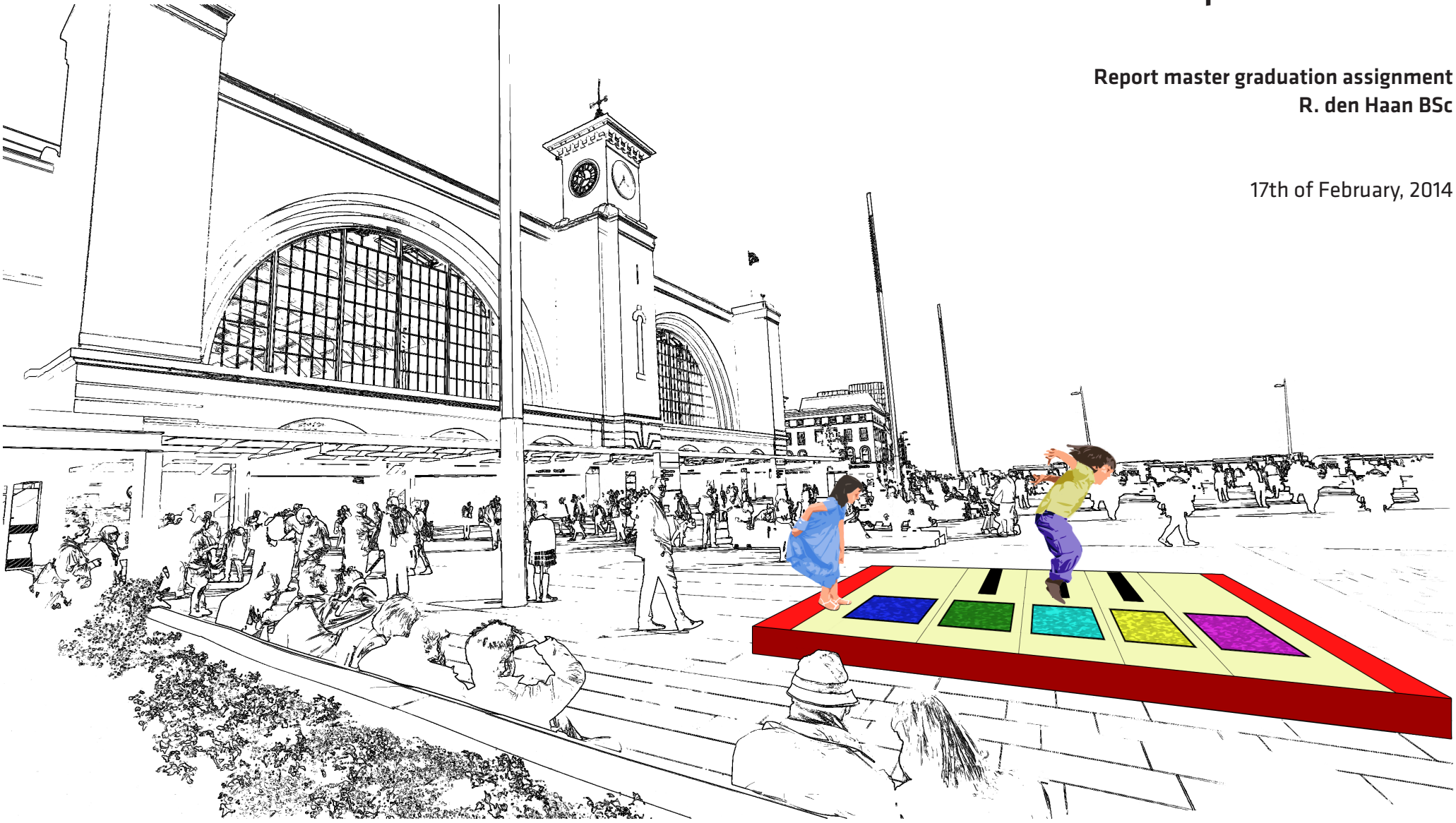
The design of conceptual interactive play sets for the outdoor public environment

Report master graduation assignment
R. den Haan BSc

17th of February, 2014



!!! Confidential until: 03-03-2016 !!!

Title:
The design of conceptual interactive play sets for the outdoor public environment

Context:
This report was written as part of the IDE D&S Master Graduation Assignment

Written by:
R. den Haan BSc s0090379

Assessment committee:
Prof.dr.ir. A.O. Eger
Dr.ir. W. Eggink
Ir. H. Tragter

Company mentors:
R. Stein
Ing. E. Siebelt

Department:
Industrial Design Engineering - Design & Styling
Faculty of Engineering Technology - University of Twente
PO Box 217
7500 AE Enschede
The Netherlands

Published:
17th of February, 2014
Prints: 6
Pages: 97
Appendices: 10

Report number:
OPM-1203

PREFACE

This report is my master thesis for the conclusion of my master program Industrial Design Engineering at the University of Twente. The report describes my work during the graduation assignment executed at Playnetic, a company located in Zutphen, The Netherlands. The graduation assignment focused on one of Playnetic's market segments; interactive play sets for the outdoor public environment. In other words, my graduation assignment focused on outdoor play opportunities for children. I could not have imagined a more fun topic for my thesis!

Firstly, I would like to thank Roy Stein and Ing. Erik Siebelt for providing this interesting and challenging graduation assignment. Their positive attitude and trust in my abilities greatly benefited the results of this design project. Furthermore, I am grateful for their support so that I was able to combine this design project with my cycling ambitions.

Besides Roy and Erik, I would like to thank Jessica, Naftalie, Jarno, Gideon, Tijl, Meike, Gerben and Rick for the pleasant atmosphere and enjoyable time while working at Playnetic.

I would like to thank Dr.ir. Wouter Eggink for all his constructive feedback and for asking me just the right questions during our progress meetings. These questions continuously provided me with new perspectives towards the design project.

I would like to thank Prof.dr.ir Arthur Eger for all the constructive discussions and enjoyable sidetracks during the graduation cycle meetings.

Lastly, this thesis would not have been possible without the support from my parents during my years as a student. Words cannot express the gratitude I have for their continued support and trust.

I hope you will enjoy reading this thesis.

Robert-Jan den Haan

ABSTRACT

Playnetic is a company located in Zutphen, the Netherlands, developing interactive play sets for the outdoor public environment. Playnetic believes that the current outdoor public environment is no longer in connection with the perception and the need for incitement of children. Therefore, Playnetic brings the interactivity known from computers, smart phones and tablets to the outdoor public environment.

Playnetic provided a graduation project in order to look at the future for the company at a strategic level. The purpose of this project was to develop a range of conceptual interactive play sets for Playnetic, to be introduced between now and ten year's time. This range of concepts had to push Playnetic's interactive play sets to a higher level of interactivity.

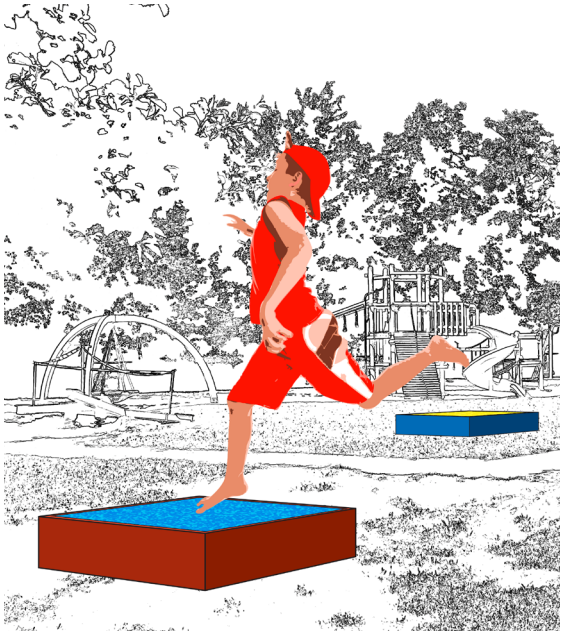
The project had to provide Playnetic with concrete concept ideas to develop in the future, making it possible to design parts and components based on future requirements. This way, Playnetic's products can be based on a modular setup and these parts and components can be used in multiple products, lowering the overall costs.

Based on a research phase consisting of multiple literature studies, an ethnography study, the application of a self-created design tool, an analysis of the evolution of playgrounds and the creation of future scenarios on the outdoor public environment in relation to play, this higher level of interactivity and subsequently future direction for Playnetic's products were determined and captured in a renewed vision statement. Summarised, the higher level of interactivity play sets can be described as open-ended interactive play sets.

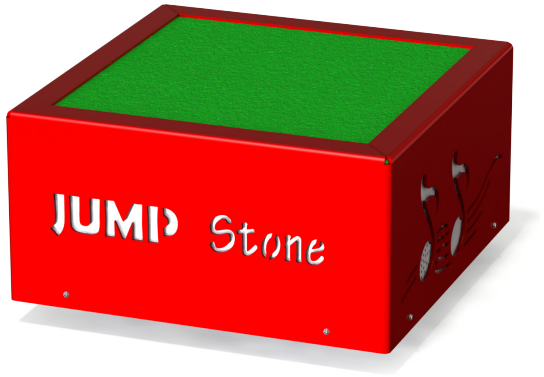
In the concept phase, six conceptual interactive play sets were developed. Firstly, search fields were explored and concept directions were created. Furthermore, mind restrictions as well as technical contradictions were overcome through the application of innovation techniques.

All six concepts push Playnetic in the direction towards open-ended interactive play sets. The concepts were developed to the point where the functionality is known. The solutions to achieve this functionality were explored and recommendations for further development were stated. Furthermore, product platforms behind Playnetic's current products and the future concepts were created and visualised, explaining which parts, components and complete products can be reused within the concepts. Additionally, a roadmap was created which serves as a guide for Playnetic in their sequential product development planning. Combined, the presented conceptual interactive play sets can all be developed and introduced in the next ten years.

In addition to the results aimed at the direct goal of the overall project, a prototype of one of the concepts was designed, constructed and subsequently evaluated. The children participating in the evaluation used the prototype in unintended and unexpected ways and incorporated the prototype within their play; they used it as an open-ended interactive play set.



Jumpstone concept drawing



Jumpstone prototype render

TABLE OF CONTENTS

00 **INTRODUCTION** p. **01**

01 **RESEARCH PHASE** p. **04**

1.1 Interactive play sets p. **04**

1.2 What is play? p. **05**

1.3 Social play development p. **10**

1.4 Ethnography of playing children p. **12**

1.5 What do children like? p. **14**

1.6 Evolution of playgrounds p. **20**

1.7 Future outlook p. **27**

1.8 Research phase conclusions p. **34**

02 **PLAYNETIC VISION AND BRAND** p. **36**

2.1 Renewed Playnetic vision p. **36**

2.2 Playnetic brand p. **37**

03 CONCEPT PHASE p. **38**

3.1 Search fields p. **38**

3.2 Concept directions p. **44**

3.3 TRIZ p. **50**

3.4 Concepts p. **52**

3.5 Product platforms p. **70**

3.6 Roadmap p. **74**

04 PROTOTYPE PHASE p. **76**

4.1 Jumpstone detailing p. **76**

4.2 Prototype construction p. **80**

4.3 Prototype evaluation p. **81**

4.3 Prototype recommendations p. **83**

05 OVERALL CONCLUSIONS & RECOMMENDATIONS p. **86**

REFERENCES p. **90**

APPENDICES p. **99**

A PLAN OF APPROACH p. **102**

B PLAY LITERATURE ANALYSIS p. **114**

C PLAY EVOLUTION LITERATURE ANALYSIS p. **122**

D ETHNOGRAPHY STUDY OF CHILDREN PLAYING p. **126**

E STUDY ON WHAT CHILDREN LIKE TO PLAY WITH p. **132**

F EVOLUTIONARY DEVELOPMENT OF PLAYGROUNDS p. **152**

G TREND DEVELOPMENTS ON THE EVOLUTION FACTORS p. **172**

H ORIGINAL PLAYNETIC VISION STATEMENT p. **186**

I TRIZ EXECUTION p. **188**

J JUMPSTONE DESIGN p. **194**

LIST OF ABBREVIATIONS

EPD	Evolutionairy Product Development
PDPD	Platform Driven Product Development (innovation technique)
PESTEL	Political, Economic, Social, Technological, Environmental and Legal (framework of macro-environmental factors)
TRIZ	Teoriya Resheniya Izobreatatelskikh Zadatch (Russian for: Theory of Inventive Problem Solving)

GLOSSARY

Child initiated play	Play which is started through children's initiation, such as children creating a game and expanding its rules.
Free play	Play which is controlled by the child; it is not pre-organised.
Interactive play sets	Play sets which allow a two-way flow of information between the play set and its user based on an electronic system; the play sets respond to the user's input.
Open-ended play	Play which is created or facilitated around materials which can be engaged in many different ways.
Multisensory experiences	Experiences which are related to more than one sense. In the context of this project; sight, hearing and touch.
Physical play	Play where the physical aspect is most important, from discovery that a child can move an object around, to two children engaging in a rough and tumble play to simply climbing on or jumping over obstacles.

00 INTRODUCTION

Playing is something everyone can relate to. Everyone has been a child and everyone has many pleasant memories of playing as a child. Not only can playing be extremely fun, play has all helped us to learn and develop ourselves; play is within all of us.

In The Netherlands, outdoor play is integrated deeply in society. However, with today's developments, it may seem to get less attention as a valuable phase in the development of children. Playnetic, a company located in Zutphen, believes that the current outdoor public environment is no longer in connection with the perception and the need for incitement of children. Therefore, Playnetic is developing interactive play sets for the outdoor public environment; they are bringing the interactivity known from computers, smart phones and tablets to the outdoor public environment.

Playnetic looks at the outdoor public environment as an important part of our lives; a large portion of our life is spent outside, on our way to work, to friends, to do grocery shopping or simply for playing and relaxing. Playnetic wants life in the public environment to have a positive effect on our well-being. As a manufacturer, Playnetic's products should contribute to a better public environment; life outside should, besides being functional, enrich our intellect as well as support better personal health.

Playnetic is currently a manufacturer of as well as supplier and partner for innovative interactive products for use in the outdoor public environment. It is Playnetic's mission to become a platform of knowledge and development, providing solutions for social issues related to the outdoor public environment.

Playnetic's expertises lie within interactive playing and supplying audio information in the outdoor public environment; the market segments in which Playnetic is active. Within these market segments, Playnetic currently offers four products. Unique selling point of three of these products is the use of kinetic energy of the user to produce the electrical energy for the products; they are 'human powered'. Furthermore, since the products are placed in the outdoor public environment, they are all designed to withstand weather conditions and to be 'vandal proof'. The three products are :

- The Audionetic™ provides audio messages in the public environment. It can for example be used to provide information on interesting locations alongside a walking or cycling route or provide recorded play ideas at playgrounds to children.
- The GameNetic™ is in essence a product extension of the Audionetic. Where the Audionetic uses the generated electrical energy to play audio messages, the Gamenetic uses this energy for playing games.

figure 0.1 Audionetic

figure 0.2 GameNetic

figure 0.3 MusicBall

- The MusicBall™ plays music when its hand crank is turned. It can be placed in a playground or at another location in the public environment where children can use it to simply listen to, to sing along with or to dance to.

To evaluate their current approach and vision on the public environment, Playnetic offered a graduation internship in order to look at the future for the company at a strategic level. The graduation internship was focused on the market segment of interactive playing. Playnetic manufactures and sells the three described products within this market segment. Besides their own products, the company is also a supplier for interactive system solutions for companies which are active in the outdoor play market segment such as Nijha. Playnetic's customers in this segment are municipalities (playground equipment), primary schools, after school care institutes and recreation parks such as amusement parks, zoos and family parks. The main users of Playnetic's products aimed at interactive playing are therefore children aged three to twelve years.

The purpose of this project is to develop a range of conceptual interactive play sets for Playnetic in order to be introduced between now and ten year's time. The range of these new concepts should aim to push Playnetic's interactive play sets to the next level of interactivity.

To achieve this, an analysis is performed on children's play behaviour as well as its development over time and children playing outdoors are observed. Additionally, an analysis is performed on the past, present and future of playgrounds and play sets and on trend developments of these. The results of these analyses are used to create an outlook on the future of the outdoor public environment. All these analyses are discussed in chapter one, the research phase.

In a brief second chapter, all knowledge learned in chapter one converges in the form of a renewed vision statement for Playnetic. In addition, Playnetic's brand is mapped, stating the core values the brand and its products stand for. Combined, the vision statement and mapped brand provide a solid base in order to create the range of conceptual interactive play sets for Playnetic as well as determine what the next level of interactivity, stated in the project goal description, should be .

In chapter three, product ideas are created using the future outlook as well as concept ideas generated in parallel. These product ideas are translated to a range of products with the support of innovation techniques such as 'TRIZ', 'disruptive imagery' and 'Platform Driven Product Development' (PDPD). By applying product platforms through PDPD, modular product setups are created, lowering the overall costs of production and assembly.

In the fourth and last chapter of this report, the design, creation and subsequently evaluation of a prototype of one of the concepts are discussed.

The deliverables of the project are:

- A future outlook on the outdoor public environment with respect to playgrounds and its play sets
- A range of conceptual interactive play sets
- A roadmap on how to further develop and introduce these products over time

Ultimately, the range of conceptual products and the overview supports Playnetic in staying ahead of its competition and in becoming the market leader in the segment of interactive play sets. It aims to provide Playnetic with concrete product ideas to develop in the future. Additionally, with the future products mapped out for Playnetic, the requirements for parts such as the electronics are known. The electronics can subsequently be developed in such a way that they are able to function in multiple products.

The complete initial plan of approach can be found in appendix A.

01 RESEARCH PHASE

This chapter describes the research phase of the project. Firstly, interactive play sets which can be found in the Netherlands are described. Next, play and play behaviour are researched. The results are subsequently verified through observations. Furthermore, the past, present and future of playgrounds and play sets are analysed, resulting in a future outlook on the outdoor public environment in relation to play allocation such as playgrounds. Each chapter provides conclusions in the form of design guidelines for the concept phase of the design project. The most important guidelines formed during the research phase are stated in a summarising chapter.

figure 1.1 Yalp's Sona

figure 1.2 Yalp's Sutu

1.1 Interactive play sets

When thinking about playgrounds, our minds immediately envision traditional play sets such as the swing and the slide. The overall design project focuses on a new type of play sets; interactive play sets. This chapter discusses several interactive play sets for the outdoor public environment which can be found in The Netherlands. Therefore, this chapter provides context for the overall design project.

Interactive play sets are defined as play sets that allow a two-way flow of information between the play set and its user, based upon an electronic system; the play sets respond to the user's input. In addition to the examples discussed in this chapter, the Playnetic products described in the introduction are also examples of such interactive play sets.

Yalp's (2006) Sona™ is an interactive play set that consists of a playing surface and a large arc (figure 1.1) with a camera located in the top of the arc, facing downwards. Children can play different types of games on the playing surface. These games are verbally explained to the children by the play set. An example of a Sona game is 'Freeze', where children are allowed to move on the playing surface as long as the music is playing. The moment the music stops, the players have to stand still; they have to 'freeze'. At the start of the game, the players stand on one of the numbers printed on the playing surface and the camera identifies the participants. While the players are moving, the camera tracks each individual's position on the playing surface. Similarly, the camera is able to register if a child moves after the music stops. When a player moves while no music is played, the play set announces that the child is out for the next round by stating its number. Thereafter, the game continues until one child is the victor.

Another interactive play set from Yalp (2011) is the Sutu™ (figure 1.2). The Sutu is described as an interactive football wall that contains sixteen panels which detects when these are hit by a ball. Furthermore, the panels can light up in different colours. Similar to the Sona, the Sutu includes multiple games. In one of these games, the children are presented with a shape on the wall, created through different panels lighting up simultaneously. Subsequently, the children have to disable the lighted panels by hitting them with a ball,

'clearing' the Sutu. In another game, the entire wall is lit up in two colours. Two children take turns shooting at the wall. By hitting a panel which is lit with the opponent's colour, it changes its colour and the panel becomes 'yours'.

Yalp's parent company Lappset also features its own interactive play set. However, Lappset's (2006) SmartUs™ is best described as an interactive play environment rather than a single play set. Each SmartUs environment features a central console, the iStation, guiding the SmartUs games with images and audio. Furthermore, the console can scan a child's iCard playing card, a card which serves as an identification card. The identification card allows children to save their progress in different SmartUs games which can be viewed from home on a computer. Furthermore, the iCards also function as a direct method of identification in certain games, much like a radio frequency identification chip. Different modular components, for example the iGrid and iPost, are added to the environment. Each of these components is connected to the iStation console and allows children to play games in the environment. Figure 1.3 shows the iGrid and the iStation behind it. An example of a game which can be played on the iGrid is 'SpeedGame II'. In this game, a child is presented with letters on the screen of the iStation, projected on a grid, and has to jump to the corresponding grid square on the iGrid. The projected letters range from A to Z and the child has to jump in the correct, alphabetical order. Furthermore, the game speeds up as time passes, increasing its difficulty.

Kompan is another manufacturer of interactive play sets. Kompan offers the ICON™ product line (n.d.), comprising four interactive play set modules: Nova, Rocky (figure 1.4), Space and Swirl. The Nova play set is similar to the Rocky, while the Space and Swirl modules also have similar features in comparison to each other. The Rocky is reviewed as an example. It features games where the children have to twirl and balance themselves as well as the entire play set. By working together, the children can set high scores. In one of Rocky's games, the central interface (figure 1.4 on the right) tells children in what direction Rocky has to be tilted. The children then have to distribute their weight to topple Rocky in the right direction. The direction continues to change and thus the children have to keep working together to follow the indicated path.

Playdale's iPlay™ (figure 1.5) (2007) is the last interactive play set presented in this chapter. The iPlay consists of three bend metal bars connected to a central console at the top. Each metal bar has two interaction points, which can be a button, a rotary knob or a hand crank. These interaction points are used in the iPlay's games. For example, in a reaction game, the child has to push the button or turn the rotary knob/hand crank after it lights up as quickly as possible.

Conclusion

Looking at all these interactive play sets, several similarities can be found. Specifically, the games of these play sets follow similar approaches. For example, the games on the Sutu football wall all relate to triggering the correct panel at the right time or as fast as possible. The games offered by the SmartUs iGrid also require children to timely trigger the correct grid square. Playdale's iPlay features interaction points which children need to trigger at the right time or in a specific order, while speed is also a factor here. However, the iPlay is not a grid based system. Instead, the grid is separated and spread out on the bend metal bars. Yet, although these are not further discussed here, the SmartUs iPost as well as Kompan's Space and Swirl all feature interaction points and

figure 1.3 Lappset's SmartUs

figure 1.4 Kompan's Rocky

figure 1.5 Playdale's iPlay

games similar to the iPlay. The setups of the iPlay, iPost, Space and Swirl may be different, but they offer similar if not the same functionality.

All these games are limited with respect to the software of the play sets; children are bound by the game rules. Additionally, the only interaction with these play sets is based on triggering the correct button or grid square at the right time. These types of games and the level of interaction can be associated with arcade games or classic video games. These are games which 'force' a player to follow a specific path; from A to B to C et cetera. As part of this design project, research is conducted to determine how to bring interactive play sets to the next level of interactivity.

Although this chapter describes interactive play sets already available in the Netherlands, the mentioned manufacturers should not be considered direct competitors of Playnetic. For instance, Yalp is a dealer of Playnetic's Audionetic and GameNetic. Furthermore, all the presented play sets, which are a good representation of the entire market segment, are in a higher price segment than Playnetic's products. The cheapest available interactive play set described in this chapter is Kompan's Rocky at 9,110 Euros, whilst the majority of these play sets are priced even higher, with the Sona coming in at 22,000 Euros, while Kompan's Swirl costs 32,630 Euros. For comparison, the Audionetic and GameNetic can be purchased from Yalp for 2,250 and 2,990 Euros respectively. Playnetic wants to keep focusing on the lower price segment, to a maximum price of around 8,000 Euros for a single product, while aiming to create revenue through higher sales numbers.

1.2 Play and play behaviour

Children always want to play; they seem programmed to do so. Playing is in fact not at all limited to children; adults and animals play just as well. However, why do we play? What is play? What is it good for? How is play behaviour defined? To answer these questions, a literature study was performed to research play and play behaviour. Goal of this literature study was to gain qualitative insight on how to approach play in interactive play set design. Therefore, design guidelines for interactive play sets were created based on the literature.

Article 31 of the United Nations Convention on the Rights of the Child, adopted by the United Nations in 1989, states:

> *"That every child has the right to rest and leisure, to engage in play and recreational activities appropriate to the age of the child and to participate freely in cultural life and the arts.*
>
> *That member governments shall respect and promote the right of the child to participate fully in cultural and artistic life and shall encourage the provision of appropriate and equal opportunities for cultural, artistic, recreational and leisure activity." (International Play Association, 2009)*

Hence, play is a right which all children have. Play is in fact in the nature of us all. But, what exactly is playing? How do we define play? According to the Oxford dictionary (2013), the definition of play is to "engage in activity for enjoyment and recreation rather than a serious or practical purpose".

Going beyond the definition of the dictionary, Brown and Vaughan (2010) define play as "any kind of purposeless, all-consuming, restorative activity". They go as far as stating

that it is the most significant factor in determining our success and happiness. Interestingly, this point of view states that play is purposeless and yet so important. Within this definition, Brown and Vaughan state seven properties of play:

- Apparently purposeless
- Voluntary
- Inherent attraction
- Freedom from time
- Diminished consciousness of self
- Improvisational potential
- Continuation desire

Play is apparently purposeless as the act of play has no immediate value to our survival. It is voluntary as we choose to engage in it. Inherent attraction means that it makes a person feel good; it provides psychological arousal. Freedom of time makes us lose sense of the passage of time. A diminished consciousness of self allows us to stop worrying about whether we look good or awkward, smart or stupid. Improvisational potential means that we are not locked into our normal way of doing; we are open to change and willing to include seemingly irrelevant elements into play. Lastly, there is a continuation desire, we do not want to stop and thus we find ways to keep on playing.

Brown and Vaughan continue their vision of play with various examples of play in the animal world. Although they state that play is apparently purposeless, meaning it has no immediate value to our survival, they also state that if so many animals are playing, there must be some purpose to it after all. Yet, play uses up energy while not providing animals with food or water in return. Natural selection would suggest that such acts should be eliminated; species that play would become extinct. Therefore play must have a form of survival value.

Similarly to Brown and Vaughan, Rubin, Fein, and Vandenberg (1983) state six characteristics as a definition of play behaviour:

- Intrinsically motivated
- Controlled by the players
- Concerned with process rather than product
- Non literal
- Free of externally imposed rules
- Characterised by the active engagement of the players

These characteristics are in line with Brown and Vaughan's definition. Intrinsically motivated implicates all-consuming, while being concerned with the process rather than the product suggests that the activity is purposeless. However, being concerned with the process rather that the product also suggests that it is in fact a learning experience.

Jones and Reynolds (1992) write on the viewpoint of play as learning experience that:

> *"Young children learn the most important things not by being told but by constructing knowledge for themselves in interaction with the physical world and with other children – and the way they do this is by playing." (Jones & Reynolds, 1992, p. 1)*

Simply put, play comprises physical, cognitive, social and emotional development. By climbing and running around, a child develops its gross motor skills, while through crafting, building and tinkering, a child stimulates the development of its fine motor skills. During play, a child learns to think about

what it is doing, learns to think ahead and to solve problems, thus developing its cognitive skills. Other examples of cognitive development through play are learning to recognise shapes and symbols or training reaction time. A child also develops its social-emotional skills by gaining insight in its own as well as others' feelings while playing. Children can experiment with actions and behaviour in play which they would otherwise be too afraid to try (Hughes, 2010).

Elkind (2009), in line with Jones and Reynolds, states that playing is a way for children to learn about itself and the world through self-initiated experiences. He therefore advocates that self-initiated child's play, for example children thinking up their own games and rules, should not be replaced by adult-organised sports or by academic activities disguised as games. Child-initiated play learns children mutual respect for one another; a child creates a set of rules and another child must follow them. In return, the initial rule maker must follow the rules created by another child later on. This child-initiated play is related to what the International Play Association (2009) defines as 'free play'. They state that play should be controlled by the child, not by the adult; it should not be organised recreational and learning activities.

An experience which illustrates the definition of play behaviour and play as a learning experience is described by Wardle (2009). He writes about observing young girls helping their mothers wash clothes in a river. After getting bored, the girls started to throw the soap bar to each other in order to try and catch the slippery object. They created a game for themselves, one in which concentration, agility and creativity was needed. Wardle explains that the girls made their game more complex and kept enjoying themselves for a long period of time. This is the continuation desire which Brown and Vaughan speak of. Furthermore, there was no immediate purpose to the girls' game. Yet, they voluntary participated in their game and showed inherent attraction, freedom of time as well as diminished consciousness of self. Additionally, the girls' game also demonstrates what Elkind calls child-initiated play. Wardle continues on how these girls used the bar of soap as a piece of open-ended play material. Open-ended play materials are materials which offer children many different ways to engage with them. He concludes that such materials spark creativity and ultimately create more flexible and creative thinkers who come up with more abstract ideas and concepts.

Playground design

Playgrounds are the place for children to be able to perform 'free play' outdoors. Similarly, on the subject of outdoor play environment facilitation, Hewes (2006) states that:

> *"The adult designs an environment with hands-on, concrete materials that encourage exploration, discovery, manipulation, and active engagement of children. The quantity, quality, and selection of play materials influence the interactions that take place between children. The adult protects the time needed for exploration, discovery, and uninterrupted play." (Hewes, 2006, p. 5)*

Her viewpoint is line with Grob's (2009) statement that outdoor play is essential in a child's development; it offers a wide range of options for exploration as well as experimentation. She quotes landscape architect Nicholson saying:

> *"In any environment, both the degree of inventiveness and creativity, and the possibility of discovery, are directly proportional to the number and kind of variables in it." (Grob, 2009, p. 18)*

Alternatively, Kalliala (2006) states that adult facilitation in regard to play environments should be:

> *"Supporting children's play is more active than simply saying you believe that it is important. When children's play culture is taken seriously, the conditions which make it flourish are carefully created. Children's play culture does not just happen naturally. Play needs time and space. It needs mental and material stimulation to be offered in abundance. Creating a rich play environment means creating good learning environments for children." (Kalliala, 2006, p. 139)*

Interestingly, she writes that play does not happen naturally; certain conditions are needed in the form of time, space and mental as well as material stimulation. The play environment should therefore be rich in all of these areas, in line with Grob's and Hewes's statement on the subject of outdoor play environment facilitation. Kalliala further writes that play environments should provide:

- rich, diverse, multisensory experiences
- opportunities for noisy, boisterous, vigorous, physically active play
- opportunities for physical challenges and risk-taking that is inherent in the value of play
- rough, uneven surfaces, with opportunities for the development of physical strength, balance, and coordination
- natural elements and loose parts that children can combine, manipulate, and adapt for their own purposes

She concludes by saying that outdoor play environments should be designed with equal care and attention as indoor environments.

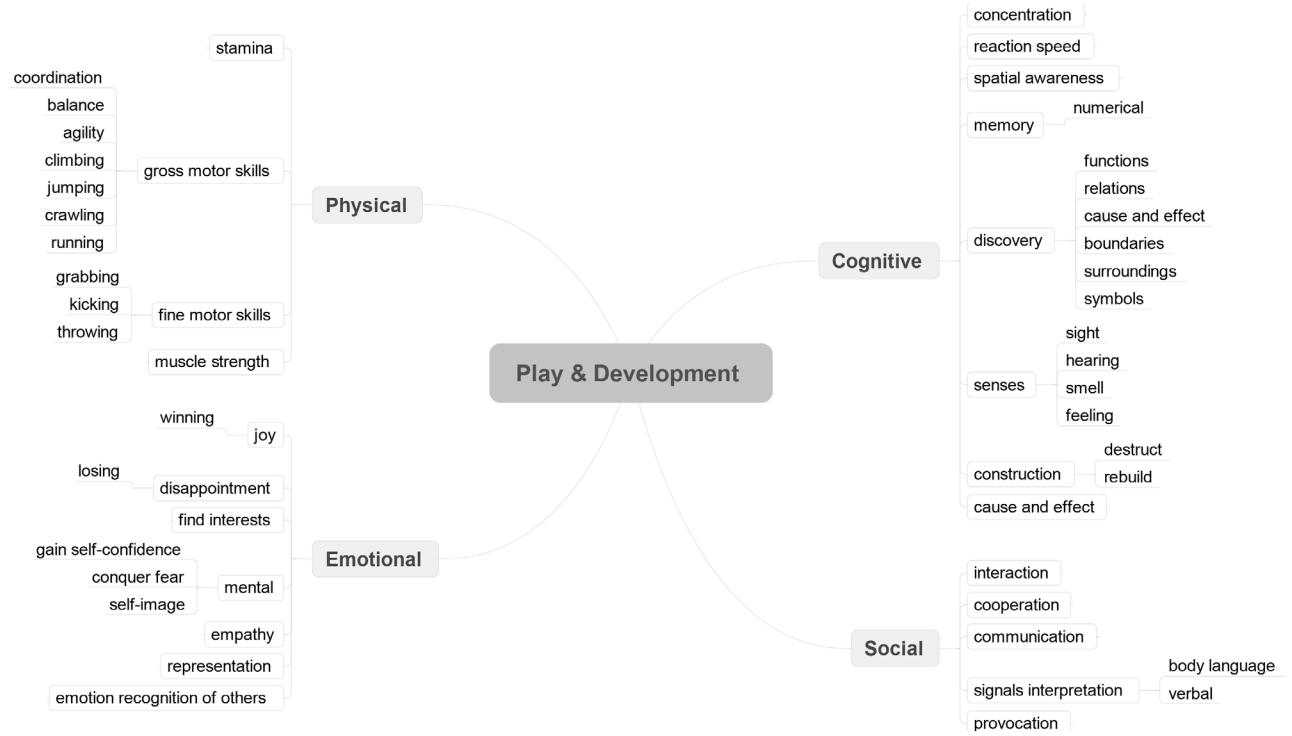


figure 1.6 Mindmap play and development

Combined, Hewes, Grob and Kalliala advocate carefully designed outdoor play environments. These environments should be spacious, rich and diverse; offering children a high amount of mental and material stimulation.

