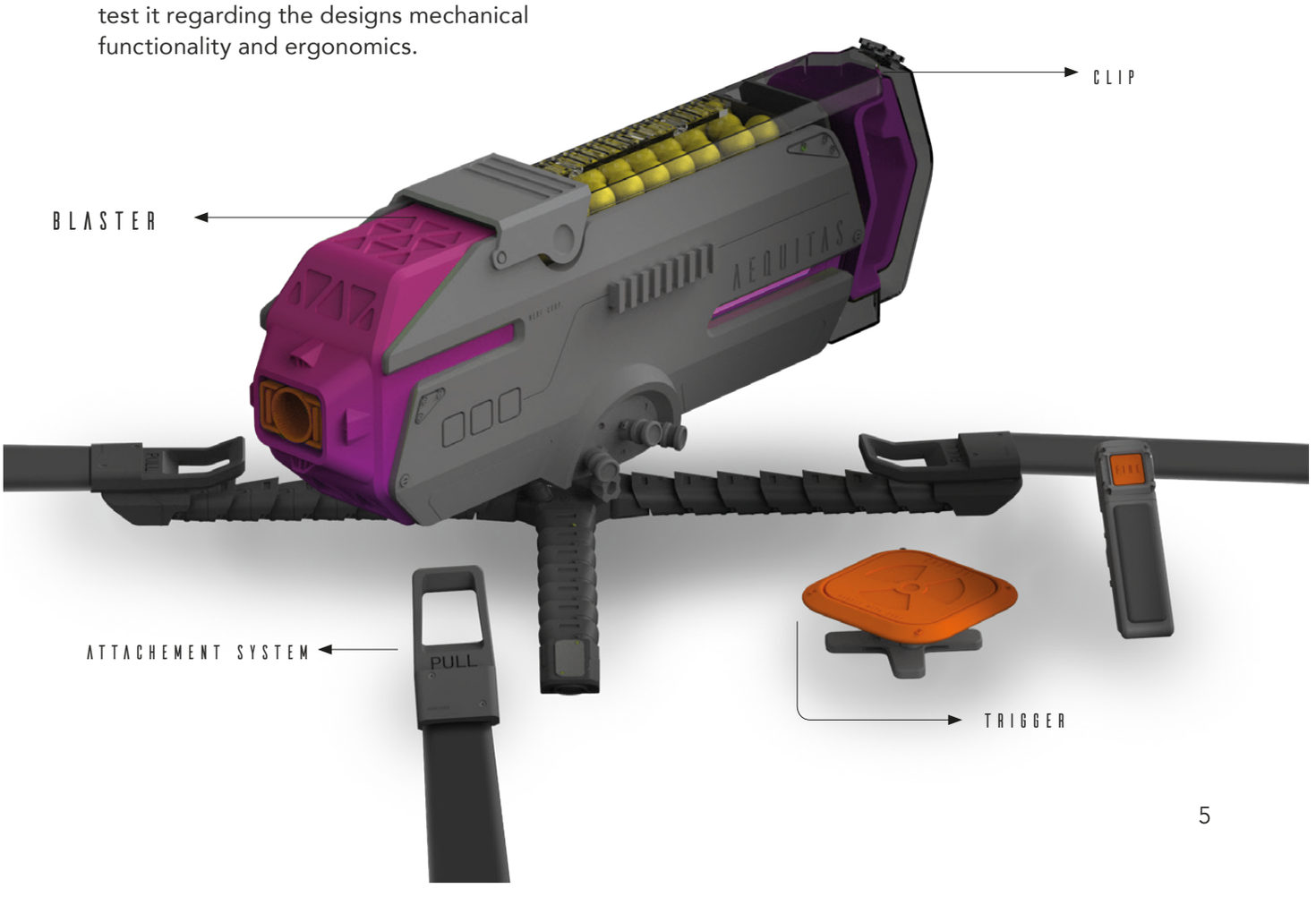
To bring the concept to the next level, one needed to get feedback from the toy industry. Therefore the concept was presented to individuals at the Hasbro headquarter in Pawtucket, USA.
The feedback emphasised the need for a

good story for the toy. Instead of going already too much into detail about technical solutions, first of all, the story needed to be convincing. Further, it became apparent that the toy's trigger had to become universal.

Integration of Feedback / Final Design

As a final step of the project, the feedback was evaluated and integrated into the concept. The outcome was the definition of a theme as well as the market positioning. Further, two parts were changed regarding their function. A test with seven children with physical disabilities was conducted to evaluate one of the reworked parts. Also, the overall styling was adapted to the defined theme.

The report finishes with an evaluation of the created concept. An upcoming step would be to build a fully functional prototype to test it regarding the designs mechanical functionality and ergonomics.



Acknowledgments

The project felt like a rollercoaster ride, fast, some ups and downs but overall it was fun! It was great to further my knowledge regarding toy design and improve my experiences regarding the design related work with children. Besides, that project gave me the opportunity to explore a new country, gain unique insights into the toy industry and meet various highly inspiring people.
Therefore I would like to thank all of the people who were involved in this project and supported me with their knowledge and time.

First of all, I would like to express my thankfulness to Dan Judkins, who made it possible for me to cooperate with a great company like Hasbro. I highly appreciate that you supported me with your time, your expertise and reference material. Further, your given feedback was to the point and thought-provoking what motivated me each time to improve my designs.
Being able to present my concept to different individuals at the headquarter of Hasbro, was a remarkable experience.
I want to thank Ceileidh Siegel, Melissa Hershey, Lauren Pulner, Scott Clark, Phil Sage, Brian Jablonski, Brian Jarvis, Fred Hopke, John Barros and Chirs Oliveri, for supporting me with their time and knowledge.

My gratitude also goes to my supervisor team who supported me with spot-on and highly useful feedback whenever it was needed. Mathieu and Maarten, I enjoyed the feedback sessions with you which I always left with a head full of new knowledge. It was motivating to see that your passion and joy regarding the project was not less than my own.

Special thanks to Nadja Kröger and Holger Semmling who made it possible for me to visit their school class three times. I highly appreciate your flexibility that made it possible for me to execute my visits in a relaxed and productive way. Your support highly contributed to the creation of this project.

Special thanks to Thomas Klee for sharing his expertise as an occupational therapist with me. I enjoyed the creative and energetic vibe of our meetings.

Last but not least, special thanks to Ute and Klaus Herzog, who made it possible for me to visit their wheelchair basketball training. To learn how to operate a wheelchair and to gain first-hand experience was a significant event during the project.

Executing the project was a great experience that furthered my knowledge in various ways. Further, I am very thankful to have received all of the support without knowing any of the involved persons beforehand.

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ref.00

1. OPPORTUNITY

Toy stores are heaven on earth for children. Shelves full of new, fun experiences, that scream to be discovered. However, that is just what the majority of children would experience. In the case of children with a physical disability (CwPD) the toys presented in a regular toy store are rarely usable. Toys with small buttons, heavyweight or the need of two hands for operating are examples which let CwPD experience failure.

Alternatives that try to suit those needs are often just focused on a therapeutic benefit than to offer a play experience without an ulterior motive (Goodley, 2010). Further, these "special" toys have limited play variations. Thus, they become boring after a few times of play (Appendix 1.1).

Equal needs

Children with and without physical disabilities have the same needs. One of these needs is to be rebellious (Gielen et al. 2013). However, the toys available for CwPD are not thought to satisfy those needs. Further, they are rarely connected to pop cultural topics. Popular toy brands or licensed themes (Star Wars, Marvel) can never be found in toys for CwPD. Attempts by parents to adapt regular toys in a DIY-approach lead to functional and aesthetically stigmatising outcomes (Appendix 1.1). The toys might still serve their practical purpose, however, point their user out as being different.

This situation offers the opportunity for designers to come up with desirable toy concepts, which include more children than just the "norm".

Focus switch

Within the design field, switching one's focus is used in different ways to generate new ideas during the phase of ideation.

Examples are design methods like "synectics", "bad brainstorming" or "switching hats" (Appendix 2.1).

The regular toy market is always in need of inventions to keep a company's portfolio of toys steadily attractive, fresh, new and exciting.
A focus switch to the abilities of CwPD offers the opportunity to create unique toy concepts for the regular toy market (Keates 2000).

A conducted literature research showed that CwPD is facing the issue of being excluded during play due to their lack of abilities. This exclusion leads to situations in which children play more often with their parents or younger siblings than with their peers (Skär et al., 2000; Karel J. Mulderij,1997). Further, it showed, that contact to peers and exposure to team play, is crucial for the development of self-confidence, social skills and good mental health (Karel J. Mulderij, 1996; Anne A. Poulsen et al., 2008; Essig, 2013). Besides, the lack of sufficient movement leads to a close to the doubled rate of obesity within the group of disabled children compared to able-bodied peers (Essig,2013).

Therefore, a mainstream toy which includes CwPD in the play world of able-bodied children offers benefits for both parties. CwPD get involved in a game, and the able-bodied children will experience a new form of play.

2. VISION

The opportunity described above was transformed into a visionary statement. It works as an overall guideline for the project and represents an abstract end goal:

“Transform the needs of the minority into the wishes of the majority”

Using the abilities of children with certain physical impairments as inspiration to create a toy that introduces new, desirable play features onto the regular toy market and thus supports inclusion.

3. KICK-OFF

The project strove to create a product suitable for the mass market. Due to this, there was the option to come up with a totally new kind of product or add to an already existing type of toy. It was chosen to go for the latter. This was done because a popular toy range would already bring the “coolness” factor with it. Resulting, the impact that the toy could have would be much higher.

Toy decision

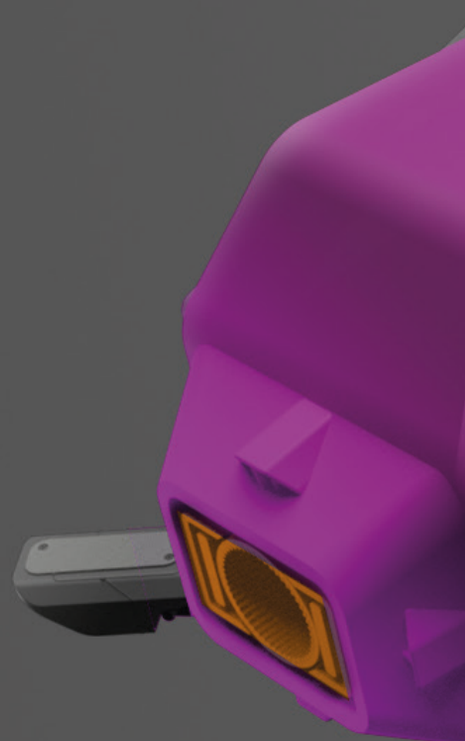
Since this project got supervised by Hasbro, it was possible to choose a product range from their portfolio. One of their toy ranges is the dart blaster called NERF. It was decided to focus on this type of toy since it combined physical activity with social contacts. A mix from which CwPD would highly benefit. Further, the NERF blaster is not just liked by children; it is also highly liked by grown-ups. This becomes visible when looking for the terms “NERF mod” or “NERF office war” on youtube. The possible impact radius of such a toy would, therefore, be even more significant.

Further, the opportunity was seen to create a toy which uses the “coolness” factor of NERF to avoid stigmatisation. The real intention of creating a toy just for children with physical disabilities could be more subtle and thus generate less exposure.

ref.01

4.AEQUITAS

Final Concept Presentation



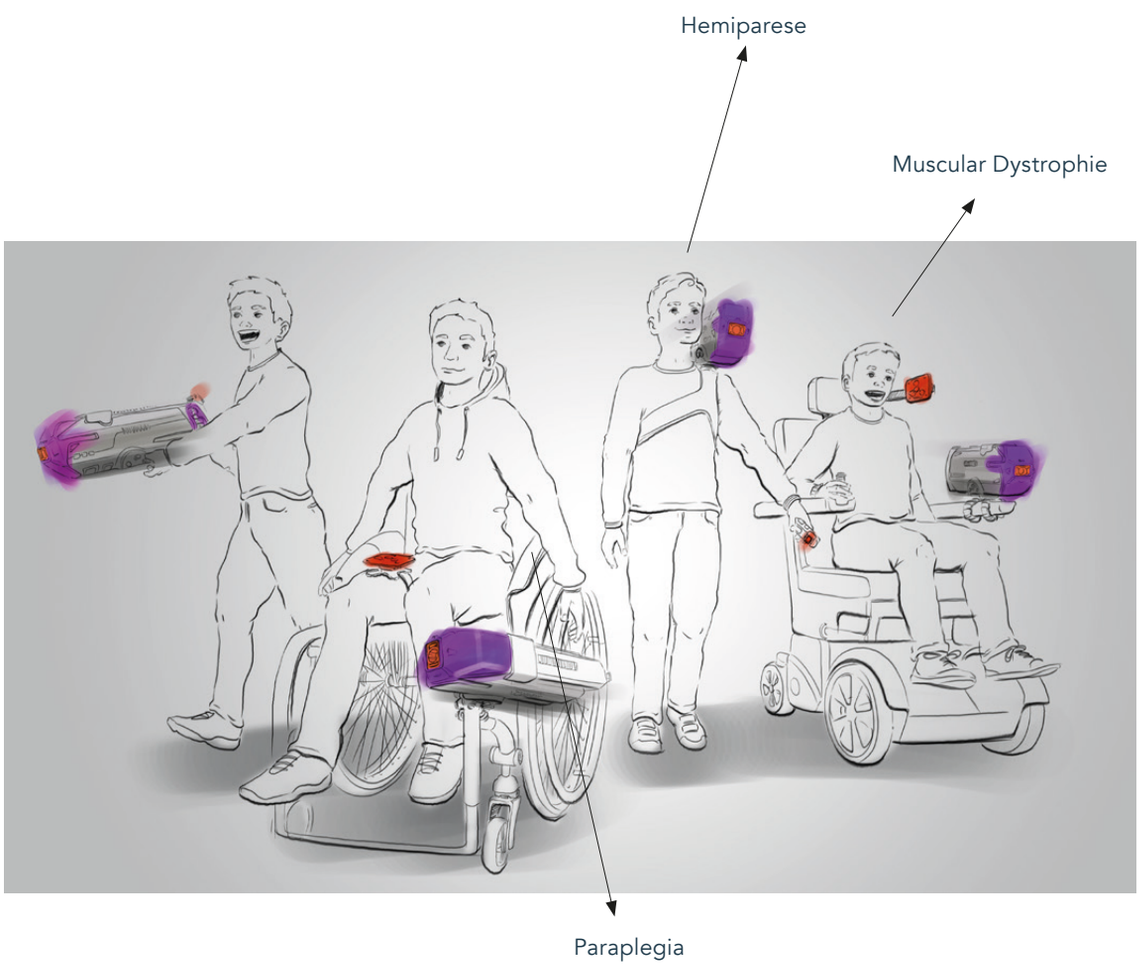
4.1 Intro

The Aequitas concept is a NERF blaster which allows being adapted to its user's needs. This is made possible by the separation of trigger and blaster. A simple attachment system on the bottom of the blaster allows it to be attached to various objects. Thus, blaster and the trigger can be arranged in the most comfortable way for the user.

Due to this, children with physical disabilities can take part in a NERF battle. The blaster can be easily attached to one's wheelchair, body or be placed all around the playfield. Different shells for the trigger adjust the way of activating. Either it is pressed by a finger, hit with a fist or activated by the head. Everything is possible.

Further, Aequitas offers new strategic approaches within a NERF battle. It enables the player to create traps. By hiding and triggering multiple blasters at once, different game mechanics and tactics can be designed.

Its name, Aequitas, is the origin of the English word "equity". In ancient Rome, "aequitas" was used as a term for the fairness between individuals (Skinner, 2002). This fairness is what the Aequitas concept should represent. To deliver great play experiences to everyone, despite their abilities.



4.2 “Cyborg” topic

Over the last ten years, humanity is on track to mix human bodies with technology. We already augment our brain by smart -watches/-phones and glasses. It is just a matter of time that the possibility of augmenting one’s body parts hits the consumer market.
Instead of indicating a disability, products like artificial limbs will stand for power and luxury. To modify and add new functions to one’s body will become a common thing.

Aequtias is the start into that new world in which disabilities are changed into powerful abilities. It enables its user to augment their body. Either the body becomes one with the blaster, or the blaster allows the user to attack from multiple positions at once.

This blaster is part of a cyborg culture. It is about the enhancement of one’s abilities. Thus the topic of “future cyborgs” was chosen for its styling and the way how it is presented.

As described later in this report, the acceptance of CwPD is a crucial part when it comes to the creation of an inclusive effect. The cyborg topic has the power to add to this acceptance. Supportive products like prostheses or wheelchairs can in that way be presented as something special and cool. They become basically a superpower that just this one child has.

Since one product is not enough for a product range there are different options on how this topic could be further expanded:

An option is to come up with different forms of wireless controlled blasters.
For example a backpack blaster with long barrels attachable to one’s arms.

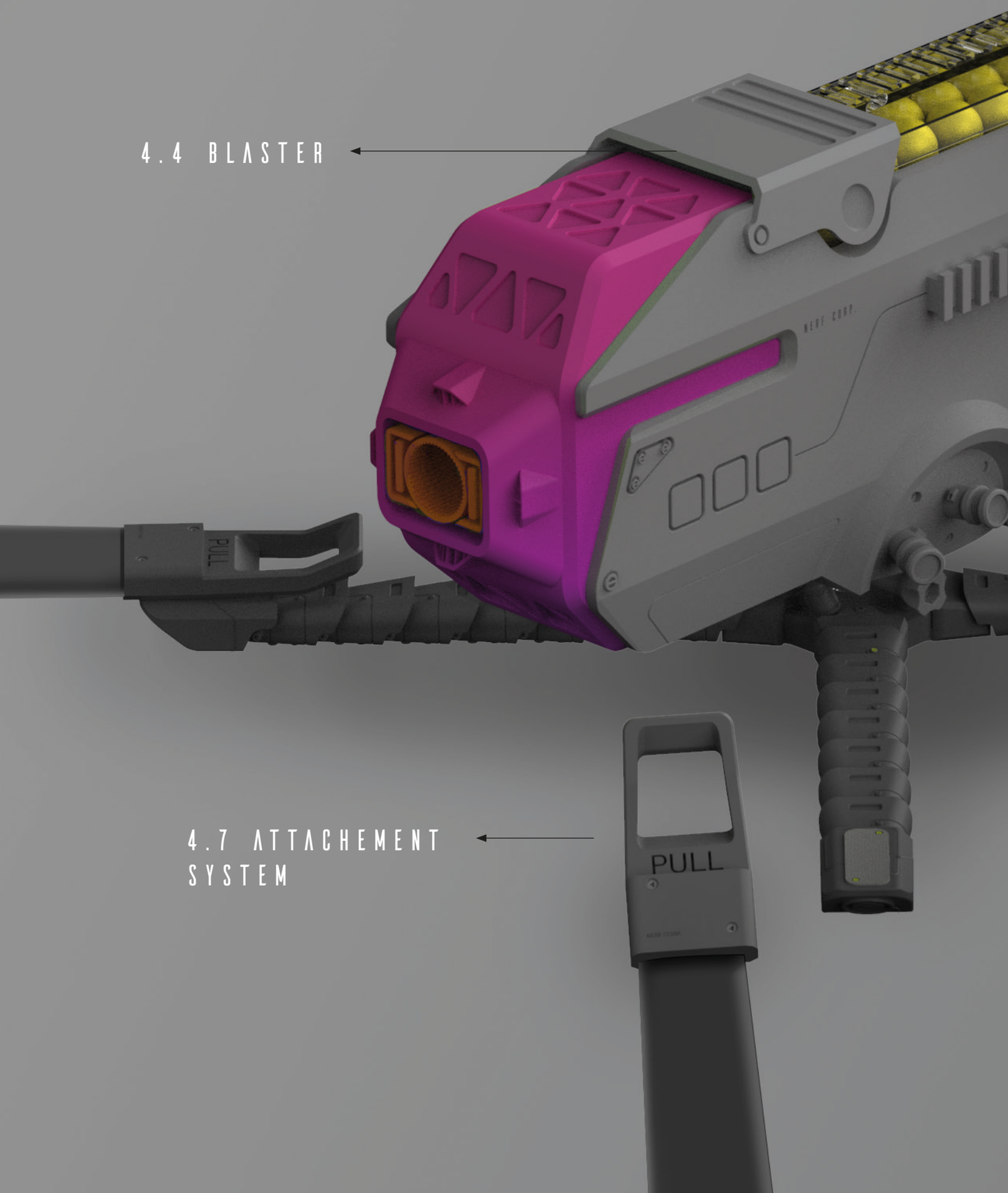
Further, motion and muscle tension trigger modules can be introduced for an even more improved feeling of connectivity between blaster and body.
The same counts for an attachable sentry system, which mimics one’s head movement.

Next to these blaster related options, there is a great opportunity to create NERF branded products.

Cooperation with companies like, i.e. limbitless (https://limbitless-solutions.org/) could lead to NERF “cyborg” styled prostheses covers (ref.02) or wheelchair accessories. This would level up the message of acceptance!

(ref.02)

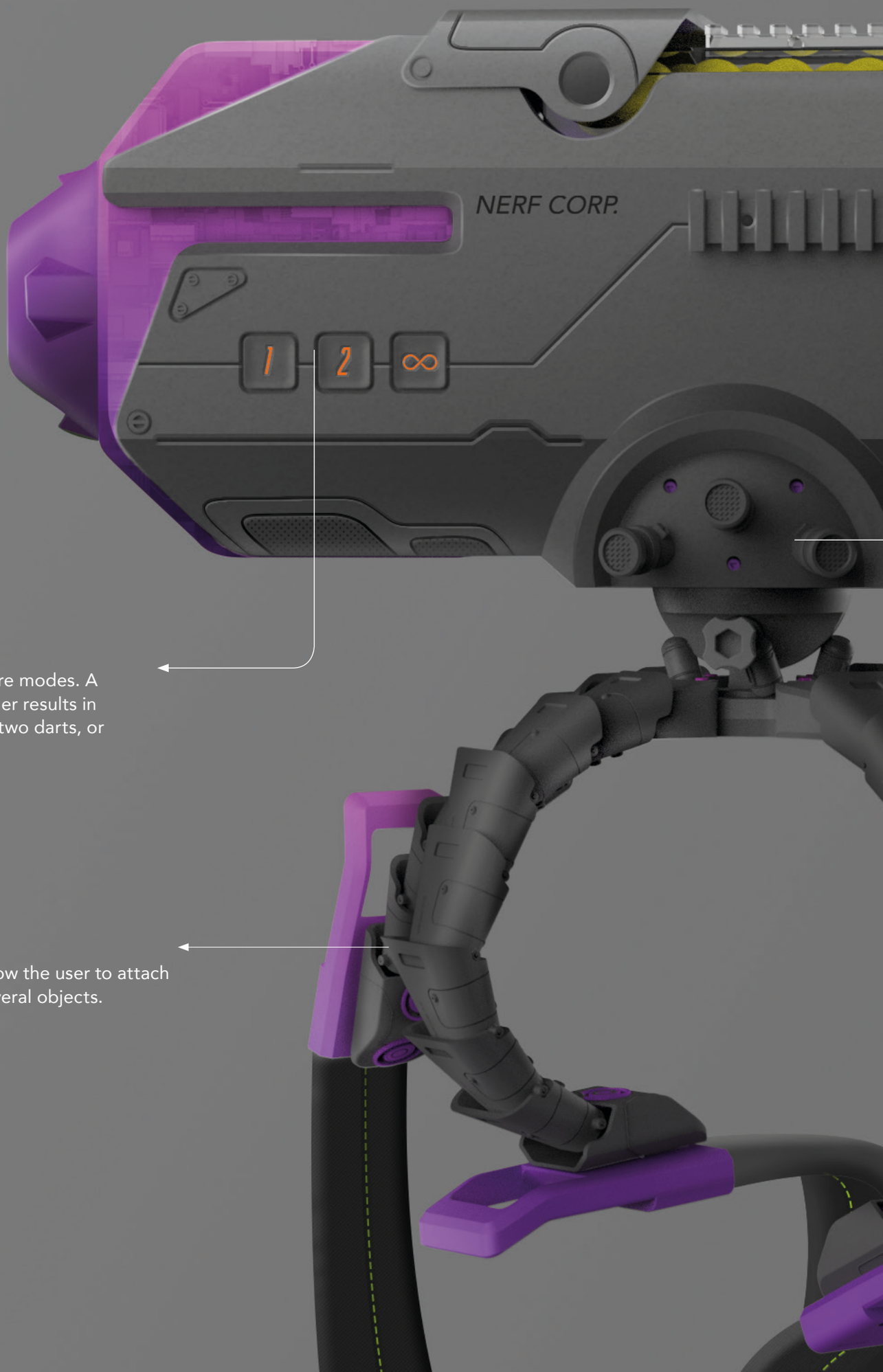
4.3 Overview



4.6 "CLOPPER"

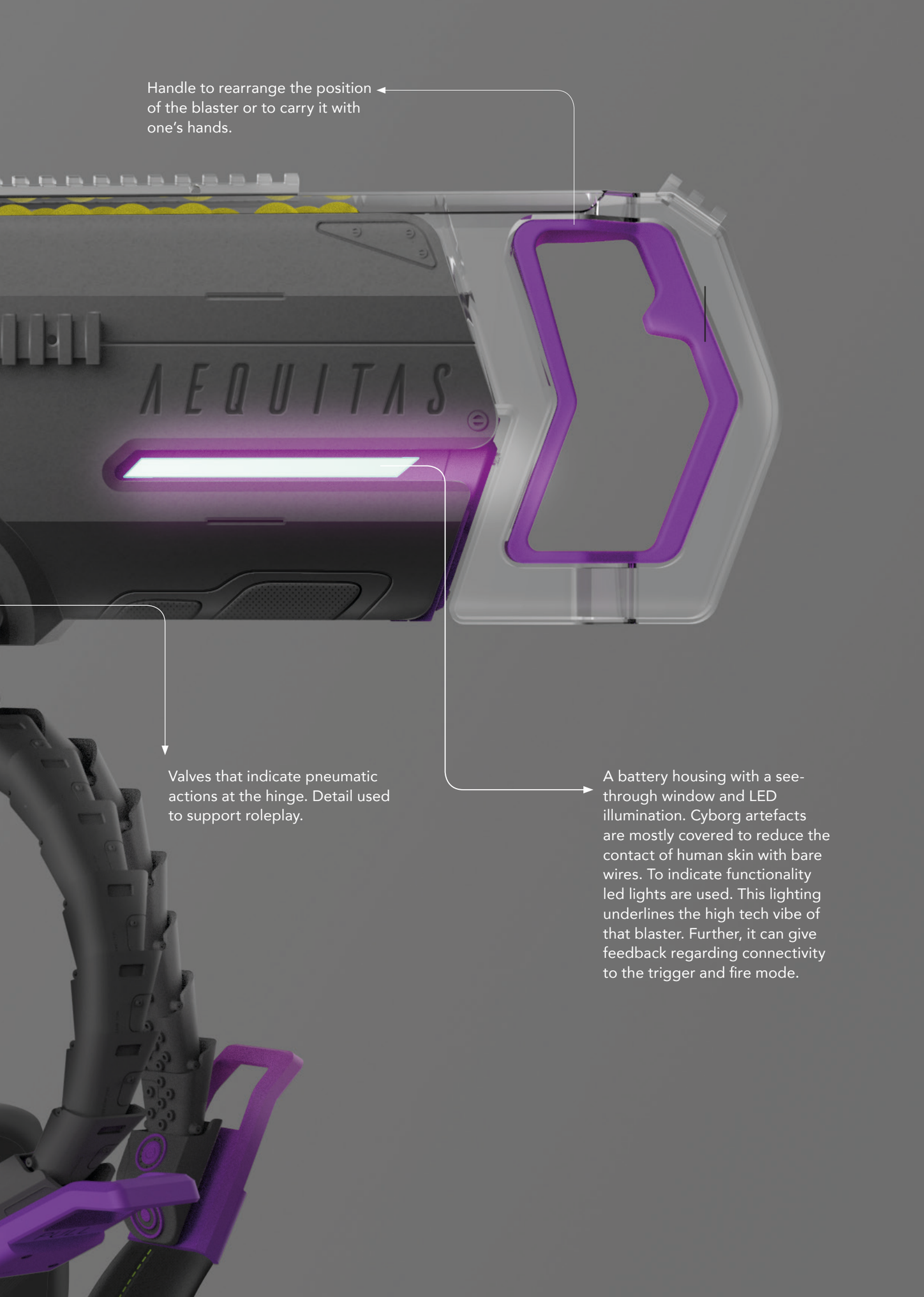
4.5 TRIGGER

4.4 BLASTER



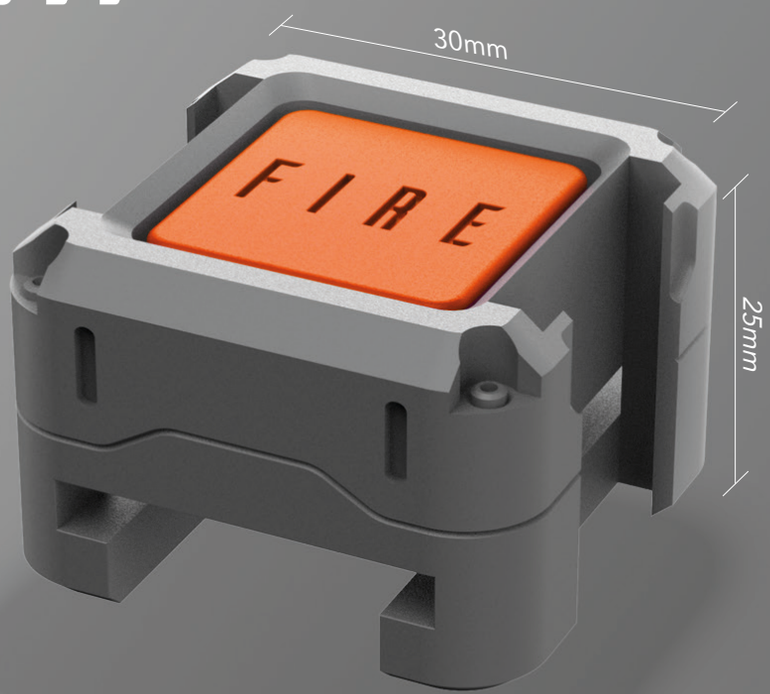
Three different fire modes. A push on the trigger results in either: one dart, two darts, or rapid fire.

Flexible legs. Allow the user to attach the blaster to several objects.


Handle to rearrange the position of the blaster or to carry it with one's hands.
AEQUITAS
Valves that indicate pneumatic actions at the hinge. Detail used to support roleplay.
A battery housing with a see-through window and LED illumination. Cyborg artefacts are mostly covered to reduce the contact of human skin with bare wires. To indicate functionality led lights are used. This lighting underlines the high tech vibe of that blaster. Further, it can give feedback regarding connectivity to the trigger and fire mode.

4.5 TRIGGER MODULE

One module to rule them all.
This module is wirelessly connected to the blaster. Through a push on the "fire" button, the blaster will be activated. Its range depends on the type of connection (Bluetooth, Radio Frequency).

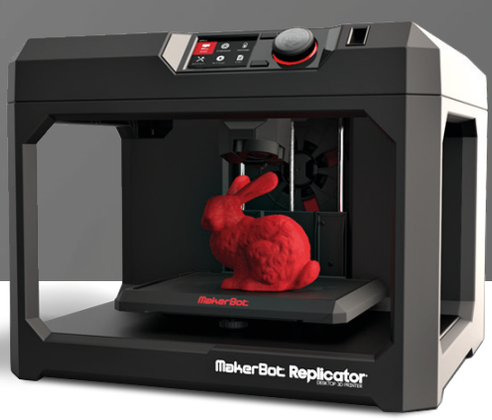


Picatinny rail opening. It enables a simple and secure attachment of the module to the blaster and the shells.

TRIGGER SHELLS

The blaster comes with two injection moulded trigger shells. These shells transform the trigger module into a hand-held or a larger button.

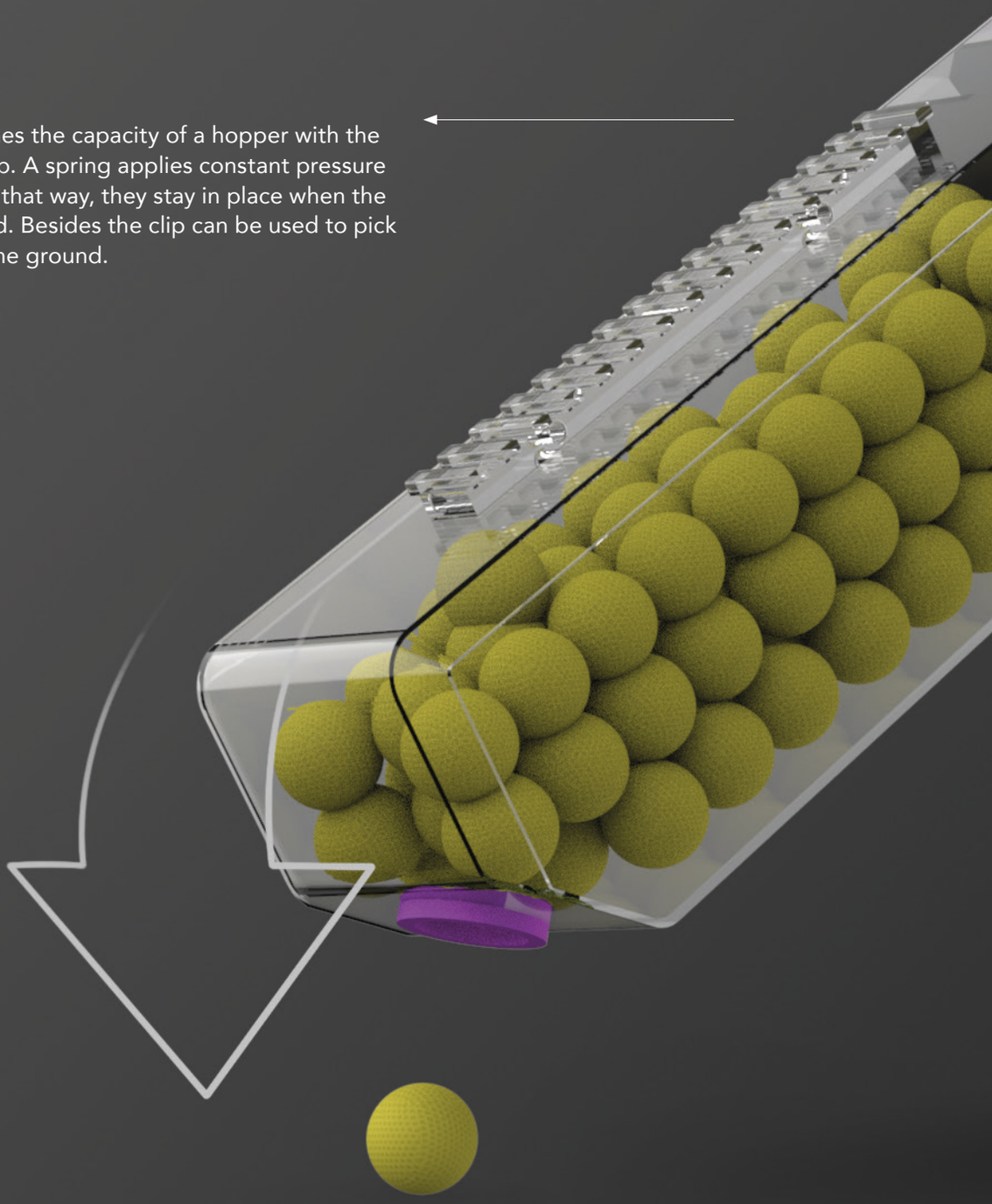
By using a 3D printer different types of shells can be created and thus guarantee full adaptability to the user's needs.

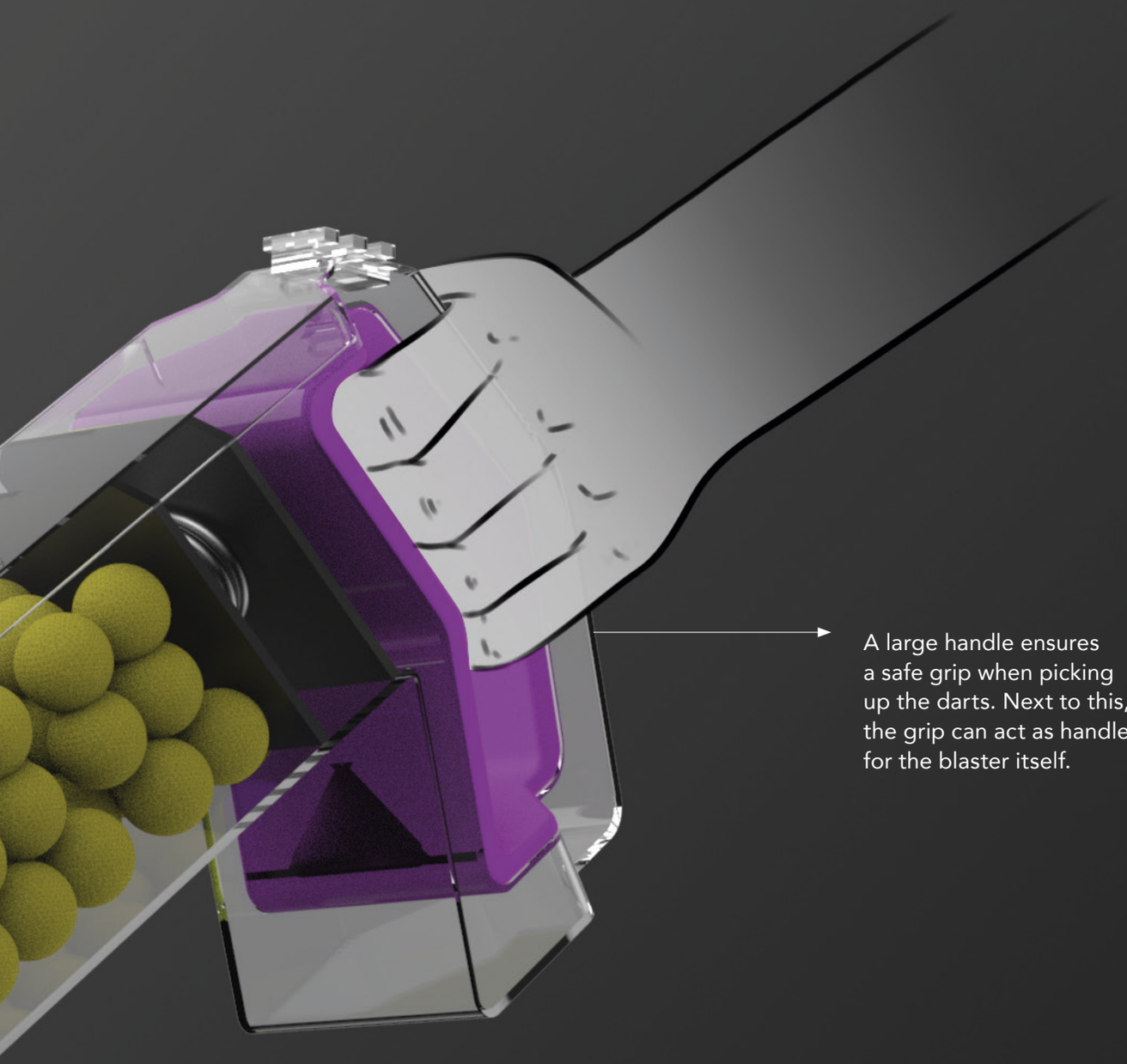


ref.03

4.6 "CLOPPER"

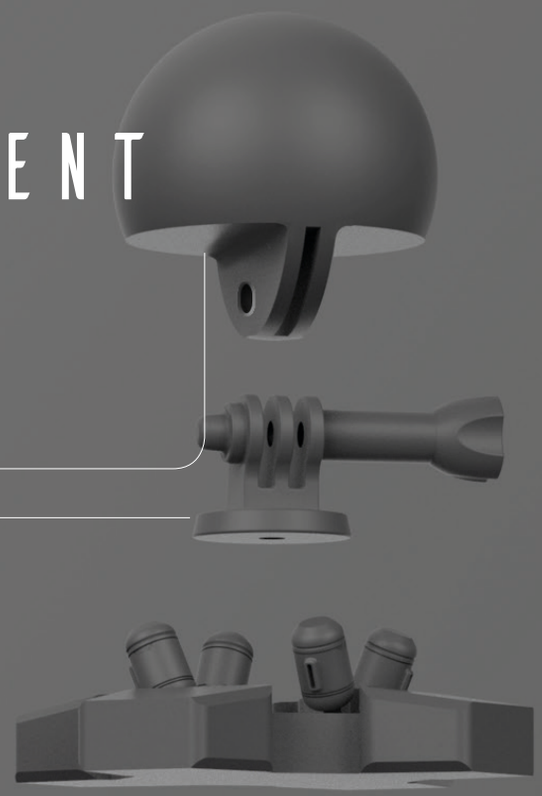
The clip combines the capacity of a hopper with the function of a clip. A spring applies constant pressure on the darts. In that way, they stay in place when the blaster is angled. Besides the clip can be used to pick up darts from the ground.