The entire literature study is found in appendix B. It provides more context on play behaviour, explains different types of play and discusses more viewpoints on approaching design of outdoor play environments.

Conclusion

From the literature study, it is concluded that play is essential for the overall development of a child. From a pedagogic viewpoint, play is probably the most important tool for children to learn and therefore essential in the development of a child. Figure 1.6 shows a visualisation on how play

contributes to a child's development, mapping examples of how play helps a child develop physical, cognitive, emotional and social skills.

Play is a safe way for children to develop their skills and processes illustrated in figure 1.6; children can experiment with actions and behaviour in play which they would otherwise be too afraid to try (Hughes, 2010). Playgrounds are, therefore, an ideal place for stimulating free play in the outdoor environment. Playgrounds provide a safe environment for children to explore and experiment.

Interactive play set design guidelines

Based on the literature study, ten design guidelines for interactive play sets are created. These should be kept in mind while designing:

- First of all, play should be fun! The play sets should first and foremost be pleasurable to use.
- The interactive play sets should further stimulate 'free play' or 'child initiated play'. Although children are free to use interactive play sets, they are bound by the rules of the game(s) programmed within them. Seek for ways to hand over (some of) the game control to the children.
- Allow the children ways to manipulate the play set. This could be in the form of construction or through imagination.
- Stimulate children playing together to aid children's social development.
- Seek for ways to stimulate different types of play while using interactive play sets in order to support all four categories of development; physical, cognitive, emotional and social.
- Enable multisensory experiences, in order to create rich and diverse play sets.
- Look for ways to stimulate active play; noisy, boisterous, vigorous and/or physical.
- Possibly add a physical challenge to the play sets.
- Do not deliberately add educational goals to the play sets.
- Try to create play sets where children are not bound by games within a specific duration. Rather allow the child to play and decide for itself when the play is over; take away fixed time frames as a factor within the play set design.

1.3 Social play development

The previous chapter describes play behaviour and provides guidelines on how to approach play in play set design. However, while the characteristics of play remain applicable, does play itself develop or remain the same as children grow older? It is expected that play develops as children grow older. Therefore, it is important to take this development into account for the design of new interactive play sets; the approach towards new interactive play sets should perhaps not be the same for children of all ages within Playnetic's target group. This was addressed by first performing literature research and subsequently verifying the findings through own observations. Goal of this research was to understand the development of play with age, and how this should be taken into account when designing new interactive play sets.

Play can be described from a sensory/behavioural perspective or a social interaction perspective. The sensory/behavioural perspective describes play as the way in which a child is playing in and engaging with its environment (Hewes, 2006). A young child might be grabbing wooden blocks of various

shapes and sizes, simply to explore or examine them; a form of exploratory or object play. An older child might use the same blocks to build a castle; a form of construction play.

The social interaction perspective describes how children start playing solitary. Over time, it becomes important for children to play solitary near each other; which is called parallel play (Hughes, 2010). As children grow older, they start to interact with each other. First by focusing on individual work, for example making a drawing, but interacting with another child becomes more important, for example by asking another child if he or she can borrow a coloured pencil, described as associative play. In the next step, children start to work together in their play; it becomes cooperative. Finally, play becomes competitive, either through direct competition, for example sports, or by trying to become better or the best at some skills. In regard to social interaction, associative and especially parallel play can be considered as playing together passively, while cooperative and competitive play can be considered as actively playing together.

Furthermore, the development of group sizes during play and gender differences were analysed. The entire study is found in appendix C.

Conclusion

There is a clear development in the social play style of children when they grow older, evolving from solitary to cooperative and competitive play. Furthermore, the group sizes during play increase as children grow older, which is only logical as young children play solitary and older children play cooperatively. Table 1.1 shows what this development looks like, based on the age of children, and combines the social interaction perspective and the sensory/behavioural perspective of play.

Age range	Group size	Social play type	Sensory/behavioural type of play
0–2.5 years	Solo	Solitary play	Exploratory play/ object play/sensory play
3–8 years	Solo	Solitary play	Dramatic play (solitary pretense)
3–8 years	Solo – dyads – small groups	Solitary, parallel, associative and cooperative play	Construction play
3–8 years	Solo – dyads – small groups	Solitary, parallel, associative and cooperative play	Physical play
3–6 years	Dyads – small groups	Cooperative play	Socio-dramatic play
5 years and up	Dyads – small groups – large groups	Cooperative and competitive play	Games with rules
5–8 years	Dyads – small groups – large groups	Cooperative and competitive play	Games with self-invented rules

table 1.1 Child play evolution

Two things have to be noted when looking at table 1.1. First of all, the ages presented are not necessarily true for all children. Children develop at different rates and have personal interests. Children do not have to participate in certain social play types at specific ages. Secondly, older children might still engage in play types which are allocated in table 1.1 to younger children. The play types do not necessarily stop after the mentioned ages in the table; those ages simply reflect when the play types have their greatest incidence.

One aspect not reflected in this table is the group size difference between boys and girls; boys play in much larger group sizes than girls. This is influenced by their interest in competitive games and preference for intimacy-enhancing activities respectively (Pelligrini, 2010).

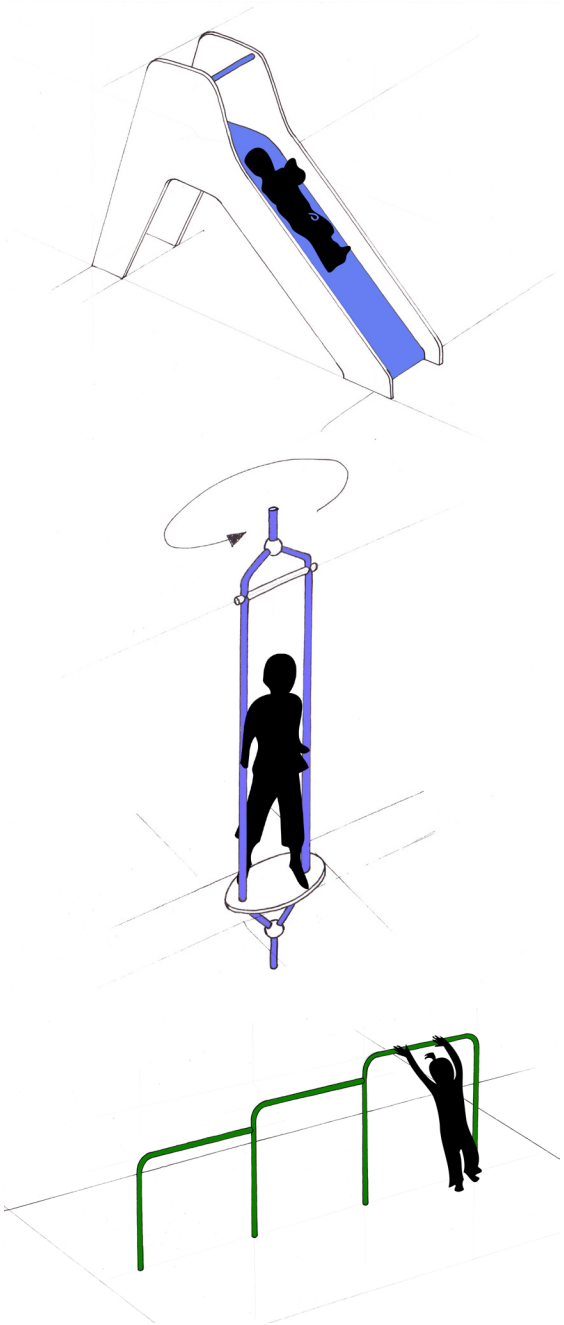


figure 1.7 Actual use: intended

For the design of new interactive play sets, table 1.1 provides a good overview of how to approach the design towards a specific target group. For example, design an interactive play set for a specific age category, or towards a specific use situation; two five year old boys looking for a physical challenge.

The findings presented in table 1.1 as well as the mentioned gender difference were verified through observations.

1.4 Ethnography of playing children

For this study, children were observed while being in their own habitat: schoolyards and their playgrounds. On six occasions, children were observed during playtime at schools. As the ethnography study was performed at schoolyards of primary schools, children younger than four were not observed. The observations therefore did not entirely cover the complete target group of Playnetic; three to twelve year old children.

Goal of the study was to gain qualitative insight in children's behaviour while playing. Besides general observation, two things were specifically looked at:

- What are the group sizes during play? Do they evolve as found in chapter 1.3?
- What are the actual use situations of the available play sets? Do children use play sets as they are designed to be used, or not. When are they using the play sets as intended and when as unintended?

As for the group sizes, it was expected that the group sizes increase as children grow older. Furthermore, it was expected that the group sizes of boys observed would be higher than those of girls, especially when looking at the older half of the children. As for the actual use situations, it was expected that children use play sets differently from how they are designed to be used. However, attention was given to observe intended use of play sets as well to exclude a biased outcome of the observations. The entire ethnography study is found in appendix D.

Group sizes

4 ~ 5 years old

The most observed play style was cooperative play in dyads or small groups. No difference in group size while playing was observed between boys and girls within this age category. Overall, the observations were consistent with the expectations.

6 ~ 8 years old

No solitary play and hardly any dyads play were observed in the age category of six to eight. It cannot be concluded that they do not engage in such play; they could still engage in construction play with for example Lego on their own. As for playing in the schoolyard though, six to eight year old children were only seen engaged in cooperative and competitive play. Similarly, children within this age category were only observed to play in groups and engaged only in games, either with or without rules. As it was expected that the children in this age category engage in solitary, dyad and group play, the observations reflected some of the expectations, but not all.

9 ~ 12 years old

With the observations mainly showing games with fixed rules, competitive play and in group sizes of small to large, the observations were consistent with the expectations.

A clear difference was also spotted in group sizes between boys and girls.

All in all, the observations were mostly in line with the expectations based on previous literature research.

Actual use of play sets

The second goal of the observations was to gain insight into the actual use of play sets. Which play sets are used as intended and why? What sparks unintended use of play sets? To approach this use on an abstract level, both the intended and unintended use situations were sketched in a simplistic way. Yet, the sketches showed a lot of similarities.

Figure 1.7 shows a collection of intended use of play sets. All these intended use situations concern physical play. These are situations where children feel the effect of their play behaviour through their bodies and/or situations that provide the children with a physical challenge. A physical challenge can be anything from jumping over a jumping rope or climbing a wall or climbing rack. These are situations where a child needs endurance while using strength and coordination to overcome obstacles.

The unintended use situations (figure 1.8) all include surfaces. The surfaces are used as boundaries, creating a play field or part of a play field that functions as a goal or aid in other types of play (like a ramp).

Conclusion

In general, the ethnography study shows exactly what was expected; children are very good at creating their own play and, while doing so, use play sets totally different from their intended use. Nevertheless, there were also observations showing intended use of play sets. This knowledge can be used in the design process. The two main design guidelines that determine intended and unintended use of play sets are therefore:

- In order to allow intended use of a play set, include a way for children to feel the play in their bodies; a type of physical play.
- In order to allow unintended use of a play set, use surfaces that children can exploit for their play creation.

Design guidelines

Comparing the literature research to the observations, it is concluded that the outcome of the observations reflects most of the literature conclusions. Therefore, table 1.1 is considered accurate and applicable for the design of interactive play sets. Based on this table, more design guidelines for interactive play sets are formed specific to different types of play:

- Interactive play sets aimed at a child engaging in exploratory/object/sensory play should:
  - Target at children aged roughly three years and younger
  - Be aimed at solitary play and
  - Ideally incorporate open-ended play materials such as sand and water

- Interactive play sets aimed at children engaging in socio-dramatic play should:
  - Target children aged roughly between three and six years
  - Allow play in dyads and small groups of up to roughly four children and
  - Enable cooperative play

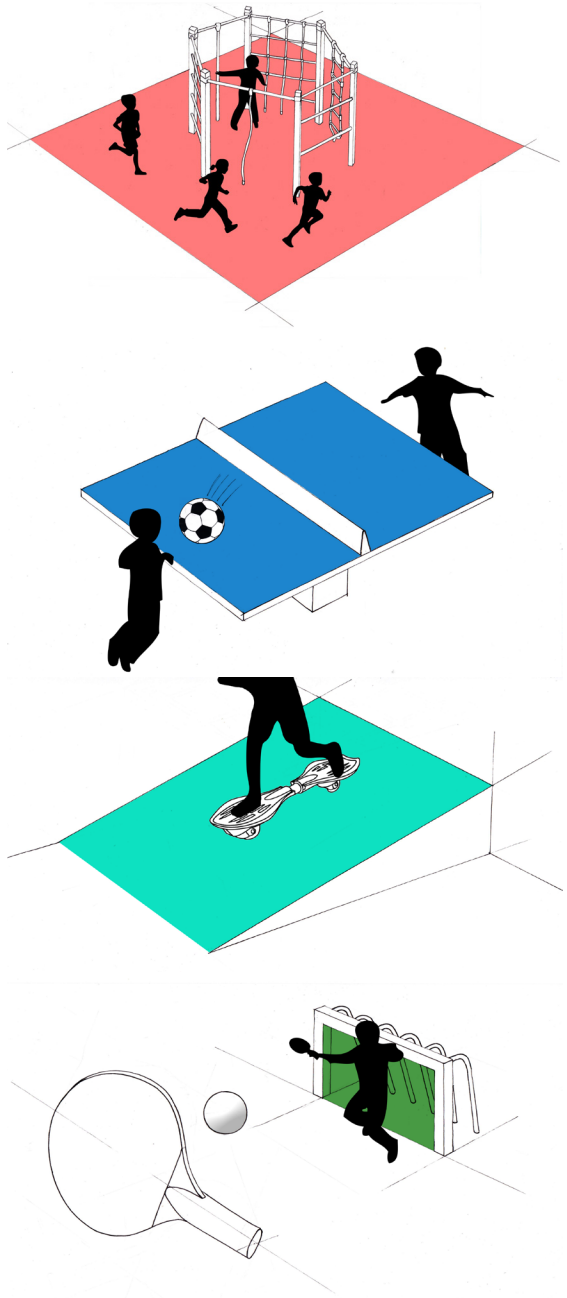


figure 1.8 Actual use: unintended

figure 1.9 Top Gear cool wall

figure 1.10 Smiley board

- Interactive play sets aimed at children engaging in physical play should:
  - Target children aged roughly between three and eight years
  - Allow playing alone, playing in dyads and in small groups of up to roughly eight children and
  - Enable solitary, parallel, associative and cooperative play

- Interactive play sets aimed at children engaging in construction play should:
  - Target children aged roughly between three and eight
  - Ideally, allow playing alone as well as in small groups and
  - Ideally, allow solitary, parallel, associative and cooperative play

- Interactive play sets aimed at children playing games with invented rules should:
  - Target children aged roughly between six and eight
  - Allow playing in groups of three to a maximum of eight and
  - Enable to incorporate play surfaces for children into their games in some form or way

- Interactive play sets which are designed around games with known rules should:
  - Target mainly boys aged roughly between six and twelve
  - Allow playing in groups of eight and larger
  - Incorporate physical play

1.5 What do children like?

Part of the overall approach of the design project was to find out what exactly attracts children. Therefore, research was performed on what children like. Goal of this research was to find out what children like to play with and why they find these play objects fun. Based on the results, interactive play sets can be designed that match the children's perception.

Particularly for this project, the designer as well as employees at Playnetic could be assuming to know what the interests of children are based on the fact that they have been part of the target group. While there is likely common ground, there are likely differences between generations; society, culture, values, technology, knowledge of the technology and individual motivations are ever changing.

Therefore, incorrectly incorporating users' needs and wishes based on biased opinions or assumptions had to be avoided. To gain the necessary insight, a child could be asked if he or she finds football fun. The answer to this question would be yes or no. Asking how much fun football is, would likely not yield a usable result. Asking if they like football more than cycling would provide an answer that is comparable, but not measurable. Yet, to find out what children like to play with, multiple play objects would have to be compared and be measurable in comparison. Therefore, a simple, effective and low-cost tool was developed to map a child's interest.

Inspiration

The created tool was inspired on an article where scientists used the 'Cool Wall' concept of the popular television show Top Gear (figure 1.9) to measure the 'coolness' of products amongst teenagers (Fitton et al., 2012). Fitton and his fellow researchers implemented the Cool Wall on a touch

screen based system where teenagers were asked to drag different objects to the cool category of their liking, based on how cool they find the object. Using the Cool Wall from Top Gear allowed the teenagers to quickly understand what the categories represented and what to do.

Implementation

While the 'Cool Wall' tool deployed by Fitton et al. was very successful, the concept had to be adapted to the goal of this design project as well as simplified; a touch screen system was not an option from the perspectives of costs and complexity. The solution was found in using a metal board in combination with pictures glued to magnets. The different categories placed on the white board were converted from 'cool' categories to 'smiley' categories. Five columns were made, each with a smiley ranging from very sad to very happy. Each column was also given a colour to further enhance the expression of the smiley. Goal of the smiley and colour approach was easy recognition of what the columns stand for. Figure 1.10 shows the created board.

The board was created in such a way that children have to think about how much fun an object is compared to another. To refer back to the introduction of this chapter, the board basically asks children to compare football and cycling, but does so for multiple play objects. Furthermore, the board provides children with a scale for their answer; children have to weigh up how much they like to play with a specific object in relation to other objects.

Objects and pictures

Rightfully so, Fitton et al. discuss the importance of the objects on the pictures and the way in which these are presented as well as their meaning. Therefore, ample attention was given to choosing the correct objects and their pictures. The objects were chosen on four main parameters: boy versus girl, the main type(s) of development the play stimulates (physical, cognitive, social and emotional), outdoor versus indoor play and individual versus group play. Twenty objects were selected representing different kind of fun products or activities based on creating a good mix amongst the parameters.

		Gender			Development type					Location			Individual	
Number	Object	Boy	Girl		Physical	Cognitive	Social	Emotional		Inside	Outside		Individual	Group
1	Nintendo Wii	x	x		x	x	x			x			x	x
2	Tablet / Smartphone	x	x			x				x	x		x	
3	Computer	x	x			x				x			x	
4	Television	x	x			x		x		x			x	x
5	Swing	x	x		x						x		x	
6	Efteling	x	x			x		x			x			x
7	Lego	x			x	x				x			x	x
8	Doll / Barbie		x				x	x		x	x		x	x
9	Football	x			x		x	x			x			x
10	Ballet		x		x		x	x		x				x
11	Bicycle	x			x		x				x		x	x
12	Jumping rope		x		x		x				x		x	x
13	Pedal car	x	x		x		x				x		x	x
14	Inline Skates	x	x		x	x					x		x	x
15	Pavement chalk	x	x		x	x	x				x		x	x
16	Dog / Cat	x	x		x		x	x		x	x		x	
17	Guitar / Flute	x	x			x		x		x			x	x
18	Drawing / Pottering	x	x		x	x		x		x			x	x
19	Reading	x	x			x		x		x			x	
20	Board games	x	x			x	x	x		x				x
		17	17		12	12	10	10		12	11		16	15

table 1.2 Twenty chosen objects of play

The twenty selected objects are found in table 1.2 on the previous page, along with their classification amongst the parameters.

Pilot

A pilot of the test was performed with one younger (four years old) and one older child (eleven years old). Both children understood the test without any explanation, apart from asking them to place the pictures based on how much they find them fun.

The pictures themselves were not all understood correctly. For example the picture with a tablet and smartphone was correctly understood by the 4 year old child, but the 11 year old child thought it was about listening music, as the tablet displayed two singing persons on its screen. The younger child did not understand the pictures showing Lego, ballet and the jumping rope. Furthermore, the picture showing a board game was interpreted as the exact game displayed instead of board games in general.

Therefore the pictures were adjusted to accommodate these findings. For example, the picture showing a tablet and a smartphone was changed to both show an Apple product and an Android based product. Only the picture showing Lego was not changed. The final twenty pictures are shown in figure 1.11.

Expectation

The tool was created so that children had to put their liking of a play object in perspective to other objects. Therefore, it was expected that the tool would provide clear and interpretable data to gain insight into what children like to play with. Based on Playnetic's approach of bringing the computer to the outdoor environment as well as personal expectations, it was expected that the tablet / smartphone, Wii and computer would be among the most fun objects. The football was expected to be a competitor for the most fun object, especially in the boys' population. As for the differences between boys and girls, it was expected that Lego, football and cycling would do well among the boys, while the doll / Barbie, ballet and jumping rope would do well in the girls' population. Lastly, it was expected that some objects would show increasing or decreasing trends when dividing the total population in different age categories and comparing the results of these age populations.

Execution

The tool was deployed at six primary schools. The schools were chosen based on their location and their school type, such as Christian or Reformed, in order to create as much differentiation as possible. The locations were chosen in order to create a good representation of the Netherlands.

The test was executed during the lunchtime of each school. The children that 'stayed over' (Dutch: overblijven) were

figure 1.11 Final object illustrations

asked to participate. At each school, children of different age groups were involved in the test. The only explanation given to the children was that they were asked to classify the pictures from least fun to most fun based on their own preference. After a child finished the test, a post-it note with a number was attached to the board and a photograph of the end result was taken. Subsequently, each child was asked why the pictures placed in the most fun category were considered to be most fun in order to gain inspiration for the design phase.

Analysis

The results of the tests were analysed statistically. Each picture was scored with a number between one and five, based on the column it was placed in, as illustrated in figure 1.12.

A total of 115 children participated in the study. Of these 115 children, 60 were boys and 55 were girls. When the test was executed, 23 children were group 1 and 2 pupils, 46 were part of the group 3 and 4 population, 23 were in group 5 and 6 and the remaining 23 were in group 7 and 8. The fact that 23 children participated in three age groups while one age group has exactly double that amount is a coincidence.

To verify if the double amount of children in the age group of 3 and 4 had any influence on the overall result, a Monte Carlo simulation with 100 trials was performed, picking 23 random entries from the 46 in this age category per trial. Figure 1.13 shows the mean scores and standard deviations, represented by the range bars, of the total population and the Monte Carlo simulation.

The values shown in figure 1.13 are very close to each other. Based on this simulation, it can be concluded that including all 46 children from the 3rd and 4th grade does not change the outcome of the overall study. At the same time, figure 1.13 shows minor differences. Using the numbers generated through the simulation does reflect the overall population of the study better.

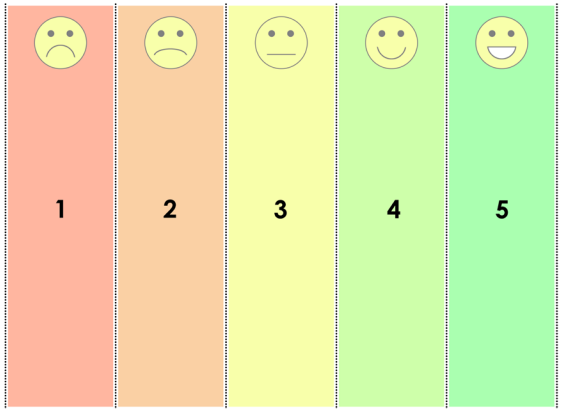


figure 1.12 Statistical analysis scoring

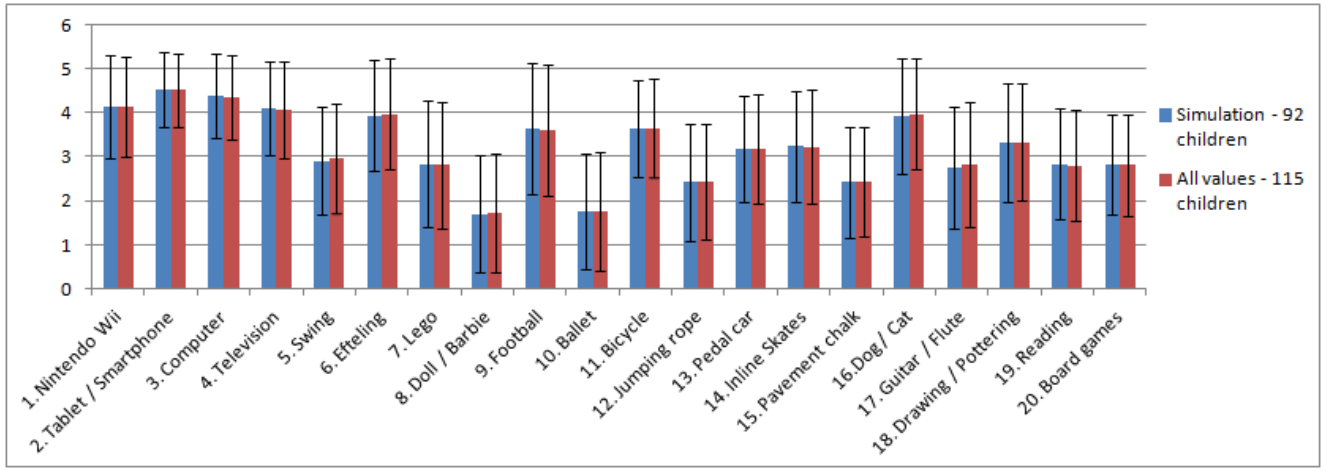


figure 1.13 Total population and Monte Carlo simulation comparison









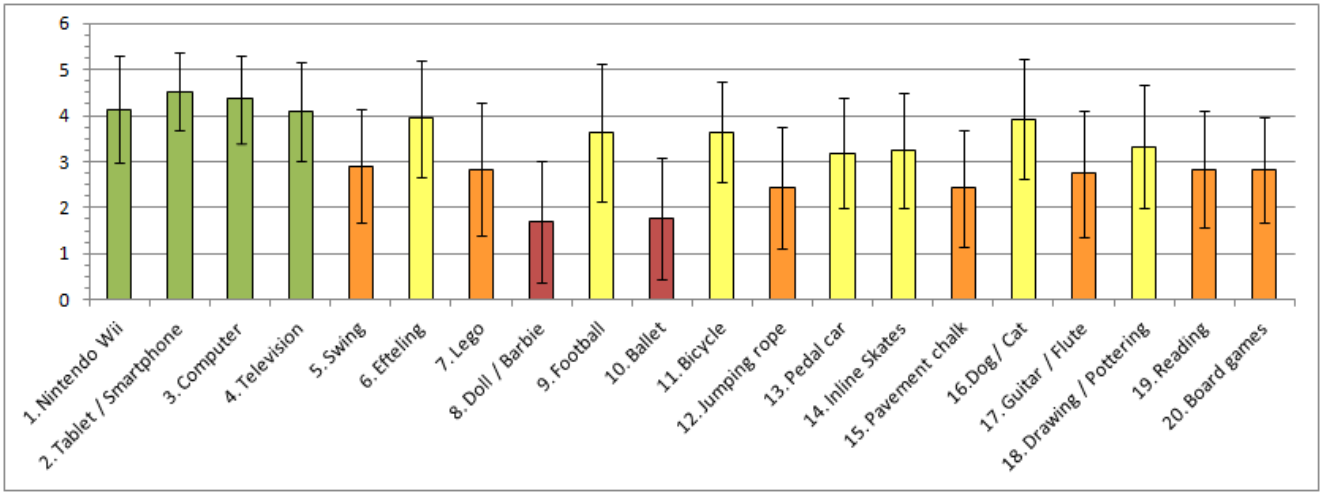


figure 1.14 Mean scores and standard deviations of each object within the Monte Carlo simulation

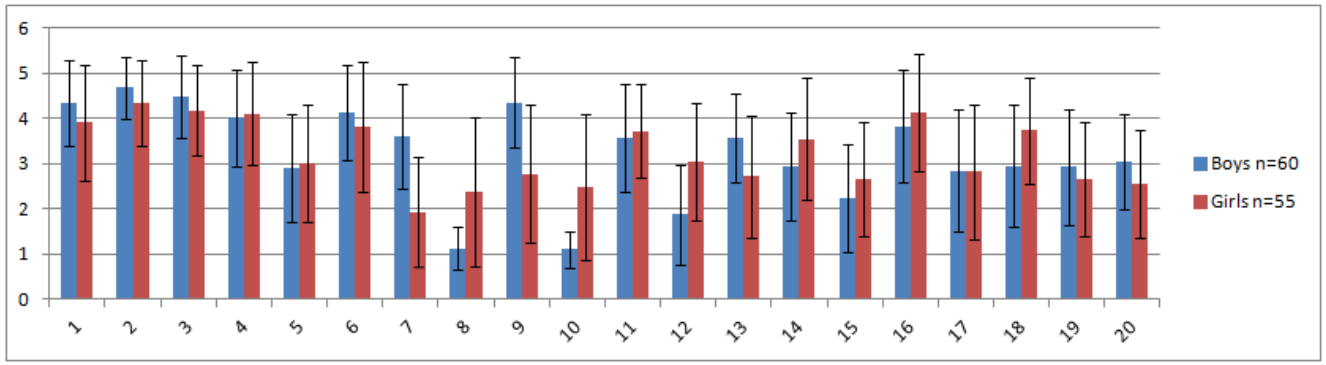


figure 1.15 Mean scores and standard deviations of each object for the populations of boys and girls

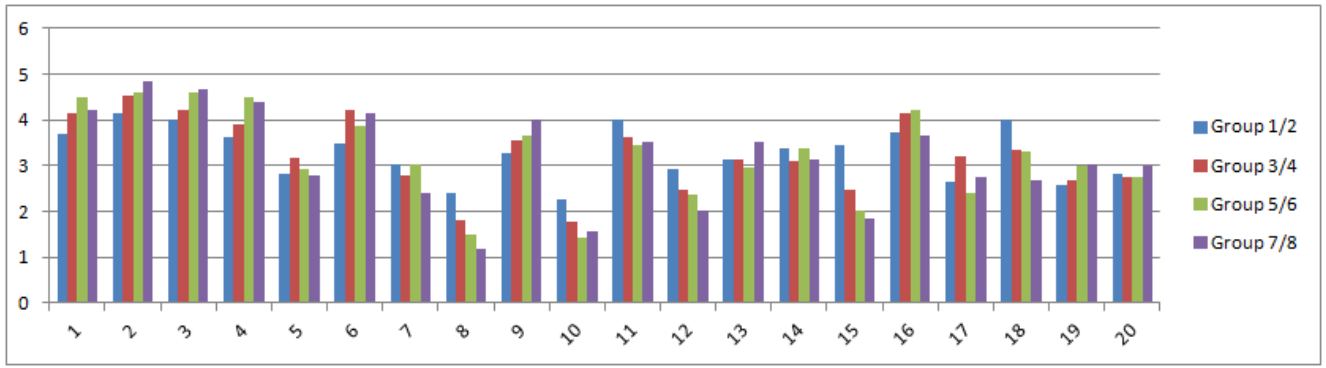


figure 1.16 Mean scores of each object for the four different age populations

Overall object scores

Figure 1.14 shows the mean scores as well as their respective standard deviations of the Monte Carlo simulation children per picture on the board. The colours of the bars in the graph resemble the height of the bar, if the mean value falls between 4 and 5, it is displayed in green, between 3 and 4 in yellow, between 2 and 3 as orange and 1 and 2 as red.

The first thing that catches the eye is the four pictures representing technology, the Wii, tablet / smartphone, computer and television, scoring the highest. The tablet / smartphone has the highest mean score with 4.52. It also has the lowest standard deviation with 0.84, meaning the variance of the position of the tablet / smartphone is the lowest in this study. The computer is a good second with a score of 4.37 and standard deviation of 0.95. These results indicate that children find technology to be very fun. More fun, on average, than playing with attributes aimed at playing outdoors, like a football, bicycle, jumping rope, pedal car, inline skates or pavement chalk.

Behind the four pictures showing technology, the Efteling and the Dog / Cat, representing pets, are almost similarly scored. Yet, these represent totally different types of play; the Efteling embodies physical thrills as well as fantasy, thus being physical and cognitive play, while playing with a pet is much more aimed at the social and emotional aspect of play. The football and the bicycle are just behind the six mentioned objects so far, which both resemble physical, outdoor play.

Other comparisons

Besides the overall object scores, different other comparisons were made, for example between boys and girls and between the different age categories. Figure 1.15 shows the mean scores and their respective standard deviations of boys and

girls and figure 1.16 shows the mean scores of the objects for each age category. Another comparison was made by allocating objects scores only to its attributes (like physical, cognitive, social or emotional) as presented in table 1.2. In addition, an attempt was made to add weighing factors to the objects in respect to these attributes. Goal of this comparison was to see if children preferred a specific side of play more than others, for example if children prefer outdoor or indoor play. However, the amount of assumptions made it impossible to create solid conclusions. A more elaborate description of all comparisons as well as a more detailed description of the tool and the execution of the test is provided in appendix E.

Design conclusions

Before stating the design conclusions, it is important to understand that these should be considered guiding principles and thoughts to pursue. Overall, the results match the expectations. An easy conclusion would therefore be to state that incorporating users' needs and wishes based on biased opinions or assumptions are not an issue. While the immediate results seem to support such a claim, it is not possible to draw this conclusion.

The tablet / smartphone object is a good example to illustrate why. It has the highest mean score in all populations; total, boy, girl and all age categories. It is also the most mentioned object during the questioning for the reasons 'games' and 'listening to music'. The reason of listening to music illustrates that the study does not incorporate how children use the objects. After concluding that the tablet / smartphone is the most fun object within the study, this would serve as a guideline for the design phase of the project. But the conclusion does not state which attributes or features of the tablet / smartphone should be incorporated in the designs. For example, the reason for tablet / smartphones to be fun was expected to be games. Playing games on the tablet / smartphone was considered individual, thus the object was allocated to individual play in table 1.2. Moreover, the way in which children use tablets and smartphones for listening music, which was also observed during one of the primary school visits, makes it an object for use in groups.

This example around the tablet / smartphone shows exactly why the tool was created; to avoid incorporating users' needs and wishes based on biased opinions or assumptions. The reason for the tablet / smartphone being fun was expected to be different than the mentioned reason; the expectation was an incorrect assumption. Therefore, it is hard to base any concrete conclusions on the direct test results towards the design project. The results do however support the following conclusions:

- The study supports Playnetic's current approach of playing in the outdoor public environment. Their current products bring technology to the public environment and make use of sound and music. This corresponds to the most mentioned reason for the tablet / smartphone being fun; listening to music.
- The three objects representing computer technology, the tablet / smartphone, Wii and computer itself have the highest three scores in the overall object scores and score high among all categories. Therefore, the study also supports the previously mentioned statement of bringing computer games to the public environment. It is a line of thought which should be continued.
- Within the new product ideas, the cognitive side of the play concepts should be considered as an important design aspect. While listening to music was given one of the reasons for the tablet / smartphone being fun, so

were games. Furthermore, more reasons were given for other objects which indicated that a cognitive challenge is considered fun.

Insight

The most important useful effect of this study cannot be explained in words. Almost all children who participated in the study experienced the test and use of the board as a type of game in itself. On multiple occasions was this observed, especially in the younger age categories. Therefore, the test provided qualitative insight into how children approach play, today.

The best example concerns a girl who did not yet attend primary school, she was slightly too young (and her results were therefore not included in the results of this study). When executing the test, she started as intended, placing the objects on the board according to her preference. By accident, she turned one of the objects upside down and noticed the coloured magnet glued to the backside of the object. Subsequently, she removed the objects from the board and turned over all objects. After taking a moment to look at the backside of the objects, she started to place the objects on the board upside down. The objects were placed so that objects with a matching coloured magnet connected; she seemed to be deliberately arranging the objects based on the colour of the magnets. After all the objects were placed, she took a moment to look at them, only to look unsatisfied with her results and removed all the objects from the board. She then proceeded to rearrange the objects on the board again, still based on the colour of the magnets on the backside of the objects. After completing her object arrangement the second time, she seemed happy with it. The next thing she did was turn over the objects to make their front side face up, but leaving the objects in the same position on the board as they were when upside down. Afterwards, she looked at the objects and started switching objects one by one to finally create her arrangement on how much she liked playing with an object, just as the tool intended. She created her own game around the tool and engaged in a form of exploratory and object play.

1.6 Evolution of playgrounds

The theory of Evolutionary Product Development (EPD) describes product phases which products go through during their development from the first product on the market until the product variants available today (Eger, 2007). Analysing a product using this theory shows how far the evolution of that product has progressed in the present day, as well as indicates what the next steps of the evolution will typically be. With the next steps in mind, a new version of the product can be developed, pushing the product towards its next evolution phase.

The EPD analysis was performed based on books, articles and dated photo material. Each source was used to determine what playgrounds looked like at a certain point in time, to map societal influences on the playground and to determine other factors contributing to the evolution of playgrounds. The playground was assumed as a total product for the analysis. The swing was regarded for the evolution of play set design as part of the playground evolution. Based on the literature and photo material on the earliest of playgrounds to those of today, the analysis examined if playgrounds and its play sets follow the EPD theory and if so, when the transitions between product phases, as described by Eger, occurred. Subsequently, recommendations were adopted

Product phase / Product characteristics	Performance	Optimisation	Itemisation	Segmentation	Individualisation
Newness	+/-	+/-	+/-	+	+
Functionality	+	+	+	+/-	+/-
Product development	+/-	+	+	+	+
Styling	+	+	+	+	+
Number of competitors	+	+	+	+/-	+/-
Pricing	?	?	?	?	?
Production	+	+	+	+	+
Promotion	+	+	-	+	+
Service	+	+/-	+	+	+
Ethics	+	+/-	+	+	+

table 1.3 EPD score overview

from the EPD theory on how to approach playground and play set design towards the future.

In addition, the goal of this analysis was to create a solid background on the history of playgrounds and its play set. This history was used to create a future outlook. Specifically, the EPD analysis was used to map the factors behind the evolution of the playground. What social, legal, economical, technological, environmental or legal factors (PESTEL) have contributed to the evolution? These factors were used as input for the creation of future scenarios by mapping them in an uncertainty/importance matrix and projecting them into the future (chapter 1.7). The complete analysis is found in appendix F.

Conclusion

Playgrounds as well as the play sets within these follow the path of EPD. As table 1.3 shows, most of the points match what the theory describes for the respective phase (+), a few times it matches partly (+/-) and on only one occasion does it not match (-). The price was not included in this analysis. Research was performed on subsidies given to, for example, playground associations. However, the amount of documented subsidies found was low and the documented subsidies that were found lacked context to be able to interpret and use them for the EPD study.

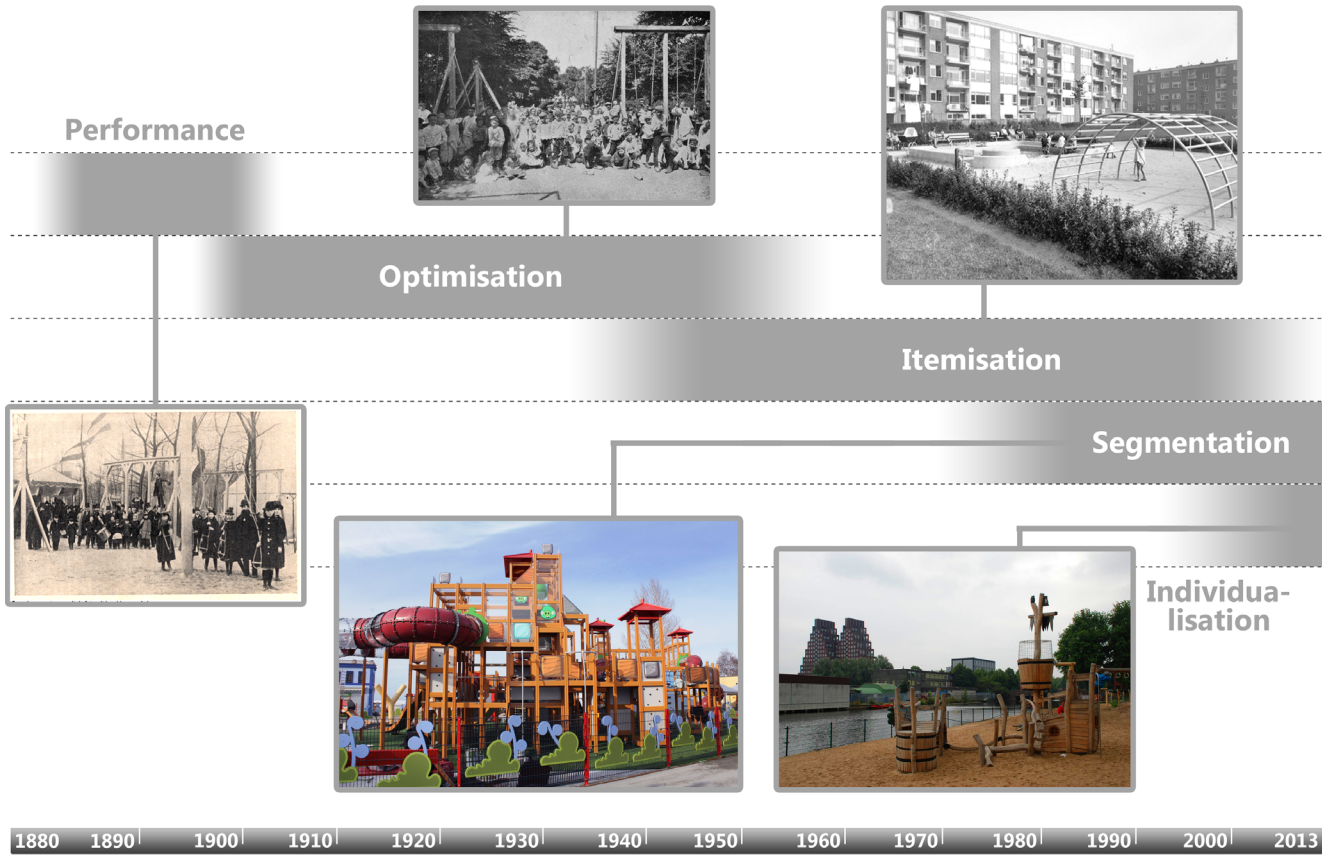


figure 1.17 EPD phases timeline

Figure 1.17 on the previous page shows the timeline of the product phases. As the figure illustrates, the current phase is both the segmentation and the individualisation phase. There are signs that the awareness phase might soon be reached or that it perhaps has been reached. Figure 1.18 shows a product tree of the playground in order to visualise how the product phases timeline is constructed. Four categories are determined in order to differentiate playgrounds:

- Traditional playgrounds: Playgrounds as they started and how we all know them; swings, slides and climbing racks.
- Interactive playgrounds: Playgrounds based on interactive play sets. They could become a new type of playgrounds or an integrated part of the traditional playground.
- Alternative playgrounds: Playgrounds which are essentially the same or similar to traditional playgrounds in terms of set up and play sets, but are for example located indoors or on a lake (floating playground).
- Substitute playgrounds: Locations which have the same primary function of a playground, supplying children with a safe place to play, but are aimed at a different or a more specific target group. Skate parks are an example.

The study was performed with two goals in mind. Firstly, the future direction of playground evolution, which can be predicted based on the EPD theory. As it is concluded that playgrounds and play sets follow the EPD theory, the next steps in its evolution can be predicted based on the theory. The second goal was to determine the major factors behind the evolution up to this point. These factors were used as input for the creation of the future scenarios later on. Both the future directions and evolution factors are summarised in the next paragraphs.

Future directions

Using the EPD theory, the future direction of the product can be mapped out, especially the direction in the short term. Below, a few design recommendations are stated in different categories with each header stating the category. The recommendations are based on where the product is now and where it should be going towards according to the EPD theory; they are adopted from the theory. Most recommendations are therefore general recommendations following the EPD theory. Specifically, the stated design recommendations result from recommendations which are focused on the last three phases of product evolution; the segmentation, individualisation and awareness phase. Only the recommendations on functionality are not direct interpretations from the EPD theory, these are based on information found in the analysis itself.

Functionality

Playgrounds are losing its effectiveness in fulfilling its primary function; providing them with a safe place to play. Especially for the older youth, playgrounds do not seem to connect with the demands and wishes of today's children and thus they seek other locations to play at. Therefore, thought should be given on how to bring back this primary function.

Playgrounds provide a learning factor for children, from physical to cognitive and social development. Interactive play sets have the potential to extend the learning factor, especially in the cognitive direction. Therefore, map out options of adding a learning factor to the interactive play sets, both from a demand point of view (society development) as well as an opportunity point of view (potential interactive play sets).

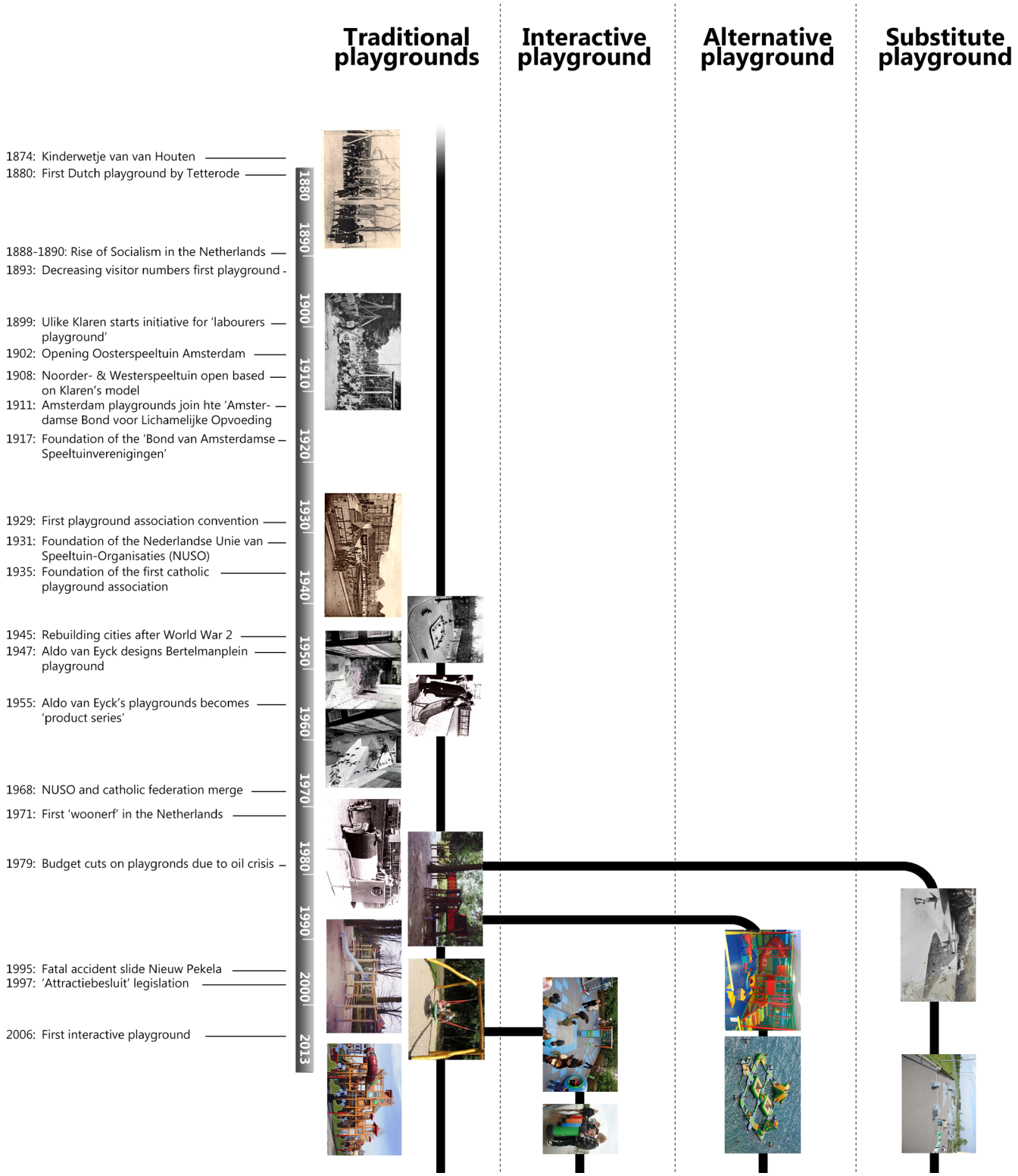


figure 1.18 EPD product tree and events timeline

Product development
Allow the costumer to customise products by offering adaptable products to suit specific needs. A step further is to include the customer in the design process of new play sets; participatory design.

Standardise parts as much as possible in order to lower costs and allow more customisation through, for example, modular design.

Shaping & Styling
The integration of form of the products should be high.

Styling should be expressive or go towards a simple, sober look.

Promotion
Look at ways to increase the promotion of the products by involving the customers through, for example, social media.

Ethics
Communicate on the ethic goals such as social goals or environmental goals of the company as well as of the products.

Evolution factors
In parallel with the research on the development of playgrounds, key factors were determined which have influenced its evolution. Below is an overview of the factors. These are classified under the macro-environmental factors political, economic, social, technological, environmental, and legal (PESTEL).

Political

Municipalities
Construction, maintenance and sometimes ownership of the playgrounds are all connected to municipalities. Budget changes for municipalities are therefore highly influential for playgrounds. Furthermore, municipalities often state recommendations for the playgrounds.

Urban landscaping
As shown under the factor of the car, it has had a huge influence on urban landscaping. Architectural styles, such as functionalism, have greatly influenced the approach as well. The approach of urban landscaping has greatly influenced the evolution of the playground.

Economic

Economic growth
On average, wealth is increasing at times of economic growth. This is seen back in a few ways in the playground. In times of economic growth, playgrounds were flourishing, while during economic recession, playgrounds were to first to receive budget cuts.

Social

Society demand
With young children causing trouble on the street as well as the streets being unhygienic at the start of the twentieth century, the middle class wanted to create a solution. It can be argued if their motive was to prevent property damage or out of charity or a combination of the two, but the fact remains that society demanded a way to ‘lure’ children off the streets as well as provide them with a safe location to

play; a function which playgrounds are still fulfilling today.

Pedagogic perspective

Research on child development changed the perspective on how children were raised. For example, the link between a healthy mind and a healthy body influenced the initial creation of the playground. The importance of strict discipline and obedience held at the time caused the adults to guide the play of children. Later pedagogic perspectives, as well as other factors like the parents themselves, turned discipline and obedience into permissiveness and affection. It transformed guided play into freedom of play.

Learning factor

The first playgrounds were focused on a strict belief that playing should support a child's physical development. Over time, and under the influence of freedom of play, this evolved into a more adventurous learning factor; to explore boundaries. The learning factor nowadays is present in the form of cognitive and social development as well as movement stimulation.

Parenting

In the early days, parents in the lower classes of society had little time for their children. With the economic growth after the Second World War, parents had more time for their children and more money to spend on them, buying them more toys. On one hand this stimulated the family visiting the playground. On the other hand though, it offered alternative options of recreation, from their own toys to, especially under the influence of increased mobility due to the car, recreation further away from home.

Recreation competition

There are many forms of recreation competition nowadays. The car made other types of recreation available to families, like attraction parks or as simple as a visit to a lake. Other forms of recreation competition are the television, recreational sports and the computer or gaming consoles more recently.

Neighbourhood composition

The composition of neighbourhood inhabitants is ever changing. The older neighbourhoods of cities generally have a fairly high average age as opposed to the newer neighbourhoods. Changes can be seen in the composition of neighbourhoods when it comes to the percentage of immigrant families. Lastly, the lower number of children on average per family has greatly reduced the total amount of children per neighbourhood in general.

Public health

Public health has been an important factor behind the playground evolution. First of all, the overall hygiene of the streets and the scientific proof of the link between a health body and the mind was one of the sparks to create playgrounds to begin with. Nowadays, this factor is regaining importance in the form of playgrounds being a way to stimulate movement and thus a way to counter obesity amongst children. Another active discussion is started around vitamin D. Children produce too little vitamin D as they do not get enough sunlight on their skin.

Awareness

Although it is questioned if the awareness phase is reached when it comes to playground, there is no denying that sustainability is now an issue in playground design. Therefore, awareness is a fairly new evolution factor.

Child perception

Over time, children have been experiencing much more freedom in their play behaviour. More options of play, more competition for the playground, have made the children more demanding of the playground itself. The playground competition, especially gaming, seems to have changed the perception of the children towards playgrounds and thus what they expect from it today.

Technological

Product interaction

Gaming and the development of touch screen products has started a trend of interactive products. Playgrounds are no exception, a complete interactive playground already exists and more and more interactive play sets are being developed.

Technology

Technology has played an important role in the evolution of the playground. Obvious influences have been the material use, both for play sets as well as the underground of playgrounds, and the production methods, which allowed the playgrounds to become a product of mass production and more recently, mass customisation. The introduction of electronics in play sets opened up a whole new chapter in the development of playgrounds as well as play sets.

Environmental

Supervision

In the first playgrounds, a paid supervisor was present to look after the children while they were in the playground. Later on, the supervisor became a volunteer, an adult from the neighbourhood, who rotated with other supervisors. After the Second World War, the parents themselves became the supervisors at the playground. Finally, no supervisors were looking after the children in the playgrounds.

The car

The car has had a dominant role in the evolution of playgrounds, both in a positive and a negative way. First of all, the car changed the approach of city planning, which, under the influence of functionalism, stimulated the need for playgrounds; the street had the function of transportation, not of playing. Later on, the car allowed families to seek recreation further away from home; it contributed to the competition of the playground. Afterwards, the car became so dominant that the streets were considered simply too unsafe to play on again. It in turn changed the approach of city planning in the form of 'woonerven', which stimulated the creation of playgrounds in new neighbourhoods. In the older city centres though, parking spaces were limited to the point where many playgrounds were turned into parking spaces.

Legal

Legislation

Initially, the law to abolish child labour contributed to the societal need for the playground. Later on in the evolution, the law which forced playgrounds and play sets to become safe by following strict guidelines has greatly influenced both the number of playgrounds today as well as how they are set up.

Safety

Safety is one of the parameters looked at in order to see if a product follows the theory of evolutionary product development. In the case of playgrounds, it has played a more dominant role than in other products. Safety was lacking

completely in the last part of the 20th century. Legislation ended that to the point where playgrounds are considered very safe in the present day. Interestingly, it has sparked a discussion if it is not too safe.

Evolution factor extrapolation

The eighteen evolution factors described above were used as input for the creation of future scenarios in the next chapter.

1.7 Future outlook

In this chapter, the future of outdoor play facilitation is explored by means of scenario planning tools. The creation of scenarios is an effective tool to look into the future. Using trend analysis, plausible directions of factors behind future developments can be determined. Some factors are almost certain to develop in a specific direction, while others are completely uncertain. At the same time, some factors hardly have any influence on the specific aspect of the future that is looked at, while others can have a huge effect. Factors which are highly uncertain and have a high influence are therefore especially important for the creation of scenarios.

Goal of this scenario analysis was to prepare Playnetic for the next ten years and be able to adapt the company's vision. By mapping the evolution factors found in the previous chapter on its importance and uncertainty, based on trend analysis and other research, the uncertainty/importance matrix was created. Figure 1.19 shows this matrix. Appendix G describes the background behind each factor in regard to its future expectation and therefore its placement in the uncertainty/importance matrix.

The uncertainty/importance matrix shows that two factors can be found closest to the top right corner; 'urban landscaping' and 'product interaction' are both considered highly uncertain as well as very important. By placing these factors on an axis system with the two opposites for each factor at the ends of its respective axis, the strategic space is created (figure 1.20 on the next page). For product interaction, one opposite is 'human-controlled'; a person grabbing his phone in order to add an appointment. Its

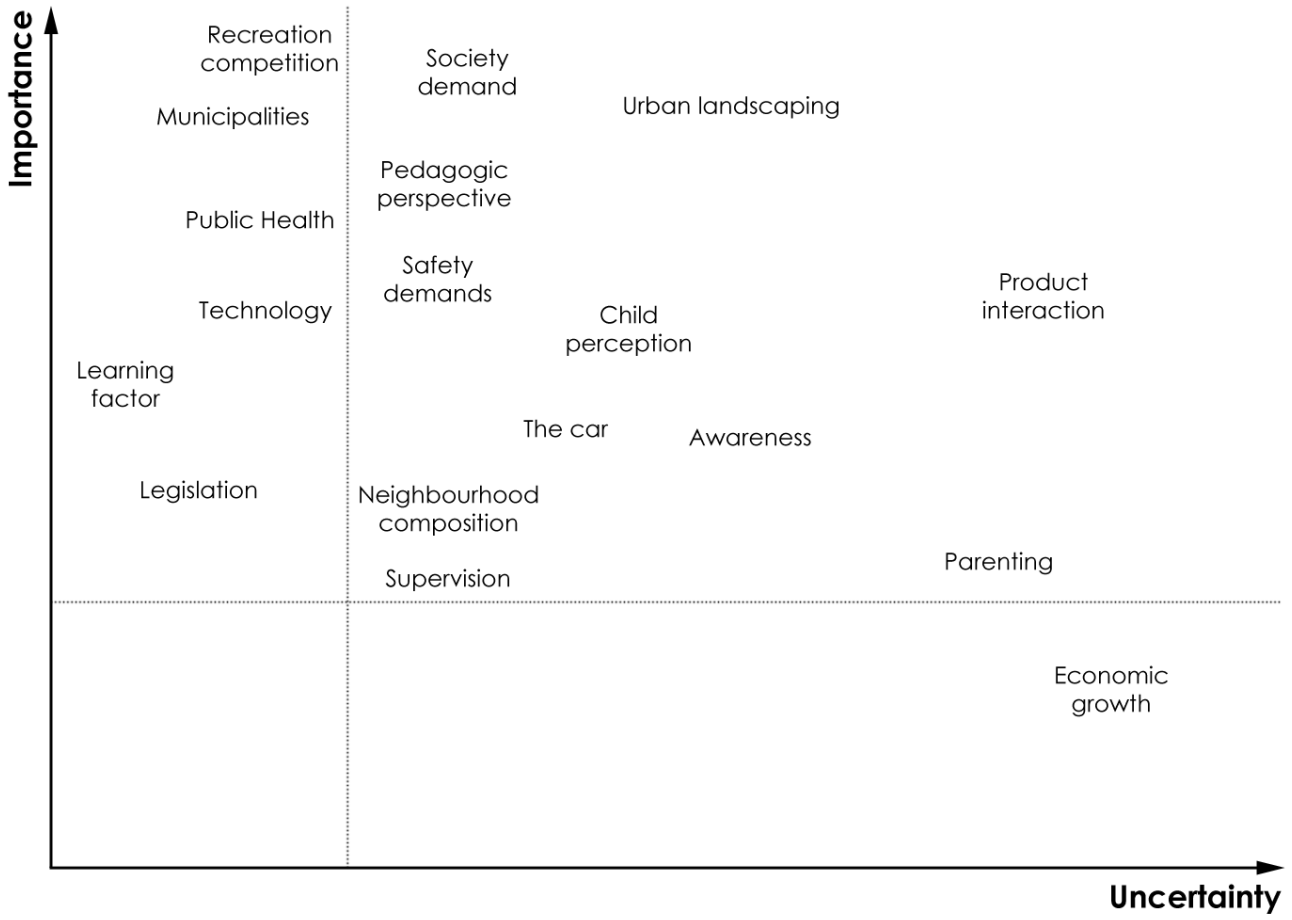


figure 1.19 Uncertainty/Importance matrix

opposite is 'technology-initiated'; a phone which would add the appointment autonomously after 'hearing' its owner create an appointment even though the phone itself lies passively on a desk. As for urban landscaping, the opposites are 'large scale projects', large new built neighbourhoods, and 'small scale reconstruction', from renovation projects to tearing down old buildings and replacing them with new built houses.

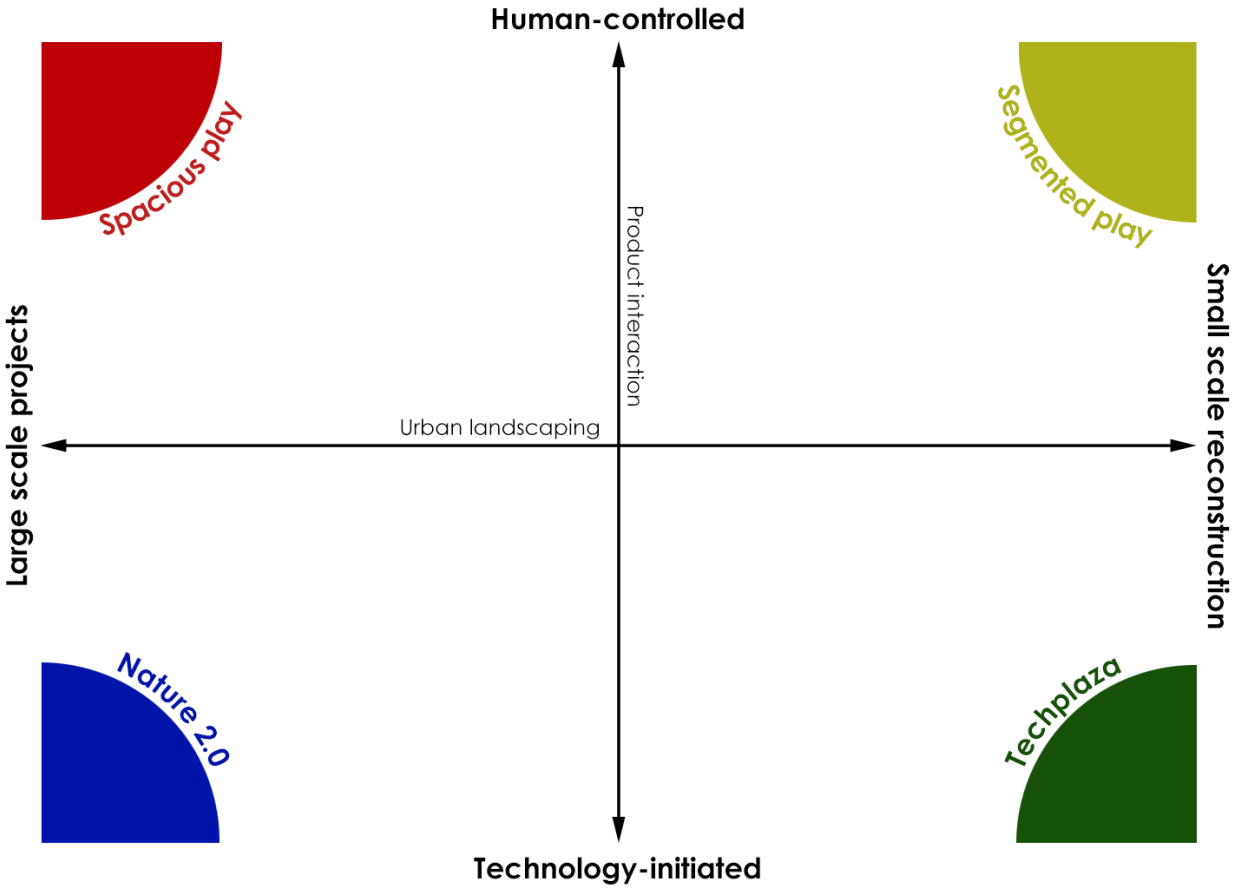


figure 1.20 Strategic space

The future scenarios only explore the next ten years, a short time span for future scenarios. As this time span is relatively short, the scenarios could therefore turn out to have similarities. To create as much diversity as possible, the choice was made to create a scenario in each corner of the strategic space, resulting in four future scenarios. These are:

- 'Spacious play',
- 'Nature 2.0',
- 'Techplaza' and
- 'Segmented play'.

While the four scenarios are built around the factors urban landscaping and product interaction, the other evolution factors still influence the future, including their uncertainty and importance. The EPD analysis showed that the factors were influenced by other factors, meaning that a development or change in one factor had an effect on another. These relations are mapped in figure 1.21 and this scheme was used to build up each scenario. The factors urban landscaping and product interaction and their respective direction for the scenario were used as a starting point for each scenario. Subsequently, the effects on other factors were analysed following the links shown in figure 1.21, systematically building up each scenario in the process.

The scenarios are explained by text and an illustration, followed by a conclusion on what the impact of each scenario has on the design of future interactive play sets for the outdoor public environment.