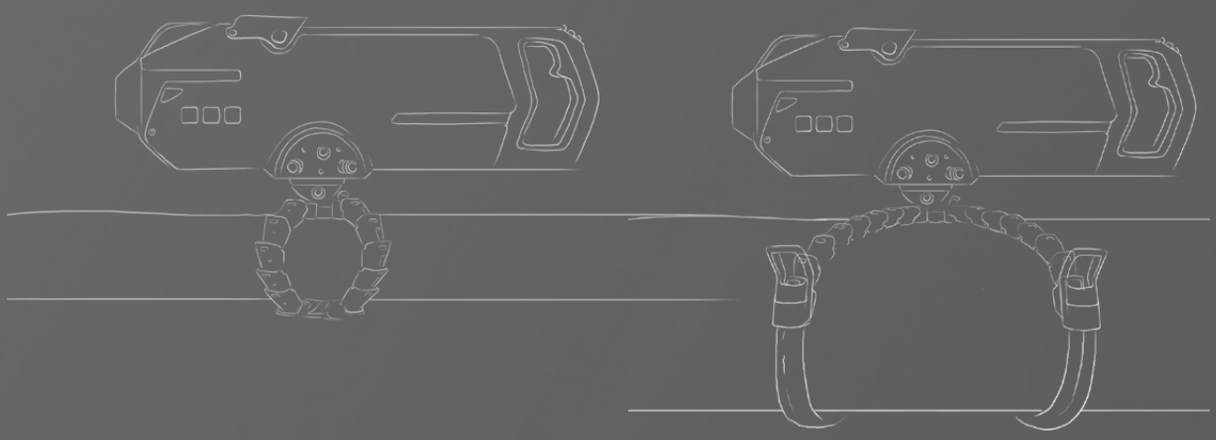
A large handle ensures a safe grip when picking up the darts. Next to this, the grip can act as handle for the blaster itself.

4.7 ATTACHMENT SYSTEM

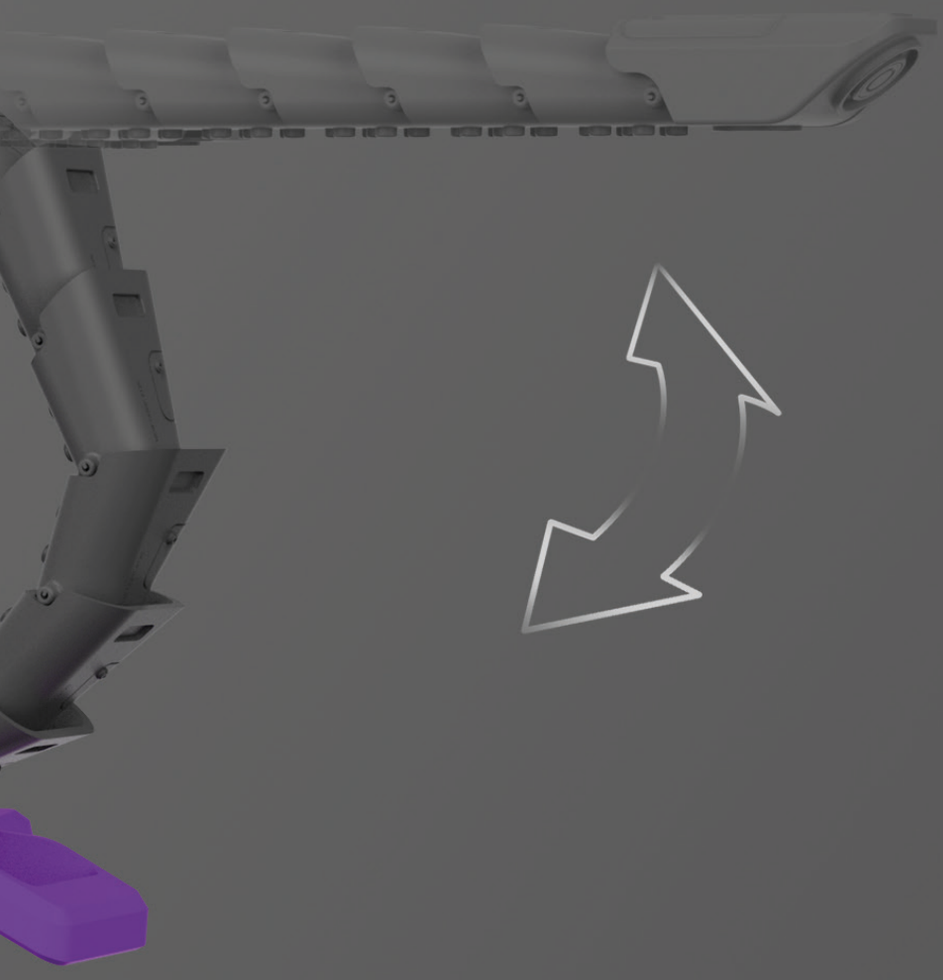


The ball-joint allows freedom of movement.

Action-Camera-Mount used as a connector allows to combine action-cam gear with the blaster. For example, tripods or body harnesses.

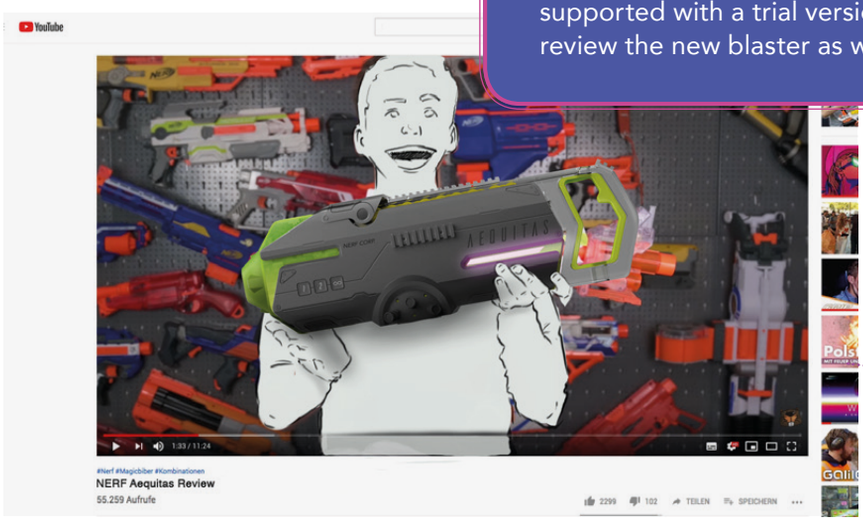


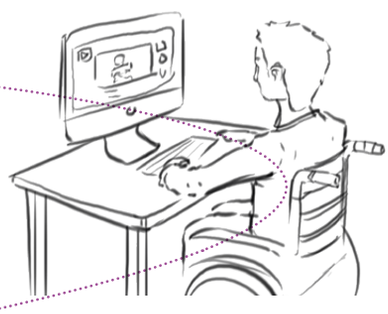
Rubber legs can be bend around objects and remain in place. That allows the user to attach the blaster onto several objects. Further, it can be used as a stand. In case the circumference of the object is too large, straps can be attached via Velcro. These straps are made out of a flexible textile. This textile contains a rubber coated pattern on one side to increase grip.

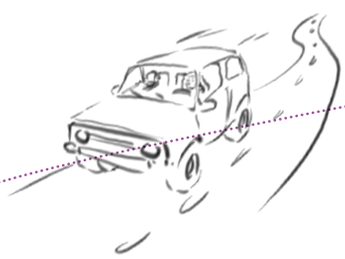


4.8 USER JOURNEY

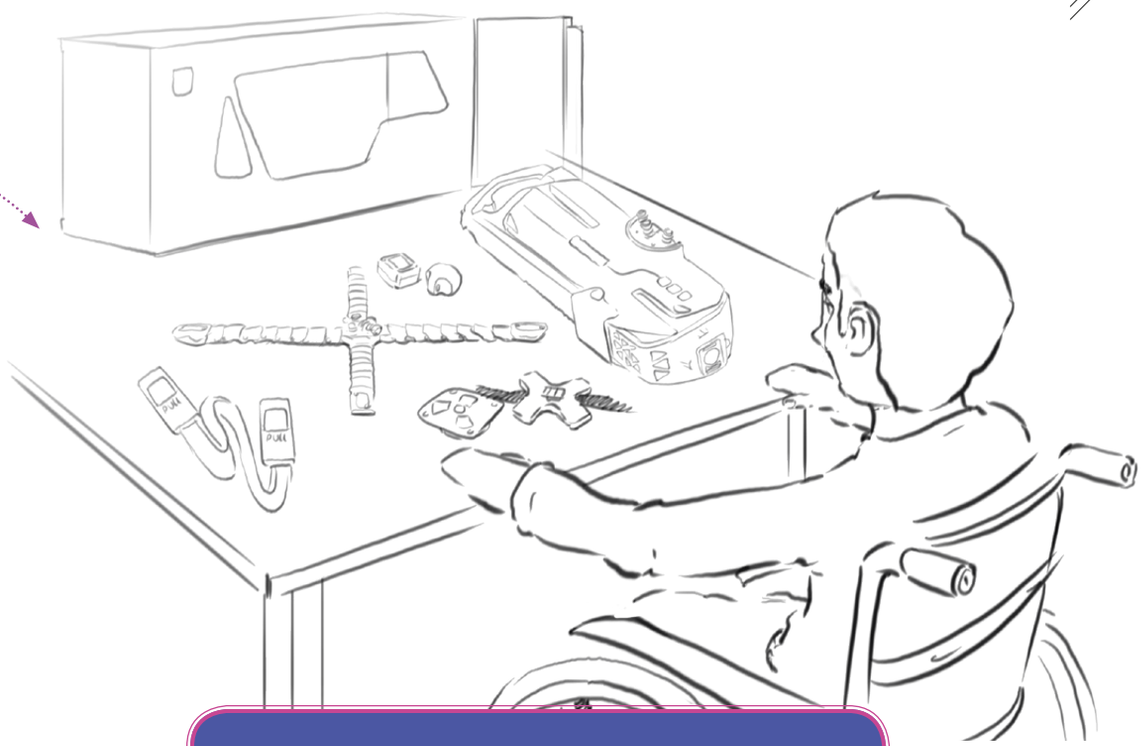
The child will get to know about the new blaster via platforms like youtube and Instagram. Influencers with a disability will be supported with a trial version. Further, other NERF platforms will review the new blaster as well.







The next time the child goes to the supermarket with one of its parents, it will be able to spot the packaging immediately. The box will communicate the message of "you are part of the NERF community" by featuring children with physical disabilities on the front illustration.



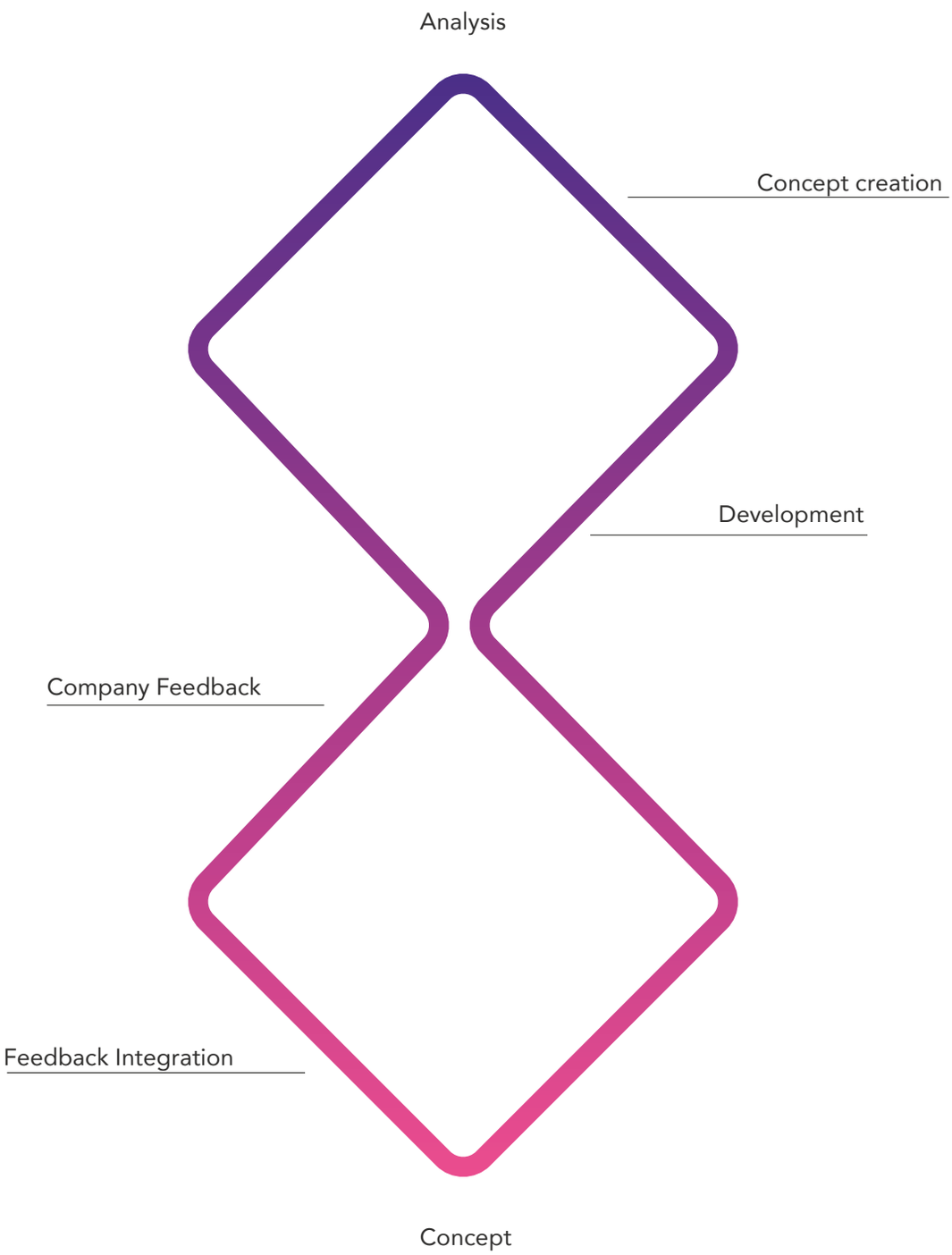
Back at home, the box includes everything that is needed to play instantly. Connect the parts - attach the blaster and enter the field! The child will have gone through the full consumer experience of buying a NERF blaster.

5. APPROACH

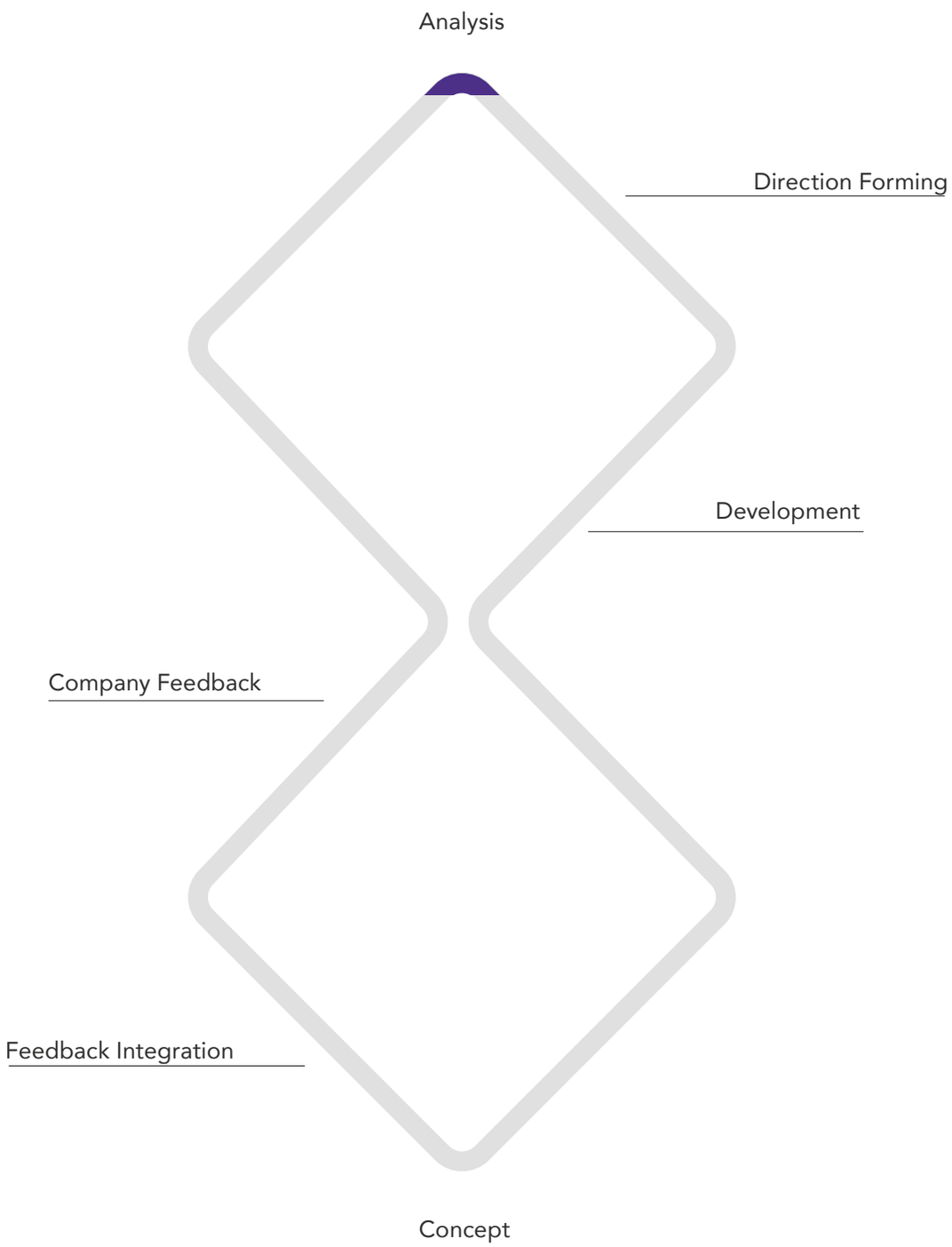
This project made use of the Bio-approach design method (Gielen,2005). It is directed to design toys for children with disabilities by focusing on their abilities instead of their disabilities. Instead of looking at the parts of a body which are out of function, one tries to find solutions to empower the remaining parts. For example, a lack of an arm is not solved by creating a mechanism that mimics an arms functions. Instead, the head movement might be used to generate an input differently.

The Bio-Approach was mainly used as an inspirational guideline rather than a strict plan. This was done since the described project had a different starting situation than the ones described by Gielen. One main inspiration taken from the Bio-approach was the goal to find a set of abilities to design with. To create this set, the project strove to find a common denominator of the various types of physical disabilities.

The project was executed by going through two loops. The first one contained the phases of analysis, ideation and concept creation. Feedback of the company started the second loop which ended with the final concept.


Analysis
Concept creation
Development
Company Feedback
Feedback Integration
Concept

6. ANALYSIS


Analysis
Direction Forming
Development
Company Feedback
Feedback Integration
Concept

6.1 Initial Questions

To find a solution for the created vision a decent base of knowledge is needed. Within the phase of analysis, the needed information are gathered by answering initial questions.

Resulting from the vision the following questions came up:

What is the NERF product about?
How can the NERF blaster support inclusion?
Which skills does a child currently need to play with a NERF blaster?
Which skills are limited to a CwPD?
How can the various disabilities be reduced to one, tangible example?

To answer these questions a literature/online research, expert visits, as well as a product-analyses, were conducted.

6.2 The Toy

As described, the product type chosen for this project was the NERF blaster.
To be able to design a blaster it is first of all needed to understand it.
Therefore, this chapter strives to create an understanding of the brand, the NERF blaster and the game with a NERF blaster. With these insights questions regarding the type of blaster to use and how a NERF could support inclusion, will be answered.

6.2.1 The brand

NERF is a brand owned by the toy company Hasbro. The NERF brand started with a foam ball for indoor use in the late 60s. Until today, most of their products are featuring this kind of foam.

Since the NERF brand is split into sub-brands, an overall brand-target group can't be defined. What can be set, is that their products are targeted towards players who like active games.

NERF Product Catergories

The NERF brand is divided into sub-brands. These are:

ref.04

The NERF Sports brand is focused on toys that are mainly thrown by hand.

ref.05

The NERF Super Soaker brand is focused on water blasters.

ref.06

The NERF Blaster brand is focused on toy blasters that shoot foam darts. They are categorised into different topics. Next to those main topics, they also create licensed products for, i.e. Star Wars or the video game "Overwatch".

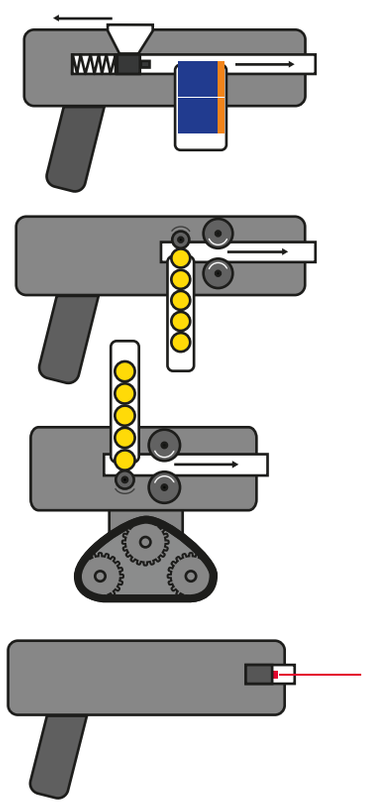
6.2.2 NERF Dart Blaster

It was decided to focus on the sub-brand "NERF Dart Blaster".

The target group for this brand are boys in the age of 8-14 years. For children above the age of 14, a series was created that goes by the name of RIVAL. These blasters have more power and a less playful styling (Appendix 1.2). It has to be mentioned that in general, the blasters' power is limited and thus is not be harmful.

Types of blasters

The blasters created by NERF can be categorized into four different categories:



Spring powered

The power of this blaster comes from a spring. This needs to be put under tension by the user. It is a fully manual blaster and thus allows just one shot at a time.

Electric powered

Batteries give these blasters their power. A system out of two spinning wheels shoots out the darts. This allows single shots but also rapid fire.

Drone

The difference to the blaster types above is that they are radio controlled and can walk around. Until now just two versions are on the market.

Laser

These blasters are relatively new. Instead of using foam darts they use light beams. Sensors on the blaster recognise a hit. These blasters are also the first ones that are connected with a smartphone.

Topics covered

To support the option of role play, there are several different topics the blasters are styled in. The blaster's function stays mainly the same. However, their styling is adapted to specific themes.

ref.07

6.2.3 Game Mechanics

The core rule of every game with a NERF blaster can be described as “try to reach a certain point with your dart”. Out of this basic principle, various forms of games can be developed. Due to the low destructive power of a NERF blaster, no special playfield is needed. A living room, an empty parking lot or a park will all be suitable to play in.

Single Player

Due to its basic principle, a game can be played with only one player. In that case, the game is about precision. Like the game of can knockdown, the player tries to hit a specific target with his dart. Since the game is not bound to specific rules, this target can vary a lot. Soda cans are as popular as trying to hit one’s little sister.

Multiplayer

When playing with multiple people the game of NERF can appear in various forms of which three are explained below. A conducted online research gathered the forms. For this research blog posts, Pinterest pictures and youtube videos were scanned. The internet is full of ideas created by NERF fans or parents. A list of further examples can be found in the (Appendix 2.2).

1)Deathmatch

In this variation of the game, all players fight against each other. In case one gets hit by a foam dart, one needs to step out of the game for a certain amount of time or move to a respawn point. An end of the game can be defined by time, loss of interest or gradual elimination of the players. To nominate a winner the fairness of the players or a referee is needed. In case of the previously mentioned NERF LaserOps, the count of hits, and thus the nomination of the winner, is done by an App, which is connected to all devices involved.

2) Capture the flag

The playground is split up into two territories. Each belongs to one team which owns a particular artefact. This artefact needs to be conquered and brought into a safety area by the opponent. The team with the highest amount of captures wins. A countdown marks the end of a game.

3) Attack and defend

Each team gets assigned a specific spot on the playground. The team needs to defend this point, but also needs to try to conquer the position of the opponents. To conquer one point, a predefined number of team members need to wait at the location for a certain amount of time. When they manage to do this, without being hit by the opponent, the team wins this round. In case one player gets hit by an opponent, he has to wait for a certain amount of time until he can enter the game again.

It needs to be said that the game types explained above are just examples. The rules are not fixed and can always be adjusted by the players. All of the described games can also be added with an extra layer of play by introducing role play/fantasy play. That adaptability makes it next to the blaster another way how NERF could become more inclusive.

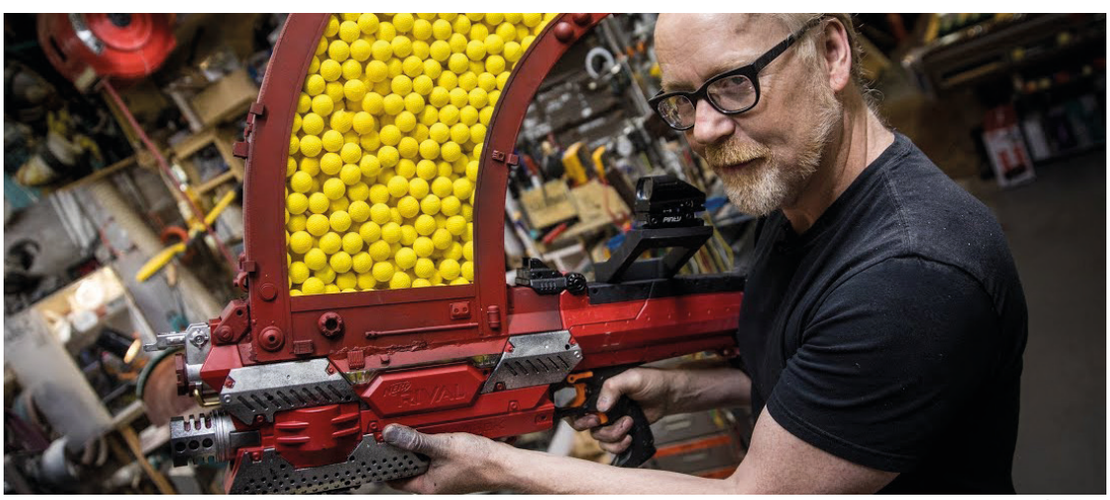
One initial part of every NERF multiplayer game is the fact that darts need to be continuously picked up from the field. It is just a side action; however it is crucial. This is especially interesting when thinking about the abilities needed to play the game. A player will either pick up darts from the field to reload his clip or pick darts from a box within a safe zone.

6.2.4 The world around NERF

Playing with a NERF blaster does not stop with battling your friends. The NERF blaster generated a large fan base over the last years. This community is highly active in several fields. For example, they produce youtube videos about the blaster. Next to staged battles one can see detailed descriptions and reviews of each blaster. Further, a modding community arose. This community is focused on repainting, remodelling and upgrading the NERF blasters. In that way, they create individualised versions regarding look and power. It is interesting to see that most of the people within the modding community are more than double the age of the actual target group.

Even conventions and world record-breaking battles with 4000 players were set up. This "hype" opened up new markets for online stores that sell, for example, stronger motors for the electric blasters.

Hasbro also gets more and more involved. The company started to produce Youtube videos with NERF related content. Further, they launched mobile Apps. These apps simulate the use of a NERF blaster and are mainly thought for promotional purpose.



ref.08

ref.09

ref.10

6.2.5 Conclusion

With these insights questions regarding the type of blaster to use and how a NERF blaster could support inclusion, can be answered.

It became obvious that NERF is not just a blaster. It is a social game that has the power to connect various types of people. In that sense, it is already an inclusive game. Further, a community formed around it. One that owns a blaster becomes a member of this group automatically. To create a feeling of social affiliation is the first inclusive aspect a NERF blaster can offer.

Next, to this, the game of NERF is not just defined by the blaster. Just as the blaster, the game mechanics play a role in how the game is experienced. A change within the blaster, as well as the game mechanics, have to be considered during the upcoming steps.

The NERF blaster series contains various forms of themes. Therefore a future theme doesn't need to comply with specific rules. It can be freely chosen to suit the vision.

6.3 Analyzing the Blaster

The previous chapter created an idea of the environment the blaster needs to fit in. Further, it showed two options which can resemble a solution space for an inclusive effect. However, one doesn't know yet which abilities are needed to take part in the game. The upcoming chapter will analyse a toy regarding this. Further, it will answer the question which play-values are currently delivered by the toy. This will give further insights into the benefits a CwPD can take from an inclusive NERF blaster. Besides, it will show what play values are needed for a full NERF blaster experience and describe the visual language of a NERF blaster.

6.3.1 Abilities

The to be designed product should be usable for CwPD. Therefore one has to know which abilities are currently needed. In that way, it can be decided later, which abilities to support or substitute. The International Classification of Functioning, Disability and Health (ICF) of the World Health Organization (WHO) is used for this. Due to the project's focus on physically disabled children, the game parts are analysed regarding motor skills. First, a blaster will be analysed, followed by the game mechanics. Within this chapter the questions should be answered:

Which abilities are needed to take part in a NERF game?

Which NERF blaster kind is most suitable to be used?

Can certain disadvantages already be spotted by using common sense?

NERF Blaster

For analysing, a blaster model was chosen, which contains the highest amount of actions needed.

Lifting and carrying objects **(ICF classification list)**
Lifting an object
Putting down objects
Carrying objects in the hands
Carrying objects in the arms
Lifting and carrying, other specified - carrying object with one hand (case of reloading)

ref.11

Hand and arms use **(ICF classification list)**
Pulling (not for Laser and Electric blaster)
Pushing (not for Laser and Electric blaster)

Fine hand use **(ICF classification list)**
Inserting (Darts) - Does not apply to LaserOps
Grasping
Manipulating
Releasing
Fine hand use, other specified - pulling (trigger)
Fine hand use, other specified - pushing (releasing clip)

Game mechanics

To analyse the game mechanics, the previously described multiplayer games were taken as examples. Moreover, a video (Appendix 2.3) that shows a game of NERF is also used as reference material. The focus for analysing was on abilities needed to participate successfully. Abilities which might happen during the game but have no necessity are excluded (example: scooting and rolling).

Changing and maintaining body positions

- Squatting
- Kneeling
- Sitting
- Standing
- Shifting the body's centre of gravity

Fine Hand use

- Manipulating (aiming at target)

Walking

- Walking short distances
- Walking on different surfaces (depending on the games environment)
- Walking around obstacles

Moving around

- Running
- Jumping

Moving around in different locations

It was surprising that the movement of one's head, mouth and eyes were not included in the ICF list. However, they are also needed when it comes to spotting the target and aiming.
By a talk with an occupational therapist, it turned out that these functions are very rare to be affected when it comes to physical disabilities. This can be seen as a reason why they are not listed in the ICF.

Regarding the disadvantages that a CwPD can encounter, the blaster resembles the most significant source. When looking at the game mechanics, it is mainly about movement.

Regarding a first evaluation of disadvantage, one can say that the blaster resembles the bigger challenge. In case one's legs are affected by a disability there are already products on the market to support this — crutches, wheelchairs and even exoskeletons (Appendix 1.3). However, in case one's hands or arms are affected there is currently no widely spread support system.

Conclusion

The abilities needed for NERF can be separated into two camps. The blaster itself relies mainly on the motor function regarding one's hand. Against this, the gameplay is in need of functioning legs and the ability to change one's body position. The head is currently not needed and is also rarely affected. This fact should be considered during the ideation phase.

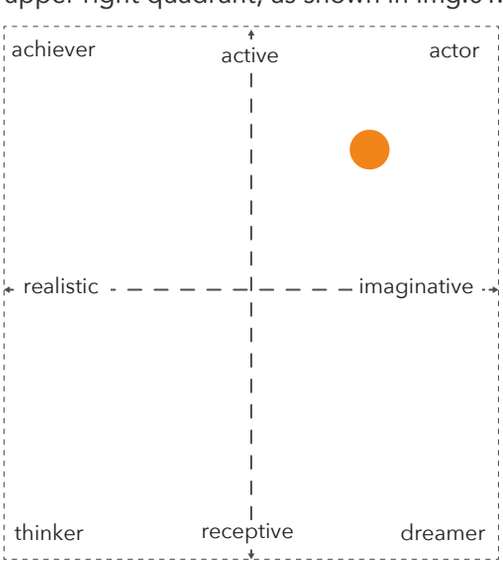
Further, the design of a blaster can have a more significant impact than just the change of the game mechanics. To reduce the number of abilities needed to operate a blaster, it should be considered to use an electric one.

6.3.2 Play Value

To assess the quality of play the five assessment elements described by Gielen, 2010, were used. The main question to solve in this chapter was to figure out the main benefits a child can gain from playing with a NERF blaster. Further, the insights should give an idea what values are represented by NERF.

1) Behavior types

The child behaviour model for children in the age of 6+ is used for this assessment (img.01).
By observing the various kinds of NERF blasters, it becomes apparent that they all look extreme in their own way. It gets visible that the NERF blasters are highly supporting imagination. Especially when comparing them to airsoft guns (Appendix 1.4), which are due to similar game objectives competitors. The NERF blaster's large parts, bright colours and wild shapes as well as their fantasy topics, classify them positively in the imaginative direction. Against this, the game mechanics are directed along the active axis of the child behaviour model. However, the player has the power to decide how he/she wants to play the game. Thus, one needs to classify it more in the mid-range of imagination and activity.
It can be classified on the left side of the upper right quadrant, as shown in img.01.



(img.01)

2) Types of play

The types of play existing at a NERF blaster need to be split into two sets. The first set contains the types which are constantly present, the second one which is optional. The ones which are constant are movement and team/success play, as well as playful handling of objects.

Movement play, because a constant movement is needed to not get hit and to spot the opponent.
Playful handling of object, because parts need to be moved and darts are placed in it.
Team/success play, because targets have to be hit and/or team effort is rewarded.

Types which are optional to be integrated into the game are: Fantasy and role play as well as construction play. Depending on the kind of NERF blaster fantasy and role play gets supported (i.e. Zombie topic). However, it doesn't force the player to play, i.e. a zombie themed game. The same counts for construction play. All blasters contain at least tactical rails that allow adding parts, like scopes, to the blaster. Moreover, the "Modulus" blaster series (Appendix 1.5) is especially directed to rearrange blaster parts to create a "custom" one. However, this can just be seen as an optional part of the game, since it requires further purchases and doesn't affect the actual gameplay.

An addition to the types of play are the Plex cards (Appendix 2.4). Themes that can be added to the analysation are:
Cruelty, Sensation, Subversion, Thrill and Simulation

Feeling the impact of a NERF dart and its power is as much part of the game as enjoying the moment of "hurting" someone with it. In that way, social standards are crossed playfully. Further, the "fear" of getting hit brings as well a certain form of excitement with it.

3) Play phases

To assess the play phases, the following part will describe each one individually with a focus on the NERF Blaster. The descriptions are based on an introspection executed by the author. For this, an unknown NERF blaster was used the first time.

Exploration

When getting in contact with a NERF Blaster for the first time, it needs to be figured out, how to hold it, how to load it and how to set it into action. In this phase, different surface structures can be felt, and functional parts signal further exploration. The bright, highlighting colours that are chosen for most of the function parts support this phase even more. When all of this is figured out a randomly activated shot will bring the child directly into the next phase.

Functional Play

After figuring out how the system works, darts will be shot in every direction. The child might check how far the darts fly and how much power they have. This can be done by holding a hand in front of the barrel or hitting a target. As soon as the first dart hits an object, the next phase will start.

Variation

The child might now start to aim at multiple different objects. For example, it is shooting at soda cans that deform by the darts impact or paper that makes a loud noise when getting hit.
Until this point, the transition from phase to phase worked well. However, when no other play partner with a NERF blaster is around the step to the phase called "integration" is difficult.

Integration

To reach this phase other children with NERF blasters are needed. Otherwise, the only option that could integrate the toy into a more complex form of play is when it is used as an accessory for role play. However, the upcoming trend of using VR/AR, could, in the future, eliminate the need to have real play partners.

4) Levels of complexity

The basic use of a NERF blaster shows low levels of complexity. In case a child owns all skill-sets needed to operate a blaster there is no increase in complexity. However, this counts for physical skills like motor and sensory.
When it comes to playing a game with a NERF blaster, the complexity is variable. It starts with the need for cognitive skills. In a single player game the size, speed of movement and amount of targets can vary the complexity significantly.
In case of a multiplayer scenario also the social and emotional skills come into play. The complexity starts with a one against one match of two friends within one's house. At the peak of complexity, the game would include multiple random people and take place in an unknown environment outside.

5) Context

As described by Gielen, 2010, the context a toy is used within needs to be assessed in two steps. First, the direct context will be described followed by the social context of the child.