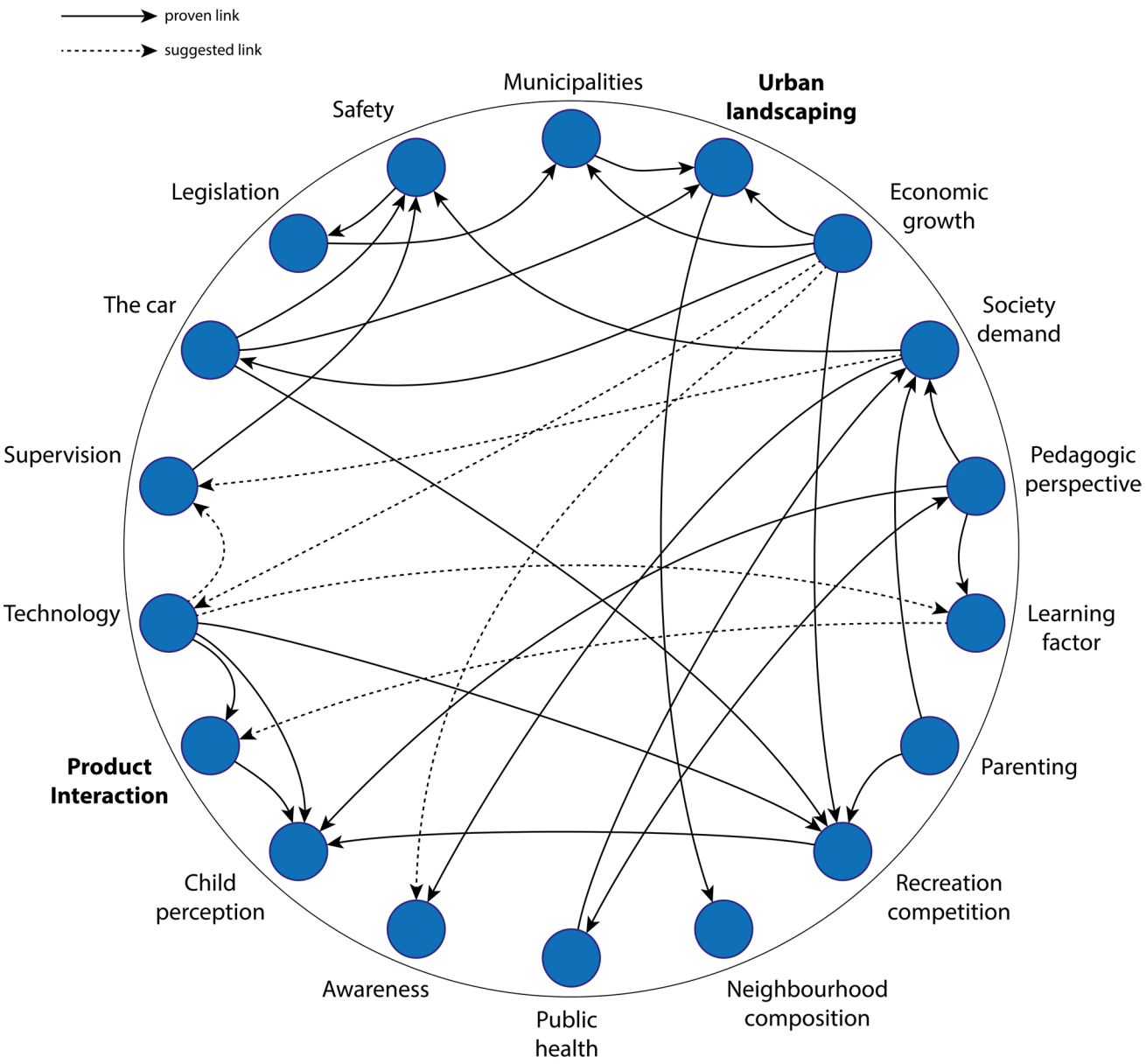


figure 1.21 Scenario factor relations

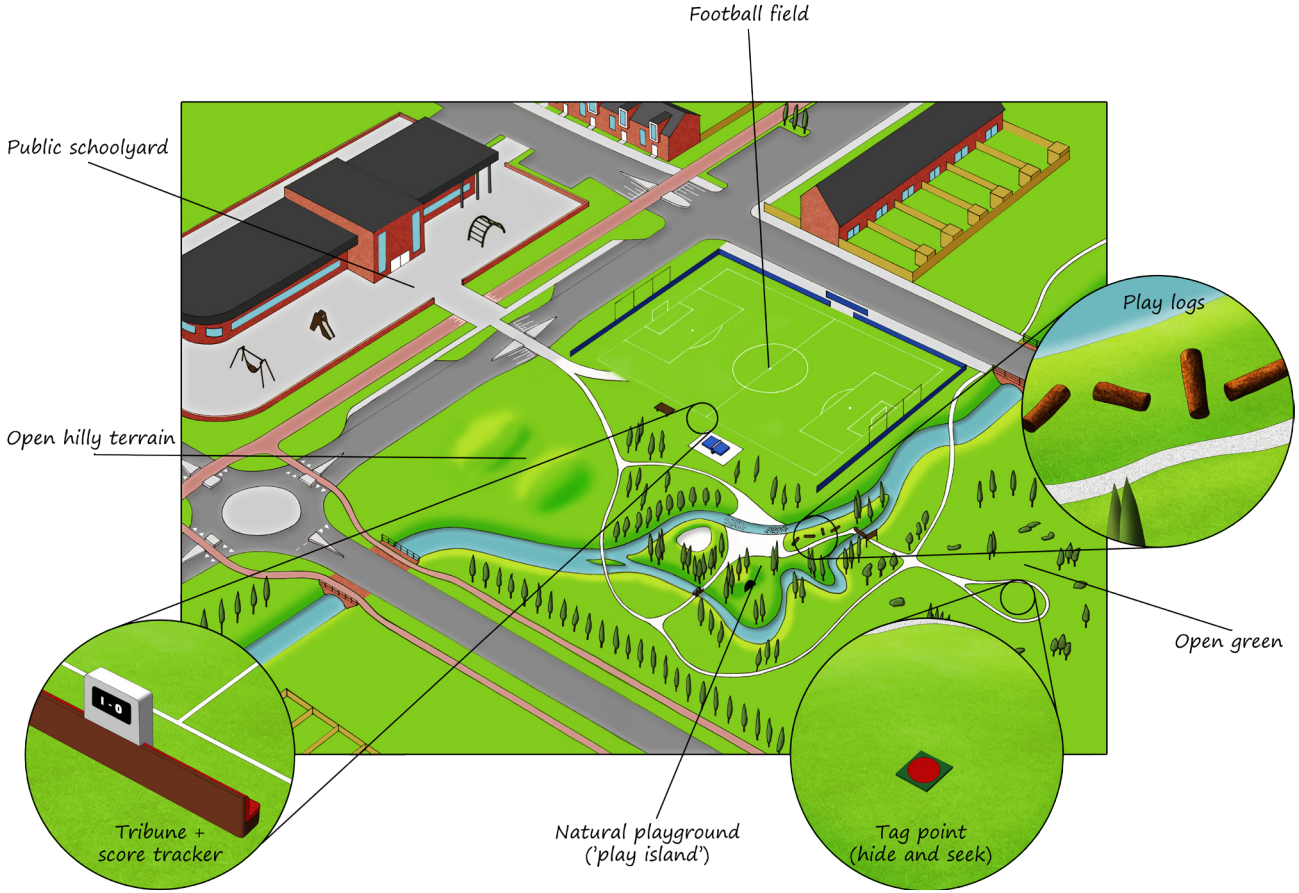


figure 1.22 Spacious play scenario

Scenario 1: "Spacious play"

In the 'spacious play' scenario, urban landscaping consists mainly of large scale projects and the product interaction is described as human-controlled. The larger projects are constructed on the edges of cities and larger, regional towns. As such, the entire area is carefully planned with a green environment, plenty of parking spaces and play facilitation. Within the large projects, community schools (Dutch: 'brede scholen') are placed centrally in the new neighbourhoods. These combined schools have public schoolyards and provide the majority of the formal play space for the neighbourhood, with the exception of sport facilitation such as a football field. This facilitation of sports is available all over the new neighbourhoods, for various sports. Municipalities eagerly construct these facilitations as it contributes to the 3% play area allocation recommendation (Vereniging van Nederlandse Gemeenten, 2006). Apart from the formal play areas, municipalities and policymakers focus on informal play areas; nature, open space and the streets themselves. The streets are created in such a way that the numbers of cars are limited; the streets are considered quite safe for children to play. Furthermore, with enough parking spaces available, cars do not occupy the streets. Besides the streets, much of the attention is focused on creating green, natural and open spaces. As such, natural playgrounds can be found in new neighbourhoods, especially within parks, playgrounds based on materials available in nature; logs, bushes forming a maze, hilly terrain, water crossings and such. Not only do natural playgrounds fit the view of municipalities and policymakers, they prefer natural playgrounds as they require little to no maintenance. Playgrounds with more conventional play sets are also available, but their form giving is much more sober, more in sync with nature. The playgrounds are set up with plenty of space between the play sets in order to stimulate movement.

Scenario 2: “Nature 2.0”

Nature 2.0 refers to the combination of nature and technology. Within this scenario, technology is even more important than before. In fact, technology performs some of our tasks and does so automatically; it is technology-initiated. Urban landscaping is approached through the large scale projects, located on the edges of cities and larger regional towns. Similar to the spacious play scenario, these large projects have community schools centralised in the newly built neighbourhoods, offering centralised play facilitation through public schoolyards, have plenty of parking spaces available and feature green environments. Different from spacious play scenario is the focus on combining nature and technology, which also blends formal and informal play space. Football fields are equipped with sensors detecting if the ball has crossed the line. Yet the integration of technology is not just limited to sports facilitation; ‘embedded technology’ is all around the neighbourhood. Sensors detecting people on the streets to trigger a small fountain in the pavement and stepping stones which play music tunes when walking over them are examples. Even in natural playgrounds, technology is incorporated into the environment. Most types of this embedded technology are aimed at stimulating exercise to battle obesity. At the same time, digital social networks are incorporated within the embedded technology; it is very easy to connect to your friends directly, share your experience or something like a high score in a game.

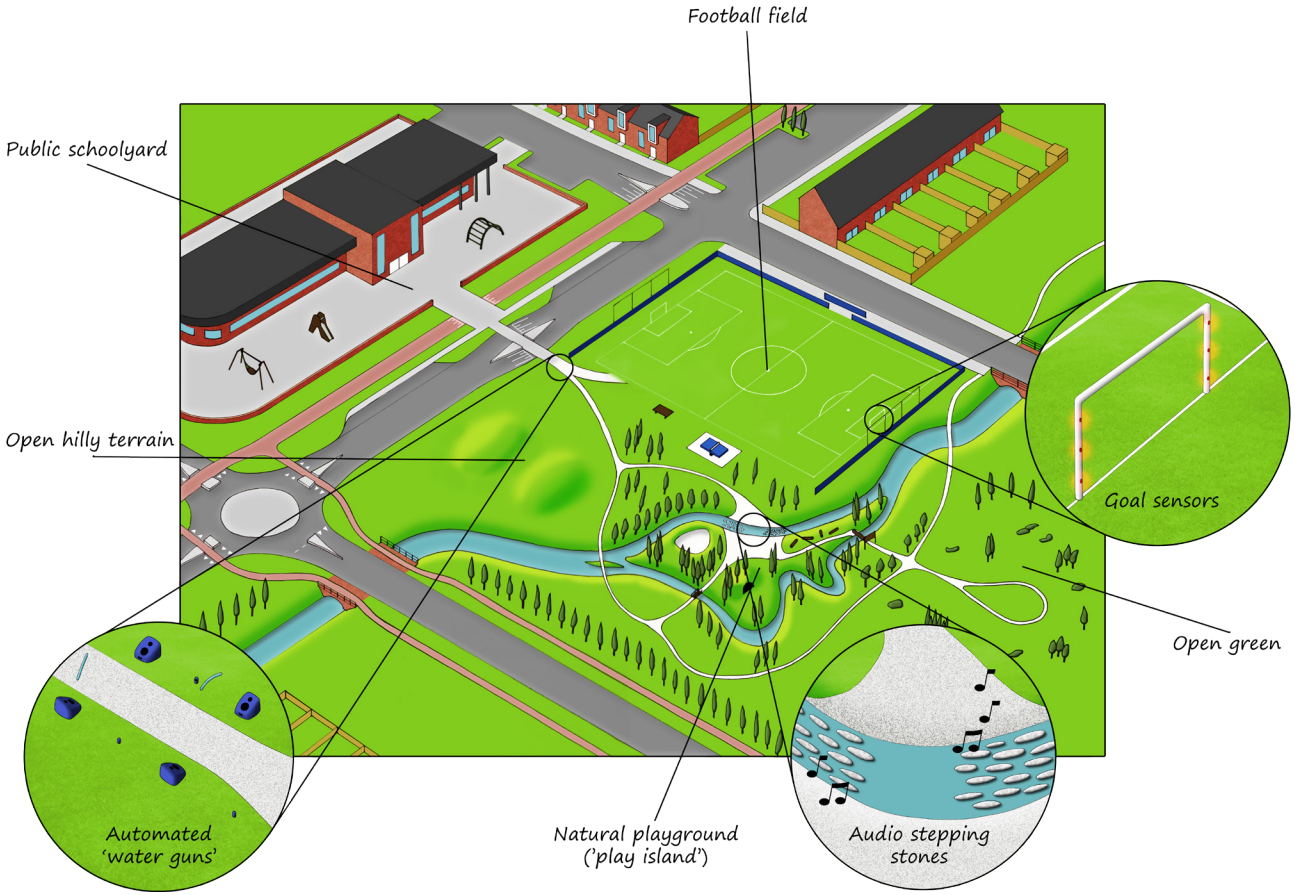


figure 1.23 Nature 2.0 scenario

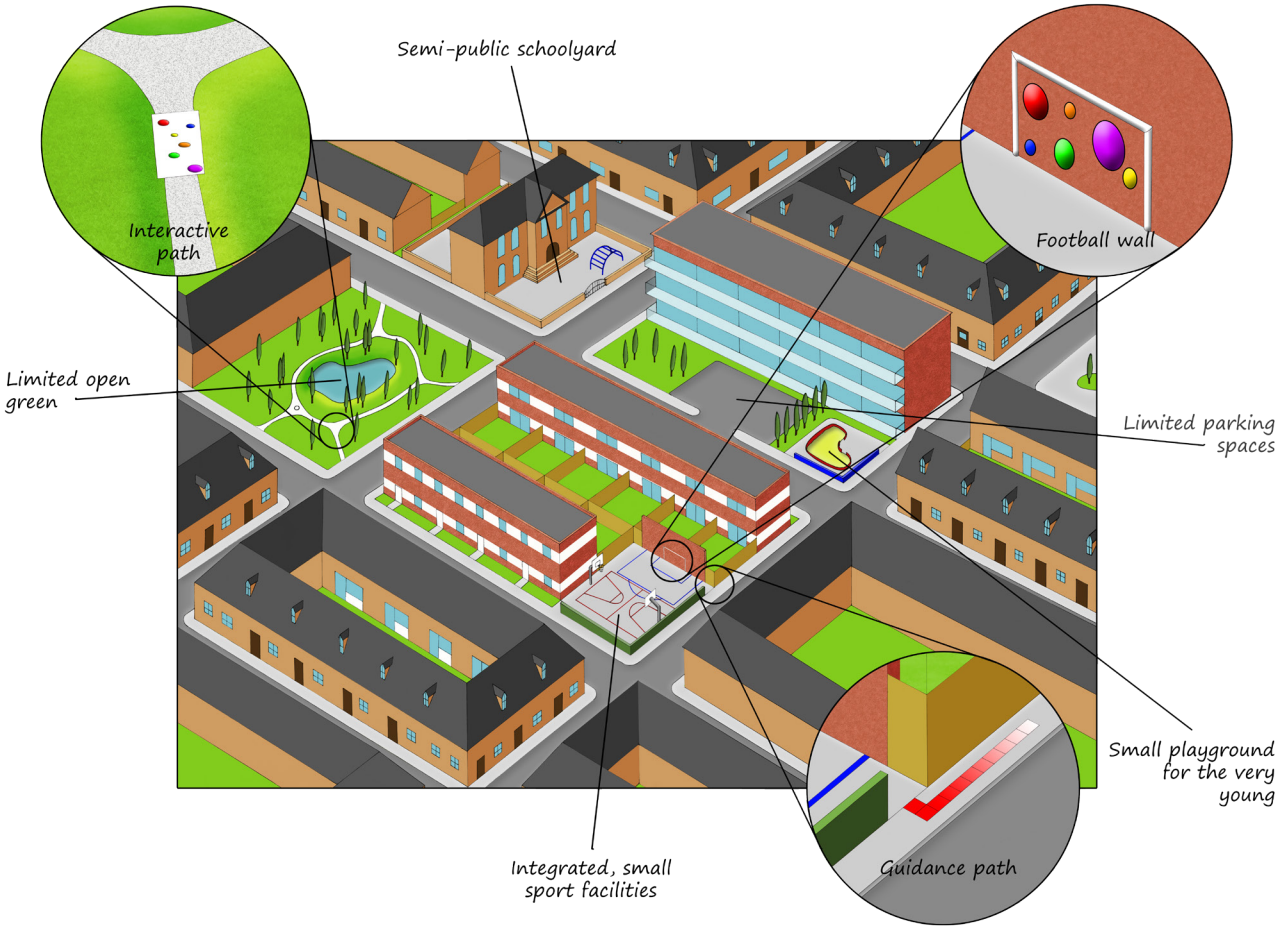


figure 1.24 Techplaza scenario

Scenario 3: "Techplaza"

In the 'Techplaza' scenario, technology also performs some of our tasks automatically and is thus considered technology-initiated. Urban landscaping is however aimed at small-scale reconstruction. The reconstruction is aimed at increasing the living standards within older neighbourhoods. Part of the neighbourhoods are torn down and replaced with new built housing, either starter homes or apartment buildings, or old factory buildings are renovated and changed into housing. Generally speaking, these neighbourhoods feature a lower percentage of children living within the neighbourhood. Furthermore, the neighbourhoods have limited parking spaces and much less green environment than the neighbourhoods further away from the city centres. As the layouts of the neighbourhoods are already predetermined by existing infrastructure, most roads are thoroughfare and as parking spaces are limited, most cars are parked on the side of the road. The streets are not considered as a place for children to play at; municipalities and policymakers focus more on formal play space in these neighbourhoods. Yet, embedded technology is present all around the neighbourhoods and in playgrounds as well as in parks, the entire formal play space. Embedded technology aimed at play in for example pavements is used to stimulate children to go to the formal play areas. Besides the technology in the playgrounds, more conventional, but expressively styled, play sets can be found. Besides play sets, there is also some form of sports facilitation, but as the amount of space is limited, this is usually limited to a basketball field, a small football cage or just a single football goal with a limited free area around it. The playgrounds themselves feature specific gathering facilitation for children with multiple connectivity options to social media for digital artefacts such as mobile phones.

Scenario 4: “Segmented play”

The ‘segmented play’ scenario features the same small scale reconstruction approach of urban landscaping as described in the ’Techplaza‘ scenario. Similar to the ‘Techplaza’ scenario, the neighbourhoods in which the small scale reconstruction is taking place has limited parking spaces, there is little green to be found in the environment and the percentage of children is low on average. The thoroughfare roads are crowded with cars and as such, policymakers and municipalities focus on formal play space as opposed to informal play space, but do try to add in some more public green and nature within the new projects. Alternatively, the product interaction is human-controlled. The scenario describes a situation where play is scattered all over neighbourhoods at various locations, mostly formal play areas, each aimed at specific age categories. On various locations in the neighbourhoods, small playgrounds and some sports facilitation, for example basketball fields and football cages, can be found. Some of them are aimed at very young children, some are aimed at older children. The play sets can be considered as more conventional, most of them chosen for being low-maintenance. The design and shaping of the playgrounds is more expressive for the older playgrounds, while more sober for the newly built playgrounds located in or near public green.

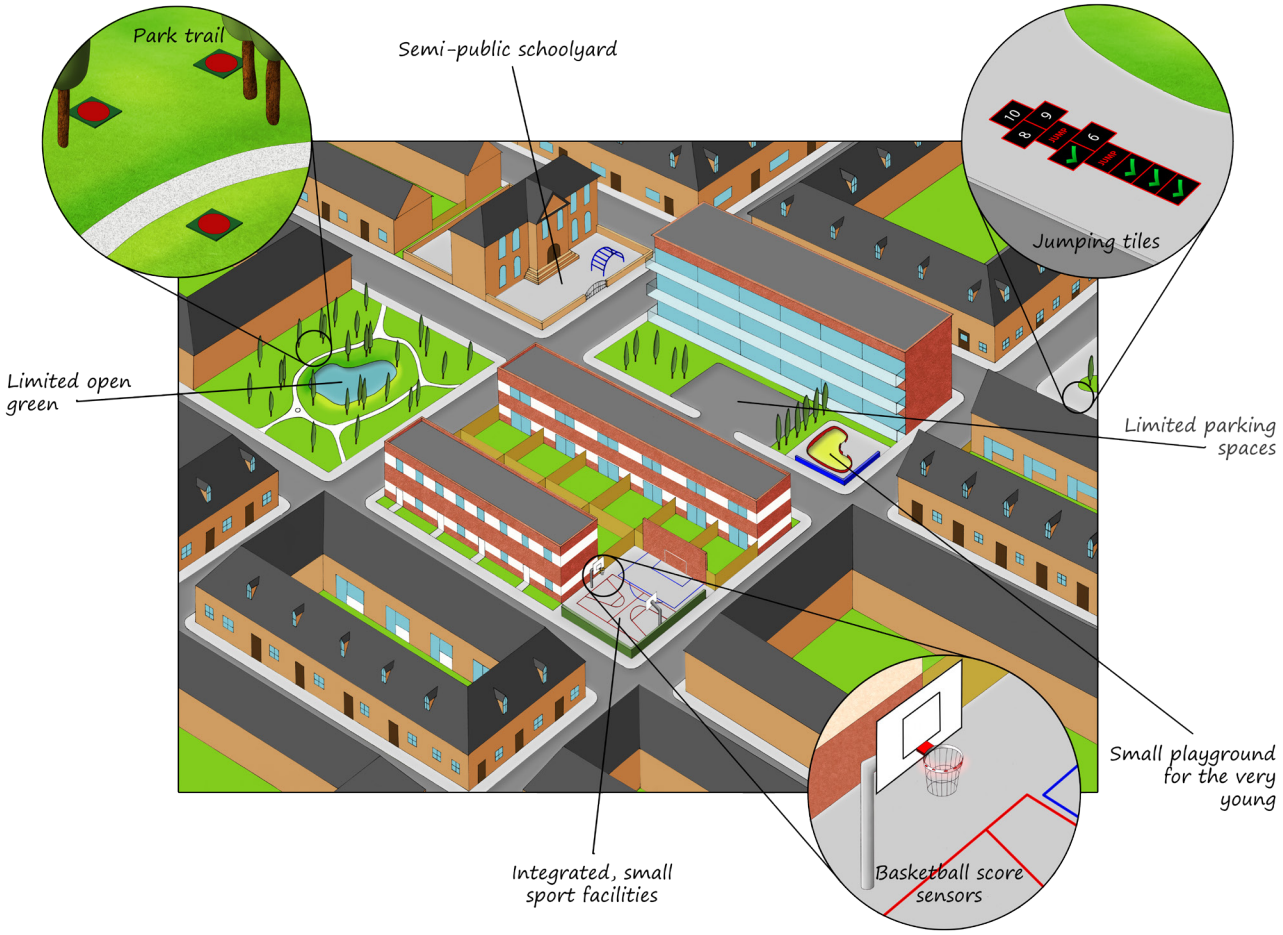


figure 1.25 Segmented play scenario

Conclusions

The four scenarios explore possible futures. The scenarios therefore show several similarities. This was expected and it can be explained by the fact that the scenarios only look ten years ahead. The shorter the time span, the more certain the directions of factors can be stated, lowering the variance of factors. Therefore, it has to be concluded that it is possible for all four scenarios to exist in parallel; they could all become a reality at the same time. Regardless, the scenarios provide context for the concepts that are to be designed. Furthermore, the scenarios provide Playnetic with insight into the future of outdoor play facilitation. The scenarios therefore allow Playnetic to easily and quickly respond to developments in society.

Each scenario can be summarised in a few short design guidelines.

1. Spacious play
    - Focus on the use of space
    - Look for ways to incorporate or stimulate play in informal play space
    - More sober design of play sets
    - Look for ways to add to natural playgrounds, as these should be considered as a competitor

2. Nature 2.0
    - Focus on the use of space
    - Look for ways that blend formal and informal play space
    - Combination of sober and expressive design of play sets
    - Combine nature and technology in natural playgrounds

3. Techplaza
    - Focus on efficient use of space
    - Focus on formal play space or the possibility to incorporate play to otherwise allocated public space such as parks or squares
    - Include persuasive design to stimulate children going to formal play areas
    - More expressive design of play sets

4. Segmented play
    - Focus on efficient use of space
    - Focus on formal play space or the possibility to incorporate play to otherwise allocated public space such as parks or squares
    - Combination of sober and expressive design of play sets

1.8 Research phase conclusions

A summary of the most important design conclusions is listed below. These are selected based upon the overall insights gained through the research phase and after discussing the results at Playnetic. These conclusions are considered as the most important guidelines for generating new concept ideas. The guidelines function as leads and sources of inspiration, not as product demands. There is no order of preference in the list of guidelines presented below.

- The interactive play sets that are to be designed should be fun (chapter 1.2)
- The interactive play sets should ideally stimulate open-ended play (chapter 1.2 & 1.4)
- Look for ways that allow children to manipulate the play

sets (chapter 1.2)

- Stimulate children to play together, either actively or passively. Ideally the play sets should also support solitary play (chapter 1.2)
- To support intended use of a play set, include a way for children to experience the play in their bodies; a type of physical play (chapter 1.4)
- To support unintended use of a play set, use surfaces that children can exploit for their play creation (chapter 1.4)
- Enable multisensory experiences, in order to create rich and diverse play sets (chapter 1.2)
- Look for ways to stimulate movement and active play (chapter 1.2)
- Consider adding a physical challenge to the play sets (chapter 1.2)
- Do not deliberately add an educational goal to the play sets (chapter 1.2)
- Try to create play sets where children are not bound by games within a specific duration. Rather let the child play and decide for itself when the play is over; take away fixed time frames as a factor within the play set design (chapter 1.2)
- Specifically consider the cognitive side of play within the new play sets (chapter 1.5)
- Look for ways to exploit more space with the play sets. Ideally, the use of space should be adjustable (chapter 1.7)
- Look beyond formal play space and find ways to incorporate play sets into informal play space or otherwise allocated public environment such as squares and parks (chapter 1.7)
- Allow more expressive as well as more sober styling of the play sets. Ideally the play sets should be adjustable to suit both (chapter 1.6 & 1.7)

Towards the Future

From the earliest of playgrounds to the playgrounds we know today, play has evolved from strict and disciplined play to free play. As the evolution of the playground shows (chapter 1.6), the facilitation in the form of playground and play set design has evolved in line with this change.

Looking at a different type of interactive play, video gaming, a similar evolution can be seen. Video games first forced the player to go from A to B to C and ultimately towards the final goal of the game. Later on, the games allowed different paths towards the goal of the game (sometimes with alternate endings). Finally, games were created that allowed players to choose their own goals within the game and thus ultimately offered the player control in respect to how he or she approached the game in general; these became 'free play video games'. These games include customisation options or even provide the player total freedom within the game. This approach creates a high level of replay value; replaying the game provides a new experience. Subsequently, players enjoy the game for a longer period of time.

Current available interactive play sets are bound by their game rules. These play sets are basically the video games guiding players from A to B to C. Towards the future, the ultimate goal should be for interactive play sets to hand over control to children; allow children to decide how to play and how to engage the play sets. As a result, interactive play sets become open-ended; they offer children different ways to engage the play set.

In addition to the design guidelines and the future statement, the four future scenarios created in chapter 1.7 serve as context for the concepts that are to be designed in the concept phase of the project.

02 PLAYNETIC VISION & BRAND

As a conversion point of the research phase, Playnetic's original vision statement was updated, based on the conclusions of the research phase and in consultation with Playnetic. Playnetic's original vision statement is found in appendix H (Dutch). Additionally, the Playnetic brand was mapped; describing the values that their products should represent. Playnetic's products are not like Coca Cola or similar brands where branding is everything, but when encountering a new interactive play set by Playnetic, ideally people recognise the product as one that could be from Playnetic as it represents all its core values. The vision description and the brand identity prism combined, offer inspiration and a starting point for the design of new products.

2.1 Renewed Playnetic vision

We believe in a world where children want to play outside, where children are cognitively and physically challenged in the outdoor public environment and where there is no distinction between formal and informal play areas within the outdoor public environment.

We believe that play is pivotal in a child's development and that outdoor play facilitation should present a variety of options for children to play in any form or way they want to. We therefore strive for a public environment which enriches our soul, inspires our lives and improves our well-being.

Interactivity has been pushed to a much higher level in recent years and will continue to be pushed even higher in the future. Subsequently, interactive play sets should evolve into products with a higher level of interactivity.

To achieve this evolution of interactive play sets, Playnetic will focus on creating open-ended interactive play sets for the public environment; interactive play sets which can be used in various ways, for extended lengths of time and without a fixed use pattern. These types of play sets should be simpler rather than complex and should be affordable.

2.2 Playnetic brand

To define what the new products need to represent in order to be Playnetic, the Playnetic brand was mapped out using Kapferer's (2008) brand identity prism, which describes six different attributes of a brand's identity: physique, relationship, reflection, personality, culture and self-image. Combined, the values allocated to the six attributes represent the values which the products of the brand and the brand itself stand for. Figure 2.1 shows the brand identity prism that was created for Playnetic. It shows what the Playnetic brand should become. The prism was established by first mapping out the current values and subsequently adding values which the brand should also stand for in consultation with the owners of the company.

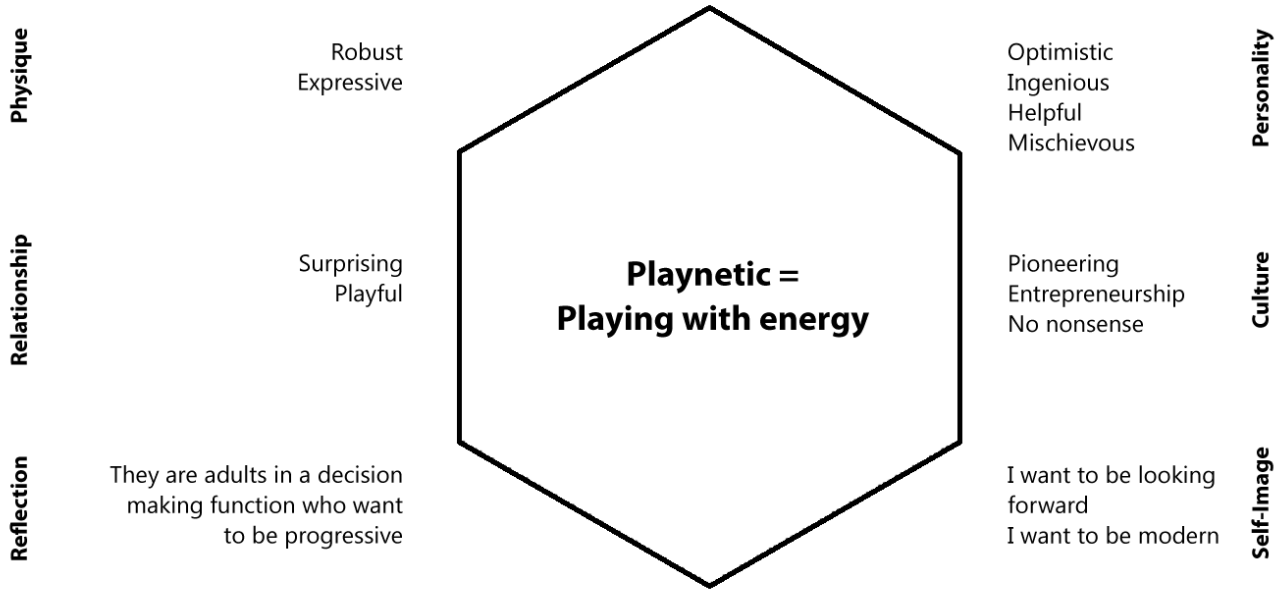


figure 2.1 Playnetic's brand identity prism

03 CONCEPT PHASE

Playnetic's renewed vision and mapped brand in combination with the design guidelines and future scenarios provide a solid platform for designing in the concept phase. Firstly, search fields are explored and used to create concept directions. Based on evaluation of these concept directions, on innovation techniques and on further design thinking, the concept directions are translated into feasible concepts. Lastly, the modular approach behind the concepts is described and a roadmap towards further development of the concepts is provided.

3.1 Search fields

Based on the results obtained from the various analyses in the research phase of the project, a few search fields were identified. These fields provided guidance for the creation of new concept ideas. Each search field is briefly explained. To create the platform for the concepts, the respective fields are supported with a mind map, created during a brainstorm, and visualised using disruptive imagery (Eggink, 2011) to stimulate creative thinking.