Direct context

Regarding the direct context, the play with a NERF blaster happens in the familiar surroundings of a child. This can be his own room, within his family house/apartment or the backyard. But also public playgrounds/ parks as well as the house of their friends. Since the darts are not powerful enough to be destructive, a special preparation of the play environment or parental guidance is not needed. The game with a NERF blaster is not relying on a specific age range. This makes it possible to have peers, older kids, siblings and parents as playmates. Due to the flexibility of the game environment, it is not dependent on the weather. Moreover, this flexibility allows the child to decide autonomously when to play. He or she does not depend on their parents to facilitate the game or for mobility reasons.

Social context

The social context of a NERF game demands awareness of social standards. Children can experience and try out how to behave regarding rules. Further, they see what it means to be part of a group and how it is to guide or to be guided. This might also result in situations, in which the child needs to apply and further his knowledge regarding conflict resolution. Children learn how to cope with the situation of losing and they experience cooperative play (Frost, 2012). All these parts of the game, reflect on the development of a child in the targeted age group has to go through (Wieder, 2009; Eccles, 1999). Moreover, the game gives the possibility to reenact role models created by movies, social media or computer games. This all furthers the creation of self-awareness and identity (Wieder,2009).
The technical mechanisms of a NERF blaster satisfy the natural human urge of exploration. Further, the toy allows children to be rebellious and play "war". Instead of "killing" each other on the battlefield the roleplay enables the child to chase, i.e. zombies or robots. This form of battle is socially more accepted since the weapons and targets are situated in a fantasy world. Thus the child is enabled to let out aggression in a way that doesn't get him or her in trouble with their parents.

Conclusion

Concluding one can say that a NERF blaster is a highly social toy. The game offers the benefit to be integrated into a social context. One can identify oneself with the product/brand. Social skills are requested and will be trained during the game. Other skills that are trained are motor skills. Further, it offers the opportunity to experience violence in a socially respected setting. In addition to this, the NERF blaster supports an autonomous play. To make sure the CwPD has a full play experience, these values need to be maintained in the to be developed concept.

Next to the insights gained regarding play values, an opportunity for innovation turned up. Since the play phase of "integration" is not yet covered by the toy this can be used to generate innovative ideas.

6.3.3 Design Language

As described in 6.2.2 the blasters come in different topics. These topics are represented within the styling of the blasters. However, what is a typical “NERF” styling? This question will be answered during this chapter.

The styling of a NERF blaster can be separated into three different levels.
1)Forms
2)Colour
3)Details

Forms

The form of a NERF blaster can be described as extreme and bulky. Big elements divided by thick split lines dominate the appearance of a blaster. This gives it a powerful and massive look as well as feel. The forms itself are created out of straight lines with rounded corners.

The blasters are mainly assembled out of two shells screwed into each other. In the resulting hollow body, the mechanism is installed. For an easier and cheaper production process, the shells do not contain forms with an undercut. In that way, a two-part injection moulded form can be used.

Color

The colours differ from topic to topic however they all have in common to be bright. Another common thing is the bright orange colour used mainly in all blasters to highlight the barrel as well as some function parts.

Details

Like the colours, also the details change from topic to topic. Functioning parts like screws or air tanks are included in the design of the shell. They are mainly represented in the form of reliefs instead of 3D objects that stick out. That makes the blaster less fragile and thus can be thrown around without losing parts.

Another form of detailing that is used is different surface structures. They make it possible to increase the grip on, i.e. a handle part or de-increase glossiness of the shell.
Further, prints are used to display product names or attach theme related graphics.

6.4 Literature Research

The previous chapter gave first insights into the benefits gained from playing with a NERF blaster. In addition, it was realised that the game mechanics could also have a good impact regarding the inclusion of CwPD.

However, these insights were based just on the toy analysation and common sense. To be able to make conscious decisions, a base of knowledge about disabilities and inclusion needs to be created. Further, one should also have a look into the current active play options for CwPD.

Therefore the following chapters will deal with the topics of:

6.4.1 Disabilities
6.4.2 Inclusion
6.4.3 Active play options for CwPD

6.4.1 Disabilities

The previous chapter created an understanding of what the game of NERF is about. It showed what play values it contains and which options it offers for creating a design that integrates CwPD. The goal of this chapter is to explain what "physically disabled" means. A conducted literature research will answer the following questions.

How do children who have a physical disability deal with it?

How is the relationship between physical disabled and non-disabled children during play?

What can be used as a simplified and tangible way to describe various forms of disabilities?

It was taken care of that the participating children, within the selected literature, didn't differ more than a maximum of 2 years +- to the set target group of children between 8-14 years.

Defintion

First of all, one needs to understand what physical disability means and in which forms it can occur.

From definition by Leyendecker, 2005, a disability is called a physical disability, when a person is affected regarding his individual fulfilment in the field of social interaction, due to an impairment of his locomotor system, organ damage or a chronic disease.

This criterion is met in several ways, resulting in a large variety of disabilities. Since NERF blasters are highly dependent on motor skills, it was decided to narrow the field of disabilities down to the ones affecting those. (Appendix 2.5)

Research outcome

Motoric development and self-development
Motoric development and self-development are firmly connected (Essig, 2013).
However, how a CwPD sees one-self is not determined only by the disability itself. It is also highly related to the environment in which the child grows up. Adverse reactions towards their disability can have tremendous effects on their self-worth. In the long term, this can lead to mental health issues. These negative reactions don't even need to come from other humans. Objects that emphasise their disability by causing failures can have the same effect (Essig, 2013).
Therefore, as described by Essig, 2013, it is crucial for a child to form a right attitude towards their disability. By being confident about their situation, a lot of negative influences can be stopped by the child itself.

During the age of seven, children with disabilities start to understand and reflect what their disability means (Eccles, J. S., 1999). Thus, they need to react to it. Since the environmental context for CwPD changes during the day, they have to adapt to different situations. For example, a school for CwPD usually exists just one time within a city or municipality. That results in long travels for the children. Due to this, they are not able to keep up their friendships autonomously (Mulderij, 1997). At their home, they are most likely one of the only children with a disability. Thus they need to deal with being different among able-bodied peers.

The attitude from able-bodied children towards physically disabled children is in theory described as positive regarding possible friendships with peers (Tripp et al. 1995; Laws et al.2005; Tamm et al. 2001). However, the situation during real-life encounters looks different. As described by various authors (Frost, 2012; Hodge et al., 2013; Kolehmainen et al., 2015; Poulsen,

2008; Doubt et al., 2003; Essing, 2013) children with physical disabilities regularly encounter the situation of being excluded from play as well as being bullied. Reasons for this are: The inability to take part in physical activities and the lack of acceptance of able-bodied children. In those cases, CwPD need to rely on playing with younger children, their siblings, parents, on their own or to be the observer (Skär et al., 2000). A fact that is hazardous to their development. Crucial needs like acceptance, success or cooperation (Acuff et al., 1997) are not satisfied.

To change this CwPD create their own coping strategies, as described by Mulderij, 1997, and Doubt at al., 2003. They reported that the children use techniques like:

•Masking their disability. They try to point out different qualities of themselves to shift the focus to a different point of interest. One example is to become the best in one type of sport, i.e. table tennis. In that way, everyone connects one with being that professional table tennis play instead of being the guy in the wheelchair.

•Finding a niche. They either can use their remaining abilities or fill in a spot within a team, which is not much liked to be taken by others. In that way, they try to become part of a group, without feeling like being "tagged along".

•Educating others about their disability. To increase understanding and reduce the aversion of contact, due to insecurity.

•Using humour and make jokes about their disability. To react in a fun way towards a strange question (in case of bullying)

•Step into the game without asking. They are taking the initiative to be part of the game and don't wait to be asked by others.

• They become creative and change the rules of a game or invent new games. For example, one in which their wheelchair becomes part of the game to pull other players.

Further, the literature research showed that the perception regarding one's level of disability cannot be described linearly. Contrary to what one would suspect it needs to be described in a more inversive way. That means that a severe level of disability is experienced as less affecting than a person with a low level of disability would experience one's affectation (Essig 2013). That fits the results of Evans et al. 1992. They showed that students with severe disabilities were accepted differently within a class, than students with a mild form of disability. An explanation for this is that mildly disabled are more often compared to able-bodied when it comes to performance whereas severe disabled are already perceived as a different group.

Conclusion

CwPD can have the same amount of self-confidence than non-disabled children. It is a skill that is highly needed to create friendships with able-bodied peers.

The creation of self-confidence depends heavily on their environment. A toy that supports their abilities can have a positive effect on this.

The skill-set of CwPD makes it not possible for them to fully participate in games of able-bodied peers. When alternatives have to be introduced to let CwPD take part in a game, acceptance on the side of the able-bodied is highly needed. This acceptance is not yet that far spread. Thus, the final solution should support that.

Throughout the literature research, it was not possible to find a simplified example that makes it easier to work with the various forms of disabilities. Further, the literature research does hardly give a real feeling of how CwPD behave. Due to these two reasons, one needs to get real-life contacts to draw further conclusions from this.

6.4.2 Inclusion

As mentioned within the vision statement, the project strives to generate a toy which supports inclusion. Therefore it is needed to understand what inclusion means and look for examples of already inclusive products.

Therefore, this chapter will be guided by the question:

What is inclusion and how could a toy support inclusion?

Inclusion can be described in three different ways.

First, the word definition. Second, what it means regarding disability, and third, what it means regarding toys.

Word definition

According to the Cambridge dictionary, Inclusion means:

"The act of including someone or something as part of a group, list, etc., or a person or thing that is included"

Instead of just bringing two different groups together but still keeping up a clear split line, inclusion strives to form one homogenous mass.

Disabilities

Regarding disabilities, it means that all people with a disability, whether cognitive, visual or physical, should be able to take part in everyday life. They should do this without encountering elements that exclude them from executing their free will.

To make sure that this is possible, the abilities of people with disabilities need already be considered during the process of creating buildings, objects and services of everyday life.

Inclusive Design

As defined by the British Standards Institute (2005) inclusive design is:

"The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible … without the need for special adaptation or specialized design."

To reach this goal, the design process is started with a broader target group in mind. This also includes those with disabilities. One method for this type of design is the universal design method (Appendix 2.6). The goals of this method are:

Body Fit
Comfort
Awareness
Understanding
Wellness
Social integration
Personalisation
Cultural appropriateness

These goals can be used at the end of the project to evaluate the outcome regarding its level of inclusion. Further, they can give insights about possible gaps that need to be closed.
These goals are overlapping with Peter Morville's "User Experience Honeycomb" model (Appendix 2.7). It represents the different parts of a full user experience (Usable, useful, desirable, findable, accessible, credible). Thus, condensed one can say that an inclusive design is one that delivers a full user experience, independent of the user's abilities.
However, one always needs to keep in

mind that due to the individual nature of disabilities it is not possible to include all people.

Inclusion is trending

Inclusion is a continually growing need in the current world. Especially public buildings and services try over the last years to become as much inclusive as possible — the same counts for products of our regular life. An interesting example is a smartphone. It comes with a large number of supportive software pre-installed. However, more relevant for this project is, to see how inclusion is currently represented within the world of play.

Inclusion in the world of play

Therefore an online-research was conducted. The research was conducted by using Google and the following keywords: “inclusion” “inclusive” “play” “game” “toy/s”. It was insightful to see that the number of inclusive toys was limited. One main category was the design of inclusive playgrounds. This topic was prominent in papers, articles and actual products. Another finding was the #atoylikeme movement created by a group of designers (http://www.toylikeme.org/). They design and promote inclusive add-ons for regular toys. Their focus is with this on the representation of disabilities within toys (ref. 10). In 2016 LEGO adopted this idea by announcing their first figure with a wheelchair. Another example is Microsoft who introduced an inclusive gamepad in the Mid of 2018 (Appendix 1.6).

Even though the topic of inclusion is already quite “old” the toy/game market reacts slowly to it. One reason for this might be too high costs to develop small niche products. However, within the last few years, the expenses for rapid prototyping decreased. This makes it now possible for small startups, big companies or also just DIY hobbyists to fulfil their ideas in a fast and cheap way.

Those ideas might not have a direct success regarding money, but they will have an influen

Conclusion

Concluding one can say that inclusion strives to deliver the same product experience to every user.
Within the world of play, it is a recognised opportunity. However, it just started to grow. Companies get more aware of the fact that it is a need that needs to be satisfied.

One can say that the topic of social acceptance plays a more significant role than the toy itself. The toy has to be seen as a key which lets a CwPD enter a world that was unavailable for them before. By this, a play bubble is created which equalises abilities and makes it possible to let the borders between abled and less abled children vanish.

ref.12

6.4.3 Market / Active play options

When designing a new product one needs to check the current market situation. By carrying out an online-research regarding blaster toys for CwPD, only one student concept showed up (ref. 11). Other products were found that could fit the idea but were not labelled in that sense (Appendix 1.7). However, those were functional and qualitative not sufficient to represent a good solution.

The NERF game is a highly active game. Due to this, it was decided to process the research with a focus on sport activities for people/children with physical disabilities. Further, one looked into how related sports to NERF deal with physically disabled players. Terms that were used for this online research via google and youtube were: “sport”, “disabled”, “paintball”, “softair”, “impairment”, “active”, “club”, “team”, “laser tag”,”physical”.

The insight was created, that sport activities for CwPD are quite popular. Especially the sport of wheelchair basketball, E-Hockey (electric wheelchair hockey) and Powerchair football (soccer), was at least represented once in each municipality within Germany (www.rollikids.de).

An interesting fact about the rules of these games was that each team was allowed to consist out of a certain number of points. Each player gets a value assigned according to one’s level of disability. The coach can then combine his team up to a predefined maximum number. In that way, it is possible to create an equally strong team.

Related Sports to NERF

Paintball, Laser Tag and Airsoft are three types of sport which are related to the game function of NERF.
Since 2005 different kinds of activities were organised to bring disabled people into the three types of sport. Especially LaserTag, followed by paintball was the sports with the highest interest. Until the year of 2013, laser tag games for wheelchair users were organised in the UK (Callum, 2013). Further, in the summer of 2018, an event for wheelchair paintball took place in the USA. Hereby the local paintball store built a special setup for paraplegic users. With it, they could activate the paintball marker with their mouth (Berry, 2018). In cases where players were still able to use their hands and arms fully it could be observed that another player pushed their wheelchair. This was done to make it possible for the active one to aim and shoot. Without this help, the game flow would be disrupted continuously by storing and balancing the gun on one’s lap.

When looking at all of the described sports one can see that they are all related to clubs. At least a particular facility is always needed to execute one of them. An autonomous play is therefore not possible.

Wheelchair as a common ground

It was interesting to see that a majority of the sports found for people with physical disabilities, were all based on the use of wheelchairs. An explanation for this can be the trial to include as many forms of motor disabilities as possible in one sport. One with functioning legs but issues with one’s arms

can always sit in a wheelchair and steer it. This would not be possible the other way around.
When looking back at chapter 6.4.1, one of the questions asked was:

What can be used as a simplified and tangible way to describe various forms of disabilities?

The wheelchair can be a solution regarding this. It seems that if it is possible to use the blaster within a wheelchair successfully, it will be usable by children with various forms of physical disability.

Conclusion

Currently, there is no product on the market that would suit the vision. Sport clubs offer active play; however, it is guided and can just take place at a specific moment.
Further, the wheelchair should also be considered as a good common ground for the development of the blaster.

(Kyle Lunau - Inclusive Dart Gun) ref.13

6.4.3 Literature Conclusion

The literature research can be concluded with the following statements:

Acceptance towards physical disability is a fundamental value and highly in need to be promoted

Hands and arms are causing the most substantial disadvantage when it comes to a NERF game.

CwPD want, like other kids, to be part of a social group

Just a change within the NERF game mechanics will hardly create inclusion

A trend towards inclusion within the toy world is visible but no similar product on the market yet

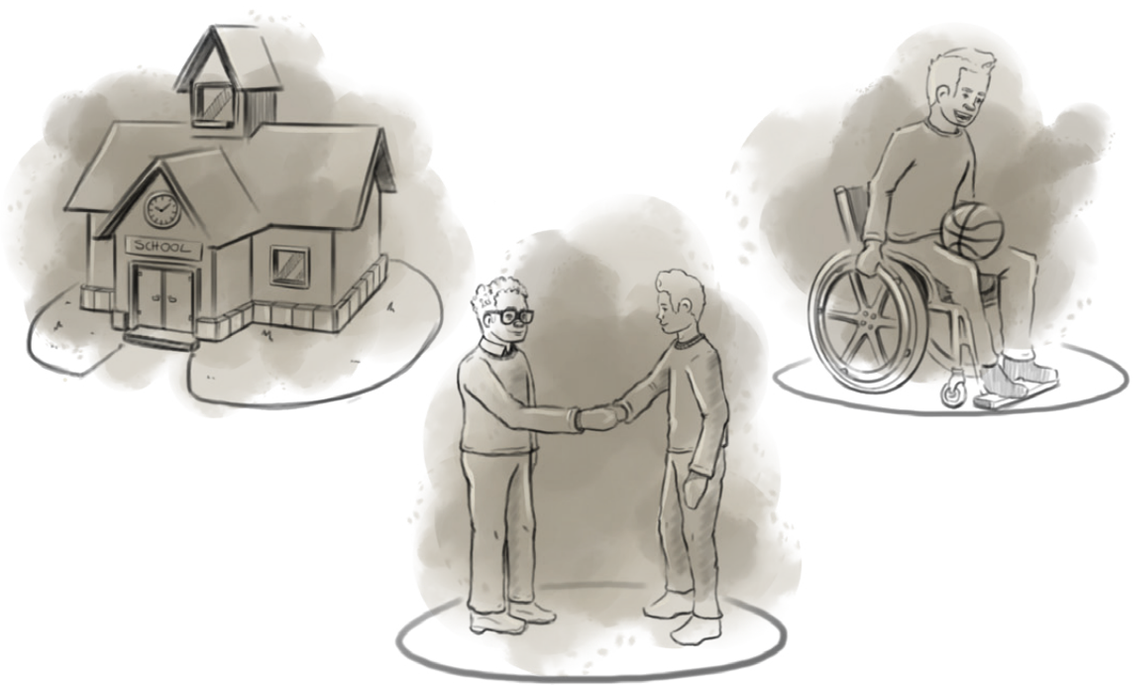
The abilities one has when using a wheelchair can be seen as a good foundation for developing a blaster

Inclusion means to deliver the full user experience regardless of the user's abilities

6.5 Visits

The previous chapter created a good theoretical knowledge base regarding the main three topics (disability, inclusion, toy). However, those insights were not gathered first hand.

During the design process, it is crucial to gain a level of empathy regarding the handled topic. This makes it easier for the designer to understand the user and draw conclusions.
It was therefore decided to conduct four visits: a school, an occupational therapist, a wheelchair sports-club as well as a trade fair. A reason for the visits was to vet the literature conclusions in real life. The second main reason was to build empathy and gain first-hand impressions.


SCHOOL

6.5.1 School

The class visited consisted of 11 students in the age between 10-11. They all had different forms of physical disabilities. Starting from a deformed leg and going up to cerebral palsy. The visit should proof if the way of behaviour correlated to what was found out during literature. To get further impressions of their abilities was another objective.

The observation took place during their sport class. That made it possible to observe them in action.

It became visible that the children are aware of their disabilities and handle it in a self-confident manner. Without any shame, they ask for help whenever their disability influences their action.

This is supported by the high amount of acceptance within the class. It makes it possible for some to take part in games where one would expect them to fail. Rules are adapted, or they accept the fact that someone might, i.e. be a bit slower.

Regarding the ability to operate a NERF blaster, the factors of "lifting and carrying objects" as well as "fine hand use" and "hand and arm use" were more affected, than the ability to move around. In case children weren't that able to stand for a long time they just used a wheelchair instead.

Children with cerebral palsy are part of the social environment, but it is recognisable that they are barely able to take part in it autonomously. A toy that brings a certain form of autonomous behaviour to them is highly beneficial.
In addition to this, it was insightful to see that the teachers adapted rules so that everyone could take part in a game. This could be part of a solution regarding the game mechanics of the NERF Game.

Conclusion

The topic of acceptance was well reflected within the class. Respecting one another made it possible to include everyone into a game.

Further, the idea of using a wheelchair as a universal criterion was supported.

Moreover, it became visible that children with cerebral palsy will highly benefit from the envisioned toy.

6.5.2 Wheelchair Basketball

During literature research and the school visit, one could see that a wheelchair is a universal tool. In the world of sports, it connects able-bodied with disabled people. Further, it became visible that the wheelchair could be used as a platform which represents multiple different types of disabilities. To see which abilities one still has when using a wheelchair it was decided to visit a wheelchair basketball club. Since basketball is similar to the action of a NERF game (holding an object, aiming, moving with the object), it was an ideal way to gather first-hand impressions.

The initial plan was to do an observation. However, it was even possible for the author to take part in the training. Thus he could gain first-hand experiences.

During the training, the author got introduced to the steering of a wheelchair. Further, training games were played within which objects needed to be picked up from the floor. Finally, a full basketball game was played.

The played games showed, that even though one's hands and arms might be fully functional, it is hindering to use them during a game. This is because they are mainly occupied by powering and steering the wheelchair.

Further, it became visible that picking up objects from the ground is challenging. Thus, picking up darts during a NERF battle is as well.
It was impressive to feel and see that this sport can bring different people together. The initial reserved feeling towards a person with physical disabilities vanished entirely as soon as one was sitting in a wheelchair. This demonstrated how the equalisation of abilities could lead to an inclusive effect.

Even though one can execute quick movements within a wheelchair, it is not possible to duck (one of the ICF skills for multi-player games). This illustrates that rule adjustments will probably always be needed to make a game of NERF fair for everyone (raise acceptance).

Conclusion

Using a wheelchair affects many abilities. It comes to a point where the use of hands is just possible in a very restricted way. In case one can use the NERF blaster while riding a wheelchair, it will also be possible for people with various forms of physical disabilities. Therefore using the wheelchair as a universal representation is very useful.

6.5.3 Occupational Therapist

To get further information about the relation between play and physical disabilities an occupational therapist was visited. It was possible to talk to Thomas Klee, who is an occupational therapist in a school and designs his own therapeutic games. A day before the meeting he was informed about the questions that will be asked and was provided with a video that showed a game of NERF (Appendix 2.3).

Questions that were asked to him were:

How does he make his games accessible for different types of children?

What does he think about using the wheelchair as a very condensed form to represent disabilities?

The first thing he mentioned was the reoccurring topic of acceptance. From his point of view, the first step to make inclusion happen is to have respect towards the individual.
This strengthens the outcome of the literature research in 6.4.1-2 as well as the school visit.

Further, he mentioned that he tries to make a game inclusive in two different ways:

1) One option is to let everyone fight for the same goal. In that way, a disability wouldn't stick out much, since the goal of the game will always be reached by team effort. Therefore a failure done by one will vanish.

2) The second option comes into place when it is not possible that everyone has the same task. In that case, each player takes over a different task which suits their abilities best. (example: one child builds a tower, the other one has to destroy it) What should still stay the same is striving for the same goal.
To get further information he was asked how he deals with the more severe forms of physical disabilities like quadriplegia. The answer was that many adjustments need to be made - "making adjustments is something we do on a daily base". This is because in these more severe forms the abilities still available become very specific. On top of this, the body measurements are differing. Products which are produced to fit the norm, wouldn't be suitable to use for these children.
In addition to this he mentioned that some disabilities transform over time. For example, a child with muscular dystrophy will lose his arm strength over time.

Regarding his opinion, the simplification of using the wheelchair as a representative should work well. He says that most of the children he works with are struggling with their hands or arms. In case they don't, they rely on a wheelchair. Thus, he agrees on the approach.

Conclusion

The simplification to a wheelchair can be used, and a toy on its own won't be able to create full inclusion.

Further, adaptability is needed if children with a severe disability should be included as well.

6.5.4 Trade Fair

While visiting the school and sports club, it was recommended to visit as well a fair for rehabilitation products. With the intention to see new developments regarding toys for CwPD, the rehacare fair in Düsseldorf was visited for a day.

Since the fair stated to have even a specific area for children, one expected to discover toy concepts which were unique and new. However, there were just two exhibitors for toys. One was Jochen Heil, a reseller of various toys for children with special needs. The toys presented within their catalogue were mainly of educational or therapeutic nature. Regarding rebellious/aggressive play the only option available were so-called "batakas - encounter bats" (ref.12). These padded sticks allow a harmless fight. The other company which exhibited at the fair was a brand called Treas Pads by INNOVAID. They sold a reaction game directed to therapeutic use.

The impression was created that there is close to no market for toys that are delivering a full user experience to CwPD. Either they lack on accessibility or desirability. The latter is caused due to a design that is not aesthetically pleasing and/ or does not relate to pop cultural topics.

Especially the latter is not understandable since other products like security helmets are designed to look aesthetically more pleasing and fit the current style. This could be explained by a stigma that is transferred not only on the child itself but also on the family members, as described by Green, 2003. In the case of a toy, this would rarely occur. At least from the view of the parent, stigmatisation might not happen during play.

Play played a secondary role at the fair. It seemed that the main focus within the world of products for CwPD is more on supportive goods like wheelchairs, crutches and talker (device to transfer written text into speech). A fact that might be understandable from an economic point of view. However, looking at the findings from chapter 6.4, it is highly needed to strengthen a good play experience within the world of CwPD.

Conclusion

The visit brought the insight that play is a side issue for the market of products for people with disabilities. This strengthens the vision to integrate inclusive toys into the mass market.

ref.14

6.6 Analysis Conclusion

During the previous chapter information about disability, the toy "NERF blaster" and inclusion were gathered. The central insights from this analysis phase were:

A NERF blaster is a highly active game. Also, it delivers benefits regarding the development of social skills and one's self-esteem. Especially the later is crucial for the development of a CwPD.

Further, the game offers autonomous play as well as the release of aggression in a safe way.

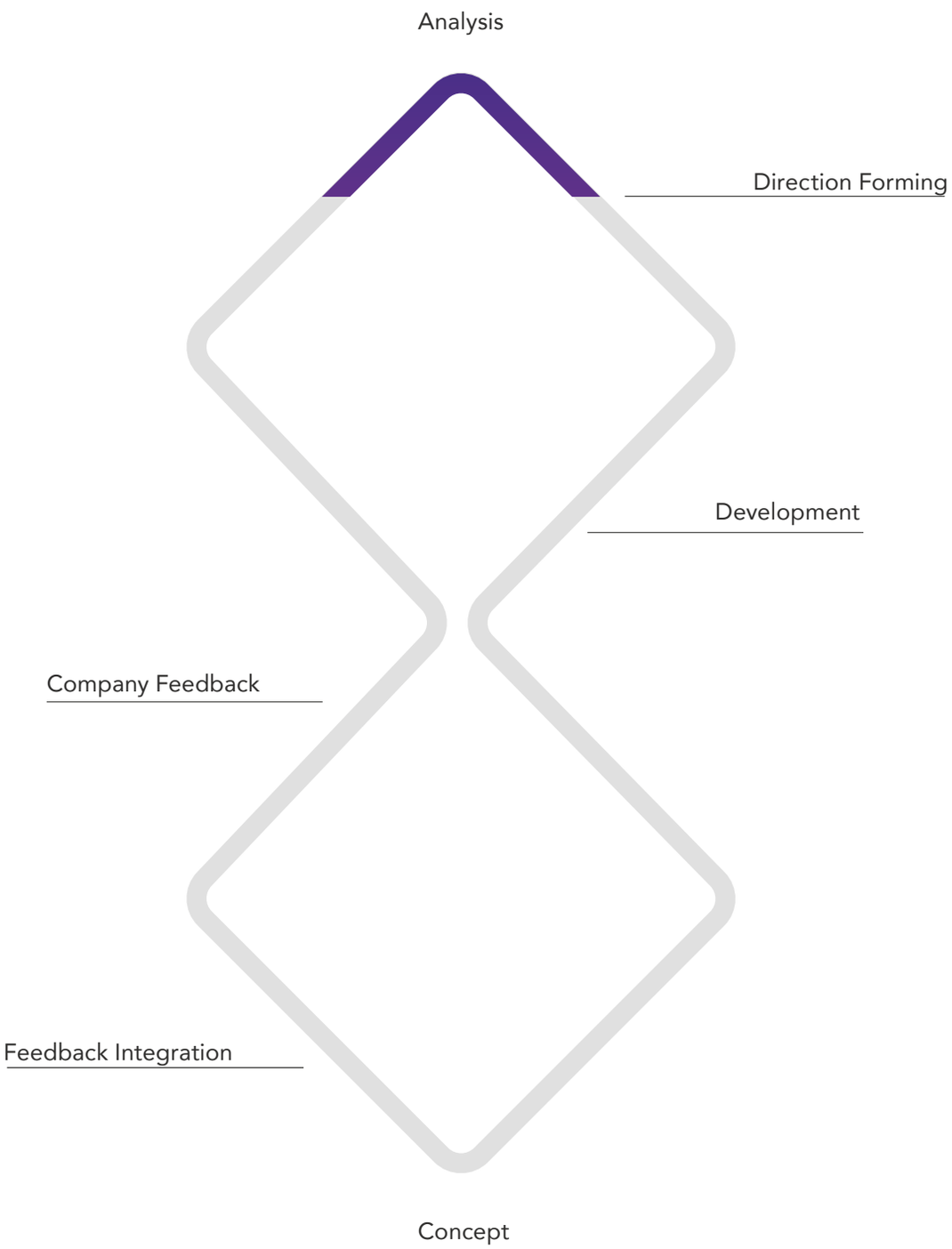
The abilities that cause the most significant disadvantage to a CwPD are the ones related to hands/arms. Therefore, the wheelchair can be used as a benchmark. If it is usable in a wheelchair, it should be usable for many.

Further, the insight was gathered that inclusion relies heavily on social acceptance. The blaster should support that and not just focus on a mechanical solution to integrate a child into a community.

It became apparent that there is an actual need and trend regarding inclusive toys. That highly supported the vision that this project is aiming to.

7. DIRECTION FORMING

The last chapter created a useful knowledge base. Within the upcoming chapter, this information will be transferred into inspiration. The primary goal of this chapter is to develop concept directions out of the inspirations taken from research.


Analysis
Direction Forming
Development
Company Feedback
Feedback Integration
Concept

7.1 Defining Criteria

During chapter 6. various insights were gathered. To go on with the process, one needs to transfer this information into inspiration for the upcoming ideation phase.
The outcome were the following guidelines:

A solution that is based on changing the interaction with the blaster

To create equality

To support social acceptance of CwPD

To enable the child to play autonomously

Design is adjustable to suit one's skills

To make a fun and active product, not a therapeutic one

Various themed product portfolio offers the possibility to create something off-standard

The missing play phase of integration offers the opportunity to create something new and unique

As mentioned, the toy is not the only part of the NERF game that could promote inclusion. The game mechanics play another significant role in it. Further, one solution could also be to create an attachment for already existing blasters.

Therefore a focus area needs to be defined before the start of the ideation process. Resulting from research three different options are possible:
1. An adapter for a blaster
2. Changing the game mechanics
3. A new blaster

Adapter

Instead of creating an entirely new blaster an option is to create a device which makes a "regular" blaster usable for CwPD. A rough and basic example would be a simple rope tied to a blaster's trigger. In that way, one could activate the blaster by pulling at the line with, i.e. one's teeth. Such an adapter is a good direction; however, it is highly dependent on the blaster. Every blaster has a different form, weight balance and mechanics. A universal adapter would end up to be a complex device. Further, certain blasters are not everywhere available. Needing to buy a fitting blaster and the adapter separately could be difficult.

Game mechanics

Changing the game mechanics would be another possibility. For example, an autonomous electronic target that can just be beaten through cooperation. However, that demands to be able to operate a blaster. In that case, the product wouldn't support the inclusion of children into the game.
Further, the game mechanics are mainly set by the players. This can be observed every time children play with each other. They hardly like to stick to given rules and instead come up with their own ones. Thus a change in game mechanics should just be an option and not forced upon them. By introducing a new type of toy, the creation of new rules can be triggered. Giving them a free choice might even increase the opportunity that children would create a game which includes CwPD.

Blaster

Due to the previously mentioned reasons, the best choice is to go for the design of a new blaster. It is the best way to bring more children into the game of NERF. Besides, it can promote a change of the game mechanics, due to its new way of functioning. Further, a blaster which is fitted to the needs of a CwPD would create a message of respect and acceptance than, i.e. just an adapter.
In addition to this, the to be designed blaster should be an electric one to be able to use various forms of input.

One example

Resulting from the research a wheelchair user was taken as the archetypical example. When actively using a wheelchair one lacks the movement of one's legs but is also restricted in arm/hand movement. This is an excellent simplified representation of the abilities several disabilities share. Since the to be designed product is not depending on fine details, such an abstract image can ease the design process. It reduces the confusing amount of disabilities to one tangible example.

How-To

From this, the How-to-question „How to use a NERF blaster with varying degrees of using one's hands" was formed. Solutions for this How-to-question were gathered with three different levels of severity in mind

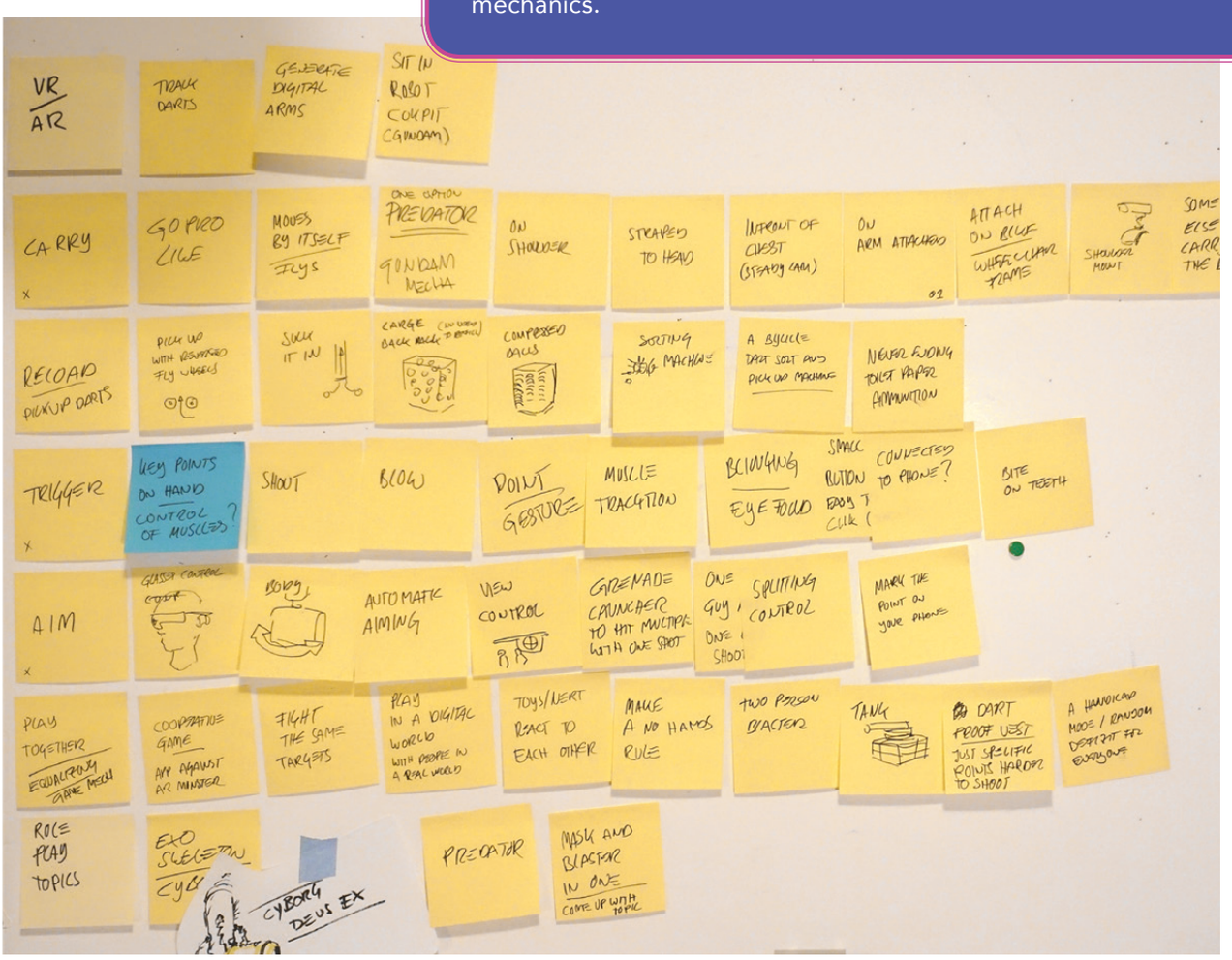
1) Quick hand movements possible
2) Gross hand movements possible
3) No hand movements possible

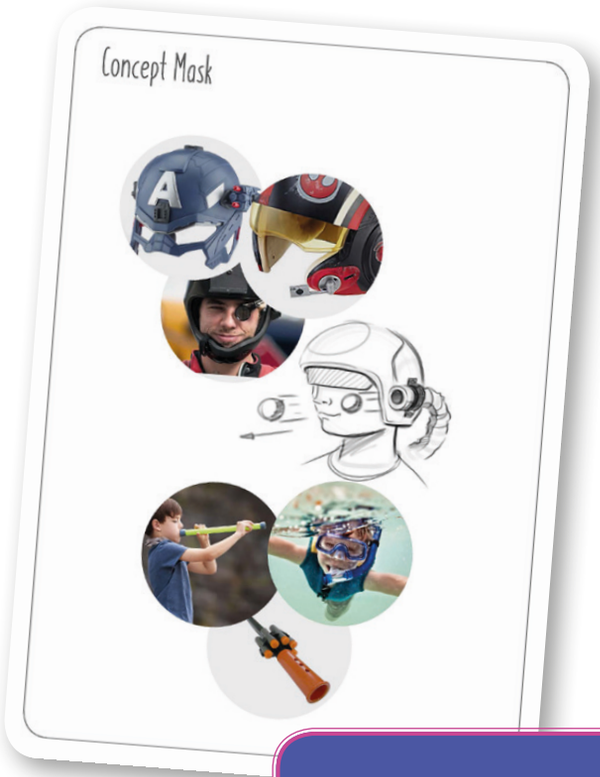
7.2 Ideating

7.2.1 First Ideation Round

As described, it was decided to focus on the design of a blaster. To do so, a morphological chart was created. The separate columns were defined by the main interactions necessary to operate a blaster.

Further, a column was added regarding the change of the game mechanics.





The outcome of the first round of ideation were four direction drafts.
Concept Mask: A blaster and mask combination which gets triggered with the mouth
Concept Predator: A shoulder mounted blaster activated with the eye
Concept Cooperation: A VR zombie game; keep together your neighbourhood clean from zombies
Concept Go-Pro: Be free where you want to place the blaster

7.2.2 Feedback Occupational Therapist

To evaluate the first draft directions a meeting with an occupational therapist was conducted. Prior to the meeting, he was asked to watch a video for preparation, that showed a game of NERF.

At the start of the meeting, the direction drafts were explained one by one. Printouts in A3 were used during the discussion as references.

The initial question was:
How would he evaluate the presented concepts, regarding feasibility and practicability for a CwPD?

Regarding the input device, he mentioned that the use of the mouth, shouldn't be a problem. From his point of view, using the head to spot the target is a natural way. Thus, he would recommend it more than mounting a blaster on the shoulder. Further, he mentioned that the head is, in general, easier to adapt to since the shoulder proportions can differ more than the heads circumference.

When it came to VR, he was in favour of the idea to keep the zombies out of the street, because it would enable every player to play at their own pace. However, from his point of view, the game should always include real physical activities. He understood that it shouldn't be used for therapeutic reasons, but making it too simple for the children could damage their development process.
Therefore, he would prefer real life targets instead of VR.

In addition to this, he mentioned that he also sees a considerable challenge in picking up the darts and reloading the clip. This issue was already recognised during research but was neglected to that point.

Conclusion

From the meeting the following insights were taken:

-Add a direction regarding clip reloading

-Consider the creation of real-life digital/ active targets

-Look into biofeedback devices as inspiration

-Keep in mind that the toy might be adapted, maybe open source is interesting

7.2.3 Second Ideation Round

The second ideation phase was started with evaluating the feedback from the previous meeting.

It was decided to add a direction regarding picking up and reloading darts. The reason for this was its expected impact regarding accessibility.

The option of a VR game or real-life interactive target should be seen as an add-on. As described at the beginning of the chapter, just the change of game mechanics don't enable a kid to use a blaster.

Biofeedback devices like muscle and brain activity sensors were taken under consideration. However, those sensors can fail easily when not placed in an exact way. The possibility of occurring failures and thus frustration by the user was too high to consider them further.

-

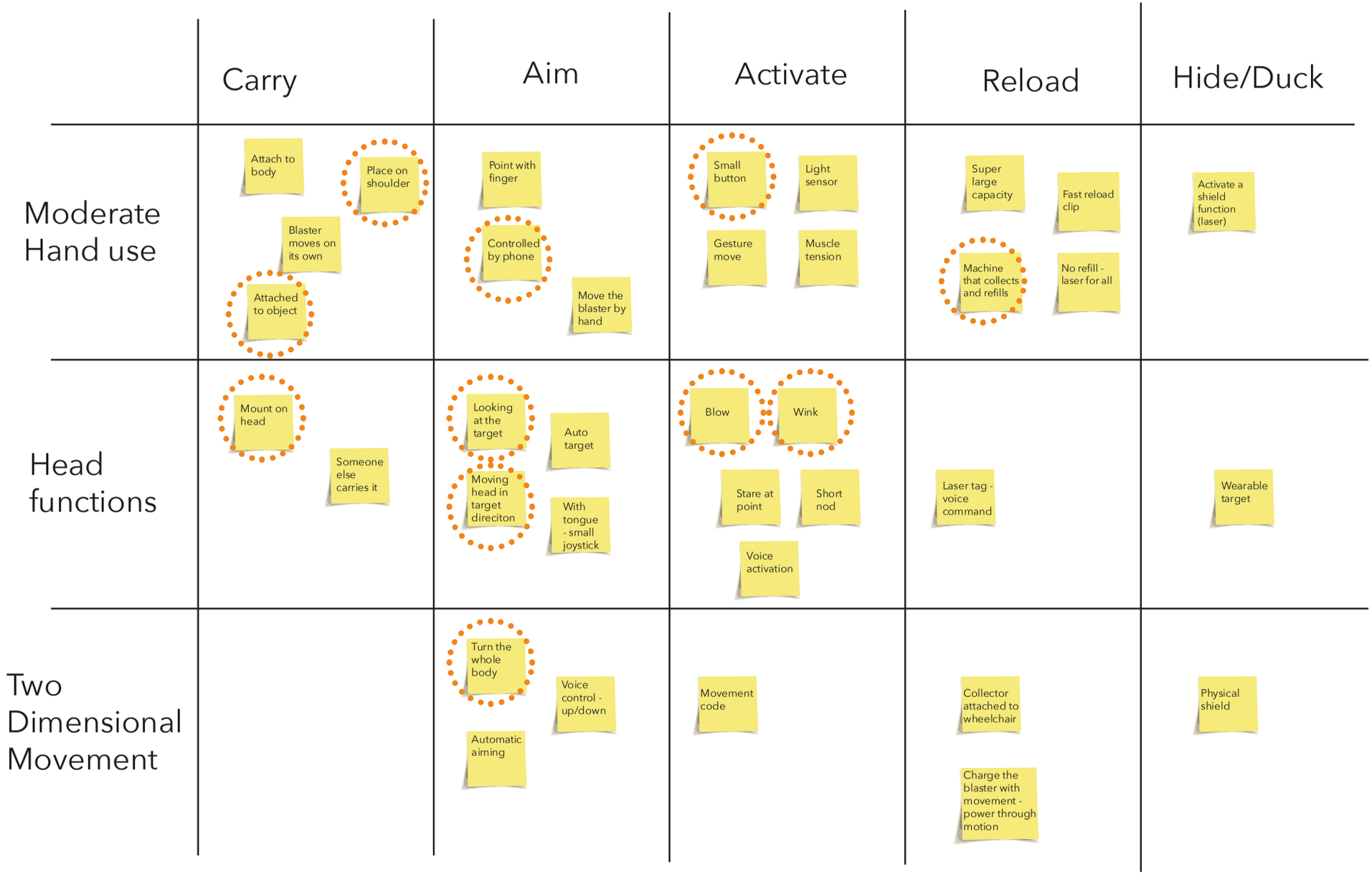
The first round of ideation was executed by using a morphological chart. However, the way how ideas were generated was not fully structured. Therefore, a more structured form of ideating was needed, to reduce the risk of missing out an option.
Inspiration was taken from the matrix used by Gielen,2005. In his approach, a selection of abilities was taken and combined with types of play to generate ideas.

For this project, it was decided to use the ICF abilities of "moderate fine hand use" - "full head functions" and "two-dimensional movement". It was decided for those abilities due to the abilities one has when operating a wheelchair.

Those abilities were combined with the functions/actions that are needed within a NERF game (carry, aim, activate, reload and hide/duck).

For each combination a "how to question" was generated and ideated upon. Out of the resulting ideas, clusters of concept directions were formed.

The outcome was that the previously created concept directions were already covering most of the possibilities. One that was added, was the collection of darts.


Carry
Aim
Activate
Reload
Hide/Duck
Moderate Hand use
Attach to body
Place on shoulder
Blaster moves on its own
Attached to object
Point with finger
Controlled by phone
Move the blaster by hand
Small button
Light sensor
Gesture move
Muscle tension
Super large capacity
Fast reload clip
Machine that collects and refills
No refill - laser for all
Activate a shield function (laser)
Head functions
Mount on head
Someone else carries it
Looking at the target
Auto target
Moving head in target direciton
With tongue - small joystick
Blow
Wink
Stare at point
Short nod
Voice activation
Laser tag - voice command
Wearable target
Two Dimensional Movement
Turn the whole body
Voice control - up/down
Automatic aiming
Movement code
Collector attached to wheelchair
Charge the blaster with movement - power through motion
Physical shield

The concept clusters were transferred into visualised concept directions. The illustrations were placed onto cards to serve as discussion material for an evaluation with a class of CwPD. This evaluation is presented in the next chapter.

PREDATOR

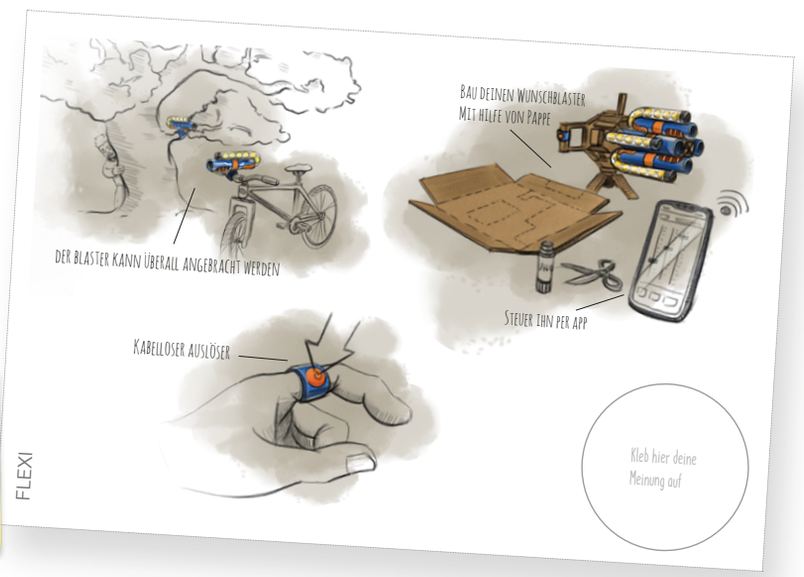
A blaster that comes in the form of a backpack. It moves in the direction to the player's view. With a wink, the blaster gets activated.

MASK

A safety mask is combined with a blaster. The heart of the blaster is stored in a backpack for more comfortable carry. The blaster gets activated by a blow.

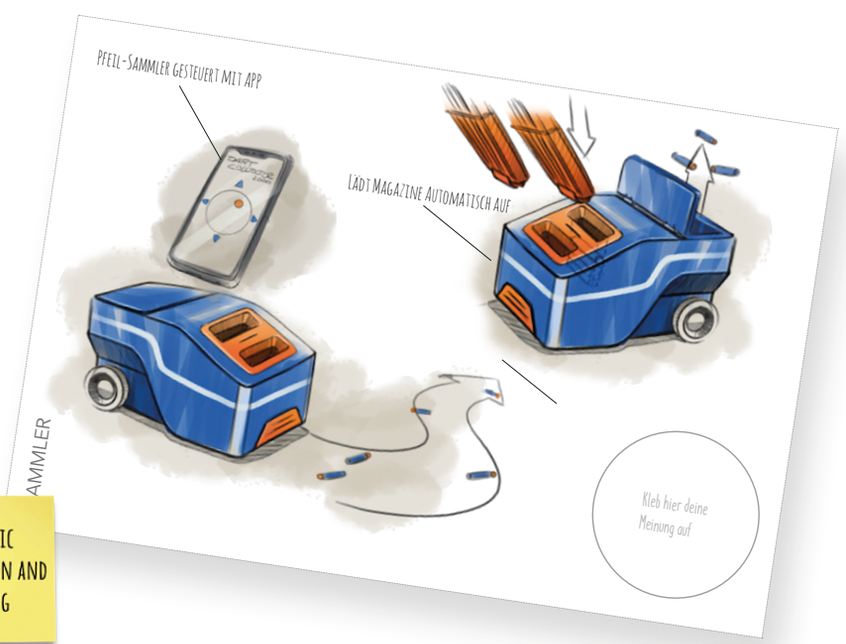
FLEXI

The core part of this direction is the separation of blaster body and trigger. This makes it possible to place the blaster independent from the player's body.



COLLECTOR

A robot like a vacuum cleaner that collects the darts on the floor. It sorts them and can reload clips.

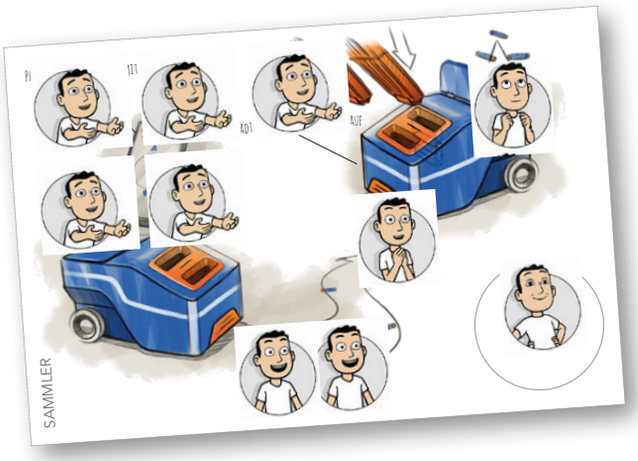


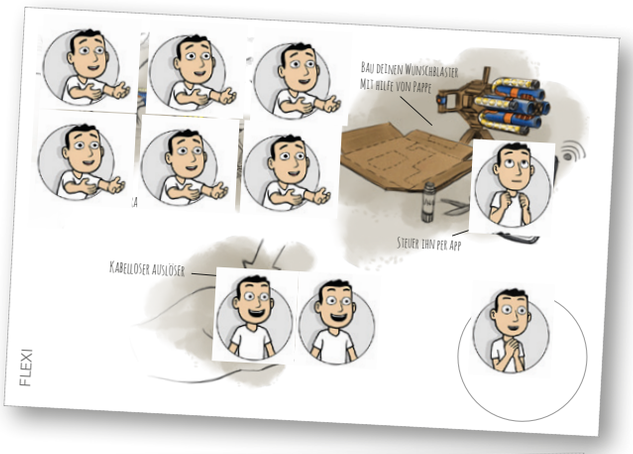
7.2.4 Feedback 2.0 children

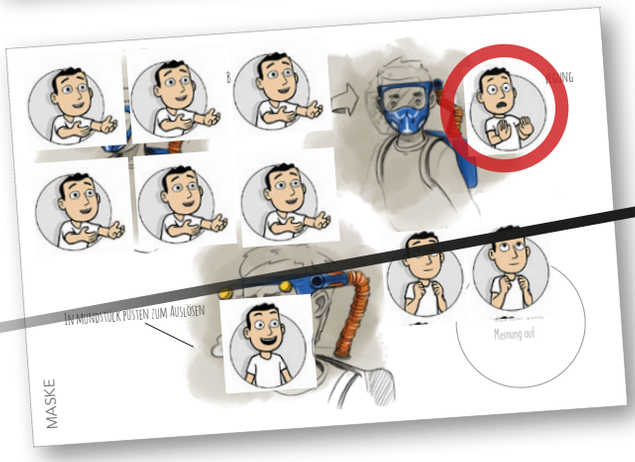
Previous to the feedback session the children were provided with a set of concept cards. Further, they got supported with a set of cards displaying the Premo faces (Desmet, 2003) (Appendix 1.8). Their task was to point out their opinion regarding the directions by using the faces.

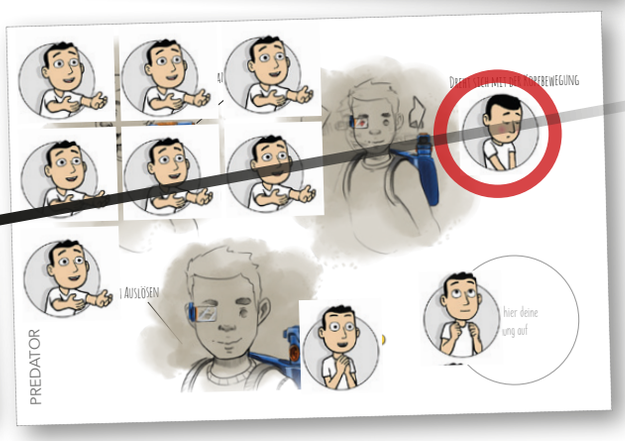
The cards were then used as a conversation starter. In groups of three, the children discussed the different concept directions. They expressed their concerns regarding accidental triggering, high weight or possible discomfort. Further, they pointed out their two favourite directions. Those were the direction “Collector” and “Flexi”. Reasons for this were the reduction of back pain, decreased the risk of getting hit and the fun of hitting someone with a dart from a hidden position.

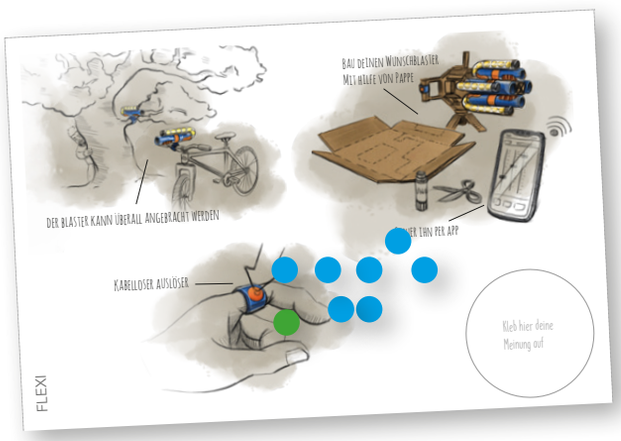
Resulting from this the directions “MASK” and “PREDATOR” were taken out of consideration.

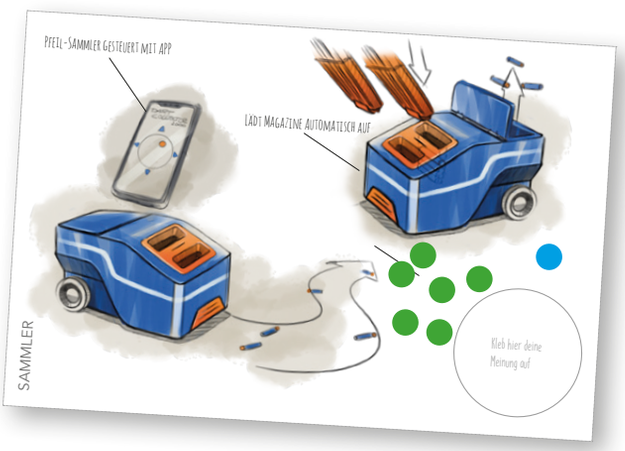

SAMMLER

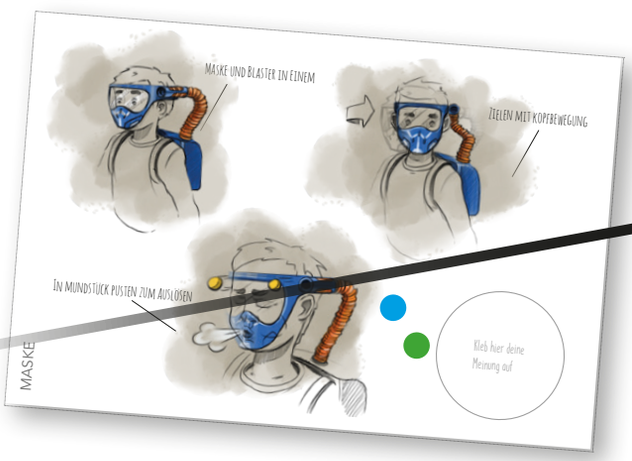

BAU DEINEN WUNSCHBLASTER
MIT HILFE VON PAPPE
STEUER IHN PER APP
KABELLOSER AUSLÖSER
FLEXI

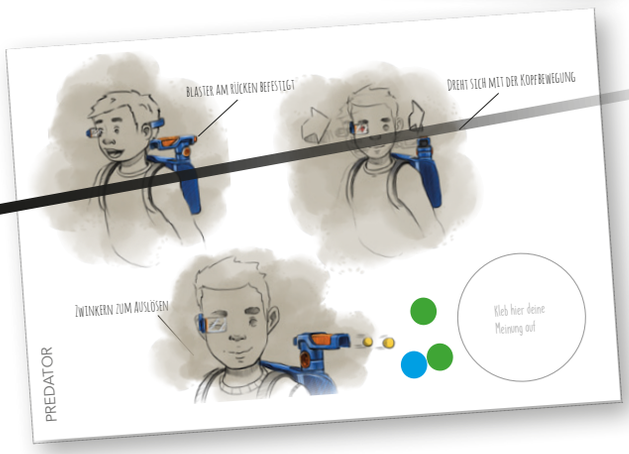

IN MUNDSTÜCK PUSTEN ZUM AUSLÖSEN
MASKE


PREDATOR


BAU DEINEN WUNSCHBLASTER
MIT HILFE VON PAPPE
DER BLASTER KANN ÜBERALL ANGEBRACHT WERDEN
KABELLOSER AUSLÖSER
FLEXI

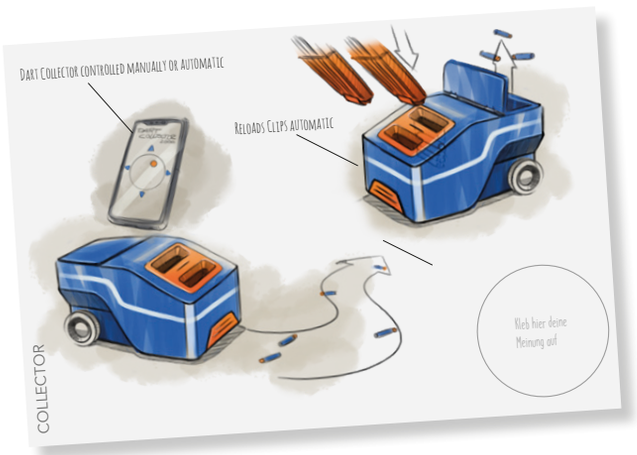

PFEIL-SAMMLER GESTEUERT MIT APP
LADT MAGAZINE AUTOMATISCH AUF
SAMMLER

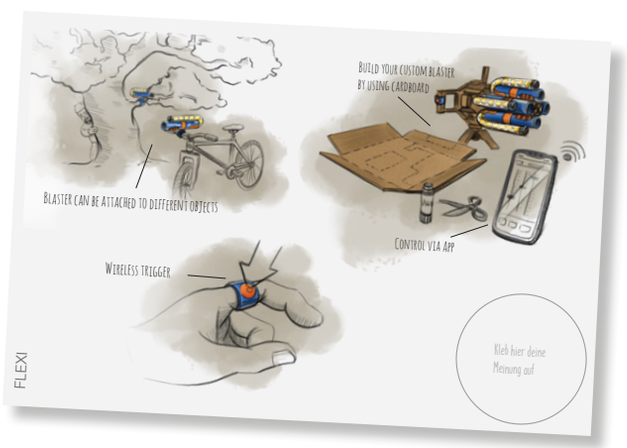

MASKE UND BLASTER IN EINEM
IN MUNDSTÜCK PUSTEN ZUM AUSLÖSEN
MASKE


BLASTER AM RÜCKEN BEFESTIGT
DREHT SICH MIT DER KÖPFBEWEGUNG
ZWINKERN ZUM AUSLÖSEN
PREDATOR

7.3 Direction Choice

7.3.1 Decision Method





Rating / Criteria	--	-	+	++
Autonomous play			■	
Adaptable	■			
Creates equality			■	
Supports social acceptance of CwPD		■		
Can use the play phase of "integration"			■	
Changing interaction with the blaster		■		

Rating / Criteria	--	-	+	++
Autonomous play				■
Adaptable				■
Creates equality			■	
Supports social acceptance of CwPD			■	
Can use the play phase of "integration"			■	
Changing interaction with the blaster			■	

To make a decision for one concept, a Harris profile was used. The previously defined guidelines were used as filter criteria. The criterion regarding the theme was left out since a topic can be applied to every product.

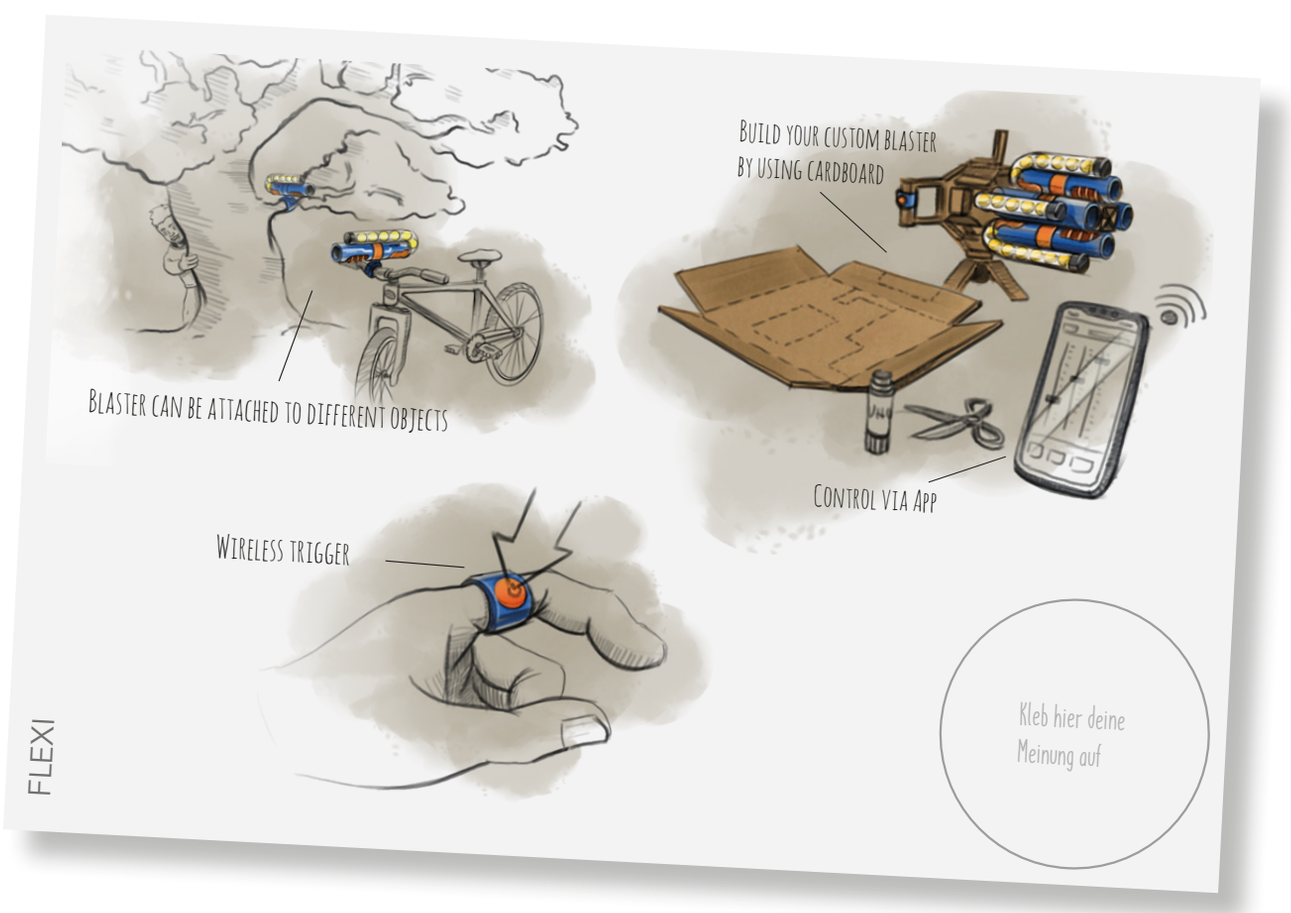
As a result of the direction called "FLEXI" was chosen. It supports autonomous play and the separation of blaster and trigger makes it adaptable. In addition, it is not just interesting for children with disabilities but also for the regular NERF customer. This is because it introduces new play opportunities like triggering multiple blasters at once or the creation of traps. In that way a different, more tactic based, game flow can be created. On top of this, such a platform offers opportunities for further add-ons. Examples are cardboard or 3D printable kits for customisation. An App could even integrate technical personalization like the rate of fire.

7.3.2 Final Direction

The main idea behind the concept direction called "FLEXI" is the separation of trigger and blaster body. In that way, it becomes possible to place the blaster wherever one fancy. To activate it, a wireless trigger is used. Due to the wireless connection, a phone App might also be an alternative option for triggering. In that case, even the sensors of the phone could be used to program automated activations. Further, e-wheelchairs have often the ability to connect via Bluetooth to devices like a PC. This could also be used to trigger the blaster.

The ability to place/mount the blaster freely makes it possible to attach it, i.e. to a wheelchair, bicycle or create traps with it.

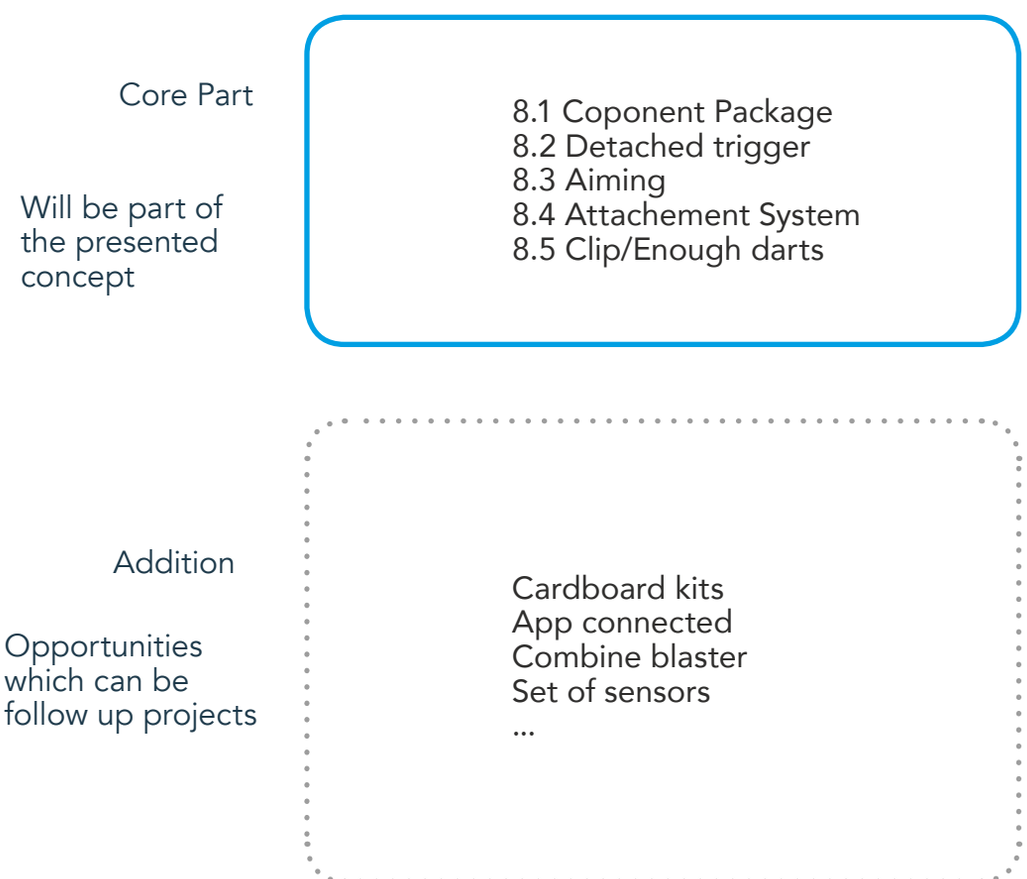
In the same way, the trigger is also free to be placed. That makes it possible to think about add-ons which allow the user to modify the blaster by using cardboard. In that way, new forms of carrying or holding it can be realised.

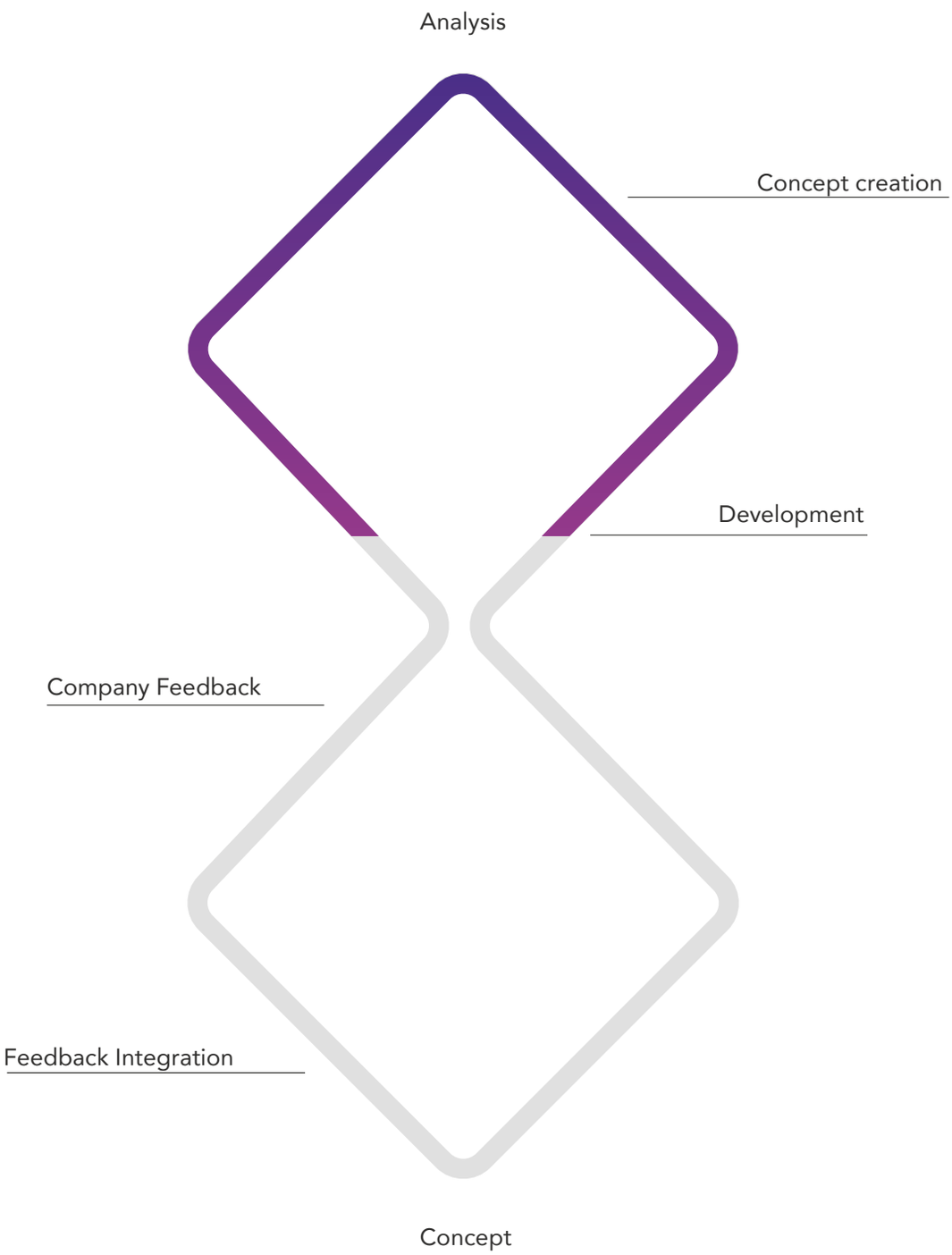


8. CONCEPT DEVELOPMENT

The chosen concept direction contained a high amount of possible sub-directions. To be able to start with the concept development, a focus needed to be set. Therefore core elements were defined. These elements form the base set of the envisioned toy. Without them, the product wouldn't work.

The following chapter will deal with the development of these core elements.




Analysis
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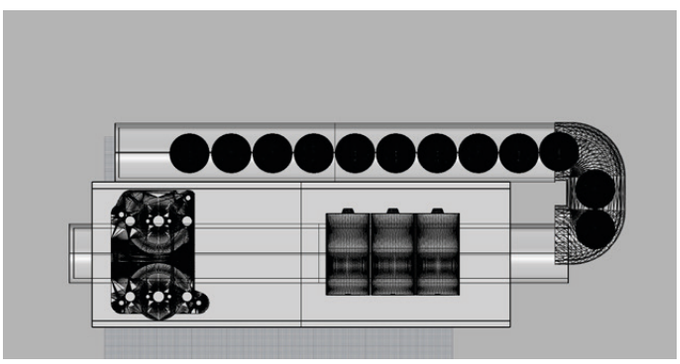
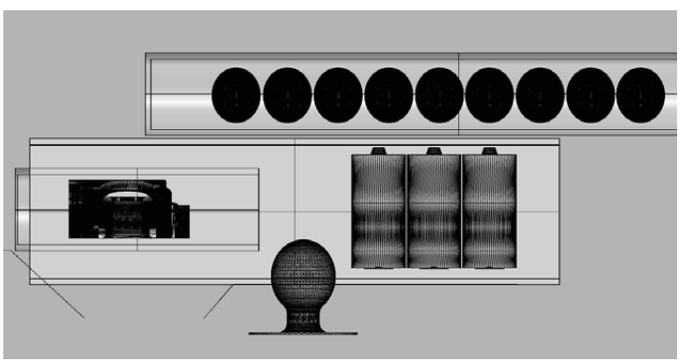
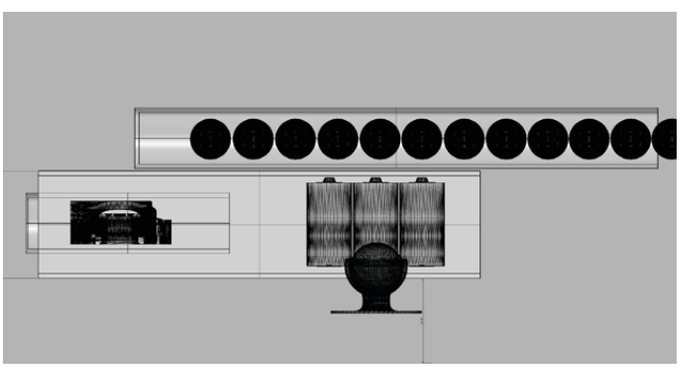
8.1 Base package

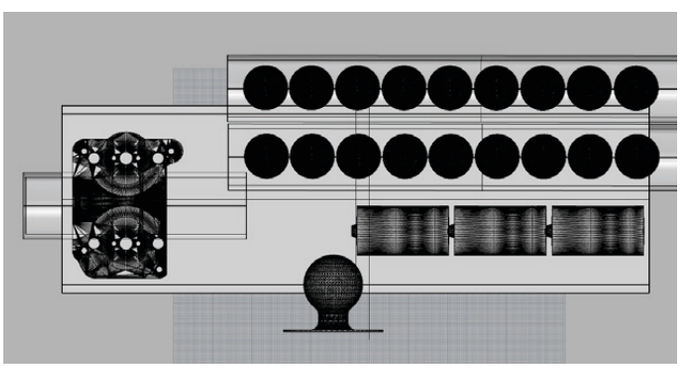
To be able to make decisions about measurements and forms, one needs to generate a basic framework first. This framework is a box in which all predefined parts have to fit in. In this case, the parts were flywheels + motors, a clip for dart storage, at least six C-cell batteries and room for circuit boards.

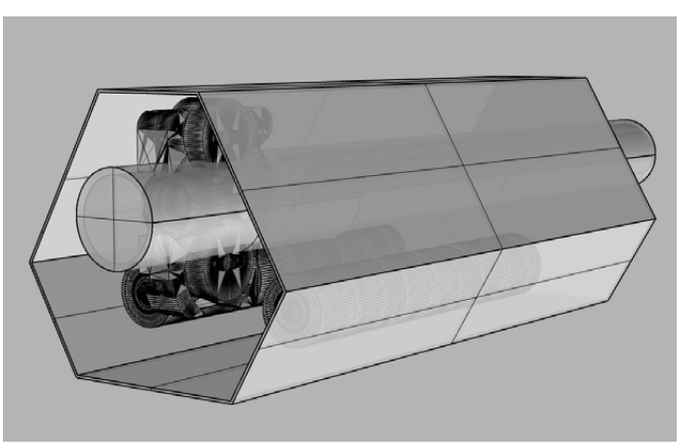
CAD models of these parts were used to try out various formations.