Search field 1: Rule making

The literature and ethnography study showed that children are very good at creating their own games. Additionally, this aspect was explored in the ethnography through the analysis of unintended and creative use of play sets. An interesting search field is therefore that of rule making; deliberately create play sets without fixed rules, but stimulating the children to create their own rules or perhaps persuade children to break rules instead.

figure 3.2 Rule making mind map

figure 3.1 Rule making disruptive image

figure 3.3 Open-ended play disruptive image

Search field 2: Open-ended play

The guideline of stimulating open-ended play is built on conclusions from literature as well as ethnography and is directly incorporated in Playnetic's renewed vision statement. It is therefore one of the most important guidelines to pursue. As the mind map of figure 3.4 shows, there are similarities between this search field and that of construction and manipulation.

figure 3.4 Open-ended play mind map

Search field 3: Construction - Manipulation

One of the directions which is interesting to explore, is that of construction and manipulation. The search field builds on the direct guideline of adding manipulation to the play sets as well as includes the guideline of supporting open-ended play. Construction and manipulation were first imagined as physical since the first association that came to mind was Lego. However, the brainstorm showed that construction and manipulation can also be built around light and sound.

figure 3.7 Construction / Manipulation mind map

figure 3.5 Construction / Manipulation disruptive image 1

figure 3.6 Construction / Manipulation disruptive image 2

figure 3.8 Informal play space disruptive image

Search field 4: Informal play space

The future outlook shows that the Dutch municipalities are focusing more and more on the quality of the overall public environment and are shifting the attention from formal play space, for example playgrounds, to informal play space, for example a field in the park. Being able to incorporate interactive play sets in the overall public environment therefore has the potential of expanding the sales market of Playnetic. Looking at the informal play space is also included in the renewed vision statement.

figure 3.9 Informal play space mind map

Search field 5: Nature and technology

Another trend following the future outlook is natural playgrounds. Natural playgrounds are allocated play spaces in a natural setting. Its play environments and play sets are crafted with natural materials. It builds on the municipalities' focus on the quality of the overall public environment. Interactive play sets are far from natural; the current styling and shaping creates associations with technology instead. Combining nature and technology in future interactive play sets can therefore expand the sales market for Playnetic in a similar way as looking at the informal play space.

figure 3.10 Nature and technology disruptive image

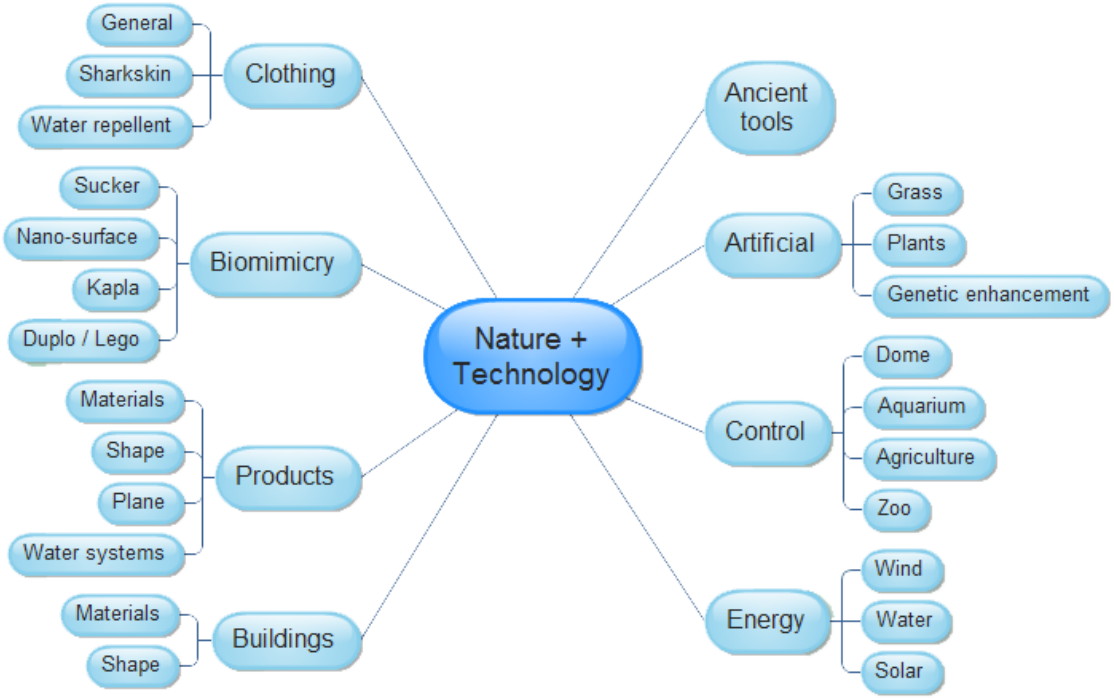


figure 3.11 Nature and technology mind map

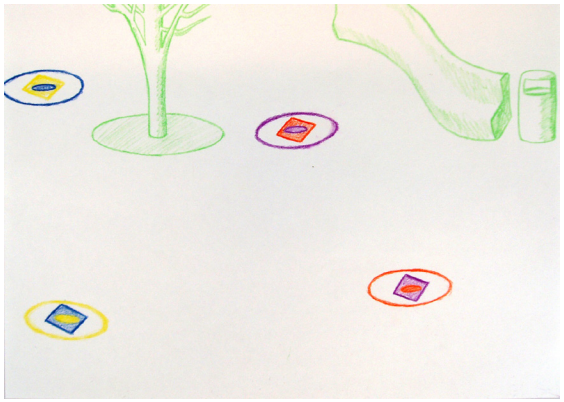


figure 3.12 Square with triggerable tiles

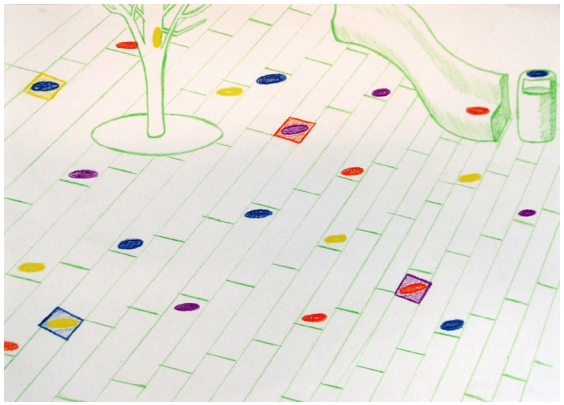


figure 3.13 Square filled with triggerable tiles and lights

figure 3.14 Square with coloured LED lines

3.2 Concept directions

With the search fields explored as well as the renewed vision and mapped brand in place, the next step of the design project was the creation of concept directions. This was realised through extensive sketch sessions. Within the sketch sessions, the three inspirational sources mentioned above were combined with the fifteen design guidelines described in chapter 1.7 to create and explore concept directions. Promising and feasible directions were selected and explored further, resulting in nine concept directions. No actual selection method was applied to select these nine concept directions. However, a few criteria were kept in mind in this selection. Examples of criteria are: Does the concept direction fit Playnetic's renewed vision? Is or will technology be available to develop this concept direction? Can it be developed in Playnetic's product price range?

This chapter describes the nine concept directions. Each concept is complemented with a selection of sketches and a brief explanation of the thought process behind them. Furthermore, the search fields and the main guidelines contributing to the thought process are stated for each concept direction. Besides the inspirational sources and design guidelines, the use of modular systems was always kept in mind as a boundary condition while sketching, as a modular approach of new concepts was part of the plan within this design project from the start.

Concept direction 1: Jumping tiles

While sketching ideas for the informal play space, the direction of turning a square into an interactive play environment was explored. One of the interesting ideas is based around tiles where children can jump on or poles they can knock over to trigger lights at other locations of the square (figure 3.12), perhaps randomised for the colour triggered (figure 3.13) or in the form of a LED line (figure 3.14 and 3.15). The concept direction is directly inspired on the informal play space search field. Furthermore, this concept direction follows the design guidelines of looking at informal play space, of using more space as well as be adjustable in respect to the required space, removes fixed time frames and supports open-ended play.

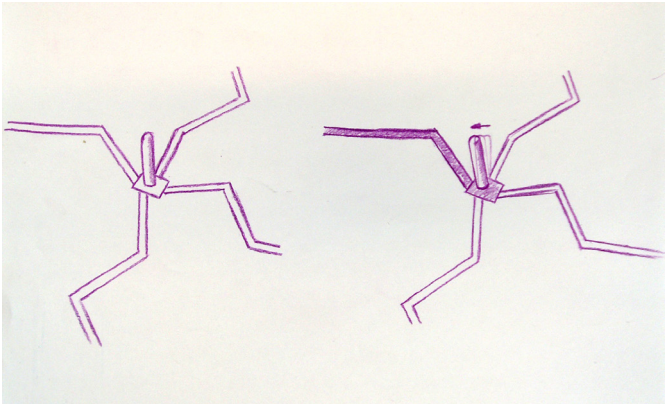


figure 3.15 Moveable poles trigger the LED lines

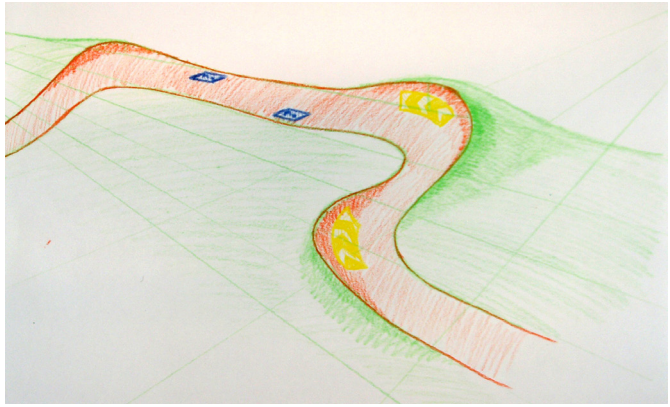


figure 3.16 Mario Kart inspired cycling or running track

One of Playnetic's current products is the Audiotile. The Audiotile is triggered by stepping on it and subsequently plays a tune or an audio message. As it is right now, the Audiotile runs on batteries. However, technology to create an Audiotile that runs on electricity generated from the kinetic energy of people stepping on it is available at Playnetic. A previous version of the Audiotile existed which did run on humen generated energy. Moreover, a concept that is currently not being developed into a real product, the Gamebox, also features technology capable of delivering the required functionality. With the technology available, creating the jumping tiles or poles should be relatively easy without high costs.

Concept directions 2: Game inspired

The use of jumping tiles within pavement triggered some other concept directions, inspired by computer games. Examples are a 'real-life Mario Kart' environment (figure 3.16) based around a 'racing track' for children to cycle on and points on the track to gain fictive power-ups. Riding over these points triggers them, playing a sound and/or giving them a glow for a short duration.

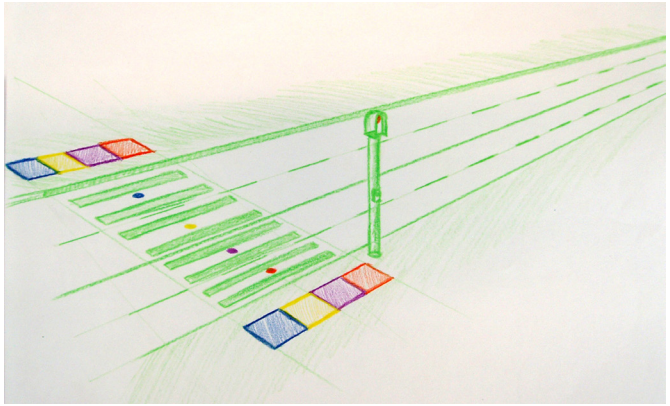


figure 3.17 Guitar Hero pedestrian crossing

Another game inspired concept is 'real life Guitar Hero' (figure 3.17). In Guitar Hero, the player has to trigger the correct button at the right time in order to play a song as the guitarist of a band. The concept could function in the same way using tiles to represent the buttons and passing cars as the indication of when to jump on the tile, with each lane marked with a colour. Consequently, a tune or a musical note is played when someone jumps and a car does pass over the marked spot at that moment while no sound is played when there is no car passing by. A clear downside of this concept is that it would require sensors placed in the road to function.

This concept direction is a spin-off from the jumping tiles. As such, it is also inspired on the informal play space search field and follows the same design guidelines.

Concept direction 3: Street instruments

The concept around Guitar Hero triggered another thought direction. If jumping on a tile produces just one musical note, then placing a couple of tiles next to each other, each with a different pitch in regard to the sound, would allow the creation of musical instruments within pavement. Applying a texture around the tiles to create an association with

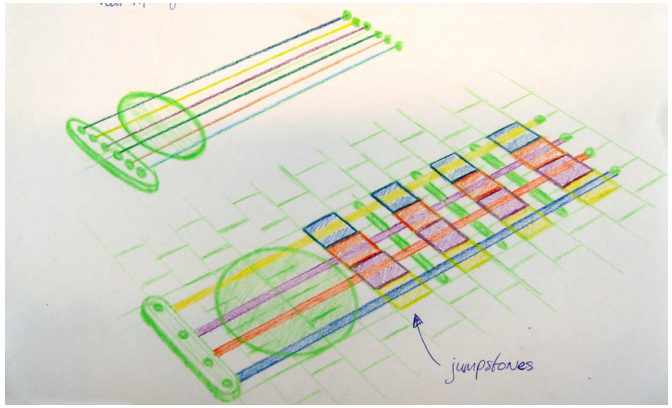


figure 3.18 Street Instruments with a guitar texture

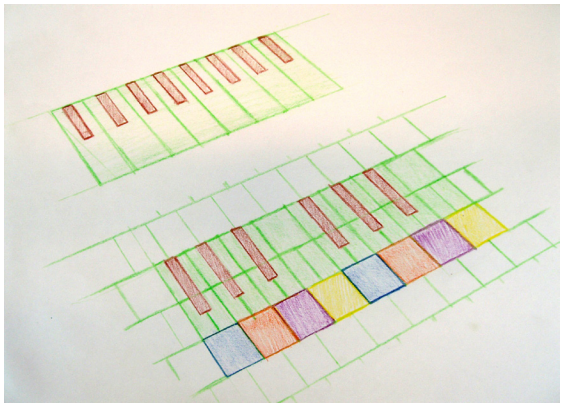


figure 3.19 Street Instruments with a piano texture

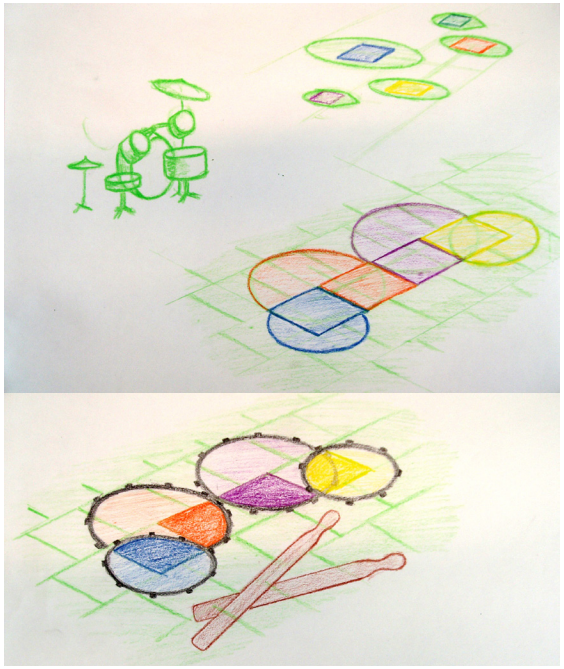


figure 3.20 Street Instruments with a drum texture

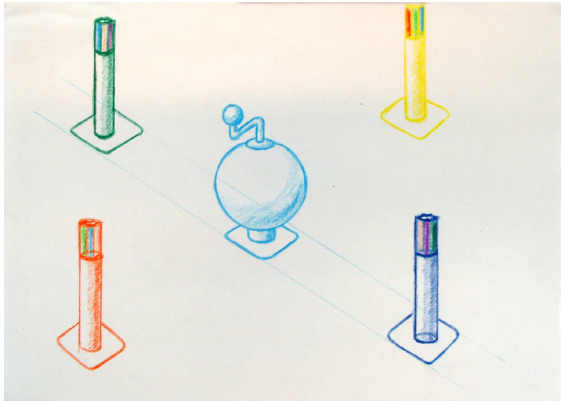


figure 3.21 Sound manipulation based on Playnetic's MusicBallas a centre console

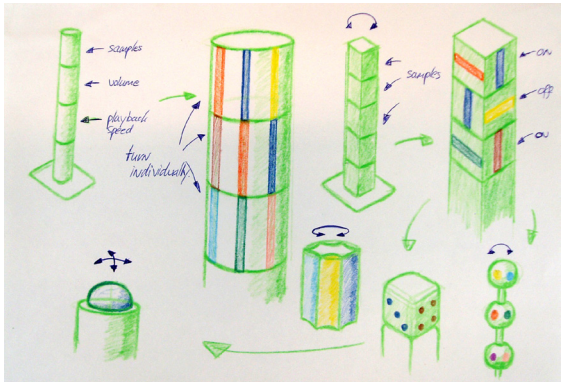


figure 3.22 Sidekick sketches

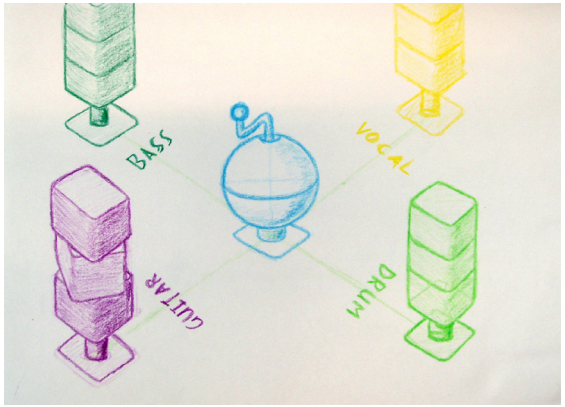


figure 3.23 Refined sound manipulation idea

musical instruments allows children, and in fact all people passing by, to easily understand what the concept does and how to use it.

This concept direction is inspired by the informal play space and constructing / manipulating search field. Furthermore, it follows the design guidelines of looking at informal play space, of using more space, removes fixed time frames and supports open-ended play. Additionally, it clearly links to the cognitive side of play.

Concept direction 4: Sound manipulation

One of the conclusions from the brainstorm on the subject of construction and manipulation is that it is not limited to physical construction or manipulation; sound can be constructed and manipulated as well. The 'street instruments' concept direction already supports the construction of sound. Sound manipulation is however an entirely different thing.

While thinking about sound manipulation, a few things came together. Firstly, Playnetic recently launched a new product called the MusicBall™. It can be a described as an audio console in the shape of a sphere, with a hand crank at the top of it which the user has to rotate in order to generate the energy to play music or an audio message. Currently, Playnetic is developing the Audiozone, a gaming zone which is based around the MusicBall as a central console and four 'sidekicks' (in the form of a sphere cut in half) placed a few meters from the console which function as buttons. The development of the Audiozone triggered the idea of a play environment where the MusicBall would also function as a central audio console, but the sidekicks would have a DJ-like function; changing positions or alignment of the sidekicks would influence the music played by the MusicBall. Figure 3.21 shows the first representation around this idea where the sidekicks are represented as rotary volume buttons. Additional sketches showed that the sidekicks work best when their shape is kept as abstract as possible.

As this concept direction is aimed at sound manipulation, it is directly inspired on the constructing / manipulating search field. The concept direction follows the design guidelines of looking at the cognitive side of play, uses more spaces and the total use of space can easily be adjusted. Furthermore, it adds manipulation to the play set and takes away fixed time frames. While the concept does hand over control to the children, it also has its boundaries; there are limits to the number of options and children can only use the sidekicks in a somewhat fixed pattern and thus it does not completely support open-ended play.

Concept direction 5: Physical manipulation

As explained, the brain storm on construction and manipulation shows that it is not limited to the physical aspect. It is however another direction that was explored. While creating different sketches in this direction, the focus

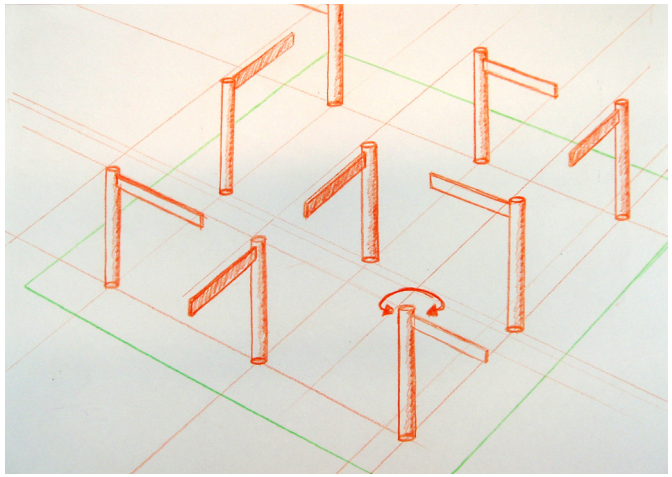


figure 3.24 Rearrangeable play field for self-invented games

shifted to creating an environment which could be physically manipulated and function as a play field for self-invented games (figure 3.24). Additional sketching created a maze like shape as illustrated in figure 3.25. Thought behind the concept is that each pole can turn to change the field of play. Additionally, the poles are connected by electronics and the energy generated by turning one of the poles is redirected to another one at random, turning it as well. While the sketch shows each pole aligned with another, they do not have to be. The concept direction represents a play environment which can be rearranged at any time and at the children's liking. Children could play tag or hide and seek in this environment, create an obstacle course to run or cycle or even host a kind of football game; it facilitates playing games.

This concept direction is inspired on the rule-making and constructing / manipulating search fields. Furthermore, it follows the guidelines of using more space as well as stimulates open-ended play, physical movement and creative (previously referred to as unintended) use of the play set.

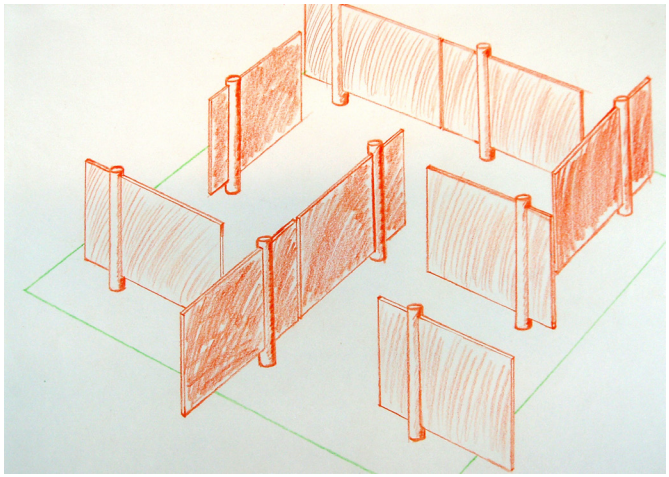


figure 3.25 Refined idea around a rearrangeable play field

Concept direction 6: Surface manipulation

The concept direction around a physical play environment that can be rearranged combined with the use of surfaces sparked an idea to rearrange or manipulate surfaces itself. Perhaps the size of overlapping surfaces could be adjusted to rearrange the play field {figure 3.26) or the surfaces could be activated or deactivated (figure 3.27). This thought direction led to the idea of a raster like surface on which different parts of the surface could be neutral in one state and coloured in another. Triggering a transition between the two states should be as simple as stepping on them (figure 3.28 and 3.29). Enabling this type of manipulation allows children to simply explore the environment and to create games within the environment. Additionally, if the area is not entirely coloured after the trigger, the concept direction could also be used to create a memory game for the public environment.

The surface manipulation concept direction is inspired on four search fields; open-ended play materials, rule-making, informal play space and constructing / manipulating. It follows the same guidelines as the concept explained

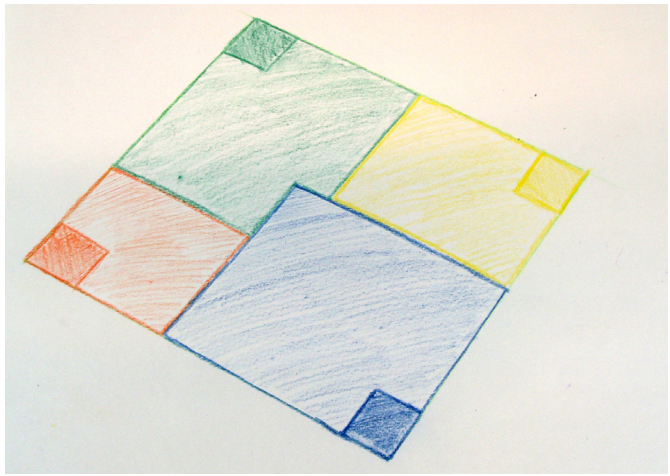


figure 3.26 Rearrangeable surfaces

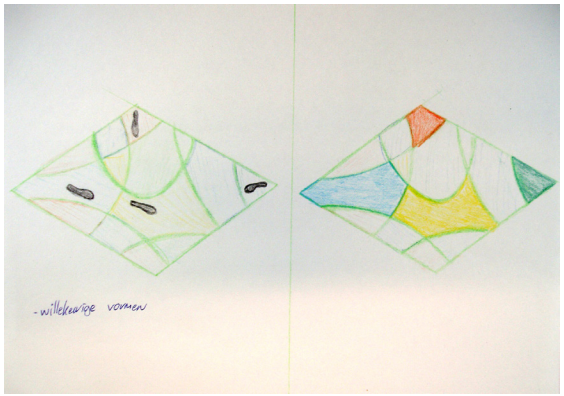


figure 3.27 Triggerable surfaces

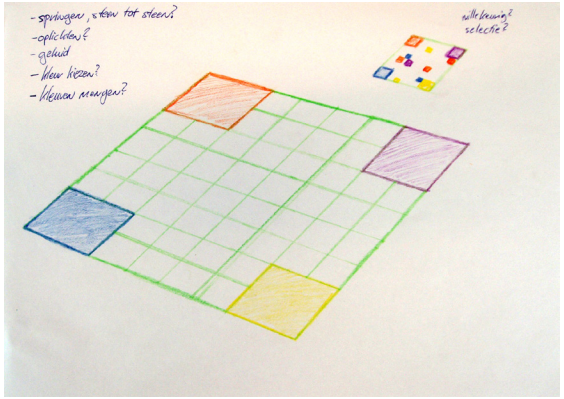


figure 3.28 Triggerable surfaces on a raster

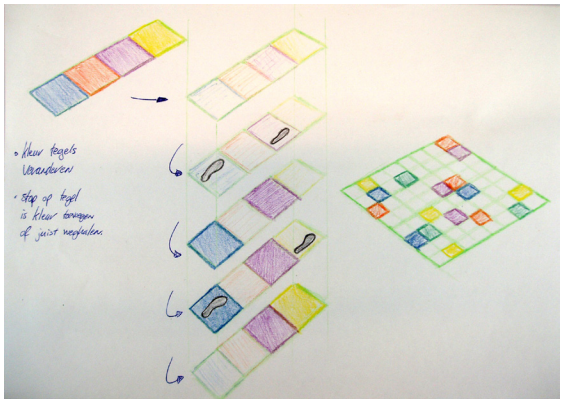


figure 3.29 Surfaces triggered by steps

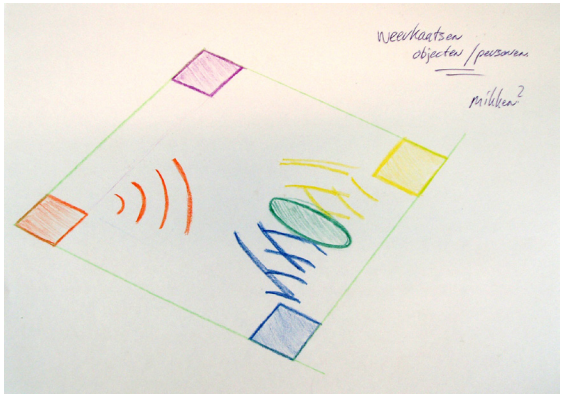


figure 3.30 Passive participation gaming surface

under physical manipulation: using more space as well as stimulating open-ended play, physical movement and creative use of the play set. In addition, it would fit perfectly in the informal play space.

Concept direction 7: Participation

Thinking about ideas related to surface manipulation in turn sparked another thought. If such an area is placed at informal play spaces such as a square, it would be possible for non-participants, for example adults, to pass over the play field. This could be seen as a problem for the concept but also as an opportunity for children to include adults in their play, without them knowing it or without them having to actively participate. The next step is to consider this passive participation of adults as a central point within a new concept direction; how to use the setting of the public environment for adults to perform their normal activities, while providing children with a playing opportunity. The direction around surface manipulation already provides ideas for a concept. Another concept is a gaming surface on the pavement where children can 'shoot' waves or bubbles which will 'bounce' of people walking until reaching the side of the surface (figure 3.30).

This concept direction is a spin-off from the surface manipulation concept direction. As such, this direction is also inspired on the open-ended play materials, rule-making, informal play space and constructing / manipulating search fields and follows the same design guidelines.

Concept direction 8: Light manipulation

Physical, sound and surface manipulation are all explored concept directions. Light manipulation is another facet which came to mind during the brain storms. While sketching in this direction, the focus quickly shifted to creating differently coloured surfaces through combining (sun) light and coloured glass (figure 3.31). The surfaces that are created through the coloured glass can be used by children to create their games. When thinking about such an application, the thought process led to the realisation that using light in such a way already falls under 'playing with energy'; it does not require any electronics to function nor to be a Playnetic product. Further sketching created nature inspired shapes in the form of a plant like concept with coloured petals (figure 3.32) and

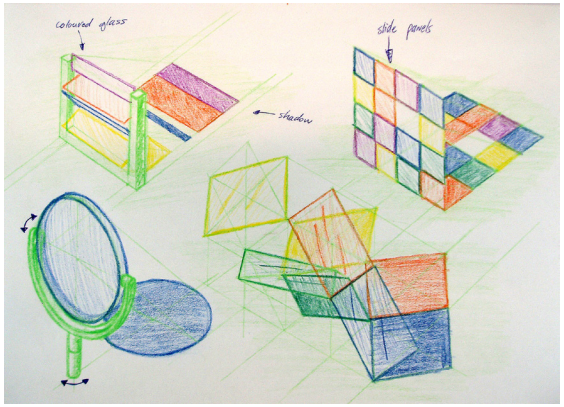


figure 3.31 Light and coloured glass

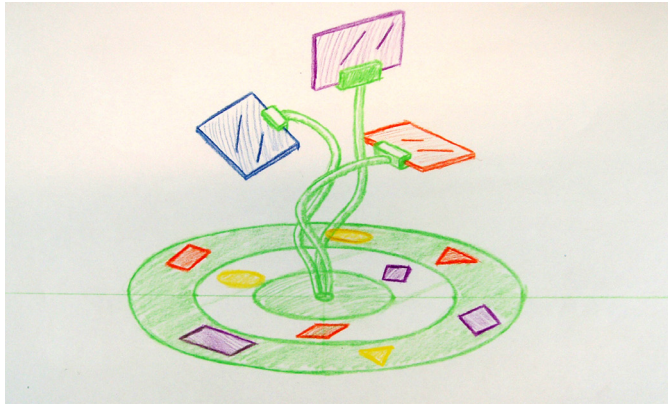


figure 3.32 Light manipulation idea

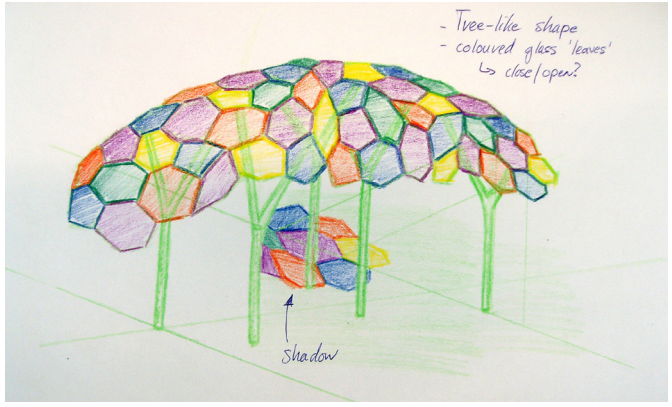


figure 3.33 Light manipulation idea

a tree like concept where leaves can be opened and closed (figure 3.33).

This concept direction is inspired on the constructing / manipulating, rule-making and nature and technology search fields. Furthermore, it follows the guidelines on stimulating open-ended and creative play, while offering options of manipulation of the play set to children.

Concept direction 9: Nature and technology

Based on the direction of physical manipulation, another direction that was explored is the use of technology to manipulate nature. Examples of ideas that were created within this direction include a play set which can be manipulated to reform hilly terrain (figure 3.34 and 3.35) or the use of tiles to jump on and function as a pump for a water fountain or stream (figure 3.36). Combined, these two ideas led to a play set where children can manipulate the direction of water streams (figure 3.37).

This concept direction is inspired on the nature and technology, construction / manipulating and open-ended play materials search fields. It embodies the guidelines of adding manipulation to the play sets and stimulating open-ended play as well as movement.

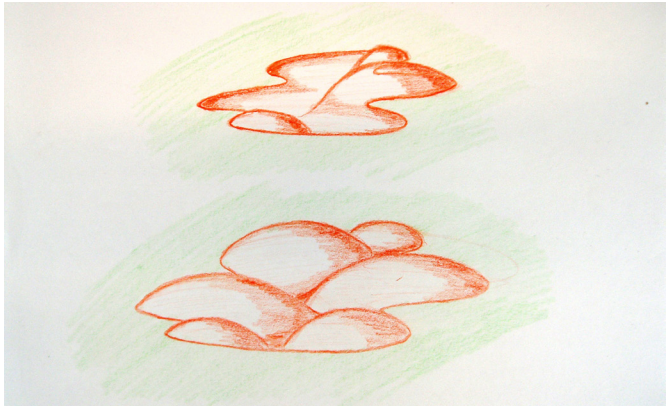


figure 3.34 Create hilly terrain

Concept evaluation

Nine concept directions are described in this chapter. After discussing these at Playnetic, the overall reaction towards the concepts was positive. However, the light manipulation direction (number 8) was not deemed to truly fit the Playnetic brand and was therefore not explored any further. The nature and technology direction (number 9) raised a few questions in regard to being able to withstand vandalism, while Playnetic also had some poor experience of combining electronics with water in the past. Subsequently, this concept was not explored further. The game inspired direction (number 2) was also discontinued for the reason that implementation as presented in the sketches would raise questions on the aspect of safety (the Guitar Hero concept idea would be placed next to busy streets for example) as well as on possible infringement of intellectual property.

Six concepts directions therefore remained and were explored further. During the evaluation, each of them presented issues as well, but these issues were considered to be solvable. The next two chapters elaborate on the explorations, including their issues and generated solutions, and finally present the new product concepts for Playnetic to develop into actual products in the future.

Lastly, while sketching, it became apparent that abstract shapes are best suited to stimulate open-ended play. During the evaluation, this insight was confirmed. The use of abstract shapes was therefore adopted as an unwritten guideline.