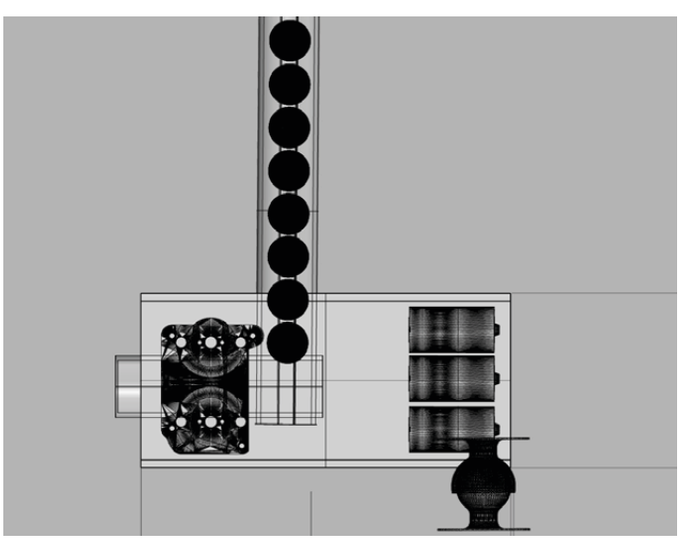




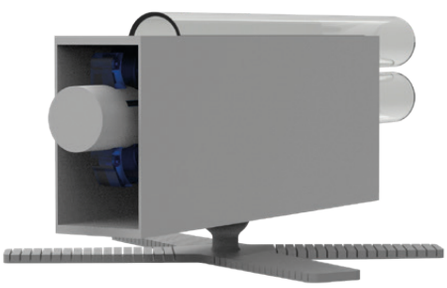


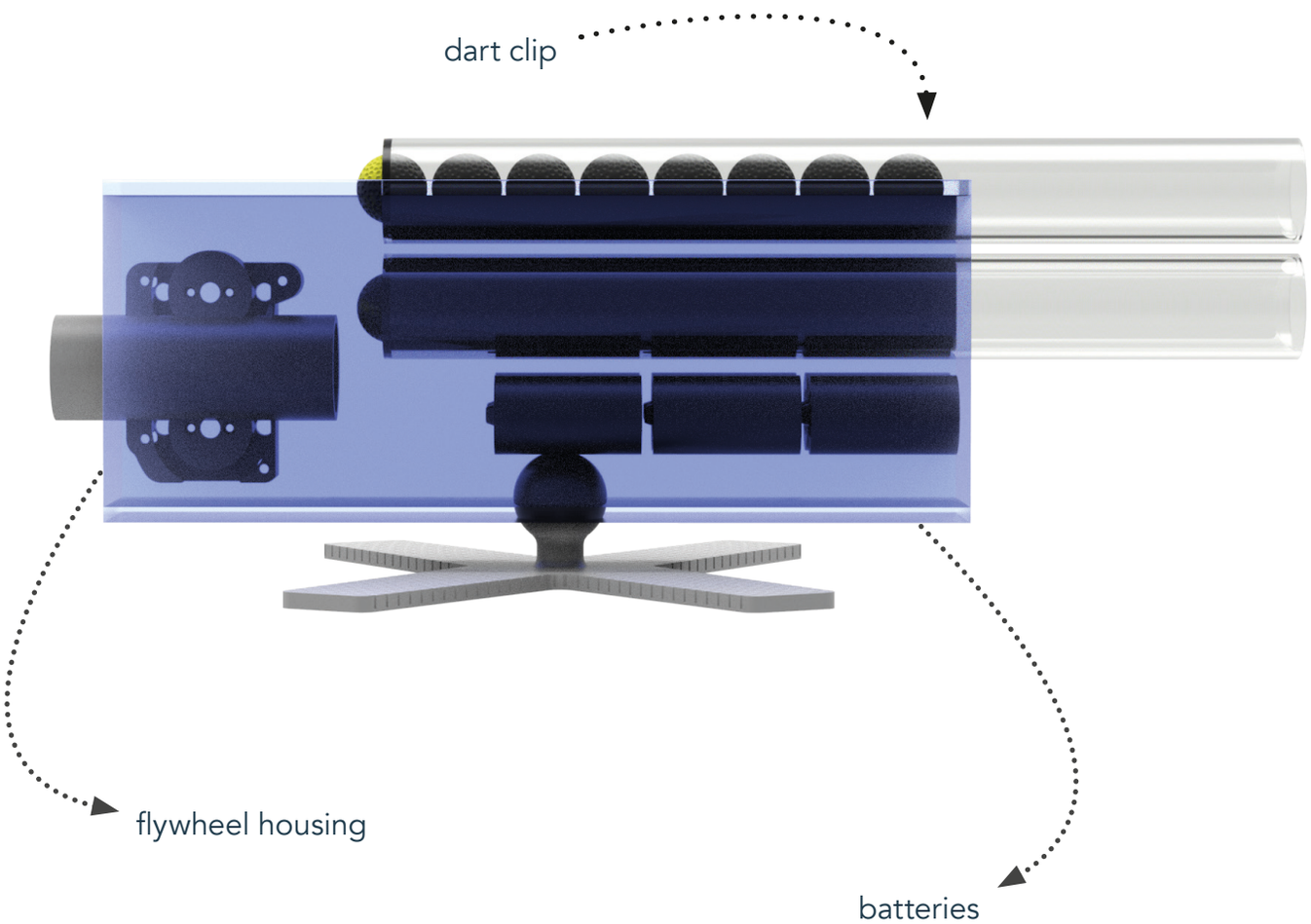






The outcome of the iterations was the version presented below. This formation created a slim profile of the blaster's body. Thus, it offers a good grip, and its form is not bulky. The later is especially important regarding the ability to place the blaster at different spots. In addition to this, it's centre of gravity is low due to the battery placement. This is beneficial regarding the ease of movement regarding aiming.





8.2 Attaching

The attachment system is next to the trigger (8.4) the most crucial part. It needs to be made sure that the blaster is attachable to objects of a small but also large circumference. Further, the system needs to be simple to use without the need for tools.

Different attachment principles were evaluated. The two most promising solutions were to use a strap or a flexible arm.

For both of these systems, a mockup was build to evaluate them.

Strap

A system using a strap to attach the blaster to an object poses various challenges. The strap needs to be detachable at least at one point to lay it around an object. This needs to be doable with gross motor skills to keep up the accessibility of the toy. Three options were considered, and it was concluded that velcro is the best option. It can be attached independent from its orientation. Further, it is close to impossible to destroy it. When too much strength is applied to it, it will just detach instead of breaking.

To increase the adhesion rubber elements need to be applied on the strap.

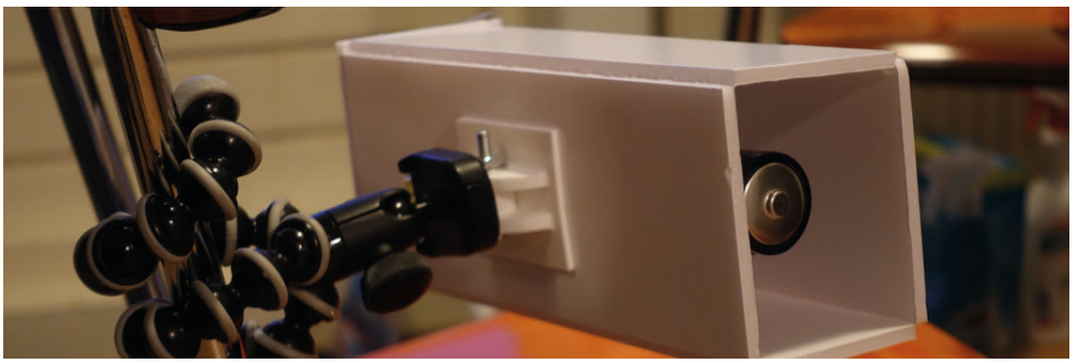
However, for smaller circumferences, a strap system is causing two issues.
1) Attaching the strap a bit further up would lead to an overhang of it.
2) Using a tightening system makes it first of all complex to operate. Also, it can lead to injuries when used in the wrong way (strangulation, bruises)

Flexible arm

Using a system like the "gorilla pods" offers various options. It can be used to attach the blaster to objects with variable circumferences. Further, it can serve as a stand and even handle. However, the system is not flexible and thus limited to a certain maximum circumference.

Combination

Due to the fact, that each solution has the others weakness as strength, it was decided to combine both. A flexible base will be used for smaller circumferences, as handle and stand. In case one likes to attach the blaster to an object with a larger circumference, a strap can be connected to the base. The strap has to be made out of a flexible fabric to allow it to stretch. A pattern of rubber pads will maintain enough adhesion.



8.3 Aiming

Depending on the place the blaster will be attached to, an adjustment of its orientation is needed. Either it is to actively aim or for making sure it shoots in the right direction.

To reach this goal the first thing tried was a combination of two hinges (img. 03): one for the X and one for the Y axe.
However, it turned out that another hinge is needed to cover the full spectrum of movement. Otherwise, the blaster could either be angled up and down or left and right.

Due to the high amount of parts, this solution was not satisfying. An inspiration for a solution was found when looking at camera tripods. The model mkc3-h01 from Manfrotto (ref.13) makes use of a ball joint. A wheel on the handle changes the pressure applied to the joint and thus regulates its clearance.

For this concept, an adjustment system wasn't needed. Therefore it was tried out to create an option which is loose enough to move but tight enough to stay in place.

To test this a 3D print and a foam board mockup were used. (img. 04)
It turned out to work well. The freedom of movement was larger than with the previous option. On top of that, the number of parts were reduced from three to one. Next to this, the ball joint can be easily detached without the risk of damaging the product. Due to this, it was decided to use this solution.

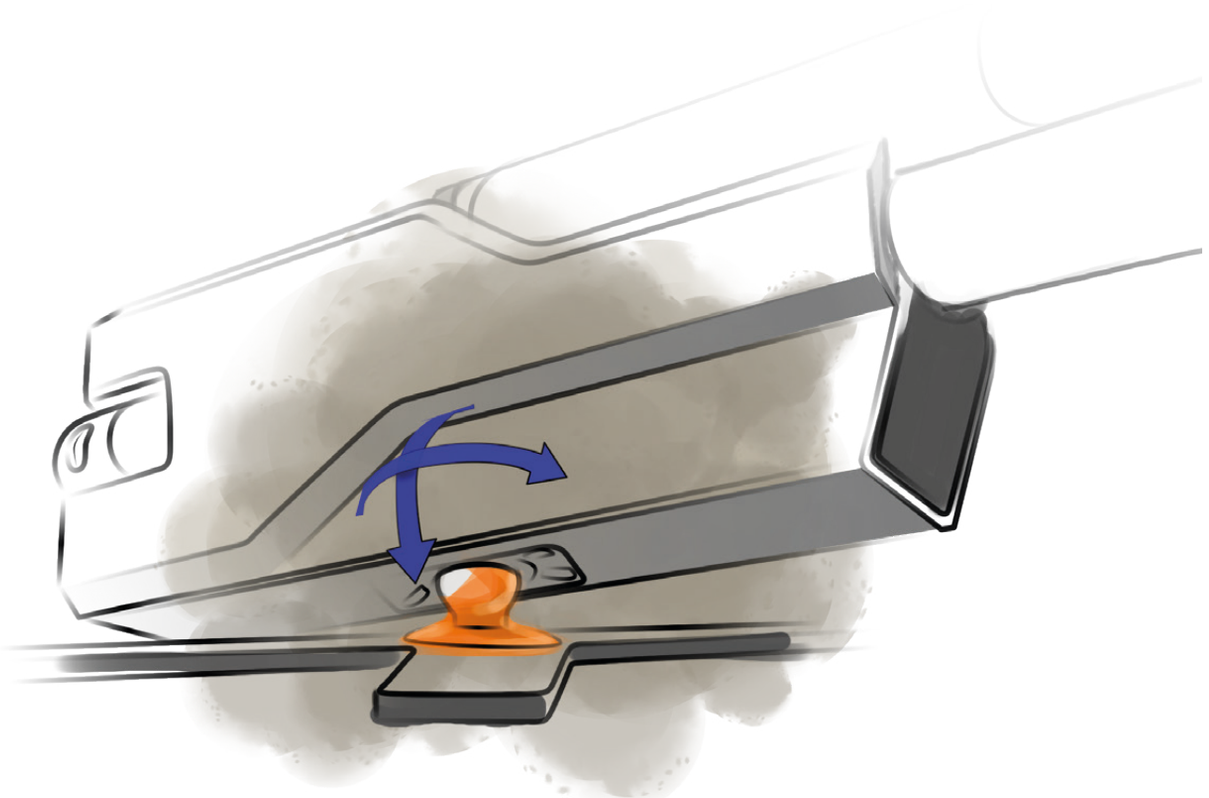
Connector

The ball joint is the connecting piece of the blaster and its base plate. The simplest option would be to attach the ball joint to the base plate through an injection moulding process. However, this part offers an excellent opportunity to make the product more adaptable. This can be done by connecting the attachment system and ball joint through an action-camera connector. In that way, it would be possible to combine every action-cam accessories with the blaster. This includes tripods, harnesses, shoulder mounts, handles et cetera.

ref.15

(img. 03)

(img. 04)



8.4 Trigger

The trigger as the primary user interface was the most crucial part of the concept. If it isn't comfortable to use for CwPD the whole blaster isn't.

As described previously it was determined that the blaster should be usable when driving a wheelchair. Because one's hands are needed to power a wheelchair, the trigger can't be held in one's hand.

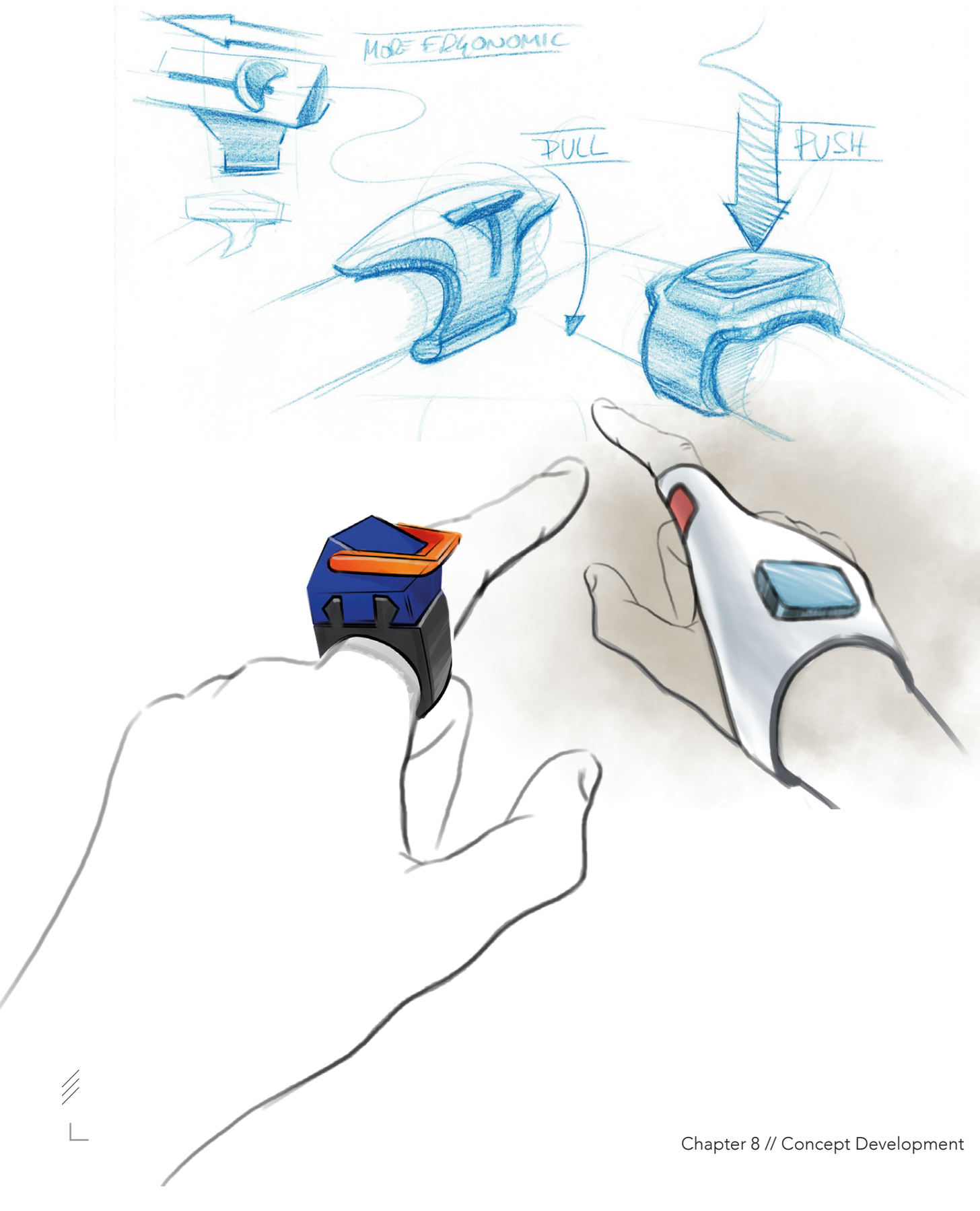
However, the trigger needs to be easily accessible as well. Out of this, the idea was born to attach the trigger to the hand. When mapping out the areas needed to power a wheelchair one concluded that attaching the trigger to one's finger would be a good choice. In that way powering the wheelchair would be possible and it is easily accessible by one's thumb.

Vibration

As described, one part of playing with a NERF blaster is the sensual play. One can feel the vibration created by the motors inside, what is a powerful feeling that is part of the blaster experience. However, this experience can't be delivered in case the blaster is not close to the user's body.
To still deliver that feedback to the user, one decided to integrate a vibration motor into the trigger. Other options of feedback that were considered were a sound module and a bone conductor. However, both require space to generate decent feedback. Integration into a hand-mounted device was therefore not feasible.

Another way to increase the experience of triggering is the form of the trigger. By using bike lights as a reference, different types of activating were tried out by the author.

The result was a form inspired by switches used in a jet fighter.


MORE ERGONOMIC
PULL
PUSH

8.5 Darts+Clip

Three different kinds of darts exist within the NERF world. Those are:

ref.16

NERF Vortex Dart

ref.17

NERF RIVAL Dart

ref.18

The disadvantage of the regular, Elite, darts is the way to pick them up. Due to their form, they can just be loaded in one specific orientation. This forces the player to pick them up and load them by hand.
Regarding CwPD the darts used within the RIVAL blaster offer better qualities.
They can be loaded regardless of their orientation. Further, the RIVAL clip can be used to pick them up. In case one has to use a wheelchair, this elongation of one's arm becomes in handy.

Thus it was decided to use the RIVAL darts for this blaster. To increase the number of darts two clips should be built into the blaster. A system that combines multiple clips is already used within another blaster. Therefore this can be seen as feasible (ref.14).

ref.19

ref.20

8.6 Conclusion

As a conclusion of this chapter, the image on this page illustrates the combination out of all decisions.

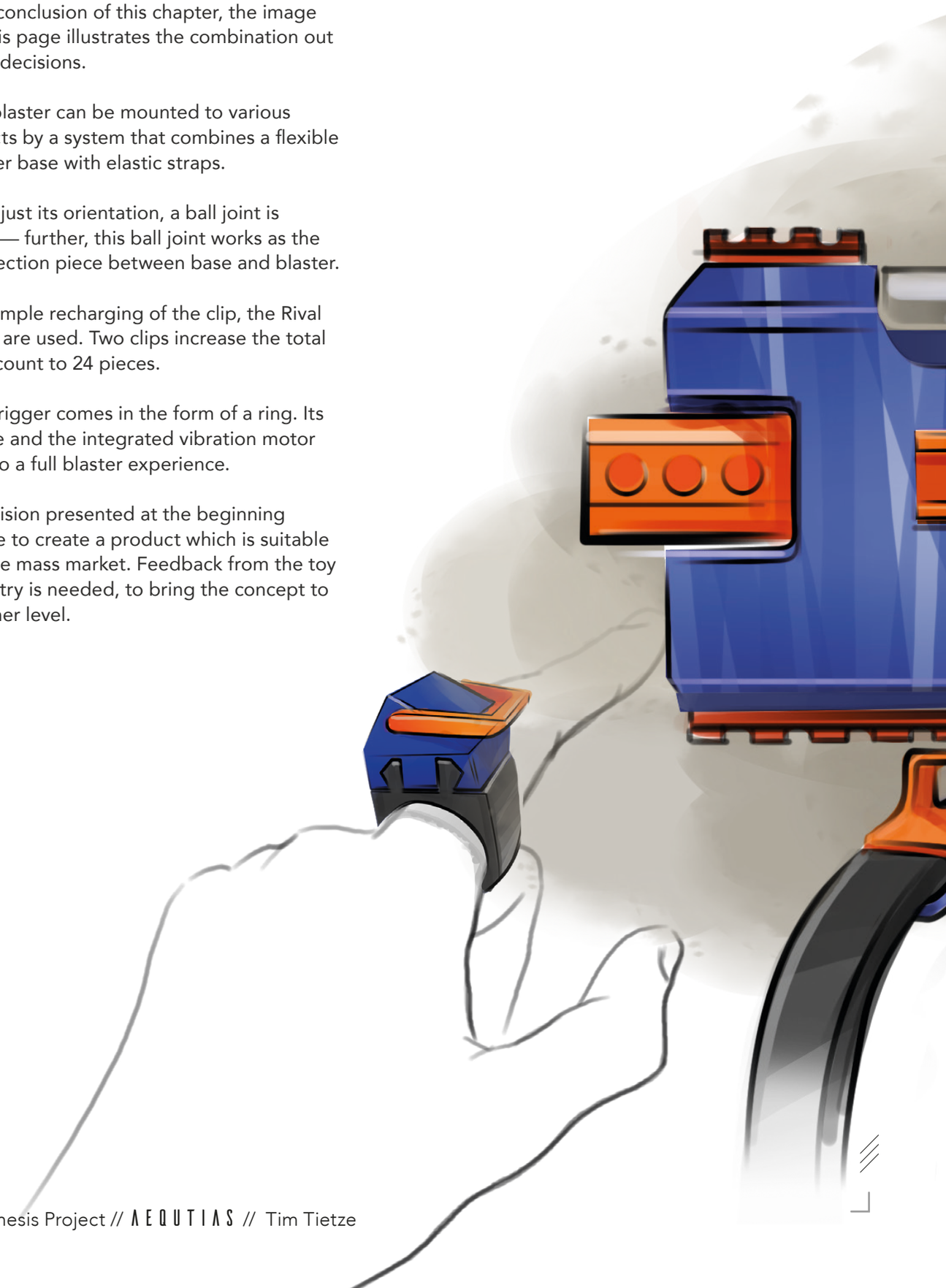
The blaster can be mounted to various objects by a system that combines a flexible rubber base with elastic straps.

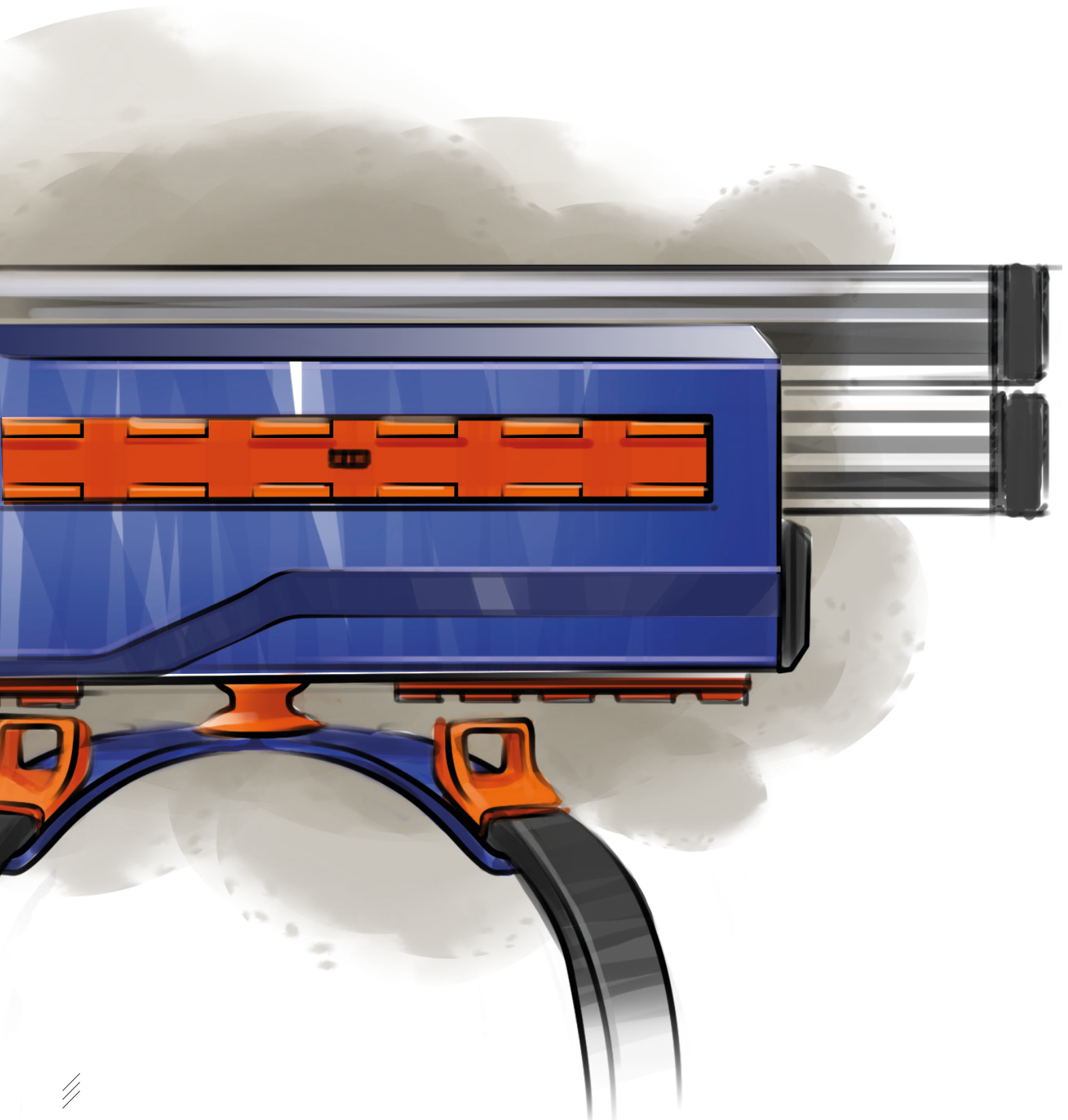
To adjust its orientation, a ball joint is used — further, this ball joint works as the connection piece between base and blaster.

For simple recharging of the clip, the Rival darts are used. Two clips increase the total dart count to 24 pieces.

The trigger comes in the form of a ring. Its shape and the integrated vibration motor add to a full blaster experience.

The vision presented at the beginning strove to create a product which is suitable for the mass market. Feedback from the toy industry is needed, to bring the concept to another level.



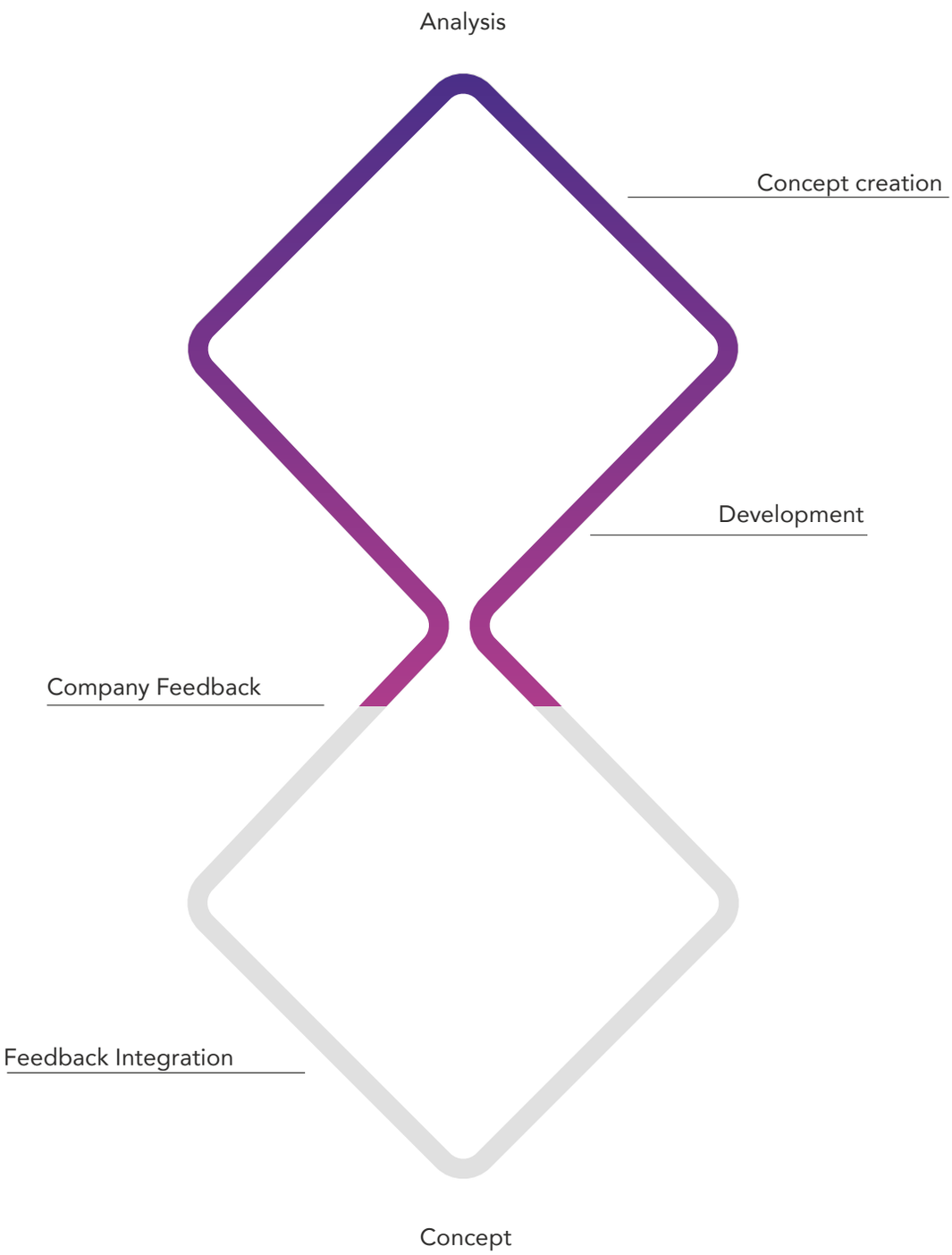


9. COMPANY VISIT

In the course of the previous chapters, a first concept proposal was created. This concept was based on information gathered through literature and field research. To go on, one option would be to stay at this stage, build a prototype, test it and iterate on the outcome. However, this would most probably just lead to the improvement of the already existing. Instead, it would be beneficial to get more general feedback about the concept. In that way, gaps can , and fresh insights created. Thus, the concept could be brought to another level.

To get this feedback, it was decided to visit the company, Hasbro.

During the visit, it was possible to present the project to ten individuals of the company. Those were engineers, industrial designer as well as marketers.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9.1 Feedback

The feedback that was given by the individuals of Hasbro was generally positive. To focus on the abilities of disabled children was appreciated by everyone. The constructive criticism that was given can be combined in the following three topics:

Feasibility

A wireless connected trigger was seen as a nice feature. However, the need for a wireless connection was doubted. The main reason was less the technical aspect, but rather the cost connected to it. It was proposed to hardwire it what would lower the cost immensely.
A “magical border” of about 100 dollars/ euro as the retail price was mentioned. This value shouldn’t be crossed to not deter customers from buying.

Further, the idea of creating an App to control the blaster was also questioned regarding costs. An App offers many opportunities, but it also needs to be maintained - in the worst case for a few years. High costs for its creation, plus the additional cost for its maintenance make an App to something exclusive. Without a strong reason, an App can’t just be added to a product.

However, next to the input to downgrade the concept, it was also asked to make it even more complex - more visionary. Since the project can be seen as a concept car, the costs shouldn’t hold one back from going visionary. Ideas of having an automatic targeting system or a motion-controlled joystick were mentioned. To keep it on a semi feasible level regarding costs, it was proposed to create a levelled system. A base system should be generated which can be upgraded by add-on kits. In this way, a child could step by step buy all functions.

Another point that was needed to be clarified was if it is possible to use third party triggers. As explained there was the idea to use an electronic wheelchair’s joystick to control the blaster. However, it was stated by the company that due to safety reasons it is not possible to create an open system. That means to connect the blaster with unauthorised third-party products isn’t allowed. Resulting from this, another way needs to be found to make the blaster as accessible as possible.

Usability

A big point of critique was the trigger. It should be more universal. A ring was critiqued to be too difficult to slide onto a finger. Further, it resembled less the actual way of triggering.
As an input for a universal trigger, the inclusive X-Box controller was given. A device which allows users with gross motor skills to control a video game (Appendix 1.6) Another input was to create a joystick-like trigger and sell an easy to produce

aftermarket kit. This kit would allow users to adapt it to the unique needs of CwPD.
Next, to the trigger, the use of two clips was also discussed. Instead of using clips it was proposed to use a hopper (Appendix 1.9). It would store more darts and makes reloading easier.

Widen the user group

During the company visit, it was stated that girls are now also presented on the regular NERF packaging. Before that, it was only boys, and a special girl line was created (NERF Rebel). However, it got recognised that the girls favoured playing with the "boy" version. Representing them now on the packaging signalises that they are part of the community - part of the game. This is a message that should also be created regarding CwPD.

Story

Everything is possible - but what is the story behind it? This was one of the biggest and least suspected takeaways from the meetings. It became clear that a significant part of a toy is its story and the way this is presented. This gives the toy the right to exist. It is not just about playing with the toy; it is the whole journey from getting to know the product, buying it, unpacking it, to finally playing with it. These were things that weren't considered to this point. However, it became obvious that they need to be fixed to give the concept a stable structure.
This also includes to make persona and go through their possible customer journeys.

9.2 Resulting Tasks

The received feedback can be separated into four main parts of the blaster.

1) Positioning/ Story
2) the trigger
3) the clip
4) visionary levelling outlook

To go on in the most effective way it was needed to set levels of priority.

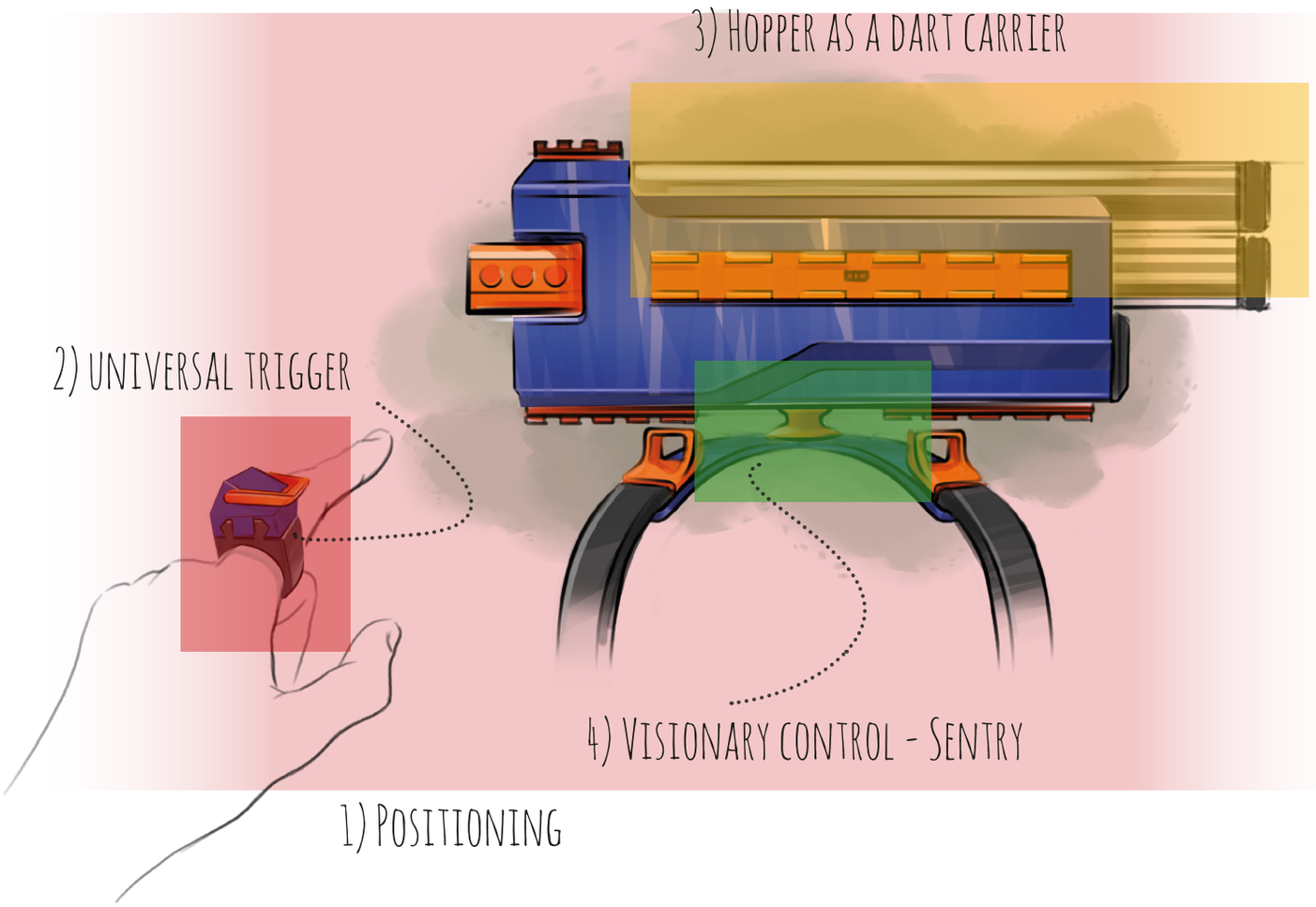
The first point one had to work on was to define the position of the product. It was highly needed to determine what the product's identity is. What should it communicate and to whom should it be targeted?

Secondly, the trigger needs retouching to become more universal.

In comparison to the parts just mentioned, the clip, as well as the visionary outlook, are less important to focus on currently. Without a more clear definition of these parts, the blaster concept would still be coherent.

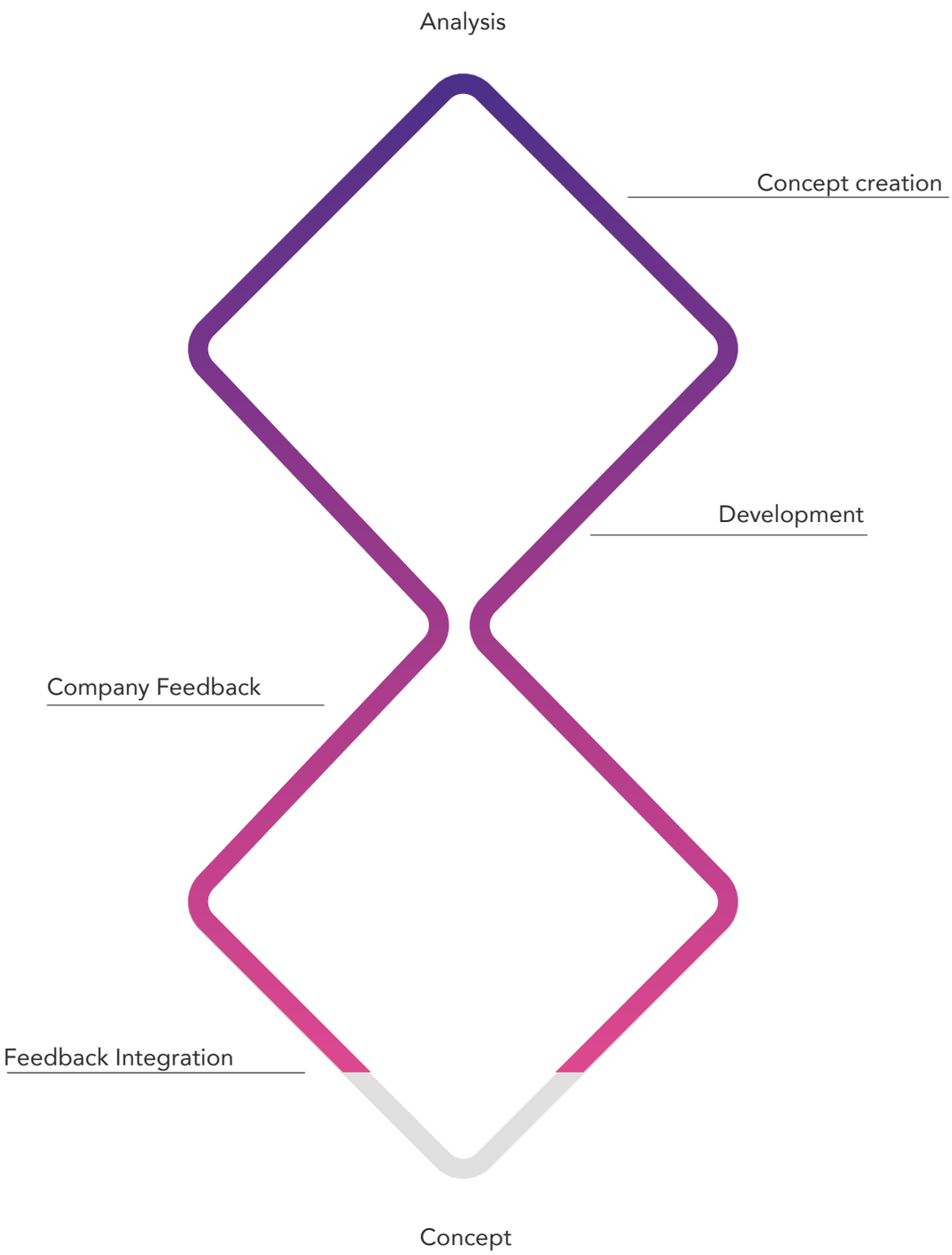
The image on the right side highlights the focus points. The more red, the more critical it is to focus on it during the rest of the project.

Focus Points



10. INTEGRATION OF FEEDBACK

The previously defined focus points will be further developed within this chapter. The chapter will describe the steps taken to come to the final concept.


Analysis
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10.1 Positioning

It was needed to define how the blaster should be positioned. Is it more targeted towards CwPD, a hybrid, or should CwPD be held in the background? To achieve a certain goal with a product, a good story is needed. It defines the character of the product. A coherent story transforms the toy from a simple piece of plastic into an experience.

In the case of this project, the positioning is highly related to the topic of stigma. Depending on how much the CwPD are placed in focus it could lead to a stigmatising effect.

The project started with the idea to create a product which is explicitly not labelled regarding disability. This was done to get rid of a possible stigmatising effect. However, during the company visit, it was stated that girls are now also represented on the regular NERF packaging. This gender issue made the author reconsider his main idea. What if showing that the product is for CwPD has a more positive than adverse effect?

Stigmatisation is focused on something negative, something that someone can not do. By representing a disabled child on, i.e. a packaging this wouldn't be the case. It would be the opposite of a stigma. Instead of discouraging someone it could have an empowering message of "you are part of us".

Therefore, the final concept should focus on delivering a full consumer experience to the CwPD.

There were three different options of how the product could be positioned.

1) Focusing mainly on the regular child - the CwDP is just an "add-on."

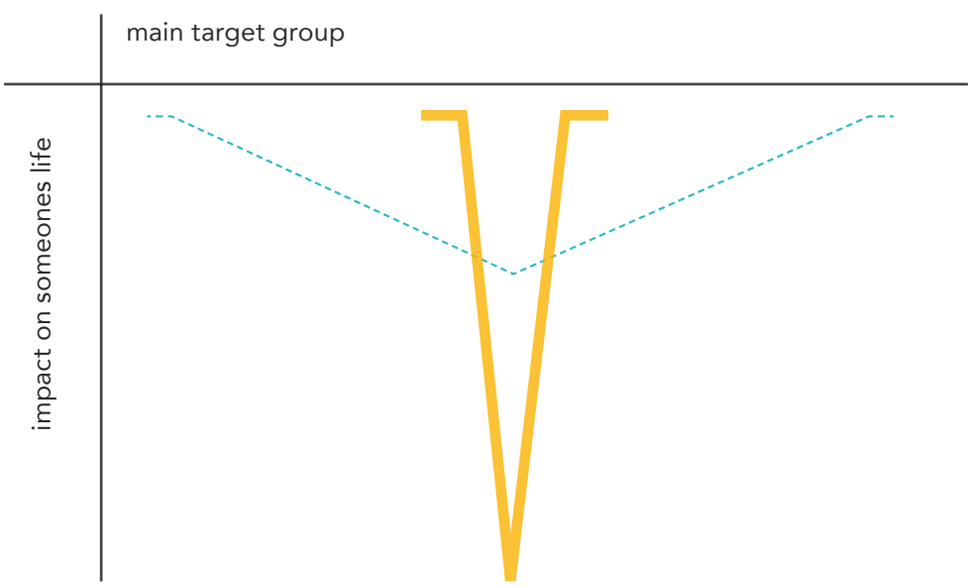
2) Focusing and satisfying both needs equally

3) Focusing more on the needs of CwPD

Concluding from the previously described, it was chosen to go with having a focus on the CwPD. Their consumer journey should work well and should not be hindered by situations that could cause a feeling of failure. That doesn't mean that the product will be unusable or "uncool" for other children. It just means that in case a decision needs to be made it will be decided in favour of the CwPD. In that way, it is ensured that the toys impact is significant enough. Regarding to create, an inclusive effect acceptance plays a major role. It is a good step in the right direction when the product itself already expresses this acceptance.
Due to this, the product's packaging should already communicate this acceptance. In the same way, as female characters were added, the blaster's packaging should feature characters within a wheelchair.

Further, the product should be advertised using social media. Youtuber with a disability should be asked to review the blaster and thus spread the information. In addition to this, a short video should be created which shows that NERF has the power to bring people together.


CwPD
able-bodied


main target group
impact on someones life

10.1.2 Feasibility vs. visionary

Within the given feedback the opinions differed. The designers were asking for more visionary ideas, which might not be immediately feasible but show up a great direction to go to. However, if it were up to the engineers the project should become more viable. Means considering hard-wired solutions as well as figuring out mechanical details.
In the course of this project, it was just possible to decide for one of they both directions. Either to end up with a coherent story or detailed mechanical solutions.

The "feasibility" option is supported by the fact that one would end the project with a blaster ready to be prototyped.

However, when deciding for this direction, one would neglect the analysis outcome. As described before, the toy itself is just one part of creating an inclusive effect. The creation of social acceptance and the support of self-esteem are other relevant parts.
Further, the technical aspects of the herein presented concept are not unique. Technical challenges can be solved by adapting already existing solutions of other blasters. Thus, there is a more substantial benefit when focusing on creating a coherent story, than ending with an elaborate technical product which has no raison d'être.

To generate this message of acceptance, it is needed to provide a full consumer experience to the CwPD. This includes advertisements featuring CwPD, representation within social media as well as on the product's packaging.

A further option is to use the blasters topic. As described, every blaster belongs to a specific overruling topic. This topic defines the way of styling and offers the option to go into role play. As described in chapter 6.4.1 CwPD try to point out their disability as something unique and cool to lower the lack of acceptance. For example, their wheelchair becomes part of the game and becomes that "special" item. e
Out of this insight, the idea arose to choose a topic for the blaster which positively represents disabilities.

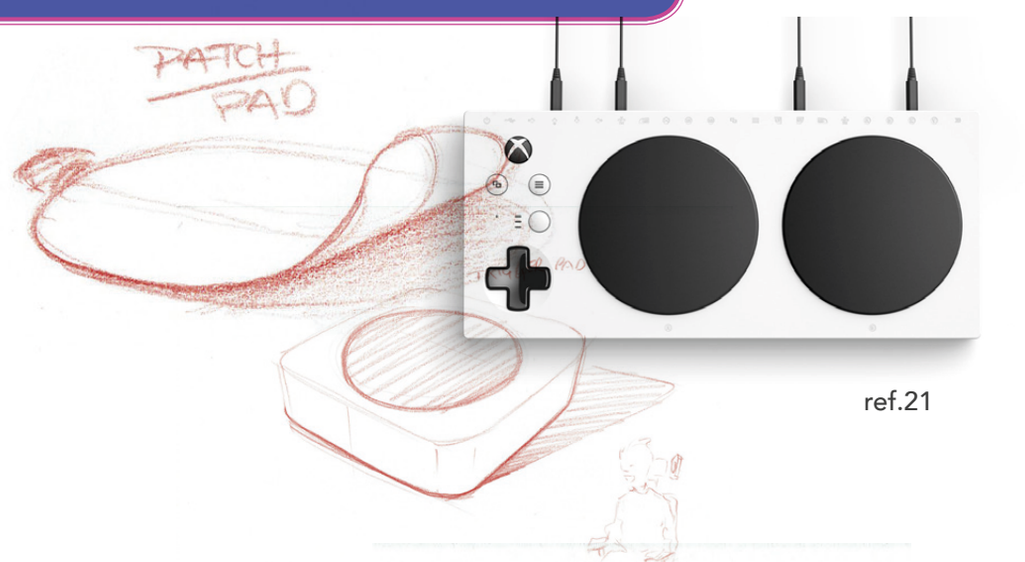
The topic

The inspiration for the topic was taken from the 2000 video game Deus-ex. The game plays in a future scenario in which humans can adapt their body with highly advanced technical parts. What is nowadays seen as a disability, prosthesis/exoskeleton, is in this cyborg world the must-have item.
To adapt one's own body with an electronic device that improves one's abilities is exactly what the "aequitas" blaster concept is striving for. Thus, the topic of "cyborg" was chosen.

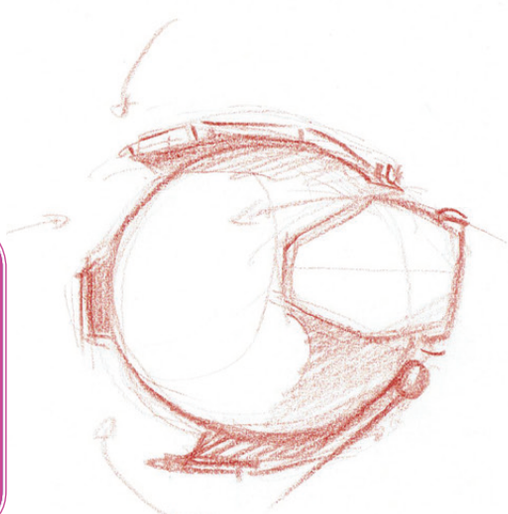
A further benefit of this topic is that its relevance is steadily growing. Instead of being based on a popular movie theme, the topic is taken from real life. From year to year the augmentation of the human body increases. Smart-watches and augmented reality glasses made the start for a cyborg future.

10.2 Trigger

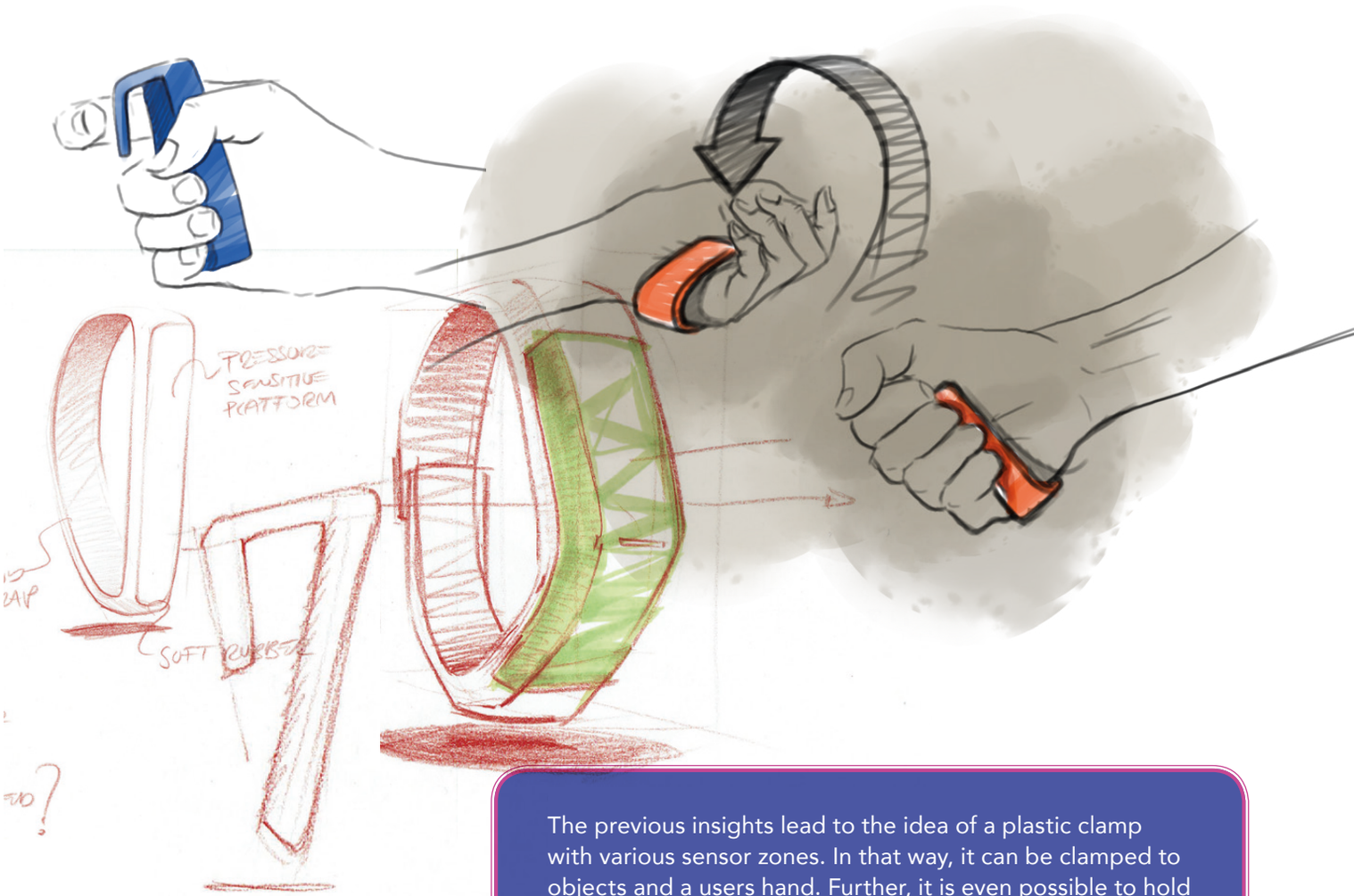
According to the feedback the trigger needed to become more universal. For this, theadaptive X-Box controller was taken as inspiration. A first attempt was the idea of a pressure sensitive pad. It could be placed in various positions. The pressure sensitivity would allow the user to trigger in whatever way one could apply pressure on it.



ref.21



To increase the haptic feedback, it was considered to use a ballow instead of a flat pad.
However, neither pad nor bellows were easy to use within a wheelchair. They couldn't be securely attached to the user or the chair.



The previous insights lead to the idea of a plastic clamp with various sensor zones. In that way, it can be clamped to objects and a users hand. Further, it is even possible to hold and trigger the clamp variant like a pistol grip.

However, this variant still required a lot of hand movement.

By dismantling a blaster, one recognised that the trigger is always created out of a standard switch which gets activated through a plastic part. This plastic part can have various forms. Out of that insight, the idea arose to create a trigger module which can be combined with different cases. The base set of the blaster would come with a trigger module and two trigger cases. A website could provide the option to order different shells through a 3D printing service. These shells can be designed by the company or uploaded by a community.
The modular system offers the opportunity to even integrate different forms of interaction like motion or voice control in the future.

More platforms for order or download on toybox Tools

ref.22

Comes with „wristband“

10.2.2 Trigger Test

The trigger is one of the most critical parts of the concept. In case the UI fails, the rest fails as well.

Ways of triggering like using motion, muscle tension, vacuum sensors or voice control were considered during the process. From a pro-contra argumentation, it became apparent that a basic switch would be the most useful trigger. Due to its simplicity and the possibility to change the way of how it is pushed (large surface, flip action, hitting etc.) it enables differently skilled people to manipulate it.

However, there were also other forms like voice activation or motion activation, which would be interesting to consider. Therefore a test was set up. The intention was to see what the children's initial idea of triggering a blaster is like. Further, it should give insights about the children's opinion on different kinds of triggering like voice activation or motion. These insights can be used to create an outlook for further developments.

It was decided to execute the testing in a wizard-of-OZ way. This means that the presented triggers are just dummies. To activate the blaster, a hidden switch was operated by the interviewer.
To do so, it was needed to build a blaster that can be triggered wireless. For this, a "NERF Speedswarm" blaster was dismantled (Appendix 1.10). The core elements were simple and small enough to be modified. The mechanical switch was removed. Afterwards, an electronic relay, controlled by an Arduino, was used to trigger the blaster electronically. For making it wireless, first, an infrared connection was used. However, it turned out that it was too inaccurate to create a convincing wizard-of-oz experience. Resulting from this, a radio frequency module was integrated. This made it possible to trigger the blaster indoors from up to 40 meters away. After building a case for the switch, the antenna was not strong enough to transmit the signal reliably. It was solved by cutting a hole into the housing so that it was possible to touch the antenna. This lead to an increase in transmission since one's body was used as an amplifier. For a further prototype, it is needed to increase the power at the transmitter and/or switch to a more powerful RF module.

The test took place in the same class as described in chapter 7.2.4.. This class is part of a school for CwPD. In total the class contains 10 children. However, due to sickness, just seven children were able to take part in that test. Further, one child was allowed to participate but didn't give permission to take pictures/video/sound recordings.

The test was separated into three parts:

1) The children got an abstract white trigger (white object in front of boxes). It had as less use cues as possible. They got asked to trigger the blaster in whatever way they could imagine it to be used. That was done to see their initial unbiased ideas.

During that time the three prepared trigger options were hidden. That was done to set their focus mainly onto the "abstract" trigger task. After one could recognise that the children wouldn't come up with more ideas on their own the three options were revealed.

2) Three trigger options were presented to them.
- one that uses a voice command
- one that reacts to movement
- one that is activated by pushing

After trying them out, the children were asked if they could imagine another command, movement or spot to place the button. It was made sure that the order of the several trigger options differed from child to child. In that way, there was never a strong focus on the first or the last option.

3) The blaster package was presented to them, and a scenario was explained. The scenario was about being in a toy store and needing to decide which trigger to buy as an add-on to the blaster. In that way, they should start to evaluate which of the trigger options they would prefer.

Insights

The push button and the movement trigger were pointed out by the same amount of children. Also, it was determined, by talking to the teacher, that the push button would be the best solution for the quadriplegic child of the class. This child couldn't participate within the test due to sickness, and thus one needed to rely on the teacher's opinion.

Abstract trigger

It was recognized that the children weren't in need of the typical trigger like form. The abstract trigger was mainly used like a Wii remote (img. 02). A reason for this could be its form. However, afterwards, it was shown to the children that the trigger could be held like a typical pistol grip. Their reaction towards this was very neutral, and they kept on holding it differently.

Three ways of triggering

Another fascinating insight was that the movement trigger fascinated the children the most. It highly motivated them to move. There was also the input of one child, to adjust the power and speed of the blaster according to his speed of motion.

Against this, the voice activation trigger was the least favoured one. This was also visible in their motivation to repeat their action.

After trying it once or twice, they stopped "firing" and went on to the next trigger. This gives a good indication of how much fun the children had by using the trigger.

Conclusion

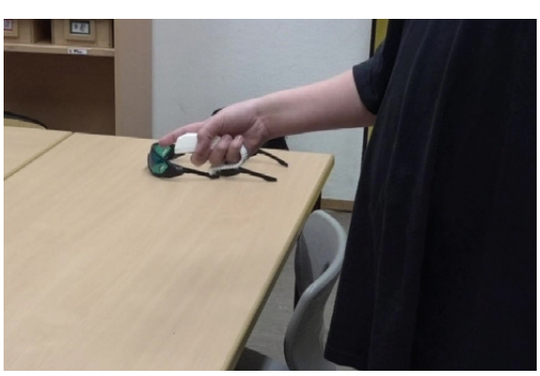
However, which of these triggers will be the one to proceed?

The answer to this is that the regular push button trigger should be integrated into the base kit. Reasons for this are:

- Least attention attracting way
- Users with different skill sets can activate it

Even though this trigger has similarities to the DIY options described in chapter 1, it is significantly different. Styling and presentation fit to the product. Instead of sticking out, the push button becomes part of the game.

However, the movement trigger should also be considered in the future. A motion-sensor module could be sold as an add-on kit. A possible integration would be a StarWars branding to use the "power" to trigger the blaster.



(img. 02)

\+ I would like to buy this one because I can do cool movements. It would adjust its power to my speed of movement.

\- Letting it hang around my neck is too dangerous. Further, others could hear me.

\+ When I am walking with my crutches, I can easily do that movement. - I don't need to hold something in my hands

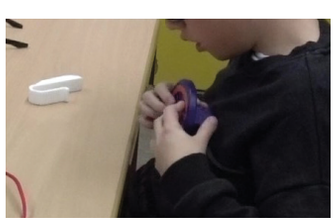
---

\+ Not an apparent reason why he preferred this over the others but would like to attach it to his arm to trigger.

\+ I also have a NERF blaster at home, and I really don't like to press that small trigger constantly. It hurts my finger after a while.

\- When I am at my grandfather's place, it will annoy him. He would continuously ask me what I said.

\- It is too annoying always to do a motion (however one has to add, that he was highly motivated and repeated the fighting action, whereas he appeared less impressed when using voice activation)



\+ I could attach it to the back of the blaster and say "shot" - compared to the other ones; it is the easiest way

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\+ I prefer the button since you will attract attention when you talk or also when you move. In case you hide from the others, they might spot you easier.

\+ I prefer the button since it has the lowest risk of failure. With the other two options, I could accidentally make a command. Further, I would like to have a camera on the device because I would like to see when I shoot someone. Otherwise, he/she might be to close to the blaster, and I hurt them.

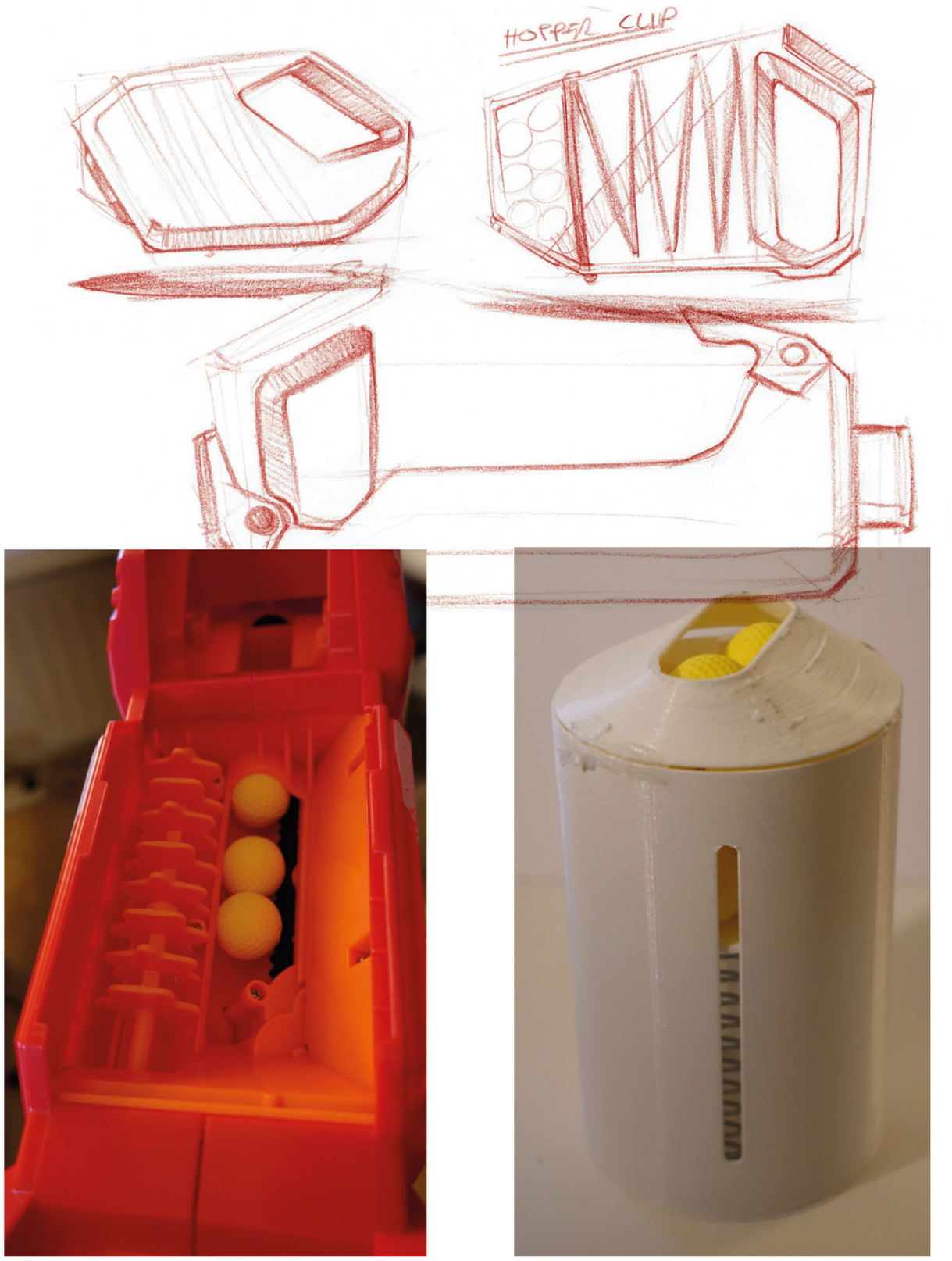
10.3 Clip

The rival blasters use two different kinds of clips. Next to the cylindrically formed ones, two RIVAL blasters use a hopper. This system is mainly known from paintball markers and can be used due to the round form of the RIVAL darts. The darts are stored in one large container. A conveyor belt feeds them into the flywheels (img.03).

The advantages of such a system are the fast way to reload it and its high capacity. Therefore it would suit well to the project. However, it relies on gravity. When the blaster gets angled, the darts won't fall onto the conveyor belt.

An attempt was made to change this by using springs. Those should compress the darts. Resulting they are not able to move within the hopper. The image of a hopper containing a spring looked like a giant version of the regular "RIVAL" clips. As described previously those have the advantage to improve the experience of picking up darts. This triggered the idea to combine a hopper with a clip. To improve the handling, it was considered to add a handle to the clip/hopper- "clopper". Besides, this handle would also function as a grip for the whole blaster.

A rough prototype was built. However, until the end of the project, it was not possible to come up with a fully functional prototype. Even though, the author is confident that a solution can be found. The current challenge is to create a funnel within the "clopper" so that the darts can not block themselves.



(img. 03)

10.4 Leveld System

To equip the blaster with unique features like an automatic targeting system would increase the price immensely. Further, it might not even be useful for every user. It was therefore decided to create a levelled system for the blaster. Within this system, the blaster is the core element. By purchasing add-on kits, new functions can be added.

This page will give an outlook on the opportunities for further developments.

Near Future

Branded harnesses
The blaster makes use of an action-camera mount. Various forms of harnesses or holding devices can be branded to suit the topic of cyborg. For example, shoulder mount harnesses or suction cups.

Trigger Modules
The trigger is based on a module. That makes it possible to develop further modules to use with the shells. For example, a trigger that reacts to a particular movement or one that uses a motion sensor to trigger the blaster as soon as someone walks by. By cooperating with a wheelchair company, even wheelchair joysticks could become a trigger.

Far Future

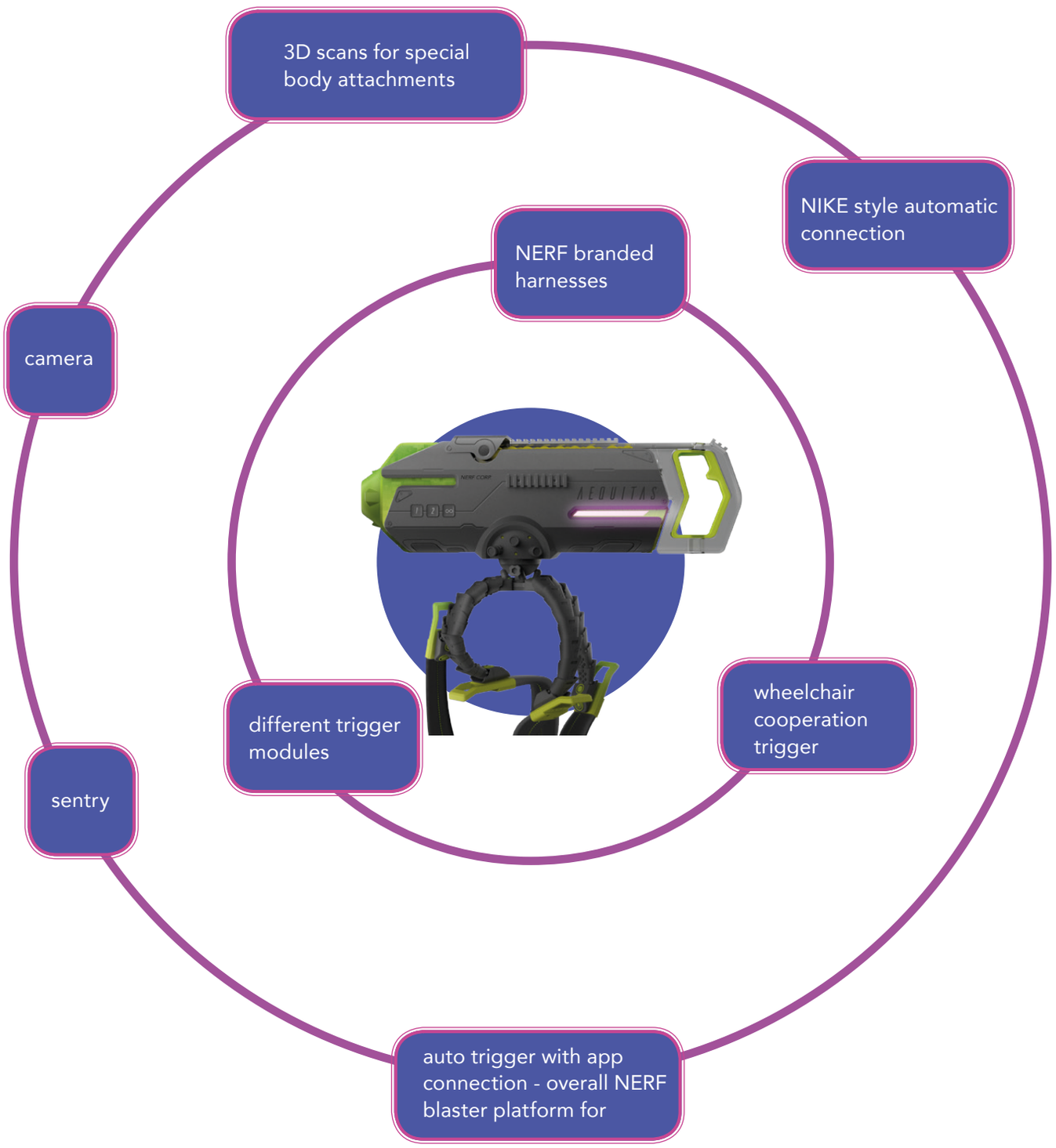
Customised parts
3D scan stations in toy stores could create super exclusive parts: perfectly fitted trigger shells or body attachment pieces.

Camera
An add on camera that transmits the image to an App.

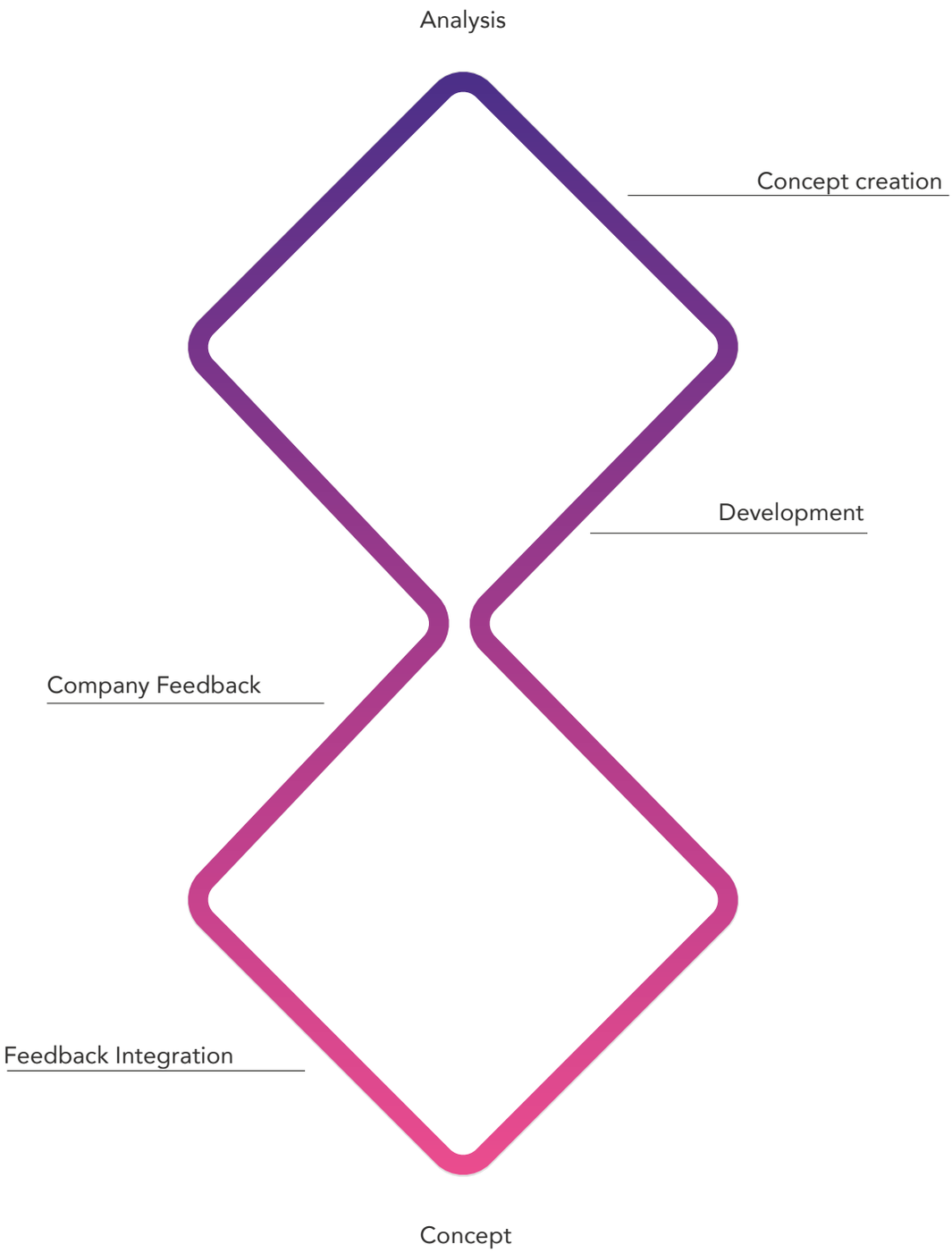
Sentry
The ball joint can be replaced by an electronic system that allows the user to aim from a distance. It comes with a motion control trigger module.

Auto-Attach
Like NIKE creates self-tying shoes, the straps could use the same mechanism to be attached to an object. Either they are controlled by an App or pressure sensor on the bottom of the blaster.

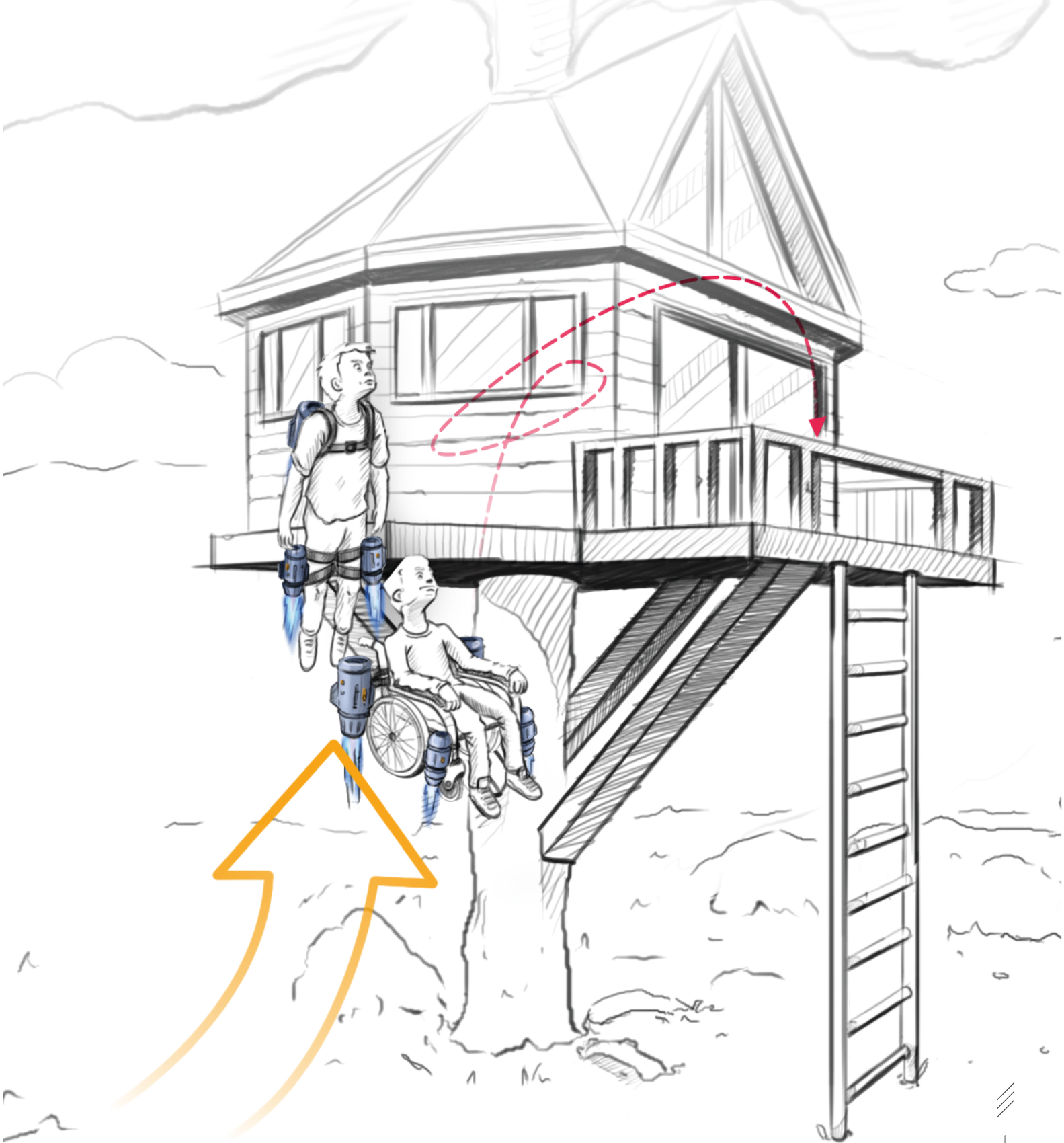
Auto-Aiming
An App could enable a smartphone to auto aim when being paired with the sentry.