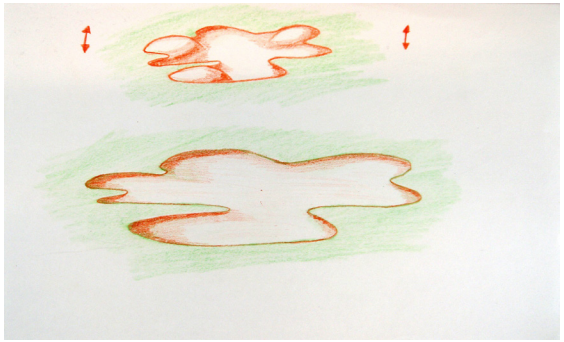


figure 3.35 Create hollow terrain

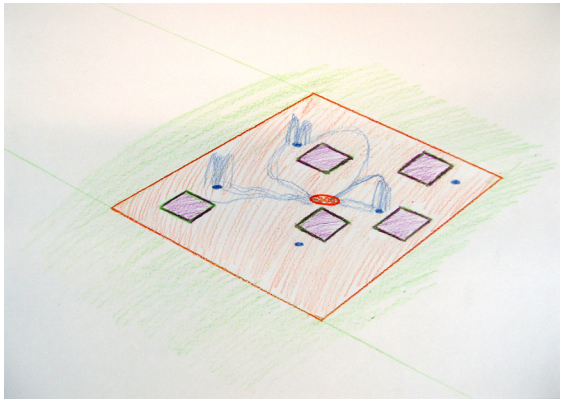


figure 3.36 Triggerable tiles to function as a pump

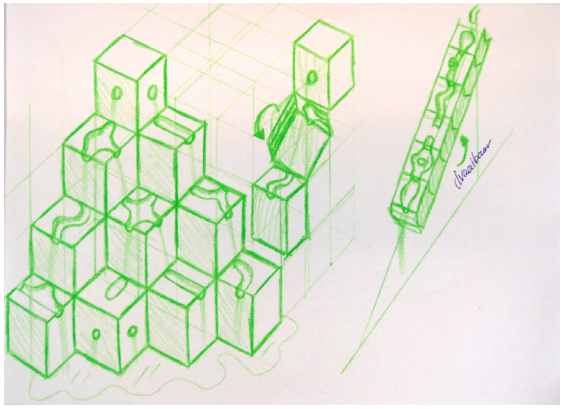


figure 3.37 Rearrange water stream

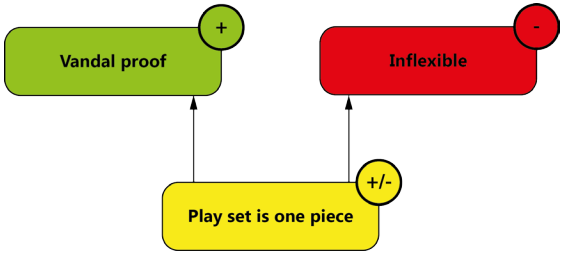


figure 3.38 Vandal proof versus inflexibility contradiction

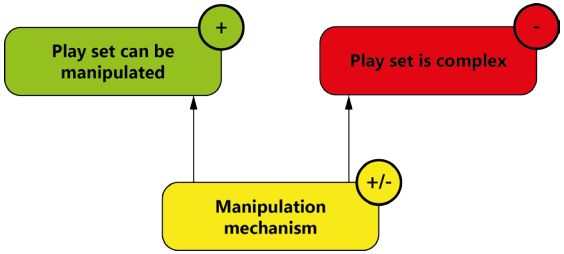


figure 3.39 Play set manipulation versus play set complexity contradiction

3.3 TRIZ

The brain storm sessions for each search field created some direct concept directions to explore, but also created mind restrictions in parallel. Similarly, the sketch sessions generated and explored interesting design directions, while creating additional mind restrictions. To overcome these mind restrictions and to generate solutions for them, TRIZ was applied in parallel with the sketch sessions. Normally, TRIZ is used as an innovation tool to solve technical contradictions in a design. In this case, TRIZ was used as an inspiration tool to guide the thought process and to overcome mind restrictions towards concept directions and subsequently concepts itself.

In total, four mind restrictions were tackled using TRIZ's Inventive Principles. Each contradiction is shortly explained, followed by solutions generated through TRIZ. Appendix I elaborates on the steps between stating the contradictions and their solutions.

Vandal proof versus inflexibility

As Playnetic's products are placed and used in the outdoor public environment, making the products vandal proof is one of the main focus points of Playnetic. In order to achieve this positive effect, the created products are sturdy and robust; they are created as one single piece. As a result, the products are inflexible. If a goal such as options for manipulation is to be achieved, this contradiction (figure 3.38) has to be overcome.

Interesting design solutions to explore further while developing and exploring concept directions are:

- Use shape memory alloys/polymers
- Use flexible joints (e.g. desk lamp)
- Manipulate the environment instead of the play set
- Create optical copies (e.g. light/shadows)
- Change the colour of the play set through light/shadow (photo chromatic), temperature (thermo chromatic) or electricity (electro chromatic)
- Use a 'raster-like' approach of the environment
- Convert kinetic energy of children's play directly into electricity for changing the environment
- Create a play set based on multiple objects
- Consider inflexibility as a positive effect
- Use acoustics

Play set manipulation versus play set complexity

During the execution of the first TRIZ approach and with Playnetic's vision statement in mind, a new contradiction appeared in the form of adding manipulation to a play set also increases its complexity. The vision statement however states that the new play sets should be simpler rather than complex. TRIZ was therefore used to generate abstract design solutions on how to keep the new play sets simple.

Interesting design solutions to explore further are:

- Divide the play set into multiple parts capable of relative moment to each other
- Change the colour of the play set instead of creating a physical change
- Change the transparency of the play set instead of creating a physical change
- When using multiple objects, replace some with copies
- Use optical, acoustic or other principles instead of a mechanical one
- Base the play set on multiple simple objects

- Limit the need for manipulation by redesigning the environment
- Consider manipulation on a line or plane instead of three dimensional

Fun versus noise

The concept direction of creating musical instruments in the street pavement is very promising. The concept is feasible to develop; the necessary technology is already developed by Playnetic. The concept itself is relatively simple, provides children with a fun play concept which offers them options to create their own play. One possible problem for this concept direction was determined beforehand. For the instruments to be a success, they need to produce an adequate sound level. While children would perceive the sound as fun, other people might perceive it as noise, especially at night. For the concept to work, this contradiction should be solved.

Interesting design solutions to explore further are:

- Adapt the volume of the play set to the sound level of the surrounding
- Place the play set at an isolated spot in the environment
- Turn the play set off at certain times when it is unwanted (e.g. at night)
- Make the volume adjustable and find the right volume levels at each location
- Change the volume levels for different times of the day (e.g. lower at night, higher during the day)

Randomiser versus chance of injury

The concept direction around an environment which can be reorganised, the concept idea which can be associated with a maze, offers children a way to change the shape of the play set. The play set itself provides a play environment rather than a single play set. The concept idea therefore offers children a way to manipulate the physical environment to create their own games and rules. Thought behind the concept is that children can adjust different pillars and by doing so, create a different play environment. Downside of this concept's idea is that turning a random pillar might make the bulkheads attached to the pillars hit another child and cause an injury. This has to be prevented.

Interesting design solutions to explore further are:

- Use flexible bulkheads (e.g. rubber or foam)
- Fragment the bulkheads into multiple, flexible parts
- Use sound to warn for a turning pillar
- Redirect the resistance from a bulkhead pushing a child to another pillar
- Use rubber tiles to allow for better fall protection
- Apply a breaking system which slows the maximum rotating speed
- Turn pillars in phases
- If a counter-pressure is found while a pillar is turning, block the pillar from rotating further
- Use multiple layers of thin, flexible bulkheads instead of one thick bulkhead

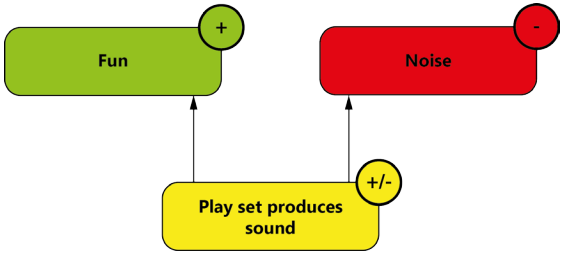


figure 3.40 Fun versus noise

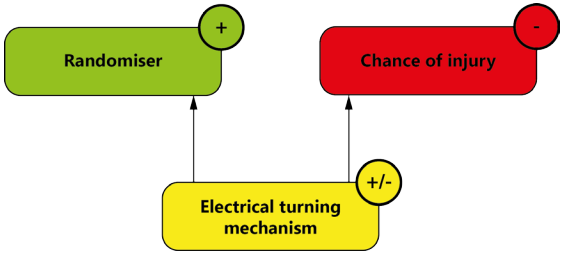


figure 3.41 Randomiser versus chance of injury

3.4 Final Concepts

This chapter describes the final concepts that were created. In total, six concept directions were explored further, resulting in six concepts. Each concept is explained, including how it functions and the thought process behind it. Additionally, recommendations are given in regard to developing each individual concept further.

After presenting the six individual concepts, an overview is given on which guidelines are represented in the concepts as well as an overview on how well the concepts fit within the four future scenarios (chapters 1.8 and 1.7 respectively).

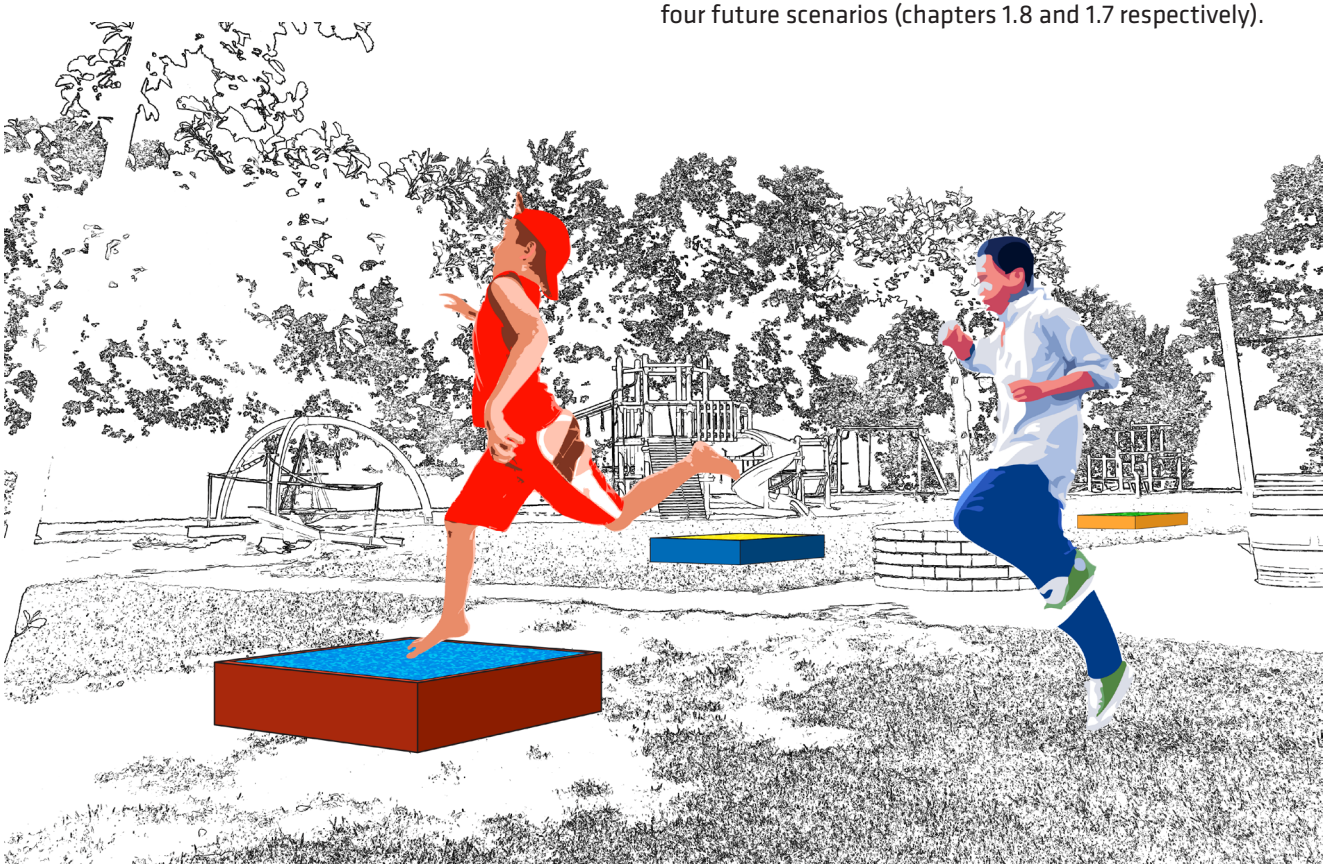


figure 3.42 Jumpstone concept representation

Concept 1: Jumpstone

The Jumpstone concept is directly inspired on the concept direction around 'jumping tiles'. During the evaluation of the jumping tiles direction, it became apparent that Playnetic had some bad experiences with embedding products in pavement, especially in the context of electronics being placed below the surface and in regard to water. In addition, Playnetic had problems to generate decent volume levels in regard to audio when placing products under the street surface. While Playnetic was very interested in the concept direction and the opportunities it presented, a system placed above the surface was preferred. Placing it above the ground surface also has the additional benefit of easier installation of the product.

The jumping tiles direction was therefore converted into a concept based on a box shape instead, resulting in the Jumpstone concept. Whereas the jumping tiles direction is based on using the tiles as a sort of button or initiation point to make lights or LED lines light up, the Jumpstone is a complete standalone concept based on triggering audio instead. The idea is that the top surface of the Jumpstone is a plateau which settles downwards when a person jumps on it. This vertical movement is used to convert kinetic energy into electric energy which is used to play sound. The sound should be as simple as a single tune or musical note, but each individual Jumpstone should be equipped with a variety of tunes.

As an added level of interaction in the concept, the force with which the audio is triggered determines the output volume and length of the played audio tune. Figure 3.44 illustrates this effect in the form of storyboards; if the Jumpstone is triggered by a cautious step, the output volume is relatively low, while the force from a jump results in a high output

volume and longer length of the audio tune.

A single Jumpstone could function as a central point in a hide and seek game or other games, while multiple Jumpstones could function as a running path. Figure 3.42 shows a representation of the concept with multiple Jumpstones. Allowing different levels of output volume also stimulates children from experimenting with the Jumpstone or perhaps a group of children would try to produce the loudest tune one-by-one. The concept hands over control of what to do with the play set to the children; it provides open-ended play opportunities.

For further development of this concept, the following recommendations are given:

- An electronic module should be developed for this concept which can measure the force or speed with which the top surface is pushed down to be able to determine the right output volume. In addition, the module should have different premade tunes on-board or allow uploading of tunes in a quick and easy way.
- The current shape of the concept is based on a box, but other outer shapes are an option as well. An example is shown in figure 3.43, which is based on adding ramps on the sides. Preferably, the outer shape is independent of the inner mechanics, meaning different outer shapes can be created which are compatible with the inner part of the concept (modularity).
- As the top surface should allow downwards settling, a solution should be engineered to sustain this movement and be able to generate electricity from it, without any outer parts performing any vertical translation where children might get their fingers stuck in between.
- The concept construction should allow different colour setups for the outer shell and top surface of the concept to be able to easily create different colour schemes such as seen in figure 3.42. This current representation shows the use of expressive and complementary colours, thus if the colours of the two parts are easily adjusted, different colour schemes can be created. Furthermore, being able to adjust these colours makes it possible to create colour schemes aimed at the specific location or to apply more sober styling.
- Look at including other modular elements that can positively add to the child's experience. An example could be including glow in the dark material to the top surface to support the use of the concept in the evening. Based on the assumption that the concept is placed at a location where there is some artificial lighting, glow in the dark surfaces could make the concept stand out and make it more usable when it is dim or dark outside.

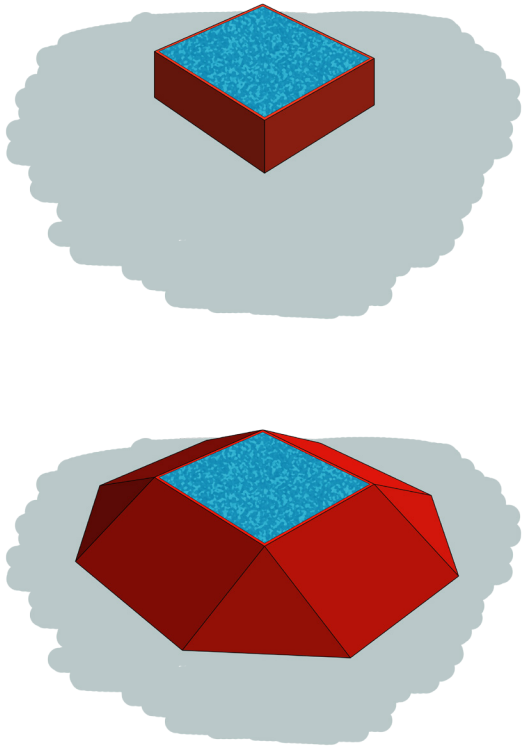


figure 3.43 Jumpstone modular outer shapes

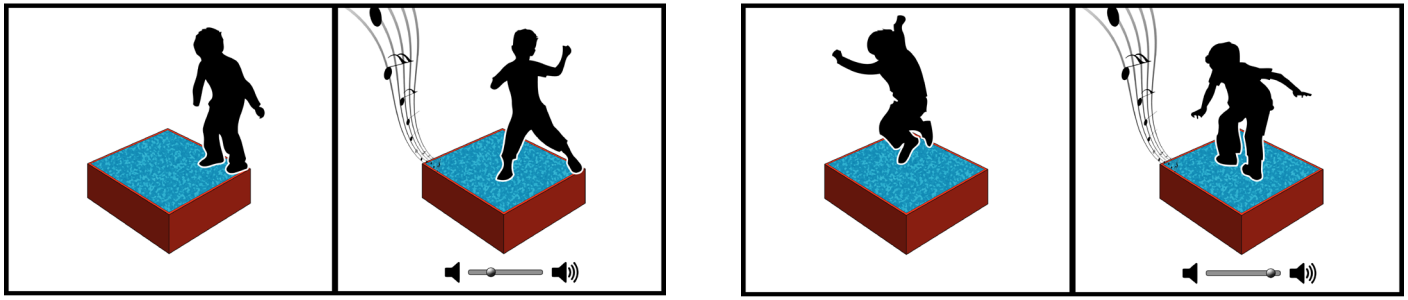


figure 3.44 Jumpstone interaction: output volume based on force exerted on the top platform of the concept

Concept 2: Street instruments

The Street instruments concept is a direct interpretation of the previously described concept direction under the same name. The concept direction describes musical instruments embedded in the pavement and is a continuation on the jumping tiles concept direction, inspired by the game Guitar Hero. Similarly, the Street instruments concept presented here is based on the Jumpstone concept, meaning that instead of a musical instrument embedded in the streets, the concept is converted to a raised platform above the ground surface.

Figure 3.45 shows how this could look in a public environment setting, in this case in the form of a piano or keyboard. Figure 3.47 shows three different instrument representations: the piano/keyboard, the guitar and the drums. Each representation is included with audio tones of the respective instrument. Each Jumpstone element triggers a fictive key, snare or drum and has a different pitch of the instrument's sound compared to the other Jumpstone elements. Add in the effect between a cautious step and a high jump determining the output volume and length of each musical note and the Street Instruments concept allows children to create musical melodies. Figure 3.46 illustrates this interaction. Alternatively, they could produce sound deliberately out of rhythm. Children can use the concept solitary, or work together to create their music. Additionally, if multiple instruments such as a guitar and drums are placed close to each other, they can cooperate in the form of a fictive band.

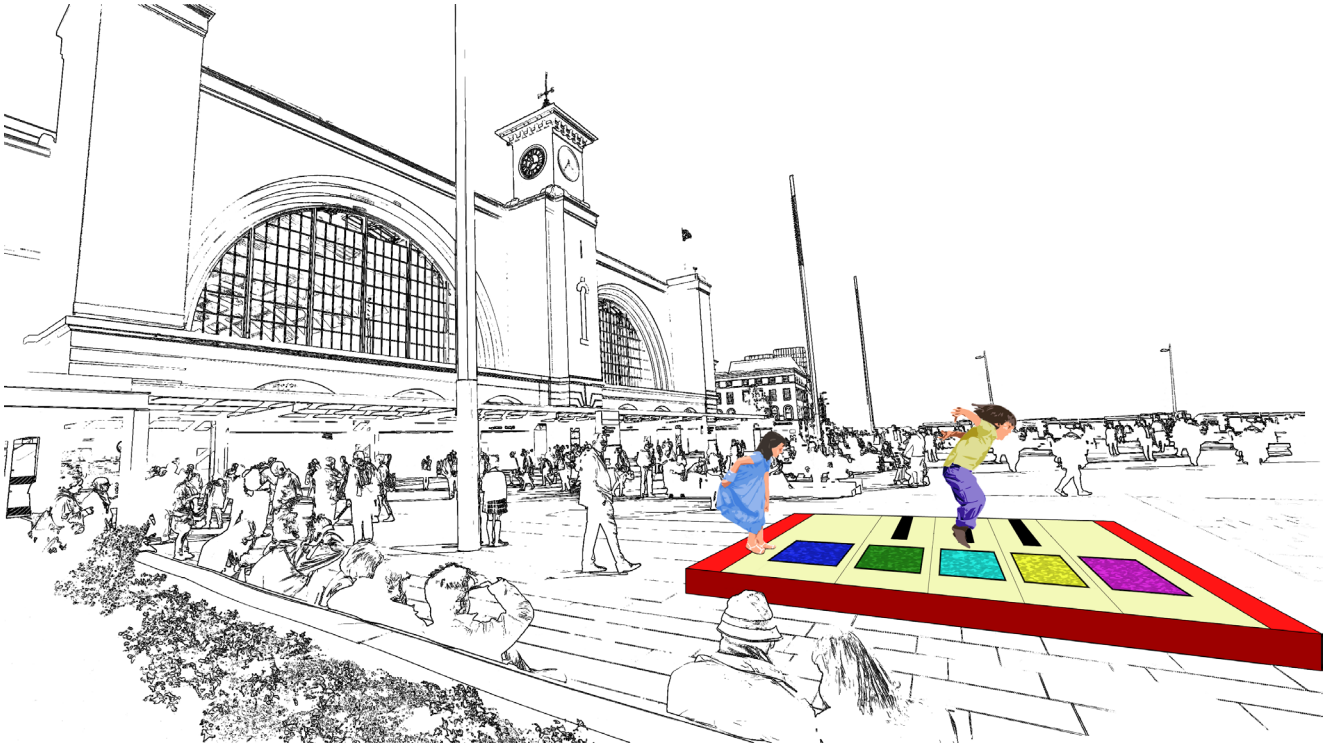


figure 3.45 Street Instruments concept representation

In the concept represented here, five Jumpstone elements are included in the platform, meaning five different pitches of the instrument can be included. This is based on the use of a pentatonic musical scale to divide an octave, which already provides quite a few options to create music. The pentatonic musical scale is for example quite commonly used in the blues. Expanding the Street instruments concept to include seven or eight Jumpstone elements would expand the concept to the heptatonic or octatonic musical scale respectively. The heptatonic musical scale is a considered more experimental, while octatonic musical scale is used in classic music as well as in jazz. Adding more Jumpstone elements offers children with more options to create music, but it also increases the overall distance between the fictive keys or snares, which may or may not be a problem. It also

increases the overall price of the concept. On the other hand, different platforms can be created to facilitate five, seven or eight Jumpstone elements and thus the use of different tone sequences.

For further development of this concept, the following recommendations are given:

- As stated at the Jumpstone recommendations, a new electronic module should be developed for the Jumpstone concept. To make sure the Jumpstone modules also provide the necessary functions for the Street instruments concept, each module should include a minimum of five to preferably eight different tone pitches, following the respective musical scale, for three (piano/keyboard, guitar and drums) or more musical instruments.
- Perform a test on how many Jumpstone elements, or number of keys and snares, are ideal for children to play with. Depending on the results, a decision can be made in regard to the size of the platforms.
- Another thing to test is if the sound produced by the Jumpstone elements can be heard properly with an added platform on top of it and if the platform itself does not function as a resonance box, deforming the sound. The platform can easily be designed and adjusted to counter these effects.
- As the representation of figure 3.45 shows, the concept is very suitable for placement at informal play spaces, for example at a square. This could be a problem at night if the concept produces too much noise. The TRIZ chapter provides some directions for solutions to this problem. The most promising solution based on current knowledge would be to include a timer to the concept, which either shuts the concept off or substantially lowers the output volume at night. If the electronic modules are designed to include a timer, this function can also be included at the Jumpstone concept if necessary for the environment.

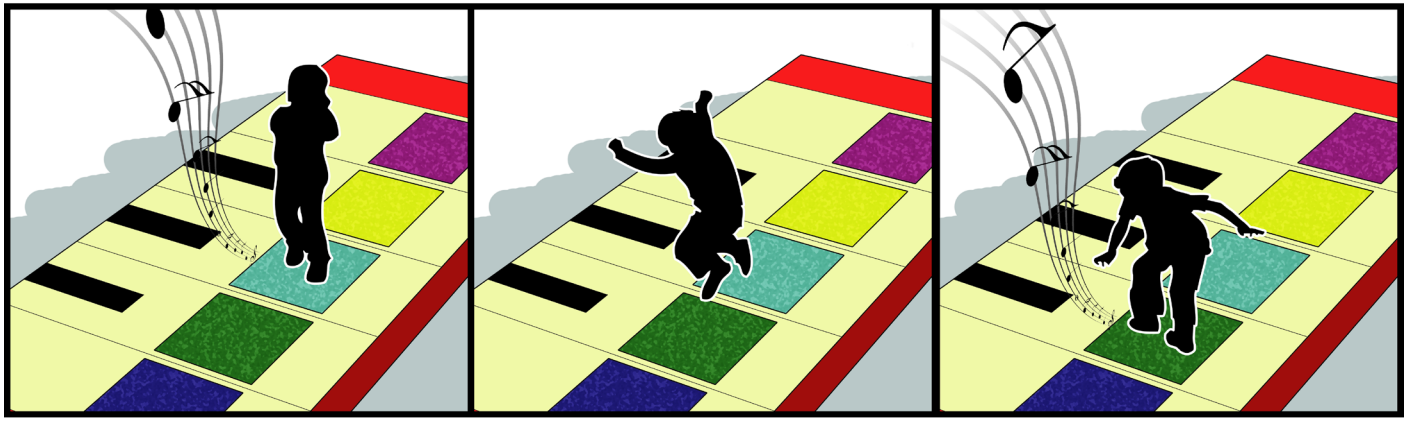


figure 3.46 Street Instruments user interaction

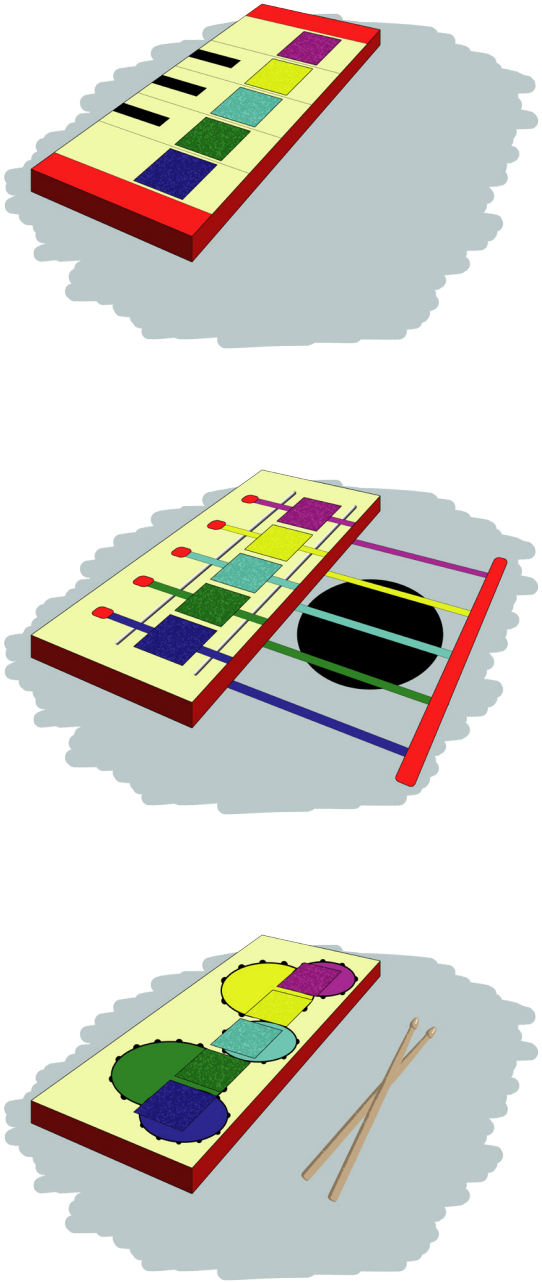


figure 3.47 Street Instruments textures

Concept 3: Audiozone 2.0

The Audiozone 2.0 concept is based on the concept direction of sound manipulation in combination with the current development of the Audiozone game environment by Playnetic. It is a direct follow-up on the concept direction explained in chapter 3.2, where Playnetic's MusicBall is used as a central console combined with sidekicks which have a DJ-like function.

Figure 3.48 shows a representation of the Audiozone 2.0 concept. Whereas the previous sketches show the sidekicks as volume buttons or as otherwise inspired shapes, they are replaced by an abstract shape in the representation, following the unwritten guideline on using abstract styling. Each sidekick has three disks which each have four aligned positions. The idea is that each sidekick supplies 'ingredients' in the form of audio samples to create or manipulate a song. For example, one sidekick could control the bass line of the song, while another controls the melody, the third controls added effects and the last one controls overall variables such as beats per minute and pitch options. All the audio samples, the ingredients, are synced to each other, meaning that they follow the same rhythm. The sidekicks function as switches; as long as the hand crank of the MusicBall is not rotated, nothing happens. Once the MusicBall is activated, the position of a sidekick's disk acts as a switch for the electronic module of the MusicBall and starts playing music. By changing the positions of the sidekicks' disks, the music played by the MusicBall changes (figure 3.50), but the music created by the children always syncs up. While the concept can be used solitary, it invites children to cooperate together. Once the music is just as the children want it to be, they can use the MusicBall just as it is intended now; to simply enjoy, song along with or dance to, or they can continuously be the DJ and change the music.

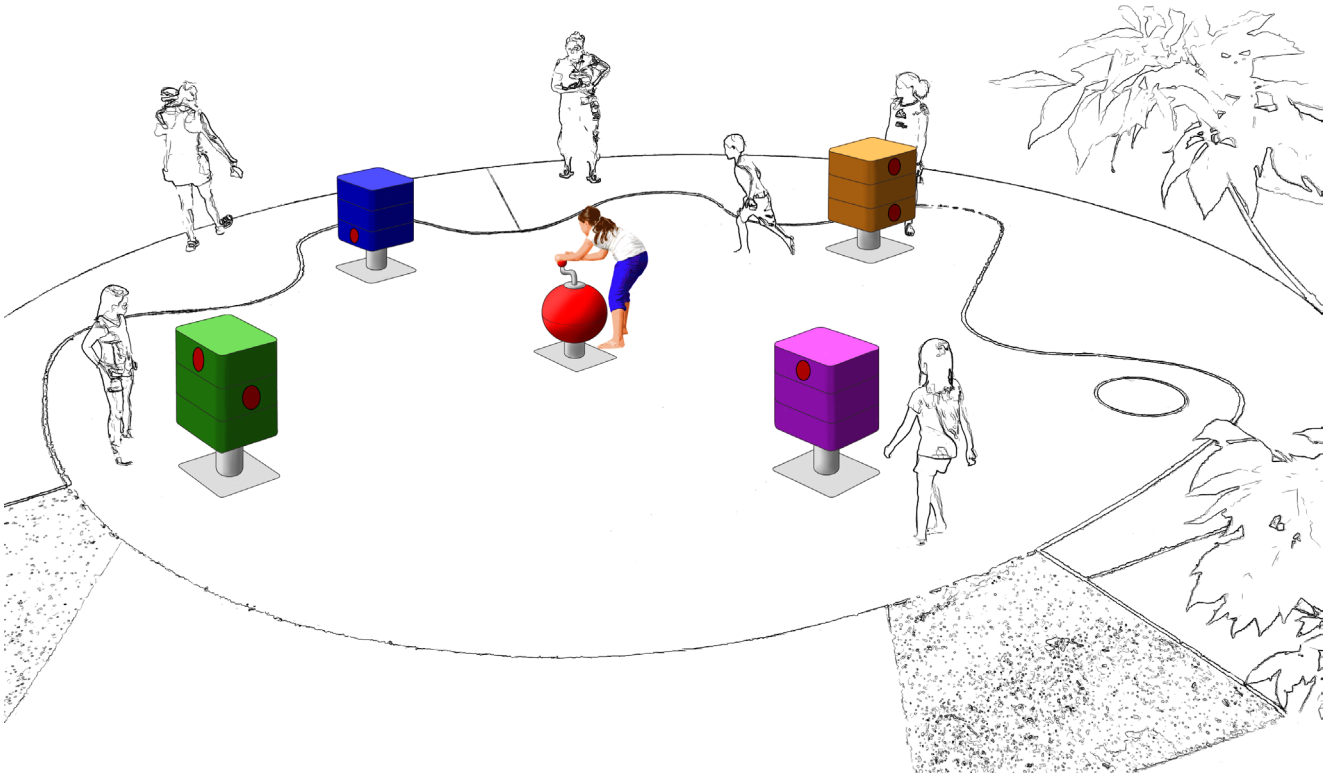


figure 3.48 Audiozone 2.0 concept representation

The sidekicks have three disks with four positions each. Meaning that each sidekick has twelve ingredients it can supply. One position of each disk is however a blank; it is neutral and that position is marked with a dot for children to understand the alignment of the disk. A disk is neutral when the dot points towards the MusicBall. One of the possible objections against this concept is stated in chapter 3.2: there is a limit to the number of options. While this is true and it was considered as a boundary at first, a simple mathematical

sum shows that, when using four sidekicks with three disks each, the total number of possible combinations is 4^{12}, which results in 16,777,216 combinations. Yet, the total amount of audio material needed, when each disk has a neutral position, is just 36.

For further development of this concept, the following recommendations are given:

- Similarly to the previous two concepts, adding a timer to the electronics of the MusicBall to lower the output volume or turn off the volume completely at night could be considered.
- The type of audio materials controlled by the sidekick, for example the previously mentioned base line, melody, et cetera, should be tested and thought through further based on the results. Changing the audio materials is part of software and is therefore as simple as uploading other sound samples. In fact, the concept is likely to be able to function on the same electronic module, perhaps with minor alterations, currently being developed by Playnetic for the Audiozone game environment based on the MusicBall and a different type of sidekick.
- It could be interesting to explore the option of adding a 'master switch' that can switch the overall style of the music between for example electro music and pop/rock music to offer different modes. This switch could be added to the centre console, perhaps even by rotating the MusicBall's hand crank clockwise for one mode and counter clockwise for the other. Alternatively, one of the sidekicks disk could function as the master switch, creating four different modes.