3D scans for special body attachments
NIKE style automatic connection
NERF branded harnesses
camera
wheelchair cooperation trigger
different trigger modules
sentry
auto trigger with app connection - overall NERF blaster platform for

11. REFLECTION PRODUCT


Analysis
Concept creation
Development
Company Feedback
Feedback Integration
Concept

The needs of the minority became wishes of the majority. Now it is about to make these wishes become reality!



At the beginning of the project, a vision was formulated.

Transform the needs of the minority into the wishes of the majority.

To get a clear answer if this vision is fulfilled a survey among the user group would be needed. However, what can already be evaluated is the inclusive impact the toy might have. To do so an expert evaluation based on criteria set up by Steinfeld and Maisel was conducted:

Body Fit
The trigger is separated and can be activated with a simple punch. Due to this, it is independent of body sizes/measurements and thus usable without limitations.

Comfort
It is possible to place the blaster where it is most comfortable for the user. It can even be put on another supportive device like a wheelchair to maintain the best comfort.
However, it is needed to create a fully functional prototype. This needs to be tested with users with different kinds of disabilities. Otherwise, it is hard to evaluate which changes are still needed to be made.

Awareness + Understanding
The main functions should be understandable for the child. Especially the package visualisations of the blaster's functions will add to it. In case the package info is missing, the fire mode buttons can be confusing. However, after one trial and error approach, a child should be able to understand it.

Wellness
The blaster has no direct effect on the users well being. However, there is the possibility that it can improve the motor skills of a CwPD. Even pushing a button is hard work for CwPD. Having the motivation to train those skills can have a positive effect on them.
Further, social integration and acceptance are highly beneficial for one's mental health.

Social Integration
The blaster can be a tool for CwPD to become part of a community that wasn't available for them before. Further, it sends out a message of acceptance by caring about the needs of CwPD.

Personalization
The user can decide where to place blaster and trigger. In case more individualisation is wanted 3D printed shells are an option.

Cultural Appropriateness
The blaster's power and the used projectiles are not harmful. It supports the relief of aggression and rebellious behaviour in a safe way. Further, its outer appearance is far away from resembling a real gun. Thus the toy is culturally appropriate. Regarding the topic of "cyborg", one can say that it will be perceived positively. The children are conscious and confident about their disability. Further, their crutches/wheelchair/prosthesis is part of their body. Highlighting this as something cool will be an appropriate way to deal with it.

Concluding one can say that the Aequitas concept can make an impact on the life of a CwPD. It has the opportunity to support inclusion and enable children to play with a toy they wouldn't be able before. Further, a trend in the direction to inclusive products can be seen. An example of this is the x-box gamepad and the way it is advertised (Appendix 1.6). This demonstrates the relevance of such a product in the upcoming years.

However, it is currently just an early concept. The next step should be to build a prototype. Beforehand some further ideation on the "clip" idea is needed. With this, tests regarding ergonomics and social acceptance have to be conducted.

Those insights will lead to improvements of the concept, based on the knowledge gathered within this project. That will bring the toy one step closer to the vision, and CwPD one step closer to become part of the NERF community.

12. REFLECTION PROJECT

Management of the Project

At the very beginning of the project, a schedule was created (Appendix 2.9). The planning was done linearly. Each phase of research, ideation and testing overlapped just by a week. However, it was realised after the first three weeks that this approach needed to be changed into a more combined and iterative one. Reasons for this were:

School

Getting in contact with a facility for CwPD took longer than expected. The first two weeks were mainly occupied by calling, e-mailing and visiting different facilities. This lead to a two week delay in the linear process since it was expected that research could be done parallel to it.

Further, the project planning was done without considering school holidays or in general a schools schedule. Due to this, the planning needed to be more flexible so that changes could easily be integrated without creating gaps.

Feedback

At the start of the project, one wasn't aware of the fact that instant feedback couldn't be gained. Instead of having co-workers around or other students dealing with the same topic, one was on one's own. Since instant feedback from stakeholders was hard to get, a phase like the "5 loops of ideation"(Appendix 2.9) was not possible to execute as planned. It was therefore needed to make educated guesses to go on working and proof them later.

Reflection

It became clear that when a third party is involved like, i.e. a school, it is needed to arrange this at least a month before the start of the project.

When working as a one-man-army on an unknown topic, a linear approach is not that useful. One needs to use a mix of ideation, testing and research. By iterating on these main pillars, a steady workflow can be maintained. Therefore the planning needs to be flexible.

For this project, the primary goals were determined for every loop. These loops were multiple weeks apart from each other. The way to fulfil them was flexible so that planning gaps could rarely appear. Every week a new plan was made. So one could adapt fast to possible changes.

Even though, or better to say because, not everything went as planned I gained many insights by executing this project. Managing communication with different parties was one of the insights. Further, I gained knowledge about setting up contacts to facilities that can provide useful information. Next to this, being at some point dependent just on my self created feedback was proper training to make decisions.

Testing and observations

During the three encounters with the children, I came across different challenges. They gave me further insights into how to test with children.

Intro

It started with making a good first impression. A good and easy icebreaker was to let them know that I am a toy inventor. This transformed them from being shy to being very talkative. Further, I recognised that taking notes with a large A4 sheet of paper made them feel insecure due to which I switched to an A5 book which was visually less present.

Observation

While doing the first observations, it was not possible for me to take pictures or video recordings. This was because the appointment needed to be made short term and permissions couldn't be given that fast. As I got to know later, it will take up to two weeks to get permissions from all the children. The one situation without video recording clearly showed me the need of it. When observing on one's own, either a partner or a camera is needed to keep track of everything that happens. Otherwise, it is easy to lose the overview.

Test

One important part that I forgot at the first test was to ask the children if they allow me to film them. Resulting, I had the feeling they were suspicious about the camera. At the second test, I asked them for their permission during the introduction. You could tell that they felt good with being able to have to power of decision.

The number of children with which I did tests/ interviews with differed from 3 to 1. I came to the insight that two children are the maximum for doing a successful test/interview. When dealing with more children, it is hard to keep everyone involved while concentrating oneself on the answers. By rewatching the video recordings, I realised that I got distracted often by the other children. Thus, I couldn't dive that deep into possible answers. Further, I learned from the recordings that I missed situations where another "why" question would have created further insights.

Another valuable insight was that it is needed to get beforehand information about the children. To know if a child is shy or super extrovert would have been beneficial during the first tests. Especially when forming groups, it is useful to know the children you are dealing with. Due to this, two of the groups ended up to be a highly active but also a very silent one. Both situations which make it hard for the interviewer to get the information he needs.

It was a great experience to be in constant contact with the user group. Especially to integrate them during the whole process helped a lot. Instead of letting them just judge in the end, they were part of the decision making at different points of the project. That improved the decision making, the ideation as well as the motivation to go on working. It clearly showed me that it is highly needed to integrate children as much as possible within a toy design project.
Besides, this constant contact was not just beneficial for me, but also for the children who highly enjoyed being asked for their opinion and to talk about toys.

Concluding one can say that my initial intention to use the graduation project to gain more knowledge regarding "testing with children" was successful. In total, I was able to get in contact with children four times during the course of this project. This lowered my feeling of insecurity towards the topic of testing with children. Further, I gained a lot of useful experiences in the future.

Visiting the company

As mentioned previously, the company Hasbro in Providence, RI, USA was visited. This was done to get feedback about the project status by professionals from the toy industry.

Visiting the company was an awe-inspiring event. Next to getting useful and on point feedback about my design, I gained further impressive and inspiring insights.

During the industrial design studies, there is a large focus on finding technical solutions. In case one wants to do marketing or graphic design, another study needs to be chosen.
However, during the company visit, I got to know that a designer needs to be flexible. The design tools/methods learned can apply to any challenge. Even though one is trained in industrial design, doesn't mean that he won't have a great idea when it comes to the design of an App, a service or a TV show. This also includes being able to kill your darlings. Being not open for change and trying aggressively to stay on one's track, might restrain one from creating successful ideas.

Further, it was inspiring to see the passion that was behind the creation of products. When talking to someone about a new invention, he/she was working on; you could see the fire in their eyes. The love to the products that were developed was very motivating.
The same counts for visionary thinking. The encouragement to come up with wild ideas was very refreshing. It was especially interesting to learn that to sell a toy concept within the company, the story around it is more important than the technical feasibility.

Concluding one can say that getting feedback about the project was the just one insight out of many taken from this trip. Getting to know various types of highly skilled people supported me by improving myself as a designer. Further, I could make useful contacts for the future and gained insights about an industry which are rare to get.

REFERENCES

Literature

Berry, B. (2018, August 24). People with quadriplegia and paraplegia get a chance to experience paintball in an epic Virginia Beach battle | News. Retrieved from https://spinalcordinjuryzone.com/news/20215/people-with-quadriplegia-and-paraplegia-get-a-chance-to-experience-paintball-in-an-epic-virginia-beach-battle

Callum. (2013, April 03). The rise of Wheelchair Laser Tag. Retrieved from http://www.accessmagazine.co.uk/the-rise-of-wheelchair-laser-tag/

Desmet, P. (2003). Measuring emotion: Development and application of an instrument to measure emotional responses to products. In Funology (pp. 111-123). Springer, Dordrecht.

Doubt, L., & McColl, M. A. (2003). A secondary guy: Physically disabled teenagers in secondary schools. Canadian Journal of Occupational Therapy, 70(3), 139-151.

Eccles, J. S. (1999). The development of children ages 6 to 14. The future of children, 30-44.

Essig, K. (2013). „Ballschule–umspiel dein Handicap ": Entwicklungsförderung körperbehinderter Kinder Auswirkungen eines ressourcenorientierten, sportspielübergreifenden Bewegungsprogramms auf motorische und psychosoziale Parameter (Doctoral dissertation).

Evans, I. M., Salisbury, C. L., Palombaro, M. M., Berryman, J., & Hollowood, T. M. (1992). Peer interactions and social acceptance of elementary-age children with severe disabilities in an inclusive school. Journal of the Association for Persons with Severe Handicaps, 17(4), 205-212.

Frost, J. L., Wortham, S. C., & Reifel, R. S. (2012). Play and child development. Merrill, Prentice Hall. 4th edition.

Gielen, M. A. (2005). Play, toys and disabilities: the Bio-approach to designing play objects for children with various abilities. In Proceedings of the 4th International Toy Research Association world congress.

Gielen, M. A. (2010) "Essential concepts in toy design education: aimlessness, empathy and play value", Int. J. Arts and Technology, Vol. 3, No. 1, pp.4-16.

Gielen, M. A., & van Leeuwen, L. (2013). Rebel by design: the merits of rebellious play and how to design for it. IASDR Conferece, Tokyo.

Goodley, D., & Runswick□Cole, K. (2010). Emancipating play: Dis/abled children, development and deconstruction. Disability & society, 25(4), 499-512.

Green, S. E. (2003). "What do you mean 'what's wrong with her?'": stigma and the lives of families of children with disabilities. Social Science & Medicine, 57(8), 1361-1374.

Hodge, N., & Runswick-Cole, K. (2013). 'They never pass me the ball': exposing ableism through the leisure experiences of disabled children, young people and their families. Children's Geographies, 11(3), 311-325.

Keates, S., Clarkson, P. J., Harrison, L. A., & Robinson, P. (2000, November). Towards a practical inclusive design approach. In Proceedings on the 2000 conference on Universal Usability (pp. 45-52). ACM.

Kolehmainen, N., Ramsay, C., McKee, L., Missiuna, C., Owen, C., & Francis, J. (2015). Participation in physical play and leisure in children with motor impairments: mixed-methods study to generate evidence for developing an intervention. Physical therapy, 95(10), 1374-1386.

Laws, G., & Kelly, E. (2005). The attitudes and friendship intentions of children in United Kingdom mainstream schools towards peers with physical or intellectual disabilities. International Journal of Disability, Development and Education, 52(2), 79-99.

Leyendecker, C. (2005). Motorische Behinderungen: Grundlagen, Zusammenhänge und Förderungsmöglichkeiten. Kohlhammer.

Mulderij, K. J. (1997). Peer relations and friendship in physically disabled children. Child: Care, Health and Development, 23(5), 379-389.

Mulderij, K. J. (1996). Research into the lifeworld of physically disabled children. Child: care, health and development, 22(5), 311-322.

Poulsen, A. A., Ziviani, J. M., Johnson, H., & Cuskelly, M. (2008). Loneliness and life satisfaction of boys with developmental coordination disorder: the impact of leisure participation and perceived freedom in leisure. Human Movement Science, 27(2), 325-343.

Skinner, Q. (2002). Visions of politics (Vol. 2). Cambridge University Press.

Skär, M. T. L. (2000). How I play: Roles and relations in the play situations of children with restricted mobility. Scandinavian Journal of Occupational Therapy, 7(4), 174-182.

Tamm, M., & Prellwitz, M. (2001). 'If I had a friend in a wheelchair': children's thoughts on disabilities. Child: Care, Health and Development, 27(3), 223-240.

Tripp, A., French, R., & Sherrill, C. (1995). Contact theory and attitudes of children in physical education programs toward peers with disabilities. Adapted physical activity quarterly, 12(4), 323-332.

Wieder, B. (2010). Entwicklung von Interessen und Nicht-Interessen bei Kindern im Kindergarten, in der Grundschule und in der Sekundarstufe I (Doctoral dissertation).

Images

ref.00 : https://www.thespec.com/living-story/7029304-hacked-toys-level-the-playing-field/

ref.01 : https://www.giguestore.com/index.php?main_page=product_info&products_id=103135

ref.02 : https://www.windowscentral.com/343-industries-partners-limbitless-halo-themed-prosthetics-children

ref.03 : https://ic.tweakimg.net/ext/i/2000595323.png

ref.04 : https://www.amazon.ca/Nerf-Sports-Vortex-Aero-Howler/dp/B01LYXR8DW

ref.05 : https://www.opentoys.cl/producto/nerf-supersoaker-dartfire/

ref.06 :https://www.galeria-kaufhof.de/pds/nerf-n-strike-elite-spielzeug-gewehr-disruptor/2000180782

ref.07 :https://www.tiendatoys.com/products/485/lanzadardos-nerf-zombie-strike-revre-reaper-8a

ref.08 : https://whatmatters.be/2018/06/je-vrienden-of-collegas-afknallen-doe-je-met-deze-brute-nerf-gun/

ref.09 : https://rock-cafe.info/suggest/huge-ball-nerf-gun-68756765.html

ref.10 : https://twilog.org/zaylog/month-1802/4

ref.11 : http://karenhalliburton.com/DoubleDown-Nerf-Wishlist-t.html

ref.12 : https://www.everyaustraliancounts.com.au/legos-wheelchair-figure-a-toy-like-me/

ref.13 : http://carleton-id.blogspot.com/2012/02/third-year-toy-projects.html

ref.14 : https://www.amazon.fr/batakas-professionnelle-enfants-%C3%A9cole-besoins/dp/B00XCVMEOY

ref.15 : https://www.manfrotto.de/compact-action-aluminium-stativ-mit-hybrid-kopf-schwarz

ref.16 : https://nerf.fandom.com/wiki/Elite_Dart

ref.17 : https://www.aliexpress.com/item/20-X-Disc-Bullet-Refill-Blaster-Dart-Toy-Gun-Nerf-Vortex-Praxis-Vigilon-Child/32564919580.html

ref.18 : https://www.aliexpress.com/item/100pcs-Ball-Bullets-for-Rival-Zeus-Apollo-Nerf-Toy-Gun-Ball-Dart-for-Nerf-Rival-Apollo/32884303512.html

ref.19 : https://www.amazon.ca/Nerf-B1594092-Rival-Magazine-Refill/dp/B00W7DDLS6

ref.20 : https://www.amazon.co.jp/Nerf-Rival-Khaos-MXVI-4000-Blaster/dp/B01KONH0X2

ref.21 : https://stevivor.com/previews/xbox-adaptive-controller-preview-inclusive-gaming/

ref.22 : https://www.reichelt.de/3d-drucker-ultimaker-2-extended-ultimaker-2-ext-p163622.html

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Master 'Integrated Product Design'
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Master thesis

Design of a cyborg NERF blaster for children with physical disabilities.
09/11/2018 - 12/02/2019

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Hasbro


TU Delft

Tim Tietze | TU Delft | 2018/2019

AEQUITAS

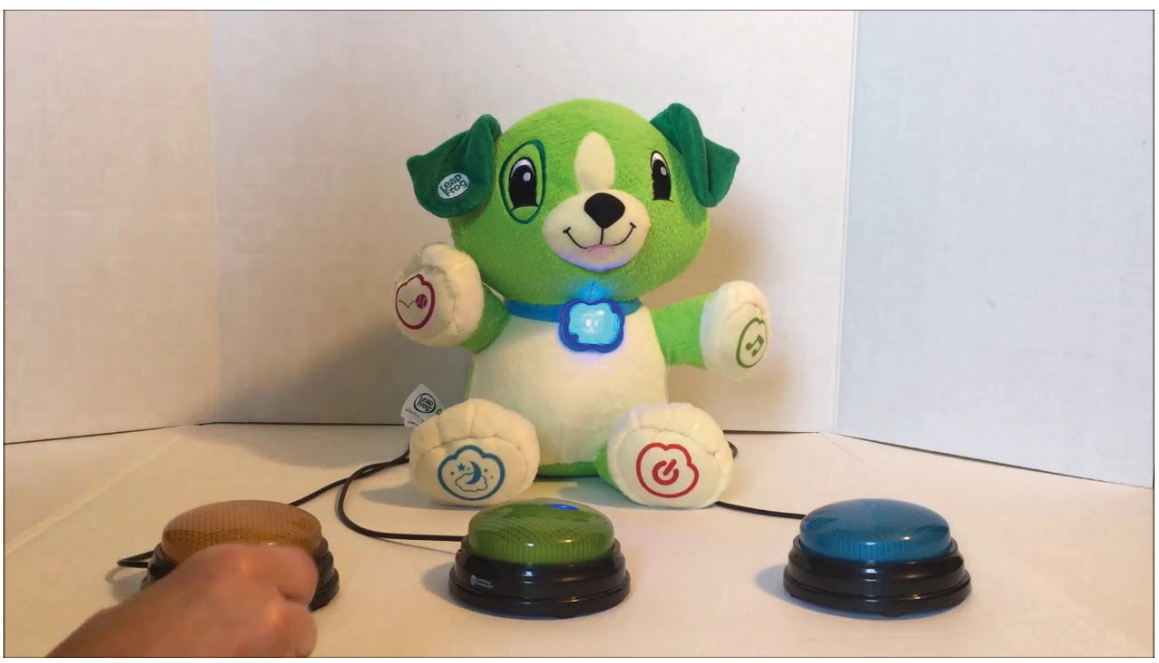
Appendix

Appendices of the graduation project by Tim Tietze

Index

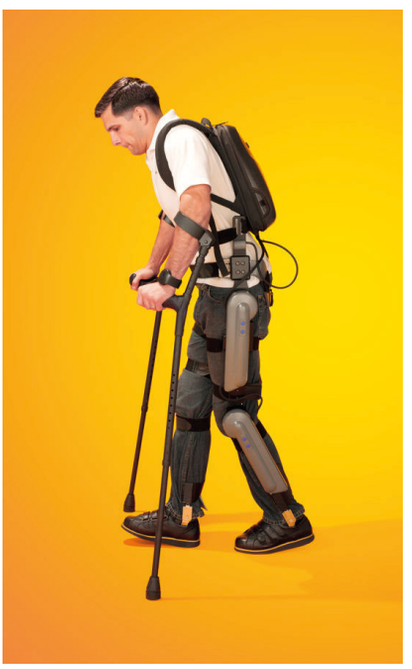
1. Images

1.1 Special Toys



1.2 NERF Rival

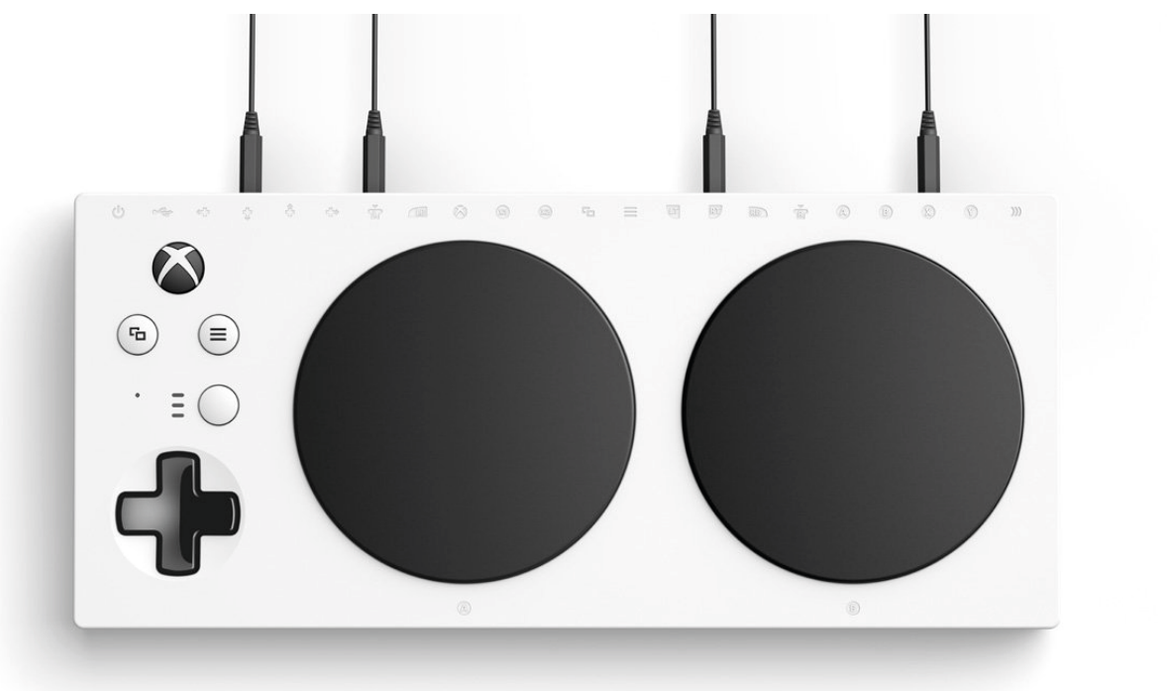
1.3 Rewalk



1.4 Airsoft

1.5 NERF Modulus

1.6 X-Box Inclusive Controller

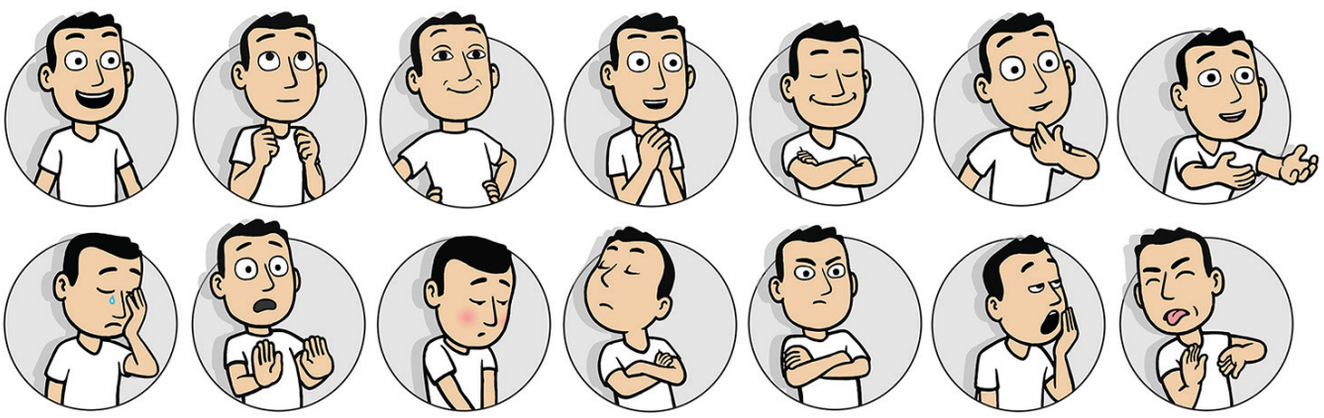


1.7 Products with similar idea


CRAZY NERF
LOADOUT


TRACK CANNON
To including Track Cannon
& Headset Controller
Wireless control between
Track Cannon & Headset Controller
Up & Down movement on cannon
(By detecting the motion signal
on the headset controller)
Aim Target and
Auto fire feature
18 bullets
to be included
Target retail at US$ 59.99

1.8 Premo faces



Product Emotion Measurement Instrument

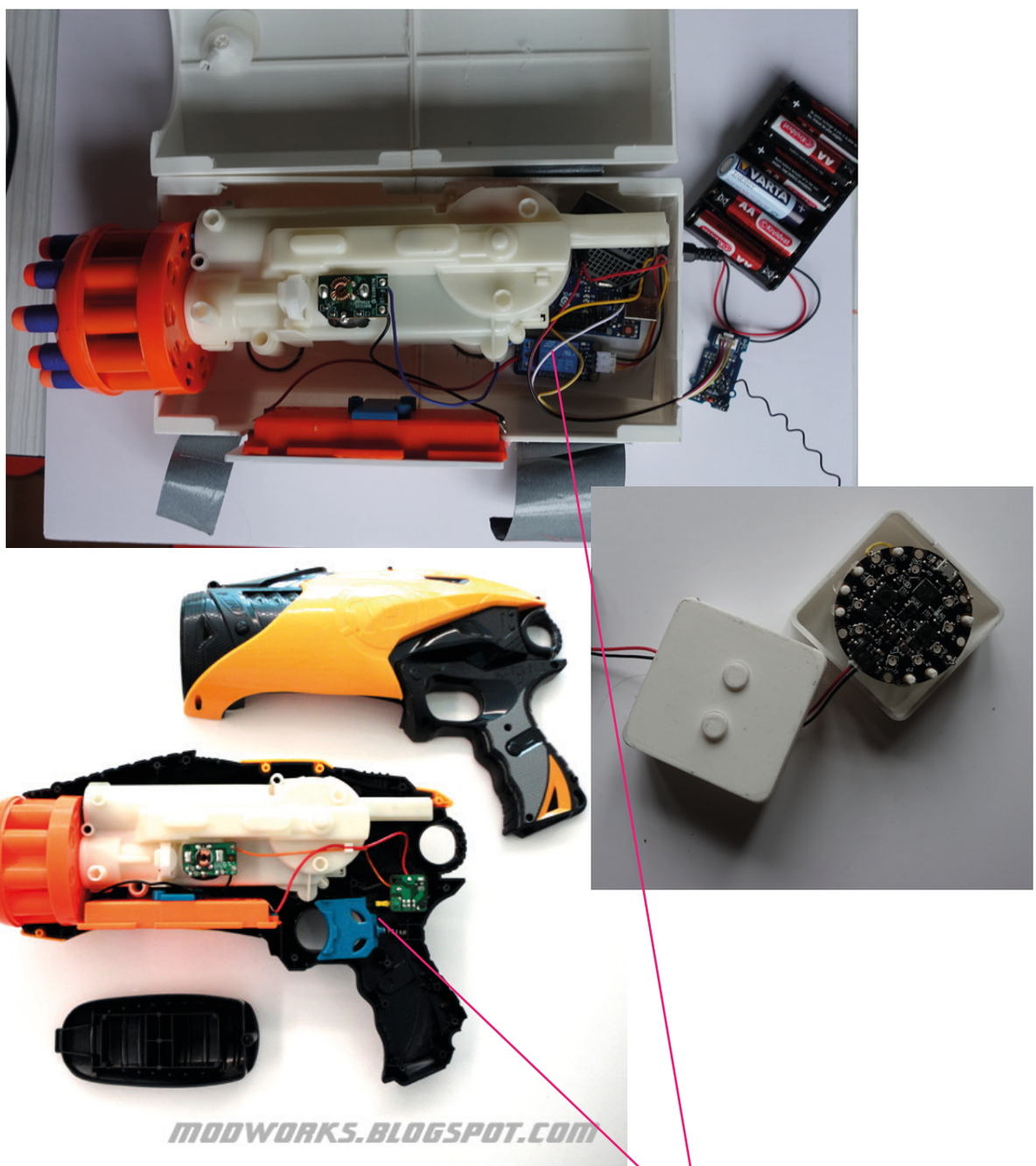
Emotions elicited by product design are typically of low intensity and mixed character. To measure these typical product emotions, a non-verbal self-report tool was developed: Product Emotion Measurement Tool (PrEmo).

PrEmo is a non-verbal self-report instrument that measures seven positive and seven negative emotions. The unique strength of PrEmo is that it combines two qualities: it measures distinct emotions and it can be used cross-culturally because it does not ask respondents to verbalize their emotions. In addition, it can be used to measure mixed emotions. PrEmo data can be useful for evaluating the emotional impact of existing designs (e.g. for creating an emotional benchmark), or for creating insights in the relationship between product features and emotional impact that are valuable in an early design stage.

PrEmo measures distinct (pleasant and unpleasant) emotions in a non-verbal manner that is validated cross-culturally. PrEmo can be used both as a quantitative tool (e.g. to identify the concept with the most pleasant emotional impact) and as a qualitative tool (e.g. to use as a discussion tool in consumer interviews).

1.9 Hopper

1.10 Prototype Inside



Mechanical button replaced by an electronic relay. The relay is controlled by an arduino. A RF module allows a second arduino to communicate with the one which controls the relay.

Code blaster

```
 #include <VirtualWire.h>

const int blasterPin = 4;
int RF_RX_PIN = 7;
int one = 0;
int check = 0;

    void setup()
    {
      pinMode(blasterPin,OUTPUT);
      Serial.begin(9600);
      Serial.println("setup");
      vw_set_rx_pin(RF_RX_PIN);
      vw_setup(2000);
      vw_rx_start();
    }

    void loop()
    {
      uint8_t buf[VW_MAX_MESSAGE_LEN];
uint8_t buflen = VW_MAX_MESSAGE_LEN;
      if(vw_get_message(buf, &buflen))
      {
        int i;

        Serial.print("Got: ");
        for(i = 0; i < buflen; ++i)
        {
          one=buf[i];
          Serial.print(buf[i],HEX);

         }
        Serial.println("");

 if(one == 111)
  {
    digitalWrite(blasterPin,LOW);
    Serial.print("done");
    delay(1020);
    one=0;
        }
  else
  {

    digitalWrite(blasterPin,HIGH);

  }

if(one == 101)
  {
    digitalWrite(blasterPin,LOW);
    Serial.print("zwo");
    delay(1800);
    digitalWrite(blasterPin,HIGH);
    one=0;
        }
  else
  {Serial.print("THIS");
    Serial.print(one);
    digitalWrite(blasterPin,HIGH);

  }


      }
    }
```

Code trigger

```
#include <Adafruit_CircuitPlayground.h>
#include <VirtualWire.h>

int RF_TX_PIN = 2;

bool leftButtonPressed;
bool rightButtonPressed;
void setup() {
  Serial.begin(9600);
  CircuitPlayground.begin();
 vw_set_tx_pin(RF_TX_PIN); // Setup transmit pin
 vw_setup(2000);
}

void loop() {
  leftButtonPressed = CircuitPlayground.leftButton();
  rightButtonPressed = CircuitPlayground.rightButton();

 if (leftButtonPressed) {
    const char *msg = "one";
    vw_send((uint8_t *)msg, strlen(msg));   .
    delay(400);
    Serial.print("one");
      } else {
    Serial.print("nothing send");
  }

  Serial.println();

  if (rightButtonPressed) {
    const char *msg = "two";
      Serial.print("two");
      vw_send((uint8_t *)msg, strlen(msg));
      delay(400);
      } else {
    Serial.print("nothing send");
  }
  Serial.println();
  delay(100);
}
```

2. Documents

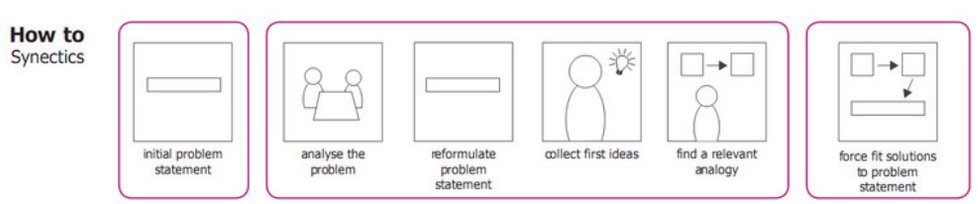
2.1 Design Methods

Synectics

The synectics procedure (see figure 1) was set up by Gordon and Prince (1976). It is a comprehensive creative procedure, containing techniques for problem analysis, idea generation and the selection stage. Synectics concentrates on the idea generation steps with the use of analogies. Analogies allow for moving away from the original problem statement and making a forced fit to develop solutions on the basis of these analogies. The synectics procedure is also based on the process of (1) preparation, (2) incubation, (3) illumination and (4) verification (Wallas, 1926). The incubation and illumination stages are now brought about through the use of analogies: 'To make the strange familiar and the familiar strange'.

In the preparatory stages, there is a problem briefing by the problem owner, an extensive problem analysis phase through questioning by the participants, and definition of a problem statement into 'one single concrete target'. After this, a purging phase takes place in which known and immediate ideas are collected and recorded. This phase is also called 'Shredding the Known'. From this point on, analogies are used to estrange yourself from the original problem statement and come up with inspirations for new solutions and approaches. These analogies take a number of forms that are presented in table 1.

For the assessment of the new solution possibilities, the synectics approach introduces yet another special technique: 'itemised response'. To every idea there are both good sides (the pluses) and poor or bad sides (the minuses). By breaking down the idea into pluses and minuses and then trying to turn the minuses into pluses (for example, through a creativity method), the original idea may be - systematically - transformed into a better one.



Bad Brainstorming

A method that use brainstorming to generate bad solutions to the problem, and then see how those could be transformed into good solutions. One way to generate ideas is to generate good solutions through brainstorming. But negative brainstorming takes a different angle on that. The method is a two-step process, that consists of first generating the worst solutions to the problem. Later transforming them into good solutions. This can be a fun way to use brainstorming in a silly manner, to work solving problems from a different angle.

Switching Hats

What would your favorite actor think of your concept? Would your president or prime minister endore it? What if you were to swtich hats with another organization? How would they change or build on your idea?

1. Write down a list of 5-6 different brands or people

2.Look at your brand, idea or product through the lens of each person on your list. How would your idea be different in their hands? For instance, if you are working on refugee resettlement, how would Versace approach it versus Nike or Oprah?

3.Sketch out a version of your idea from each perspective - make them as extreme as possible.

4.Repeat this exercise with different brands or celebrities.

2.2 Game Types

Attack and defend.
This simple match mode requires one group of players to defend a pre-specified base or point, while the other team tries to capture it. Usually, this game type comes with a time limit, giving an added thrill to players who are required to rush to the finish. If the defending team continues to defend the point until the time runs out, they win. If the attacking team captures the point and is holding it while time expires, they win.

Capture the flag.
Capture the flag gives an extra goal for players. Each team is given a colored flag, which is placed on their side of the field. The goal is to defend their own flag while also attempting to capture and steal the enemy's flag. The first team to capture the other team's flag a certain number of times (typically once) is the team to win.

Hostage.
This is an extremely thrilling match option for those who want to take their Nerf wars to the next level. Each team is given an unarmed player to play the hostage, who will be hidden at the enemy's base. The opposing team must successfully rescue their hostage within a certain time limit in order to win. The hostage cannot move until one of the friendly players taps them with their hand.

Team Deathmatch.
Deathmatch is one of the most popular – if not the most popular – forms of Nerf wars. This is a standard combat match, where players must simply tag out the enemy team and take them down before they are taken down themselves. Each team has a certain amount of tags, or "deaths", until they are out for good. The last team to have any remaining players wins the match.

Hide and seek.
This is another popular Nerf war variant. In hide and seek, one team is given a head-start to go and hide. This match is best achieved in an urban or wooded area. The opposing team, also known as the "seekers", must find all of the enemy team members and tag them in order to get them out. The hiding team also has the opportunity to tag out the seeking team as well. The team with the last untagged person remaining wins the match.

Control points.
Similar to "attack and defend", the control points Nerf war match adds a dynamic challenge to the game. There are a pre-determined amount of points set out among the field, and the teams must fight each other to take control of these points. In order to capture a point, a player must stand next to the point and count to a certain number, typically 10 or 15, in order to capture it. If the player counts to the number without being attacked or tagged, they are then able to switch the control point's colors with their own team's colors. The first team to capture the other team's home base wins the challenge.

Assasin.
In an assassin game, each team designates one player as the "target", who is only allowed to carry a single shot blaster. That player's team acts as the guards, with the other team becoming the assassins. Guards can take hits for the target as the assassins attempt to destroy them. After a certain amount of time, the target can escape, thus ending the game.

Hunger Games.
Much like the best-selling book, this tame has players split into two teams. All weapons and ammo must go in a pile in the center of the playing field. Everyone starts out standing an equal distance away from each other and from the pile. When the game signals its start, players must rush to collect their weapons in this all-out brawl.

Civil War.
In a Civil War, only single-shot blasters are allowed. Both teams start out in a position that faces each other when the game starts. They must stand in a straight line as they face each other. When the game begins, they must fight Civil War-style. If a player is hit in the arm, they cannot use that arm. If they lose both of their arms or legs, they must move on their knees, or they "die" for the remainder of the game.

Humans vs. Zombies.
In a humans vs. zombies match, one team becomes the humans, who are armed with Nerf weapons, while the other team becomes the zombies, who are not allowed to wield any weapons at all. Humans who are touched by zombies become zombies. The humans win if all zombies are destroyed, and the zombies win if all humans are turned into zombies.

Anarchy.
Anarchy is one of the oldest Nerf war game types still in play. The game is played with multiple teams of two people each, who fight to determine the last team standing. Players die with a single hit in this game.