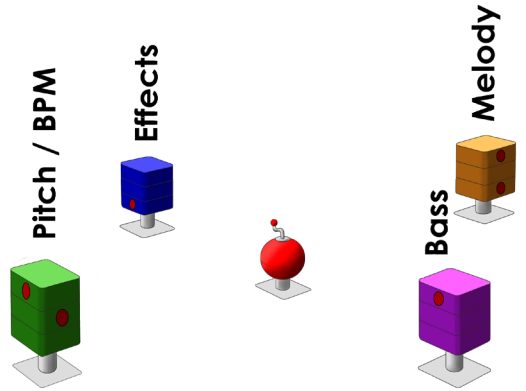


figure 3.49 Functions of each sidekick

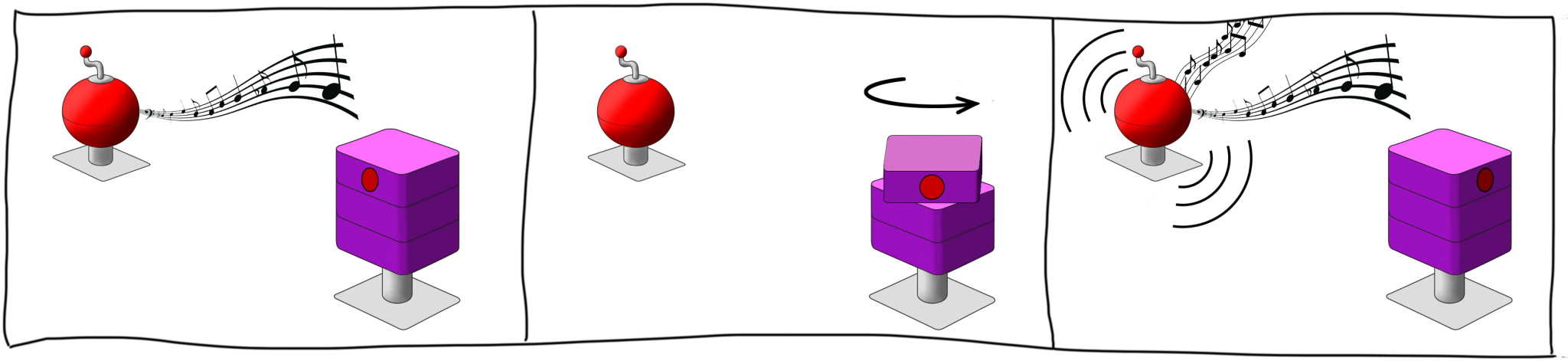


figure 3.50 Audiozone 2.0 user interaction

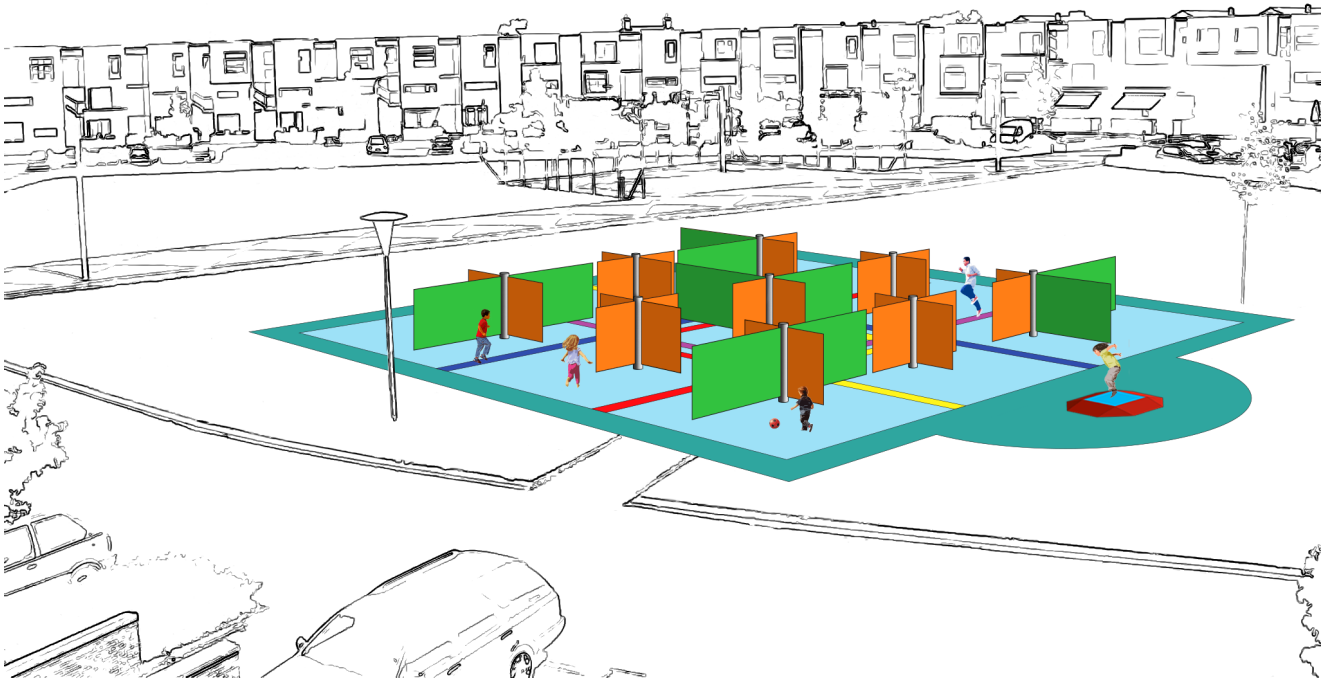


figure 3.51 Re-maze concept representation

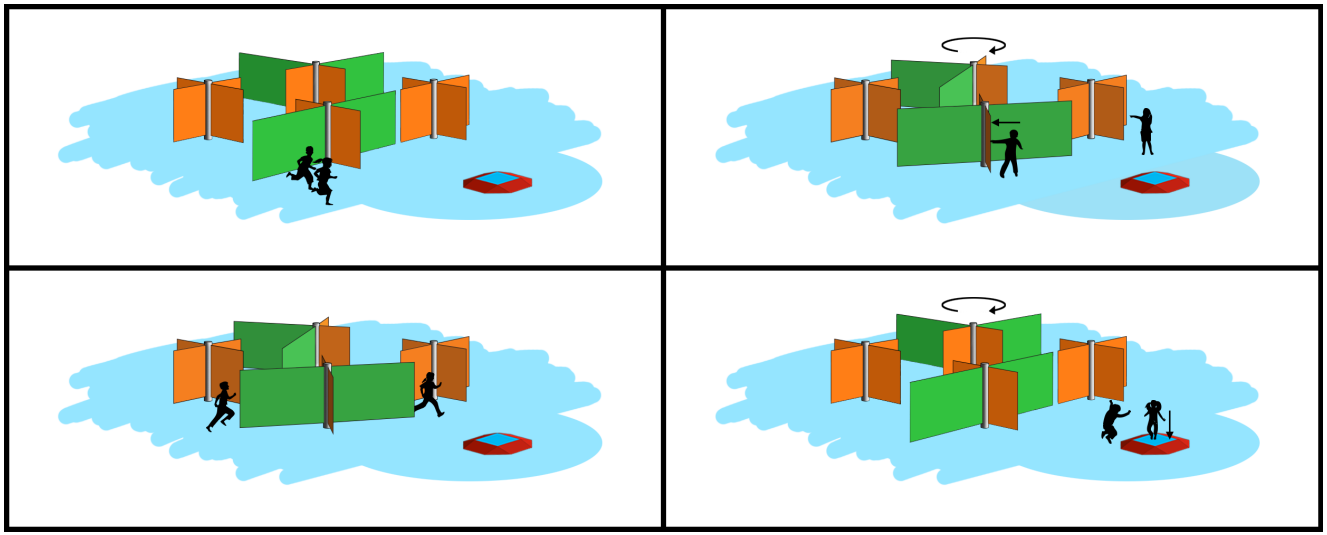


figure 3.52 Re-maze user interaction

Concept 4: Re-maze

The Re-maze concept is based on the concept direction of a play field for children to create self-invented games as explained under the physical manipulation headline in chapter 3.2. The related sketches already show a design that can easily be associated with a maze. Furthermore, the thought behind the concept direction is that the environment can be rearranged; 're-mazed'.

Figure 3.51 shows the representation of the Re-maze concept. The concept is similar to the idea sketched in the physical manipulation concept direction, but there are some distinct changes. First of all, the concept direction is based on generating energy from a pillar when it is rotated. The energy is used to rotate another, random pillar. While this effect could cause a safety problem as explored in the fourth TRIZ contradiction in chapter 3.3, it could also create frustration among children. For example, a child might be trying to create a specific arrangement of the pillars, but is unable to as each time he or she pushes a pillar in the correct position, another one is moved as well. Consequently, this feature is removed in the Re-maze concept. Instead, each pillar is connected to a Jumpstone, located on the side of the play field. The Jumpstone functions as a reset button; jumping on it rearranges the play field to a random, but aligned position. If the Jumpstone is used after the pillars are aligned, pillars will one by one, at random, rotate an additional 90 degrees. Furthermore, each pillar is equipped with a way bearing, which makes it easy for children to rotate the pillar in the same direction of the reset mechanism, which is based around a simple servomotor. The storyboard shown in figure 3.52 illustrates how children can rearrange the play field by hand and reset it using the Jumpstone.

The second notable change is the shape of the pillars. Whereas the sketch (figure 3.25 in chapter 3.2) shows pillar bulkheads only placed at two sides of the pillar, resulting in a line if looked at from the top, these are now placed on four sides, which results in a cross like shape if again looking at the top view. While this change might seem to make the concept more complicated, it actually makes the concept simpler when looking at construction and cost. In the concept direction sketches, all nine pillars, using a three by three setup, have electronics included within them and all pillars are connected to each other. Inspired by the TRIZ inventive principle of using copies and models (TRIZ has not actually been applied here), only five pillars can rotate and thus require electronics in the Re-maze concept, while the other four are static copies. Figure 3.53 shows the rotatable pillars on the left and the static ones on the right.

Lastly, the use of surfaces is included in the Re-maze concept. As the goal of the physical manipulation concept direction is to stimulate children to create their own games, a large surface where the pillars are placed on is included. This creates a marked area which can be included for self-invented games. In addition, lines are added to the surface, zigzagging from one side to the opposite side between the pillars. These lines can function as a route, can be used to divide the overall surface in multiple pieces or can be ignored depending on how children fit them in their games.

For further development of this concept, the following recommendations are given:

- One possible problem for the concept is that it includes rotating objects; if a pillar is rotated by a child, it could hit another child if he or she is standing behind it. This problem is explored in chapter 3.3 through the application of TRIZ. Based on current insight, the best solutions are likely the use of flexible bulkheads or playing sound when a pillar is rotated, or a combination of these solutions.
- Instead of connecting the pillars to a Jumpstone as a reset button, the Jumpstone could also function as a tag point for their games. It could therefore be interesting to look at adding more than one Jumpstone. Adding another Jumpstone at the opposite side of the play field or three extra Jumpstones, one at each side of the play field, offers children with more options to create self-invented games. Multiple Jumpstones could stimulate a running course or they could function as checkpoints which children want to 'capture' in their games.

figure 3.53 Five pillars with large bulkheads are rotatable (left), four pillars with only small bulkheads are static (right)

Concept 5: Colour Tiles

In chapter 3.2, the idea of triggerable surfaces is proposed under the surface manipulation concept direction. The Colour tiles concept is a direct interpretation of that idea; a raster like shape, based on the size of normal pavement tiles, where each tile can be triggered individually by stepping on them. In their neutral state, the tiles are coloured similarly as the surrounding tiles or in a different non-expressive colour. In their activated state, the tiles change over to an expressive colour; one of the primary or secondary colours. The Colour tiles are not just activated when a person steps on them, but remain activated until another step is made, triggering the tile to go back to its neutral state.

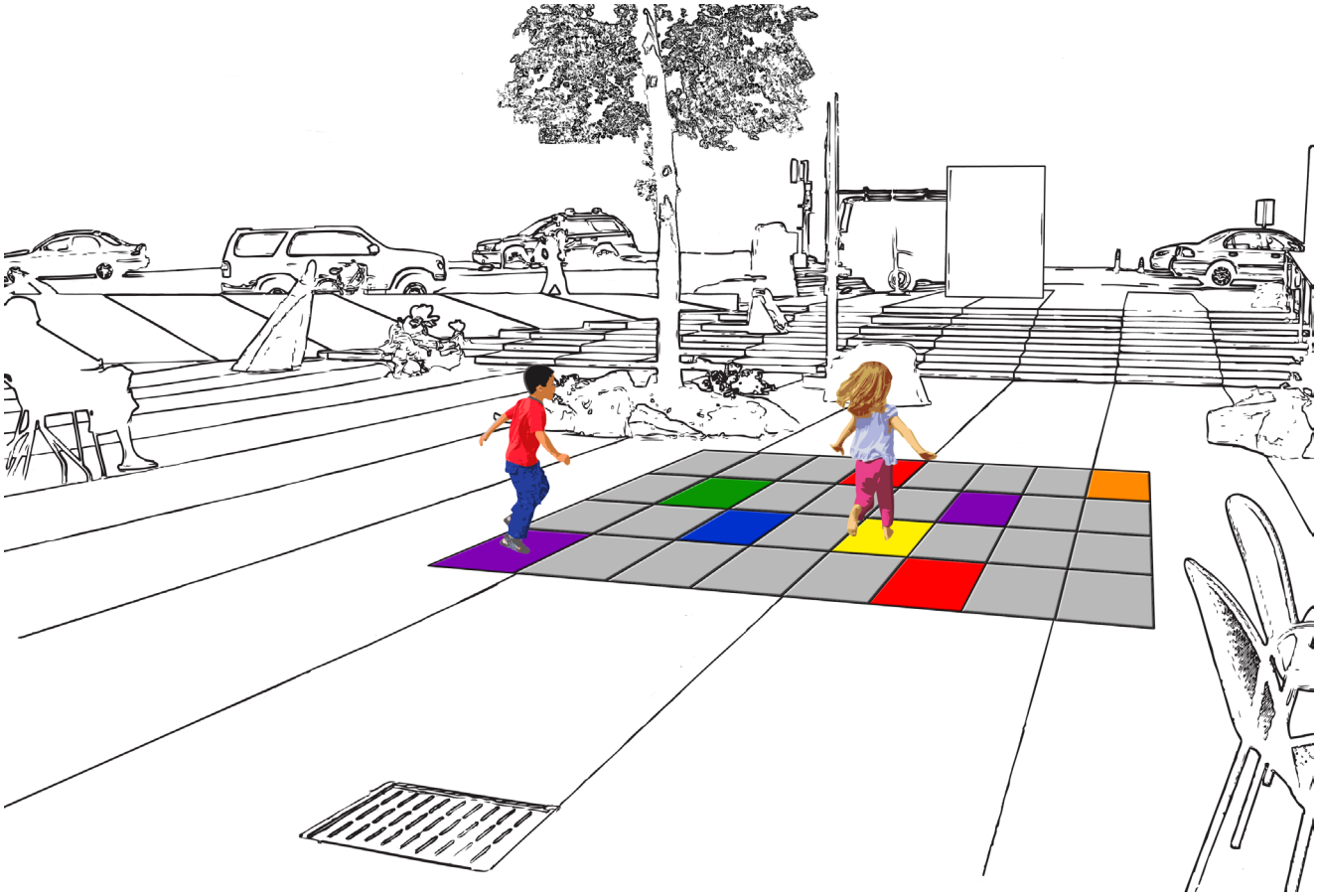


figure 3.54 Colour Tiles concept representation

Figure 3.54 shows a representation of the Colour tiles concept, while the two storyboards of figure 3.56 explain the effect of triggering the tiles between their neutral and activated state. Figure 3.55 shows how the concept can change what it looks like. The concept provides children with an environment to explore and to create games. A child might try to memorise the locations of tiles with the same colour and jump to each of those locations to only trigger that specific colour. Alternatively, children might first trigger all the tiles and then start removing colours. It could also spark a competitive game where children pick one colour and try to deactivate the colours of their opponents before their own are deactivated. Perhaps children deactivate all the tiles and pick one colour as a 'bomb' and they have to trigger a tile in turns without setting of a bomb. Another option is to create a raster with Colour tiles of only one colour, which allows the creation of 'pixel drawings' such as smileys. As an added design possibility, a memory game can be created if the activated state of a tile does not completely change colour and leave a logo or clip art style shape in its neutral colour.

If the Colour tiles concept is given the shortest possible description, it would be interactive tiles. There are however already some interactive tiles available on the market today. Although no concrete competition analysis is performed, the Colour tiles concept distinguishes itself from other interactive tiles based on these unique selling points:

- The tiles function on human-generated energy; they do not require an external power supply.
- After the initial trigger, the tiles remain activated until another trigger is made.

Different technological options to realise this concept now or in the near future were explored. Two interesting solutions were found that could create the functionality needed for the concept to work. The first solution is the application of electrochromic polymers. Electrochromic polymers are conductive polymers which have a neutral and oxidised state. Especially the conjugated electrochromic polymers created by the Reynolds research group of the University of Florida are interesting (Reynolds et al, 2003). These polymers change between their two states after an applied potential and have a different colour in each state. Furthermore, the polymers remain in their oxidised state until a new potential is applied, changing them into their opposing state; they retain their colour after activation (the oxidised state). There are no perfect batteries however, so they slowly fall back to their neutral state over time. Reynolds and his fellow researchers explain that these materials are perfect for easily processed devices; they have a high level of processability, good mechanical properties, fast switching speeds, high contrast and their colours can be tuned through structural modification. Application examples put forward by Reynolds are multicoloured displays and switchable mirrors, while they could also be used for electronic paper devices. The technology has the potential to fulfil the necessary functions for the Colour tiles concept, but two major questions remain: How much energy or applied potential is needed to switch the electrochromic polymers between its states? Ideally, one or a couple of piezo-elements built within the tile generate enough energy. Secondly, many papers on this subject were found dating approximately ten years back stating that these materials are ideal for simple devices. However, the only application of the materials to date is in the form of smart glass such as used in the new Boeing 787 Dreamliner, where the windows no longer have shades but can be darkened instead. The second remaining question therefore concerns the cost of these materials; are these materials affordable to realise this concept in the next ten years or do they push the price of one Colour tile too high to commercialise? Experts were contacted to answers these questions, but no definitive answers were found.

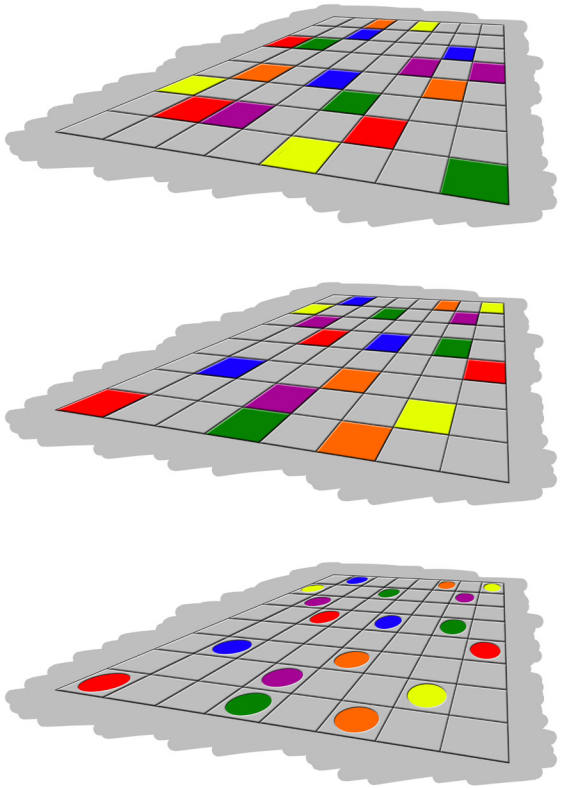


figure 3.55 Different layouts of the concept in use

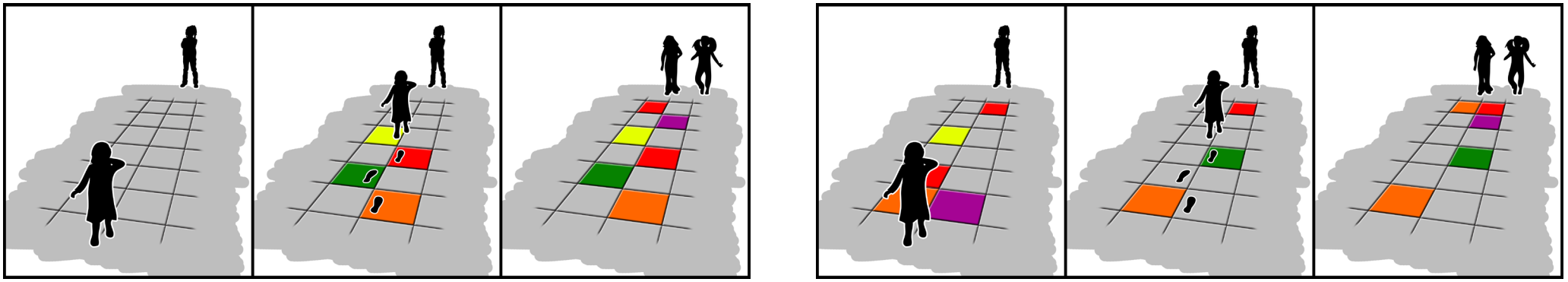


figure 3.56 Colour tiles concept user interaction

The second solution to realise this concept is the application of two polarised filters placed on top of each other, with a surface below it coloured slightly lighter than the primary or secondary colours (for example light blue instead of blue). Polarised filters are linear filters where only light which has its wave aligned with the filter can pass through. This technology is therefore commonly applied in photography and sunglasses. When two polarised filters are placed on top of each other in parallel, their effect is only boosted slightly as the filters are aligned and both allow the same light waves to pass (figure 3.57). When the filters are placed perpendicular to each other, each filter blocks light waves which pass through the other filter, resulting in no or close to no light passing through the combination of the two filters. If applied in the Colour tiles concept, the neutral state of the tile has the two filters in perpendicular positions and the activated state has the filters placed in parallel. As the colour surfaces are coloured lighter and the polarised filters slightly darken the colour in their parallel state, the visible result is a colour close to the primary or secondary colour. To realise this solution, it might be practical or even necessary to create tiles such as seen in the third setup of figure 3.55, where only a circle in the middle is coloured on activation as opposed to the entire tile.

For further development of this concept, the following recommendations are given:

- The size of the tiles needs to match the size of regular pavement tiles in order to easily be included in the public environment. If necessary, the height of the Colour tiles can be higher than pavement tiles.
- Further research and subsequently testing should be performed on the two proposed technological solutions to create this concept. Especially tests on different outdoor light conditions and visibility of the Colour tiles under these conditions are advised.

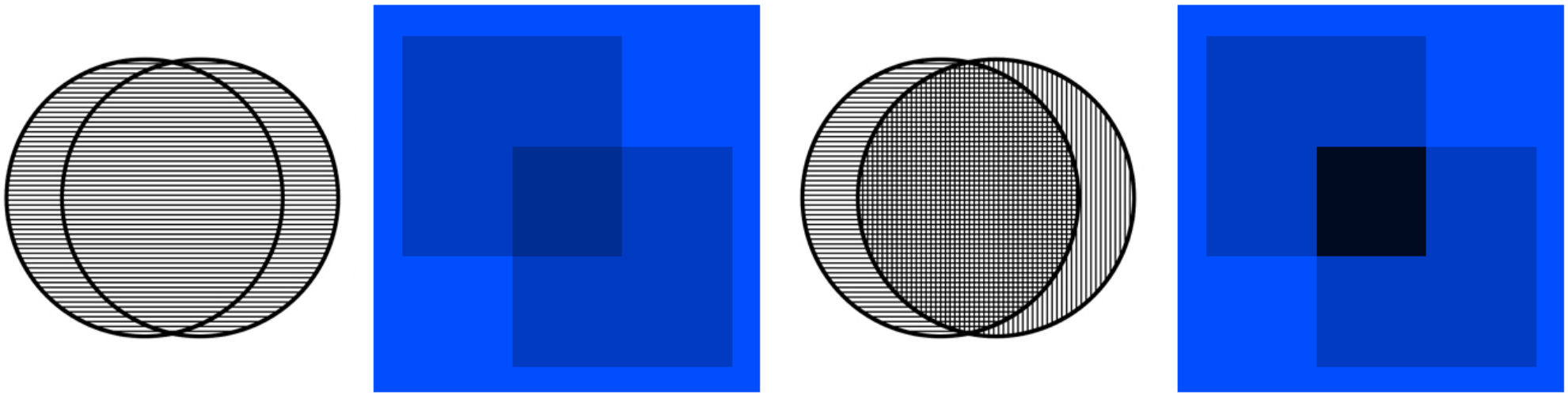


figure 3.57 Effect on colour visibility of two polarised filters in parallel (left) and perpendicular (right)

Concept 6: Audiozone 3.0

The Audiozone 3.0 is, as the name suggest, a continuation on the Audiozone 2.0. Similarly to the Audiozone 2.0, children can create music using Playnetic's MusicBall as a centre console. Different from the Audiozone 2.0, there are no sidekicks to manipulate the music in this concept. Instead, people themselves are the sidekicks. The word people is deliberate chosen in this context as besides children, adults who pass by the concept become passive participants. The Audiozone 3.0 concept is inspired on the ideas suggested under the participation concept direction in chapter 3.2, but the concept presented here goes in another direction.

The idea behind the concept is that a circular zone is created around the MusicBall where people are detected and used as input to create music. Different positions of people create different sounds; the music therefore changes when people move. Two people close together have an additional effect on the sound; it creates sort of an interaction of the input. Additionally, perhaps larger objects such as a bicycle could also be detected and used as input, but this is not a necessity for the concept. Figure 3.58 shows the representation of the concept. The larger circle represents the zone where the concept is active and can be created through a simple texture on the pavement surface. The circles which are visible below the children are indicators of their input to the centre console; do not have to be visible for the concept to work, but it would give children real-time feedback on the input used by the centre console. The storyboard in figure 3.60 illustrates how movement and proximity changes the music created with the Audiozone 3.0 concept and played by the MusicBall. The concept encourages children to explore and understand the mechanism and interaction behind the concept. It provides children with a play environment where they can create music and play with it the way they like, while stimulating movement. Furthermore, if placed at an informal play space, children can include adults in their play, stimulating social interaction, while adults can choose to be passive participants or to engage actively.

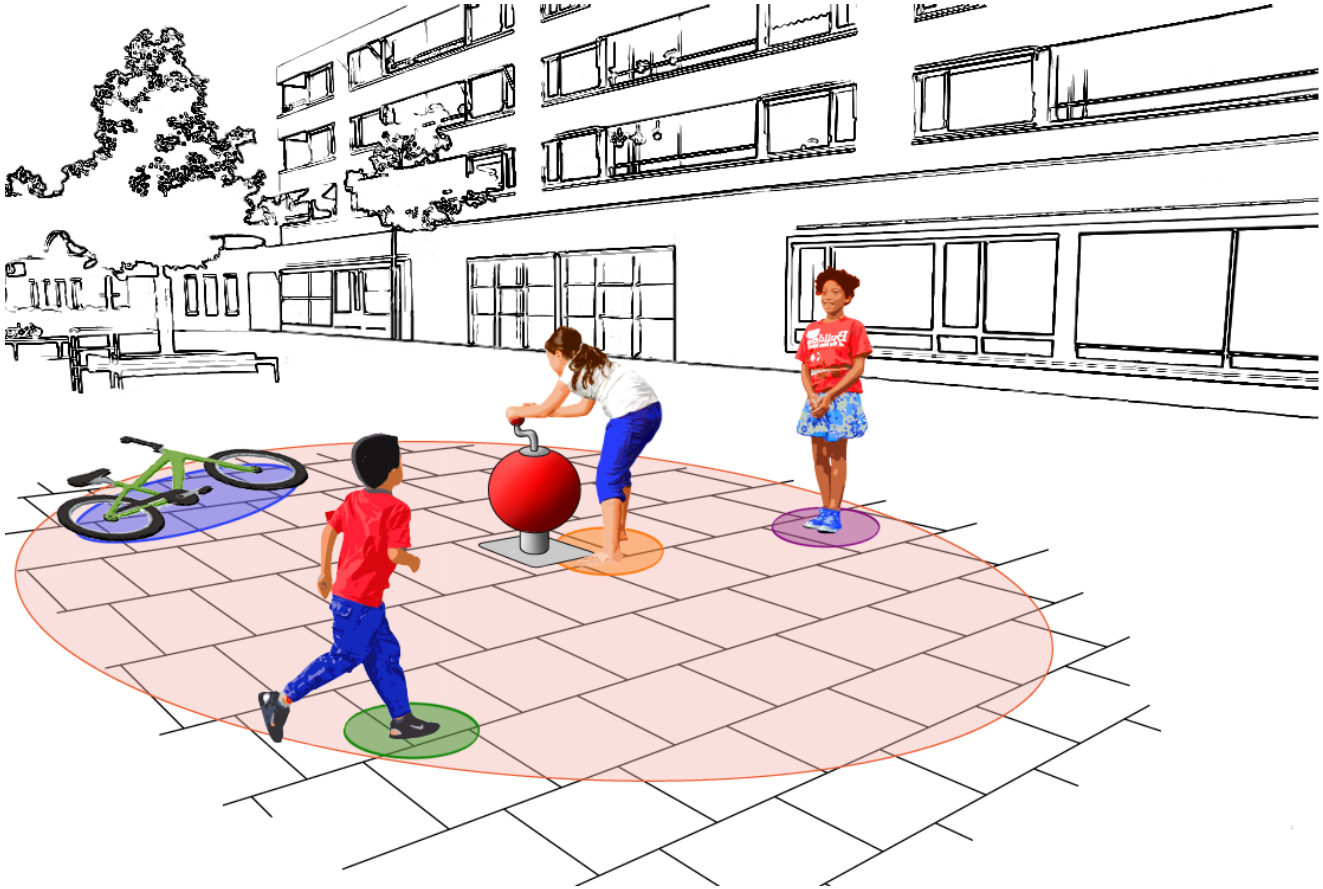


figure 3.58 Audiozone 3.0 concept representation

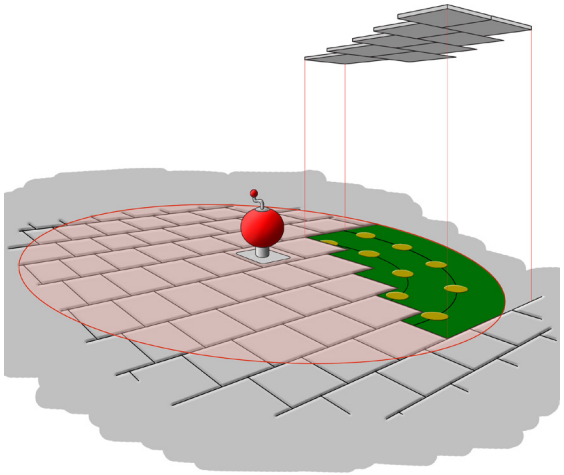


figure 3.59 Raster solution based on pavement tiles

Different solutions were explored to realise this concept. The first solution is illustrated in figure 3.59. A raster like zone is created, for example based on pavement tiles, and each point or pixel on the raster is included with a sensor or piezo-element. The sensor or piezo-element sends a signal to the centre console if a person is standing on it and it can also detect pressure changes, indicating movement (it could also make jumping an interesting form of input). The smaller the pixels or points in the zone, and thus the more sensors are included (a higher 'resolution'), the higher the accuracy of the concept and with it, the more options of interaction the concept offers to children. If this solution is impractical to realise, it can also be created in the form of lines with sensors instead of a complete zone, as illustrated in figure 3.61. Another possible solution is to use a camera-based system, where a camera determines the positions of people in the active concept zone. A clear disadvantage of such a system is that it is far less likely to be able to function without an external power supply.

All solutions can identify if people are standing or moving within the concept zone and can therefore be used to realise the Audiozone 3.0 concept. All solutions do not provide a way to detect which individual is standing or moving within the zone. In order to be able to detect that, technology such as RFID chips would be necessary. However, this is unwanted as it adds a barrier for children to start playing and does not allow passive participantion of people passing by. Therefore, each position within the zone, whether a point on the raster or detected through a camera, needs to provide a fixed input like a drum beat or guitar riff (while proximity of another point adds an effect to the combined input). With current insight, the solution based on the use of a raster and sensors/piezo-elements is advised. Using this solution,

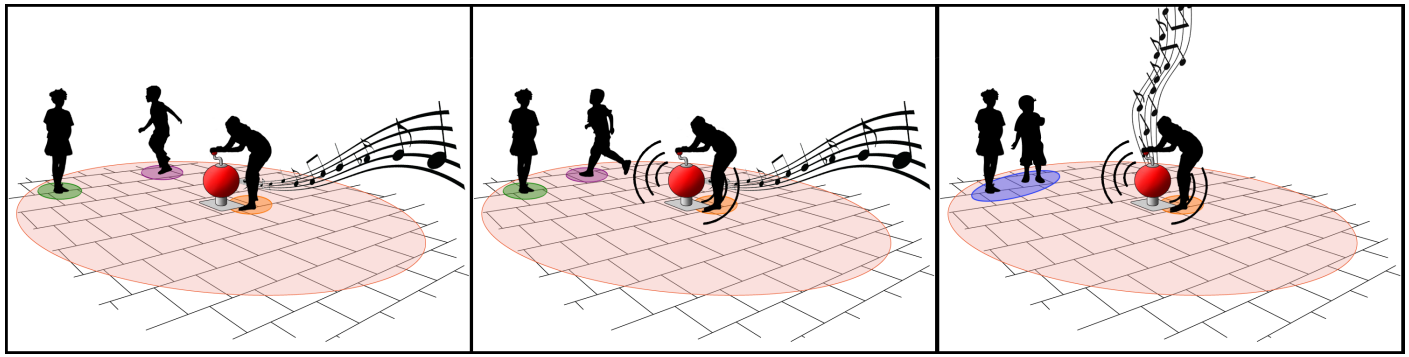


figure 3.60 Audiozone 3.0 user interaction

pressure can be included as having an additional effect on the input, stimulating jumping on the spot or to other points. Furthermore, using a raster based surface has the added potential of being able to easily show visible feedback on which areas are currently activated (like the circles seen below the children in all concept illustrations). The raster based system could be based on a simplified version of the Colour tiles concept. Moreover, if the energy generation of the Colour tiles system allows it, the Colour tiles concept could be incorporated entirely as modules for the Audiozone 3.0 concept.