Hunter.
This is a solo-based Nerf war game. One player becomes the “hunter”, armed with just a blaster. The other players in the game have to avoid being tagged or hit by the hunter. As soon as another player becomes tagged by the hunter, they become the hunter themselves. Whoever can go the longest without being tagged is the winner.

Regicide.
This popular Nerf war game is based off of the match type from the Halo video game series. One player on each side becomes the “king”, who is given a large blaster and a unique identification badge to wear. Whoever tags out the other team’s king first wins.

Deathmatch.
This is another solo-based Nerf game. This is a full-on battle, with no unique rules or specially designated players. The last person standing wins.
Alliance. In an alliance match, a non-player is responsible for hiding all equipment. Players are then sent to find and pick up the equipment. During the game, players are encouraged to form alliances with each other. These alliances cannot be broken or betrayed, or else the player is out. The maximum amount of players in a single alliance is three players. An alliance can only break if the members are the last one standings. The last player alive wins.

Standoff.
A standoff is a good old-fashioned Western-themed match. Players can only wield single-shot blasters. All players are assigned a spot to stand, and they cannot move from this spot. The blasters start out on empty, and when the game begins, they must do one of three things: “Fire”, which requires taking a single shot at an opponent, “Block”, in which the player crosses their arms over their chest and are protected from hits, or “Reload”, which allows the player to reload after taking a shot. They must reload before taking another shot. Every time a player is eliminated, the players move closer to each other. The last one standing wins.

2.3 Video NERF Game

https://www.youtube.com/watch?v=qFbCpdYclx0

https://www.youtube.com/watch?v=EPNwjnfwACY

2.4 Plex Cards

http://www.funkydesignspaces.com/plex/

2.5 Physical Disabilities

Types of physical disabilities

Acquired brain injury

Acquired brain injuries are due to damage that happens to the brain after birth. They can be caused through a wide range of factors including a blow to the head, stroke, alcohol or drugs, infection, disease such as AIDs or cancer, or a lack of oxygen.

It is common for many people with a brain injury to find that they are slower at processing information, planning, and solving problems. They may also experience changes to their behaviour and personality, physical and sensory abilities, or thinking and learning.

The effects of brain injuries and the disabilities they cause can be temporary or permanent.

Spinal cord injury (SCI)

A spinal cord injury often causes a permanent physical disability. The spinal cord can become injured if too much pressure is applied and/or if the blood and oxygen supply to the spinal cord is cut. When the spinal cord has been damaged, it leads to a loss of function such as mobility or feeling.

For some people, a spinal cord injury results in paraplegia (loss of function below the chest), for others it leads to quadriplegia (loss of function below the neck).

Accidents account for 79% of spinal cord injuries in Australia – mostly caused by motor vehicle accidents and falls. Other causes include cancer, arthritis, infections, blood clots, and degenerative spinal conditions.

As well as affecting the ability to move through paralysis, it may affect many areas of a person's body – such as the cardiovascular and respiratory systems, bladder and bowel function, temperature, and sensory abilities.

Spina bifida

Spina bifida is the incomplete formation of the spine and spinal cord in utero. It can cause the spinal cord and nerves to be exposed on the surface of the back, instead of being inside a canal of bone surrounded by muscle.

People with spina bifida experience a range of mild to severe physical disabilities including paralysis or weakness in the legs, bowel and bladder incontinence, hydrocephalus (too much fluid in the brain cavities), deformities of the spine, and learning difficulties.

The cause of spina bifida is not well understood, but it is likely caused by genetic and

environmental factors. Adequate intake of folate by the mother in early pregnancy has been found to be a significant factor in preventing a child developing the disability.

Cerebral palsy

Cerebral palsy is associated with movement, muscle tone, and posture – 'Cerebral' refers to the brain and 'palsy' means weakness or lack of muscle control.

Typically, it is due to an injury to the developing brain before or during birth, caused by a reduced blood supply and lack of oxygen to the brain. Illnesses during pregnancy such as rubella (the German measles), accidental injury to the brain, meningitis in young children, and premature birth can all be causes.

In Australia, over 90% of cerebral palsy was due to a brain injury while the mother was pregnant, or before one month of age, however, 10% of people develop the disability later in life, usually as a result of infections such as meningitis or encephalitis, stroke, or a severe head injury (Cerebral Palsy Alliance).

People with Cerebral palsy may experience epilepsy, and may have difficulty with awareness and comprehension.

Cystic fibrosis (CF)

Cystic fibrosis (CF) is an inherited genetic condition, which affects the body's respiratory, digestive, and reproductive systems. It specifically affects the mucus and sweat glands in the body, causing mucus to be thick and sticky. In the case of the lungs, this can clog the air passages and trap bacteria causing lung damage and recurrent infections.

In Australia, more than 1 in 25 people carry the cystic fibrosis gene, but being a carrier doesn't mean that you will also have CF itself (Better Health Channel).

A range of other symptoms are caused by the effects of CF on other parts of the body, including sinus infections, liver damage, diabetes, poor growth, diarrhoea, and infertility. In the case of the pancreas, the release of enzymes needed to digest food is prevented, which means people with CF must consume a very high calorie diet – 20 to 50% more each day than the recommended intake.

People with CF can also have low salt levels in the body which causes problems such as fatigue, cramps, and dehydration.

Epilepsy

Epilepsy is a neurological condition where a person has a tendency to have recurring seizures due to a sudden burst of electrical activity in the brain. Seizures can cause unusual movements, odd feelings or sensations, a change a person's behaviour, or cause them to lose consciousness.

The causes of epilepsy are not always known, however, brain injuries, strokes, cancer, brain infection, structural abnormalities of the brain, and other genetic factors can all cause epilepsy.

There are many different types of epilepsy and the nature and severity of seizures experienced by people can vary widely. Some people can control their seizures with medication and the condition is not lifelong for every person.

Multiple sclerosis (MS)

MS occurs when the myelin sheath – protective tissue around nerve fibres in the body – becomes damaged, causing random patches or scars. The scars can interfere with messages sent through the central nervous system, affecting the brain, optic nerves, and spinal cord.

The symptoms of MS are very varied but can include fatigue, loss of motor control, tingling, numbness, visual disturbances, memory loss, depression, and cognitive difficulties.

The progress and severity of MS can be difficult to predict – it may progress very slowly for one person, but develop quickly in another.

Muscular dystrophy

Muscular dystrophy is a group of disorders that lead to progressive and irreversible weakness and loss of muscle mass. There are more than 30 different types of muscular dystrophy, and each has a separate cause. They are all however genetic conditions, which means that they are caused by an alteration within the genetic makeup.

Signs and symptoms can be very varied however can include difficulty walking, trouble breathing or swallowing, restriction in joint motion, and heart and other organ problems.

Symptoms of the most common type of the disease appear in childhood, however, others do not become apparent until middle age or older.

Tourette syndrome

Tourette syndrome is a neurological disorder which involves involuntary and repetitive vocalisations, sounds, and movements called tics. These tics are neurological not behavioural – which means a person with Tourette syndrome cannot control them.

Vocal tics can include sniffing, throat clearing, tongue clicking, grunting, or more rarely blurting out socially unacceptable words or phrases. Motor tics can include repetitive eye blinking, shoulder shrugging, nose twitching, head jerking, facial expressions, touching

objects or other people, spinning around, imitating someone else's actions, or jumping up and down.

Tourette syndrome is typically diagnosed between the ages of 2 and 21. It is not known exactly what causes Tourette syndrome, but it is likely a combination of genetic, environmental, and neurochemical (chemicals of the brain) factors.

Dwarfism

Dwarfism is short stature (abnormal skeletal growth) which can be caused by over 300 genetic or medical conditions. It is generally defined as an adult height of 4 feet 10 inches or less, with the average height of someone with dwarfism being 4 feet (Mayo Clinic).

In general, there are two categories for dwarfism:

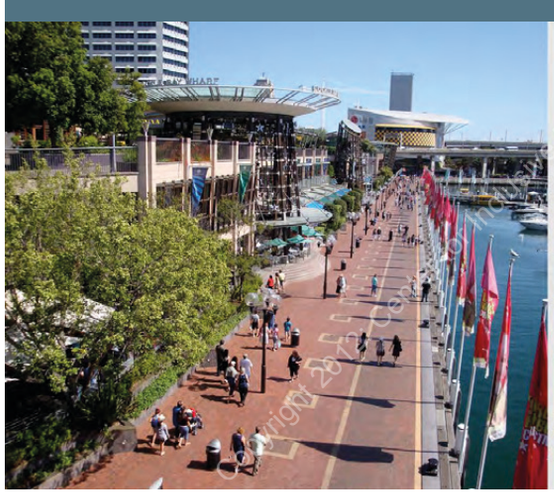
Disproportionate dwarfism: where some parts of the body are smaller, whilst other parts are average or above-average.
Proportionate dwarfism where the body is averagely proportioned, and all parts of the body are small to the same degree
Children with dwarfism may experience a delay on developing motor skills, however, dwarfism does not have a link to any intellectual disability.

2.6 Universal Design

The Goals of Universal Design

Edward Steinfeld
UD2012 Oslo, June 11-13, 2012

Increasing adoption of universal design?



- UD is innovation
- Expand beneficiaries
- Increase relevance
- Clarify the concept

Defining Universal Design

The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. (Mace,1985)

….design for human diversity, social inclusion, and equality. (Design for All Europe, 2008)

The Principles of Universal Design

- Equitable Use
- Flexibility in Use
- Simple and Intuitive Use
- Perceptible Information
- Tolerance for Error
- Low Physical Effort
- Size and Space for Approach and Use

Body Fit

Accommodating a wide a range of body sizes and abilities

Comfort

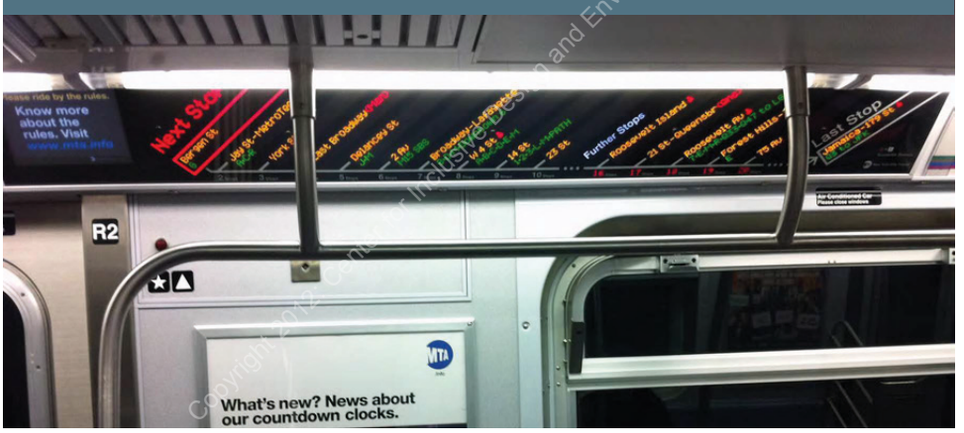
Keeping demands within desirable limits of body function

Awareness

Ensuring that critical information for use is easily perceived

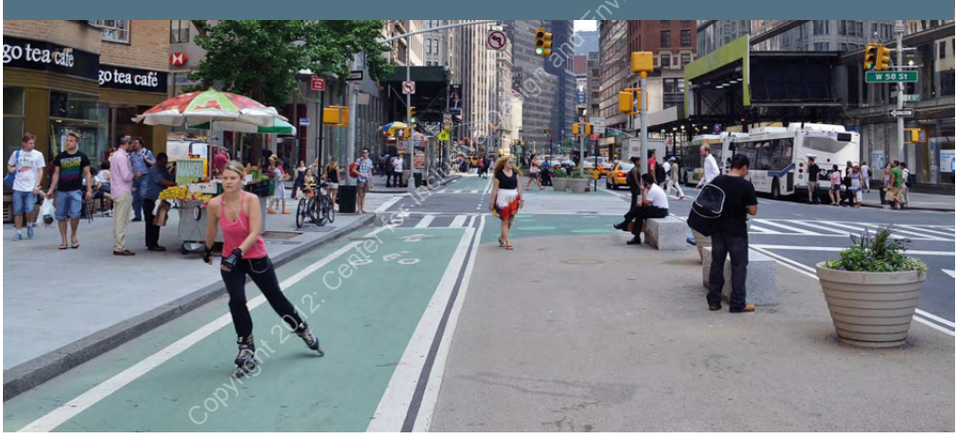
Understanding

Making methods of operation and use intuitive, clear, and unambiguous



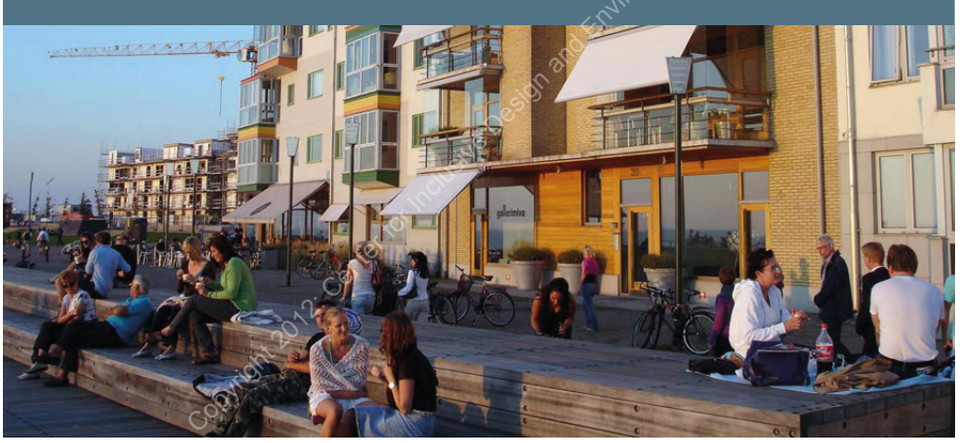
Wellness

Contributing to health promotion, avoidance of disease, and prevention of injury



Social Integration

Treating all groups with dignity and respect



Personalization

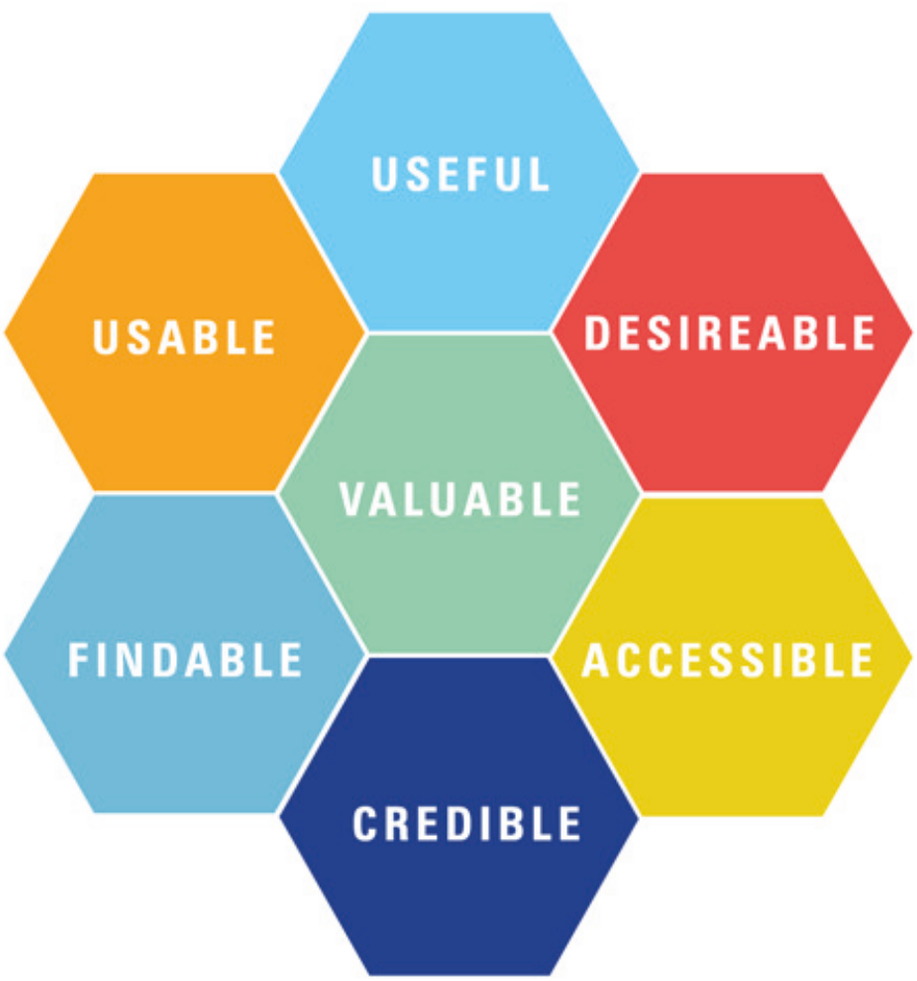
Incorporating opportunities for choice and the expression of individual preferences

Cultural Appropriateness

Respecting and reinforcing cultural values and the social and environmental context of any design project

Conclusion

2.7 UX Honey Comb



2.8 Test Documents

2.8.1 Direction evaluation

Research Goal
The goal for this research is, to find out the opinion of differently physically disabled children, regarding the four concept directions. Further, insights should be gathered, about the abilities to reload a blaster.
This is both needed, to support the decision, in which direction, further work should be executed.

The class consists of 11 children, of which one can't participate due to its disability of autism. Another one needs to be asked separately, since his ability to communicate via the talker, is too difficult to do during a small group interview.

Material
The material that is needed:
- set of cards that explain each concept
- stickers with premo faces
- if possible, regarding time, paper mockups, in a very abstract geometric form
- camera
- audio recorder
- tripod
- a nerf blaster
- a target

Set Up
A round table, on which the interviewer, and the other children are sitting.
A camera is positioned at the table, another one films the room.
The cardboard mockups are first hidden.
In the background one of the teaching stuff should be present, to operate camera, but mainly to be the security person.

Procedure
The children will be given a homework, at day in advance, in which they get the cards, and a set of stickers. On each card the concept is explained in form of pictures, and in form of text on the backside. Their task is too rate each concept with one of the premo sticker, and bring all of them to the interview.

Before the interview, the children will be explained that they can leave the room at any moment, and that it is not a test, and they can't do things wrong. They can't even harm the interviewer, because the ideas were from a college of him.

At the interview, the children will be asked about their intention of using a certain sticker. Further they will be asked to use the abstract mock ups and describe what they think of the use of it.
To end the interview, each child is allowed to shoot the NERF blaster at the target. To do so, they have to first assemble the blaster, by putting the dart in the clip and placing the clip into the blaster.
The duration of each interview and test should not expand over 15 minutes (?)

Analyzation Interview

General Description of the procedure
Before every interview it was asked who already played with a NERF blaster before, and all of the children answered with yes. The class was separated into 4 interview groups.

Group 1

Three boys in the age 10-11.
Started with an introduction about what the rules are.
Spoke about NERF blaster who already played with it.
Tried as an icebreaker to let them play with the blaster.
One of the children had major problems to find out how to load the clip and how to insert it into the blaster, for that he used the blaster called rampage. Due to one dart that could slightly stuck, and a repetitive loading action, the barrel got blocked by a dart and made the blaster unusable.

Insights mentioned from the children:
- not allowed to play inside, if he plays outside darts get lost
- have the "fear" that the wink sensor just shoots accidently "would be embarrassing"
- attach blaster to the back could be quite heavy
- "collector" automatic is better, I can play outside while he collects my darts
- "collector" switch between automatic and manual, if one stays on the ground you get them in manual mode
- "collector" would be cool if he would recognize you and stays with you, like a little dog that collects your darts and brings them to you
- Would the collector also work outside?
- A vest would be cool that lights up at the spot where you got hit, and you can store darts in it
- The mask is strange because if I run a lot he might shoot accidently because I blowed into it

Favorite of the children:
Child 01: My favorite is the "collector" because when I play with my sister the darts lay around everywhere. Then I could play something different while he picks up my darts. The predator I don't like, because I can just look and shoot in the same direction. If someone is behind me, I would like to be able to turn my head to check what's going on in my environment. With the predator I might miss someone and get hit.

Child 02: My favorite is "collector" and "flexi" – the "collector is really useful" "(..) because you don't need to duck – during a NERF battle, when you duck to pick darts up, you get shot"
"you don't need to bend down, that's good"

Child 03: my favorite is the "collector" because I can't see the darts that well. Sometimes my parents come in and say "oh look there are still some others, and here as well"

Due to the fact that they couldn't decide for one "bad one" – it was decided to ask for the second favorite one, to create in that way a ranking.

Child 01: Flexi, however would like to have the app tell him if someone is behind him.

Child 02: Flexi, you can place it everywhere and it would be fun to hide somewhere and then shoot at someone who passes by.

Child 03: The Predator (however it needs to be said that he then starts to just explain negative aspects of it – further it turned out that he didn't understood that it turns by itself)

Group 2

Three children, two boys one girl. Age 10-11.

Comments of children:
- "collector is nice but will probably cost a lot"
- Is the backpack heavy?
- Probably difficult to build something like this (flexi)
- Afraid that the predator shoots accidently
- Can collector drive over carpet?
- They were amazed to see the target getting hit, sensopatic play is super important and should be considered during further design steps

Children should choose their favorite, however they said "I like them all". Therefor a story was constructed where we imagined to be in a toy store and we have money for one of them, which one would they like to buy.

Child 04:
I like the collector, because if you have backpain you don't need to bend down.
And it is great that is reloads the magazine (should have asked why – however by watching him loading one of the blaster later at the target shooting, he did it without any problems, so it can just be imagined that it takes long and thus is annoying)

Child 05:
I like the predator. The reason it because he can shoot sideways with it. (a miss interpretation of the drawing, but good input)

Child 06:
Flexi, because I can hide it and shoot someone if he walks by the door.
As the second one I like the "collector", because it is sometimes hard to find them, or to reach them. They are under the couch and this is hard to reach.

Negative:
Child 01: if you wear the mask, you will be out of breath after a while
Child 02: yeah and the nose is partly covered, so you get less air and that wouldn't feel good

Group 3

Two boys age 10. One of them was severely disabled, and thus had his assistant with him to interpret answers and give further information.

Child 07:
Mask and predator were the favorite ones for him. He stated that he would prefer the blowing in the mask, because it is easier to shoot than usual. The question why it is easier than usual was not clearly answered, or better to say he couldn't formulate why. Just likes to shoot his parents with it.

Child 08:
It was stated that the Mask is nothing nice to wear. Everything that covers the head is uncomfortable for him. Trigger it with the eyes would be ok, but there is a wish to maybe control it with his "talker". Issue that the backpack like predator can't be attached to the wheelchair. Therefor the favorite is named Predator, however not a clear reason for it is given. What was explained, what is needed. Would fit actually better to the flexi. A lot of adaption is needed.
Further it was mentioned, that a toy with which he, by himself could throw a ball would be great. During the sport class they always have to throw a ball, or it is part of some games. It would be great if he could do it on his own.

Child07: Would kick out the collector because it is too boring for him. Asking the reasons why it is boring and then giving examples like because there is no weapon on it, or because it just drives around, didn't led to an answer.
Child08: Kicked out the mask. Covering the face is not good! (maybe a helmet should be considered in that case)

Test shooting
Child 07: Had a paralyzed arm, however he managed to load the blaster with no problem. However, you can see here, that loading a clip, would ask for laying the blaster down.

Group 4

Two boys. Age 10 and 11. One of the two was disabled in a sense that his arms were shortened

and the number of fingers was reduced to three per hand.

Child 09:
Flexi is first one because
Collector as second favorite one

Child 10:
Flexi as well – but camera and sound recording were shut down during that moment

Collector second favorite one. Because the risk is not there to get hit when bending down to pick up darts.

Overall conclusion

Concluding one can say, that the concept direction with the name "collector" was the most favorized direction. Reasons for this were physical limitations to pick up darts like back pain or bad eyesight. Further the machine was seen as a relief from the annoying task to clean up. The time could be used in better ways like playing another game. In addition to this, the children mentioned that it would improve their game experience, since they expect to be less shot. From their experience, picking up darts and reloading is a reason to be shot, since you are not concentrated on the game anymore, have to duck down and thus become an easy target. A fact that was asked in every group was, if the collector would be able to collect independent of the underground (outside, inside, carpet, wood floor)

As the second favorite direction, flexi was chosen. Through the interview it became visible, that the flexibility made it that popular. Whether it was the option to build a trap, to attach it to ones bike or to create a new blaster out of it, made this direction interesting to the children.

It couldn't be recognized that there is one direction which was totally disliked. However, it was visible that the concepts Mask and Predator had some irritating effects on the children. The children were unsure about the sensor's reliability. Triggering the blaster accidently was an argument spread over all groups. Further the idea of using a backpack raised wasn't that promising for the children. Arguments against it were the heavy weight as well as its movement during play. Another argument against the concept was that the player needed to always look in the direction he wants to shoot at. It was stated that you have to shoot in one direction but need to look out for opponents in another direction.

An insight taken from the observation of the children playing with the NERF blaster was, that they were all able to operate it, except one child. This one child would however benefit from a wireless solution which could be connected to a device he is able to control.

Conclusion regarding testing (what to do better next time)
- Should try to dive deeper into what the kids say, for that a group of two is better
- make sure that everything gets explained, you forgot to explain one concept in the first group due to too many impressions that needed to be processes in your head.
-ask more why questions to get deeper into the reason, two children is better for this
- need to check beforehand what kid his how and then predefine groups, maybe one alone or three together
- make sure that everyone understands really every concept, present it with models
- asked directly why, asking how they play with it is more confusing than just asking why
-after 15 minutes of talking the concentration was gone
-impressive how enthusiastic they were when it went from talking to trying out
- depending on the next test, but it was interesting to see how they commented and tried out stuff while I was not in the room, consider to create a test setup like this for the next time
- next time the groups need to be considered beforehand, the children are really different from each other due to their abilities and also slight cognitive disabilities. Therefor each group was completely different to the other one
- it was good to use a target instead of doing free play, since it turned out that children where not feeling safe when it comes to getting hit with the darts. It was ok to hit a target and all had fun doing so, however when it came to be hit, children told others not to.

2.8.2 Visit Basketball

As described, it was visible, that the wheelchair plays an important role in the world of sports for people/children with physical disabilities. To gain more empathy with the topic of a wheelchair and understand the abilities one has while operating it, a visit at a wheelchair basketball club was organized. (illustration of how it looked like)

Set Up
The research questions which were of interest to be answered during the visit were:

- How fast is a game within wheelchairs?
- How easy is it to pick up objects (related to darts that fall to the ground)?
- Are problems visible when carrying the ball?
- How agile are the children within the wheelchair?
- How much hand movement is involved?

The training took place in a school's gym and was separated into three groups which took place after each other. The first group was intended for children up to the age of 8 and the second group up to the age of 16.

Instead of the planned observation, it was offered to take part in the training, to get first hands experience of what it feels like to sit in a wheelchair.

Younger group

The training for the younger children, was less a basketball training, than more a training for maneuvering the wheelchair. Obstacles, resembling small steps and gaps in the pavement, needed to be passed. For this, certain techniques were trained, so that it was possible to lift of the small front wheels and balance on the back wheel. These techniques needed a full body involvement. In case of stopping the wheelchair, one needed to lean backwards, and when starting to move, lean forward. This was needed to prevent accidental tilting and keep full control over the wheelchair. A problem regarding freedom of movement was not recognizable. Even the youngest children, about 5 years old, who just started to drive a wheelchair, maneuvered in it without problems. The end of the training was formed by a game, in which everyone played together, to steal "flowers" represented by loops of cloth, out of a defined square, which was protected by grumpy dwarf. It showed, that picking up objects, out of a wheelchair is challenging, since one needs to stop close enough to reach the object, and don't limit one-self with parts of the chair.

Older group

Getting involved in the real game of basketball showed that the tempo, with which the game is played is high. A constant movement of the hands is needed to react quickly to changes of direction and speed. By doing this, mainly the thumb and thenar are touching the wheel. Since, it is needed, by rules, to dribble the ball every two wheelchair pushes, a technique was developed, where the ball is thrown with

a spin, in front of the wheelchair, so that it jumps back into the players lap. That is done to have the possibility to keep up the speed while, dribbling. Doing it with one hand is also possible, however it will lead to a change of direction over time, since the wheelchair needs to be powered by both hands to go straight. Carrying the ball on one's lap is possible, however is not fixed during abrupt stops. One observation that was done apart from the technical and functional side of the observation, was, that it was not visible who was dependent on a wheelchair and who wasn't. Since everyone had the same ability, the border in one's mind, between unimpaired and impaired, vanished.

Conclusion

Visiting the wheelchair club showed, that even though one's hands and arms might be fully functional, it would be hindering to use them during a game like NERF, when sitting in a wheelchair. It also emphasized, that a wheelchair sport has the ability to bring disabled, and non-disabled together to enjoy sport. Further it showed that picking up objects from the ground is challenging, and thus picking up darts during a NERF battle gets difficult. Even Though one is able to change the position quickly within a wheelchair, there will always be the issue that i.e. lying flat on the ground to prevent a dart from hitting, is not possible.

2.8.3 Visit School Observation

Prior to the school visit, it was communicated to the teacher, that the reason for the visit was to observe the children during active activities, and if possible, to ask them further questions regarding their impression and ideas about toys. Moreover, it was asked that the class to be meet, is between the age of 8-14. Due to the fact that the visit needed to be organized short term, it was not possible to get permissions by the parents, so that it was agreed on not taking pictures or audio recordings. Regarding the request to interview the children, it was allowed to ask questions during the lunch break.

The research question for the observation were:

- How do the children handle their disability?
- Are there workarounds, which are used to compensate their disability?
- Which kind of support systems are being used?
- Is there a difference between the children within a wheelchair and without one?
- Regarding the list of abilities needed to operate a NERF blaster, which ones cause the biggest trouble?
- What type of toys do they play with, and is there one which is to difficult to operate?

Material
As preparation for the group interview during lunch time, a set of conversation cards was created. Instead of asking questions that might be too difficult to understand, the pictures and bullet points, should trigger conversations. The cards contained pictures as well as bullet points regarding the following topics:

- my favorite toy
- what i like most
- what i dislike
- my wish
- NERF Blaster
- VR Glasses
- Robots and Cyborgs
- AR games (Pokemon go)
- NERF Battle outside

(Picture of cards)

Further it was prepared:
- A4 sheets with pre-printed columns for observation notes
- one blaster, in case it would be allowed to test it

Set Up
During the observation of the sport class, the observer was sitting on benches which are placed around the gym. (illustration)

The visited class contained out of 11 children in the age range of 10-11 years of age.
The disabilities present within the observed class were Cerebral palsy, Hemiparesis, Muscular Dystrophy, Dysmelia as well as forms of development disorder and deformation of the legs.

Observation- Sport Class

Already before the start of the sport class,

the first insight was created regarding the way of preparing the observation material. It was noticeable that children were confused by the large A4 paper within the hand of the observer. The question if they will be tested today, was asked from three different children, by referencing to the paper, in an insecure way, that it was decided to use an A5 sized black notebook instead.

During the sport class, the children played basketball, what made it possible, to observe them in full motion. Against the first expectations, the child with foreshortened arms, was able to undertake all the tasks, regarding to throw and catch the ball. The children which were perceived as slightly disabled, showed bigger problems to fulfill these tasks. A reason for this were partly paralyzed arms and hands. To compensate the foreshortened arms, it was visible that the whole body was used to take the speed of out the ball when catching. Running/ Moving around, was less a problem, and if so, the children had crutches or asked for a wheelchair, at the point where it became too exhausting for them. Further it was observed, that a child with crutches could also go without, but this was experienced as a form of a training, what made him feel visibly uncomfortable when doing so. Even Though the child with cerebral palsy, was not capable either to pick up or to throw the ball by himself, he was integrated into the play, by letting his caretaker do all the moves for him and pushing him around constantly. It was later interesting to get to know, that this child, would be actually able to move around by itself, with the help of a joystick, however he refuses to do so.

By observing the teachers, one could recognize that they constantly adapted, games and rules, dependent on the difficulties they saw regarding a child's disability.

Workarounds which were visible, was to use the crutches instead of hands, to throw the ball, use the paralyzed arm as a stabilizer for grabbing an object with the other arm, and in case of the child with foreshortened arms, to use the body movement to compensate missing arm joints. A further workaround, was to use a different person to fulfill tasks. It was also observed, that the social atmosphere within the class was very positive. Everyone behaved with respect to one another and disabilities were at no point of the visit a topic. There was even a point, about halfway through the visit, at which the behavior of the children seemed so usual, that one would forget that every one of them is affected by a disability.

Regarding the used support systems, wheelchairs and crutches as well as a eye tracking system for communication was used within the class.
(illustration of some of the scenes)

//adding a visualized form of the notes that were taken

Question Round

After the sport class, and during the following lunch break, it was possible to ask the children questions regarding their experience with toys. This took place at the room within the children were also eating their lunch bread. The time limit was about 15-20 minutes, until the next lesson would start.

The first question that was asked by showing the conversation card, was "what is your favorite toy". At this point it was already hard to keep the control over the conversation, since every child started to explain what their favorite toy is, asked others question about it, and some wandered of to bring something they wanted to show, but never came back. As a try to calm down the situation, it was explained that everyone can answer after the one next to him is finished. Due to the unpredictability of the reaction to the next question, it was decided to ask directly about NERF Blaster. This was done by showing them a picture of a Blaster and asking "what do you think about this toy". Against the rule set before, the answers came from all directions. What was possible to note down was: "i have one at home", "my brother owns a cool one", "i would like to have one but my mom doesn't allow it - this is sad", " i had one but can't find it anymore".

Further, they went immediately into creating ideas which were: a NERF mine to explode when someone passes by, a dart count on glasses and a large trigger in form of a round button at the back of the blaster. To ask for more details or reason for it, was not possible since the children, were triggered by their own ideas to wander off into different topics, or just left the conversation.

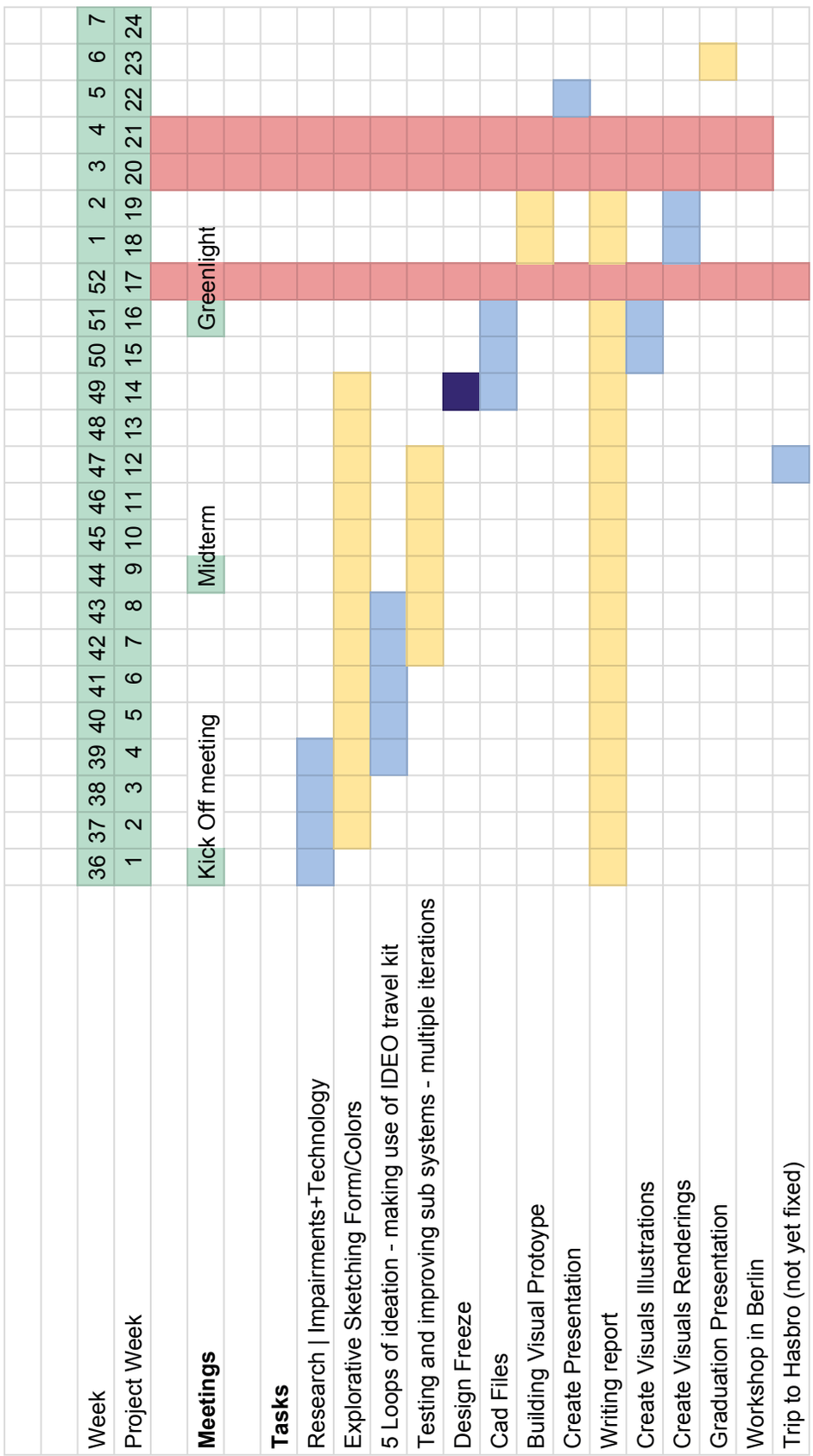
Conclusion
Concluding, one can say, that the children are aware of their disabilities and learned how to life with it, what makes it possible for them to take part in games, where one would actually expect them to fail. Regarding the ability to operate a NERF blaster, the factors of "lifting and carrying objects" as well as "fine hand use" and "hand and arm use", were more affected, than the ability to move around. Further, children with cerebral palsy, take part in a social context, but it is recognizable that they hardly can take part in it autonomously. In addition to this, to see that the teachers adapted rules so that everyone could take part in a game, could be part of a solution regarding game mechanics of the NERF Game.

Asking questions
The insights made from the question round, are related more towards the improvement of a next round, than towards insights related to the design project.
It is definitely recommended to do an upcoming interview in smaller groups, and during a time that is especially reserved for this. From the authors point of view, asking questions during a time frame where children expect leisure time instead of being focused, makes it difficult to keep them motivated. In addition, sensitizing material should be send before a visit, so that more direct questions can be asked.

Further it needs to be considered, that some of the children are also affected slightly mentally, what makes tasks like focusing especially difficult for them.

Resulting from this, the question got raised, that if the children seem to all know, and also play with NERF, how does it actually look like when they play with it? A request to test this out, was postponed by the school due to upcoming fall holidays. Therefore, it needs to be relied on what can be taken from the analyzation of YouTube videos in combination with the ICF classifications.

2.9 Initital Planning



Tim Tietze | TU Delft | 2018/2019