For further development of this concept, the following recommendations are given:

- Further thinking and subsequently testing is needed to determine if the proposed raster based system functions as intended for this concept or if a camera based system is a better alternative.
- For both the raster and camera based system, the location of a person provides a fixed input, with an added effect upon proximity of another person. Therefore, a map of the active zone around the MusicBall should be created to visualise what the input of each position could be. Subsequently, tests should be conducted to experiment with the sound effects resulting from using the concept. Sound fragments from the Audiozone 2.0 can be used as a starting point in these tests.
- Adding the same timer to the electronics of the MusicBall as proposed at the Audiozone 2.0 to lower the output volume or turn off the volume completely at night could be considered.
- Similarly, adding different music modes for the concept as proposed for the Audiozone 2.0 could be considered.

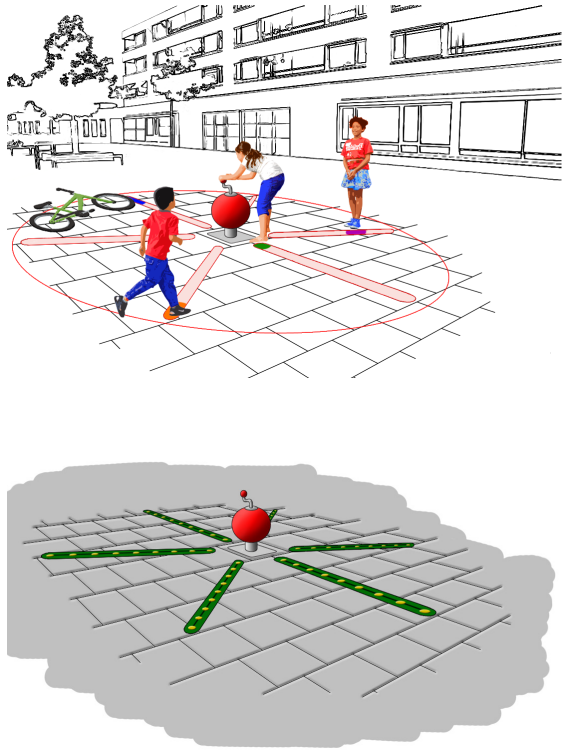


figure 3.61 Alternative concept realisation solution

	Concept 1: Jumpstone	Concept 2: Street instruments	Concept 3: Audiozone 2.0	Concept 4: Re-maze	Concept 5: Colour tiles	Concept 6: Audiozone 3.0
1. First and foremost, the interactive play sets that are to be designed should be fun	?	?	?	?	?	?
2. The interactive play sets should ideally stimulate open-ended play	?	?	?	?	?	?
3. Look for ways for children to manipulate the play sets	-	+/-	+	+	+	+
4. Stimulate children to play together, either actively or passively. Ideally the play sets should also support solitary play	+/-	+	+	+	+	+
5. To support intended use of a play set, include a way for children to feel the play in their bodies; a type of physical play	+/-	+/-	-	-	-	-
6. To support unintended use of a play set, thus spark creative use of the play set, use surfaces that children can exploit for their play creation	-	-	-	+	+	+/-
7. Enable multisensory experiences, in order to create rich and diverse play sets	+/-	+/-	+/-	+/-	-	+/-
8. Look for ways to stimulate movement and active play	+/-	+/-	-	+	+	+
9. Consider adding a physical challenge to the play sets	-	-	-	-	-	-
10. Do not deliberately add an educational goal to the play sets	+	+	+	+	+	+
11. Try to create play sets where children are not bound by games within a specific duration. Rather let the child play and decide for itself when the play is over; take away fixed time frames as a factor within the play set design	+	+	+	+	+	+
12. Specifically consider the cognitive side of play within the new play sets	+/-	+	+	+/-	+	+
13. Look for ways to exploit more space with the play sets. Ideally, the use of space should be adjustable	+	+/-	+	+	+	+
14. Look beyond formal play space (playgrounds) and find ways to incorporate play sets into informal play space or otherwise allocated public environment such as squares	+	+	+/-	-	+	+
15. Allow more expressive as well as more sober styling of the play sets. Ideally the play sets should be adjustable to suit both	+	+	+/-	+/-	-	+/-

table 3.1 Design guidelines implementation in each concept

Conclusion

Six concepts are presented that fit in the renewed Playnetic vision and are based on the fifteen design guidelines resulting from the research phase of the project. Especially the first few concepts stay close to the core products that Playnetic offers now by focussing on audio, while still offering open-ended play opportunities right from the first concept. Although all guidelines were taken into account while designing the concepts, not all guidelines are implemented in all concepts. As explained in chapter 1.8, the guidelines function as leads and sources of inspiration, not as product demands. To provide an overview of the concepts in regard to the applied design guidelines, table 3.1 shows if a design guideline is present within the concept in the range of not present (-), partly present (+/-) or present (+).

As the table shows, some guidelines are present in all concepts, some are present in a few concepts, but not all, while one guideline is not present in any of the concepts. No conclusions can be drawn on the first two guidelines. Creating conclusions on these would require tests. Based on insight gained throughout this project, it is however expected that all concepts follow these two guidelines.

As for the other guidelines, guideline #9, consider adding a physical challenge to the play sets, cannot be found in any of the concepts. While adding a physical challenge was considered, this guideline is contradicted by guideline #12 which states that especially the cognitive side of play should be considered in the new concepts. It is not impossible to combine the cognitive side of play with a physical challenge, but the entire design phase showed that the cognitive side of the play sets is more interesting in regard to interactive play sets and more fitting with Playnetic.

In line with the focus on the cognitive side of play in combination with guideline #2, to stimulate open-ended play, the guideline to support intended use of the play set (#5) is only partly present in the first two concepts in the form of stimulating jumping to trigger louder sound.

In turn, other guidelines are present in all concepts; the concepts should stimulate children playing together (#4), not add a deliberate educational goal (#10), not be bound by a specific time duration (#11) and look for ways to exploit more space (#13).

From the guidelines mentioned as present in all concepts, not adding a deliberate educational goal guideline (#10) needs additional explaining. The guideline was created based on the literature research, stating that if children are asked to play with an object, they do not perceive it as play, but as a chore. Similarly, if children understand that a clear educational goal is behind an action, they experience it as less fun. While designing, educational goals were therefore not included in any form. At the same time, if the concepts are looked at now, educational gains can be found in each concept. Besides that the same literature research concludes that play is development in itself and thus all concepts have educational purposes, the Audiozone 2.0 and 3.0 concepts as well as the Colour tiles concept for example allow children to understand the result of their actions; they learn cause and effect while playing with these concepts and develop their analytical skills through it. While educational goals were deliberately ignored in the design of the concepts, educational gains are present in all of them.

In addition to the guidelines, table 3.2 looks at how well each concept fits within the four future scenarios (chapter 1.7).

	Concept 1: Jumpstone	Concept 2: Street instruments	Concept 3: Audiozone 2.0	Concept 4: Re-maze	Concept 5: Colour tiles	Concept 6: Audiozone 3.0
Scenario 1: Spacious play	**+/-**	**+/-**	**+/-**	**+/-**	**+/-**	**+**
• Focus on the use of space	+	+/-	+	+	+	+
• Look for ways to incorporate or stimulate play in informal play space	+	+	+/-	-	+	+
• More sober design of play sets	+/-	+/-	+/-	-	-	+/-
• Look for ways to add to natural playgrounds, as these should be considered as a competitor	-	-	-	-	-	+/-
Scenario 2: Nature 2.0	**+**	**+/-**	**+/-**	**+/-**	**+**	**+**
• Focus on the use of space	+	+/-	+	+	+	+
• Look for ways that blend formal and informal play space	+	+	+/-	-	+	+
• Combination of sober and expressive design of play sets	+	+	+/-	+/-	-	+/-
• Combine nature and technology in natural playgrounds	+/-	-	-	-	+	+
Scenario 3: Techplaza	**+**	**+**	**+**	**+/-**	**+**	**+**
• Focus on efficient use of space	+	+	+	-	+	+
• Focus on formal play space or the possibility to incorporate play to otherwise allocated public space such as parks or squares	+	+	+	+	+	+
• Include persuasive design to stimulate children going to formal play areas	+	-	-	-	+	-
• More expressive design of play sets	+	+	+	+	+	+
Scenario 4: Segmented play	**+**	**+**	**+**	**+/-**	**+**	**+**
• Focus on efficient use of space	+	+	+	-	+	+
• Focus on formal play space or the possibility to incorporate play to otherwise allocated public space such as parks or squares	+	+	+	+	+	+
• Combination of sober and expressive design of play sets	+	+	+/-	+/-	-	+/-

table 3.2 Overview on how concepts fit within the scenarios

Overall, table 3.2 shows that the concepts fit decently well in the four future scenarios. From the concept perspective, it can be concluded that all of them have their place in the different public environments sketched within the scenarios. Only the Re-maze concept does not fit in one scenario, Spacious play, and only partly in the other scenarios. The foremost reason for this scenario fit is that the Re-maze concept focuses on the use of space and is most suitable for formal play space. The first two scenarios describe a situation where the focus should be on the use of space and on informal play space. In the last two scenarios, the focus should be on the efficient use of space and more on formal play space.

From the scenario point of view, it can be concluded that only the Audiozone 3.0 concept fits well within the Spacious play scenario. The other concepts only partly fit this scenario, except for the Re-maze concept. This can mostly be allocated to the concepts all being expressive in their styling and represented to create associations with technology. However, the scenario guidelines state that more sober styling and a focus on natural playgrounds should be applied. The fact that the concepts do not fit well in the Spacious play scenario is not a direct problem since the four scenarios can all become a reality at the same time. As an overall recommendation, if indications towards the future show that the Spacious play scenario becomes a reality and has a predominant position in the public environment, then the concepts should be assessed and adjusted to better fit within the scenario.

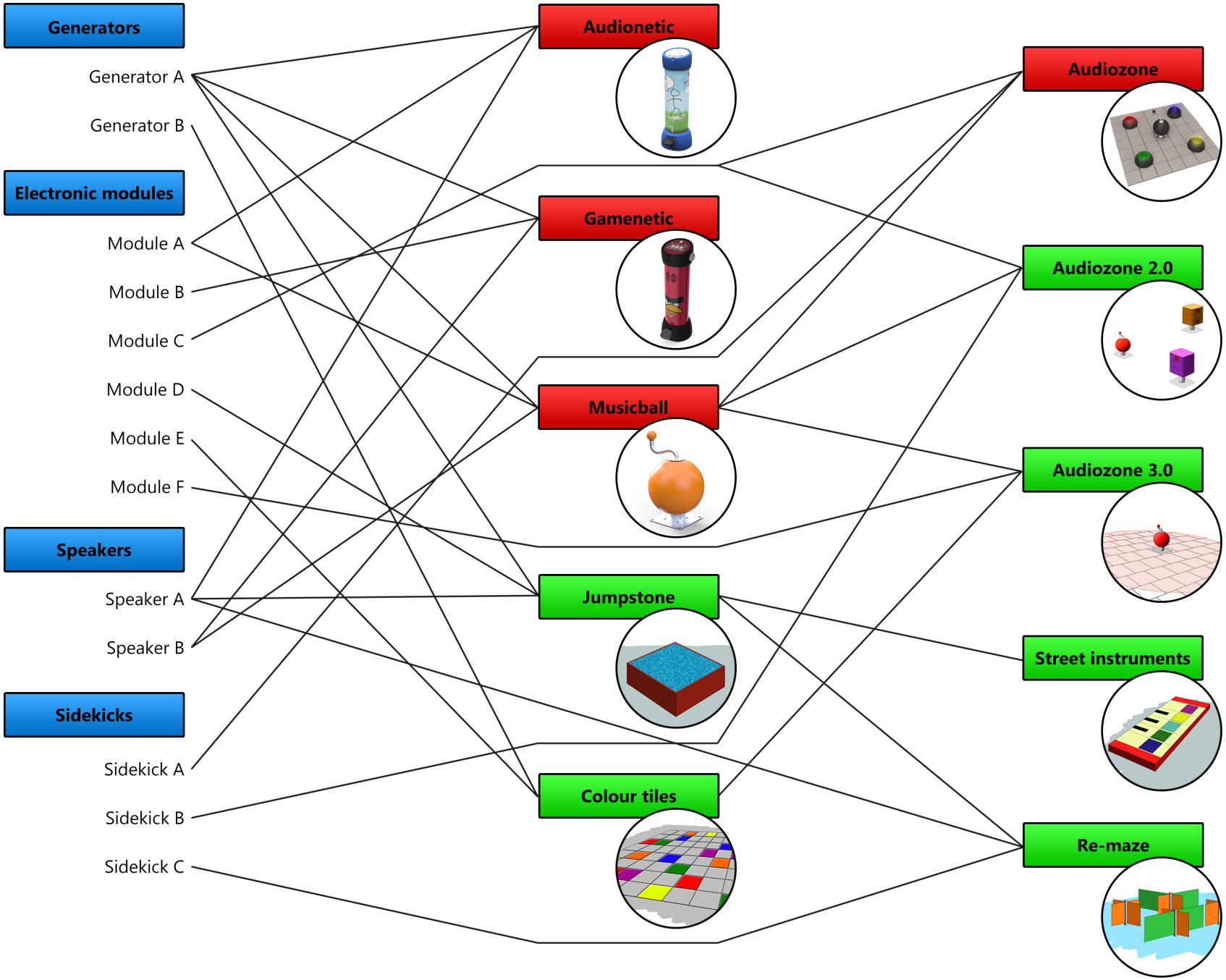


figure 3.62 Overview on Playnetic product platforms; modular use of products and components

3.5 Product platforms

Besides the disruptive imagery and TRIZ innovation techniques, one more innovation technique is included in the plan of approach: Platform Driven Product Development (Reinders et al, 2012). As stated in the plan of approach, one of the aims of the project is to establish new concepts, based on a modular approach.

Parts of products can be reused using modularity, from components and modules to technology. Applying modularity enables the creation of product families; sets of derivative products which can be developed and launched efficiently (Meyer & Lehnerd, 1997, p. 7). Reusing modules lowers costs as the modules can be produced in larger series, whilst knowing that the modules are used in future products, allows the modules to be designed with the future implementations in mind. Applying modularity and creating product platforms was kept in mind throughout the design process. A clear example is the use of Playnetic's MusicBall in two concepts. This chapter provides an overview of the modular approach and how components and products are reused in the concepts.

Figure 3.62 shows an overview of the entire Playnetic interactive play set product family based on the current products (red) and concepts (green) in relation to reused components (blue). The scheme is simplified in order to create a clear overview; more specific components could be included in the scheme. Figure 3.62 illustrates that a clear product family exists between the current products and future concepts; all concepts are linked to components of current products or use a complete product or concept as a component in itself.

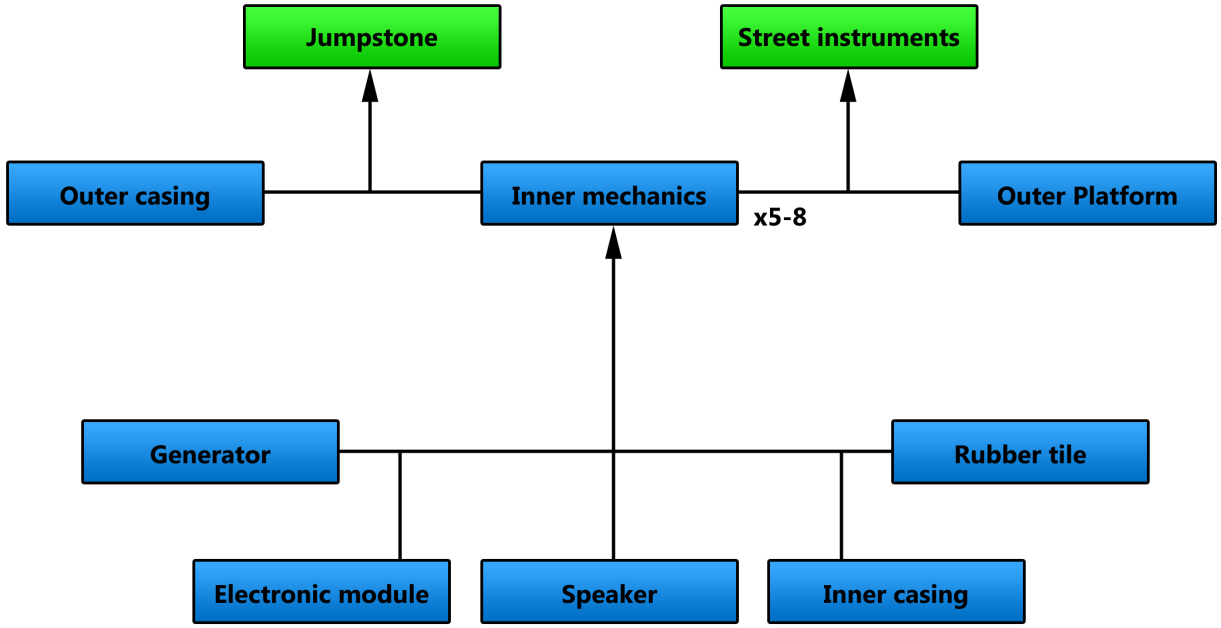


figure 3.63 Jumpstone and Street Instruments product platform

To provide more clear and more detailed examples, figures 3.63 and 3.64 illustrate the application of PDPD in relation to the Jumpstone concept and MusicBall product respectively.

As figure 3.63 illustrates, the Jumpstone and Street instruments concepts are based on the exact same inner mechanics. The Jumpstone combines one of these inner mechanics modules with an outer casing, while the Street instruments concept is five to eight of these modules in combination with an outer platform.

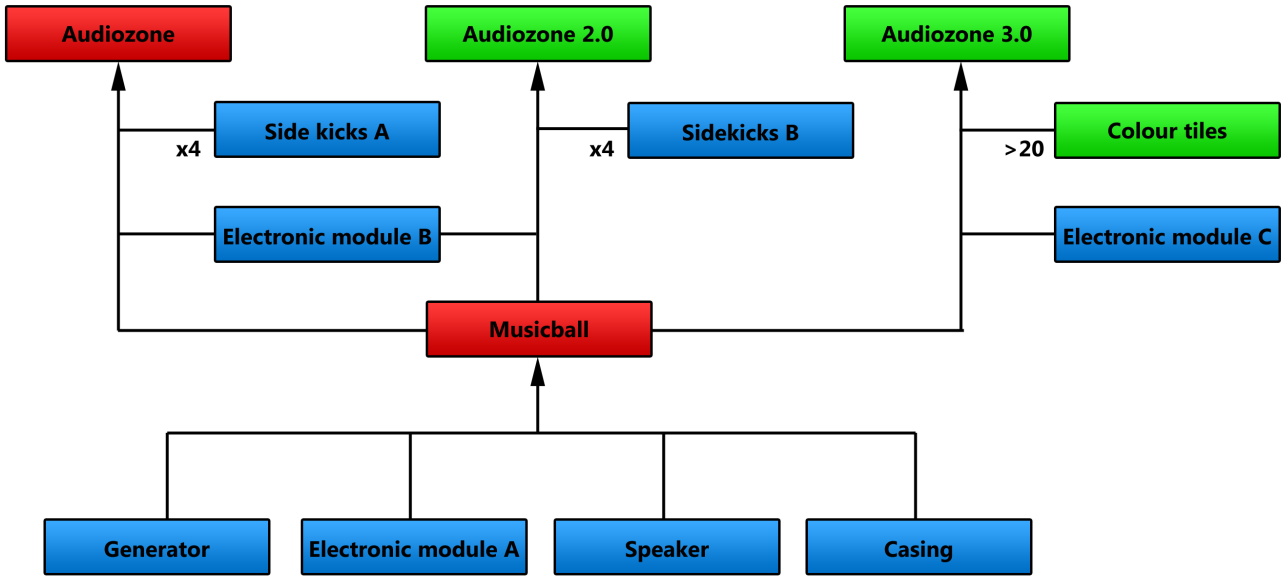


figure 3.64 Musicball product platform

Similarly to the Jumpstone and Street instruments concept, figure 3.64 illustrates how Playnetic's MusicBall is used as a modular component for the three Audiozones, the first Audiozone being the interactive game environment currently in development by Playnetic and the other two being the Audiozone 2.0 and 3.0 concepts. Each Audiozone requires one main component to be combined with the MusicBall, sidekicks for the Audiozone as well as Audiozone 2.0 and a simplified version of the Colour tiles (or a different solution to provide the necessary input for the concept to work, see chapter 3.4) for the Audiozone 3.0. The Audiozone requires a different electronic module to be placed in the MusicBall in order to function, but this module, combined with new software, is likely to fulfil the necessary functionality for the Audiozone 2.0 as well. The Audiozone 3.0 requires a different electronic module, simply to be able to connect to all the Colour tiles or equivalent mechanism and handle the input.

Overall it can be concluded that a high level of modularity is present throughout the Playnetic products and proposed concepts.

3.6 Roadmap

In support of the strategic side of the project goal, this chapter describes a roadmap on the introduction of the six concepts. This roadmap was envisioned as a step by step plan at the start of the design project. However, general developments at Playnetic during the entire design project showed that there are too many uncertainties regarding peripheral issues to create a detailed road map with clear milestones. Therefore, the roadmap described in this chapter serves as a guide for Playnetic in their sequential product development planning. Figure 3.65 provides a visualisation of the roadmap, indicating time windows when introduction of each concept should be pursued. The reasons for each concept's time windows are briefly elaborated.

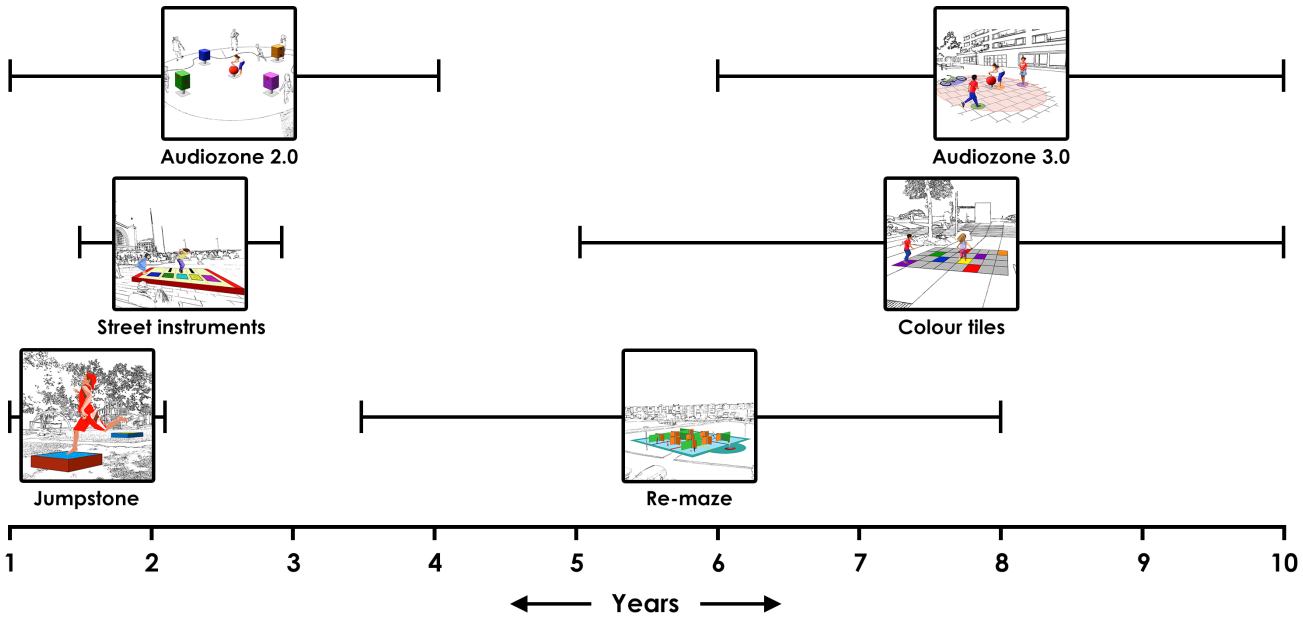


figure 3.65 Ten year roadmap

Jumpstone

The first concept to be introduced on the market is the Jumpstone. The Jumpstone can be developed and subsequently introduced within a short time-period, as a prototype is available (part 4 of this report) that provides a solid base to continue its development. The current prototype revealed one issue which should be corrected. Therefore, a new prototype should be designed, built, and tested. The development of a new prototype is expected to take a limited amount of time. The actual time until possible introduction of the Jumpstone depends mostly on two aspects:

- whether priority is given to the Jumpstone development and
- whether dealers can be found that are interested to add the Jumpstone to their portfolio.

Street instruments

As shown in figure 3.63 (chapter 3.5), the Street instruments concept is based on the use of the Jumpstone elements. Consequently, the Street instruments concept should be developed and introduced after the Jumpstone. This can be done shortly after the Jumpstone is in production, as the Street instruments concept requires no additional electronics to be developed. The only addition required is a platform to cover multiple Jumpstone elements. Therefore, the Street instruments concept can be developed and introduced shortly after the introduction of the Jumpstone. Alternatively, the introduction of the Street instruments concept could be planned later to first gain feedback on the Jumpstone and possibly improve the Jumpstone elements if problems are observed.

Audiozone 2.0

The Audiozone 2.0 is the third presented concept. However, it is not dependent on the Jumpstone or Street instruments concepts. Additionally, the Audiozone 2.0 is not dependent the Audiozone concept that is currently being developed either. Furthermore, the Audiozone 2.0 does not require any currently unavailable technology. Therefore in theory, the Audiozone 2.0 development can be initiated as soon as possible. However, it is advised to wait with the development of the Audiozone 2.0 until a substantial amount of feedback on the current Audiozone concept is available that can lead to improvements the user might want to see. Subsequently, this feedback can be used in the development phase of the Audiozone 2.0. While a relatively short time period is expected for the development of the Jumpstone and Street instruments concepts, this cannot be said for the Audiozone 2.0 concept. While the concept itself is relatively simple, it requires more complicated software and use of electronics than current Playnetic products. Developing this concept is therefore expected to consume a considerable amount of time.

Re-maze

Similar to the Audiozone 2.0, the Re-maze concept is not dependent on the development of other concepts. However, it is proposed to include one or multiple Jumpstones in the Re-maze environment. Developing and introducing the Re-maze concept should therefore take place after the Jumpstone and the Street instruments concepts are available on the market. Furthermore, it is advised that the Re-maze concept is not developed until Playnetic has more space available in its office building. The concept as presented takes up a considerable amount of space in storage, space which is not available at the current location.

Colour tiles

Although the development of the Colour tiles concept is not dependent on any of the other concepts, development and introduction of the concept should be planned for year five of this plan at the earliest. The main reason is technology; the proposed solution of electrochromic polymers is not a commercially available solution in the next few years. Whether it becomes a viable solution in the fifth or later year of this roadmap is unknown. The alternative solution of using two polarised filters can in theory be applied today. Research has to be conducted on these solutions. Regardless of the chosen solution, the Colour tiles concept requires an extensive amount of development time before it can be introduced to the market. Therefore, it is expected that the development of this concept is capital intensive in comparison to the other concepts. It is advised to take this capital intensive development into account as a variable when planning the development of the Colour tiles concept.

Audiozone 3.0

Although the name of the Audiozone 3.0 concept suggests otherwise, the concept is not dependent on the development of the Audiozone 2.0 concept. However, it can be dependent on the Colour tiles concept; one of the proposed solutions to create a raster projection around the Audiozone 3.0's centre console is the use of (simplified) Colour tiles as trigger points. If the Colour tiles are not used, the Audiozone 3.0 can be developed before the Colour tiles concept itself. The technology to create the Audiozone 3.0 concept is available today. However, developing the concept today would not enable the concept to be available within Playnetic's current price range. Therefore, the development and introduction of the Audiozone 3.0 should be planned for the last four years of the ten year roadmap, in anticipation of the required technology becoming affordable.

04 PROTOTYPE PHASE

The original plan of approach for the overall project (appendix A) states that the assignment goals are to create a future outlook of the public environment, a range of conceptual products and a roadmap to introduce these products over time. As it would be interesting to test one of the concepts, it was proposed to extend the project and create an experimental setup that could test the principles behind one of the concepts; do children find it fun, do they use it as intended or unintended and do they create their own play while incorporating the play set? Alternatively, Playnetic proposed to create a prototype of the Jumpstone concept and test it instead. It is a concept with similarities to a previous concept of Playnetic, thus knowledge was available to start the prototype design. The next chapters describe the creation of the Jumpstone prototype, both design and construction, and its evaluation.

4.1 Jumpstone detailing

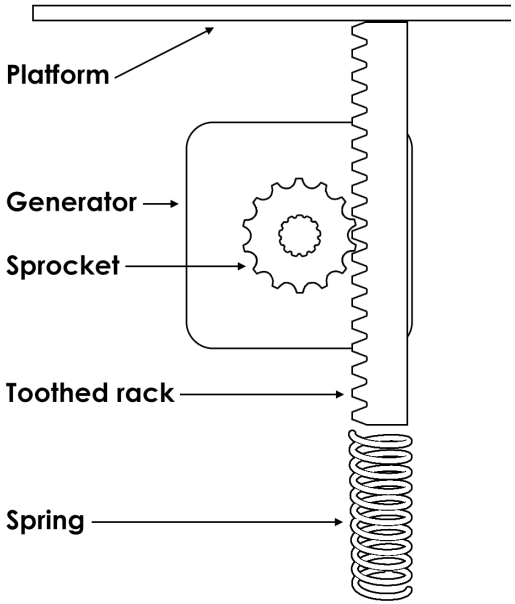


figure 4.1 Jumpstone power generation

Before describing the detailing process of the Jumpstone, it is important to state that the process was performed partly in parallel with the creation of the final concepts, as it would take time for all the parts to arrive and thus before the prototype could be constructed and subsequently tested.

A few starting points were chosen to engineer the Jumpstone. Firstly, the electric energy to play an audio fragment or a music note would be generated using the same generator found in the Audionetic, GameNetic and MusicBall in combination with a sprocket and a toothed rack placed vertically on a spring and attached to a jump platform (figure 4.1).

A second starting point was based on one of the recommendations for the Jumpstone: as the top surface should allow downwards settling, a solution should be engineered to sustain this movement and be able to generate electricity from it, without any outer parts performing any vertical translation where children might get their fingers stuck in between. To follow this recommendation, the entire concept is based around a rubber tile as the top surface, in particular the most commonly used rubber tile in playground design: 500 by 500 millimetres wide and 30 millimetres thick. Using a rubber tile makes the top platform flexible. Creating the Jumpstone around a rubber tile makes sure that there are no outer, reachable parts performing any vertical translation in relation to one another.

Lastly, the Jumpstone would be constructed using fabrication steel in the form of sheet metal and laser cutting was chosen as the fabrication method. Steel sheet is a relatively cheap type of material, while it can create a robust, vandal proof product. Additionally, laser cutting allows the creation of a puzzle like design of the Jumpstone, which simplifies the assembly of the prototype. The material properties of steel sheet as well as adjustments for the tolerances of laser

cutting were taken into account directly from the start of engineering the Jumpstone. The chosen thickness of the sheet metal was four millimetres.

With these three starting points defined, the design of the Jumpstone started. Firstly, a box was created, strengthened with an inner cross between the four outer side surfaces (figure 4.2). Additionally, the cross is positioned in such a way that it also functions as two sides for the square profile shape in the centre where the toothed rack and spring are placed and are able to perform vertical translation. Three more parts out of steel sheet material complete this square profile, while leaving an opening where the sprocket is placed and connects with the toothed rack. The inner cross is also used to attach the generator and electronic module.

On top of the box shape, a strip was added on all sides where the rubber tile can rest on. The rubber tile further rests on a platform connected to the toothed rack. By jumping on the middle of the rubber tile, the platform and toothed rack are pushed down, spinning the sprocket. When no pressure is executed on the rubber tile and platform, the spring placed below the toothed rack pushes the platform back up. This proposed a possible problem. During the overall graduation project, different broken components of other products passed by. One broken component which was observed multiple times was the drive belt in the Audionetic and GameNMetic frames which spins the generator. The drive belt is a thick rubber band with metal clasps attached to its ends. These clasps are also fabricated through laser cutting standard steel sheets. One of the reasons that the drive belts broke was that the metal clasps cut through the rubber band in use; the sides were sharp enough to cut into the band. Therefore, if the strip where the rubber tile rests on has a

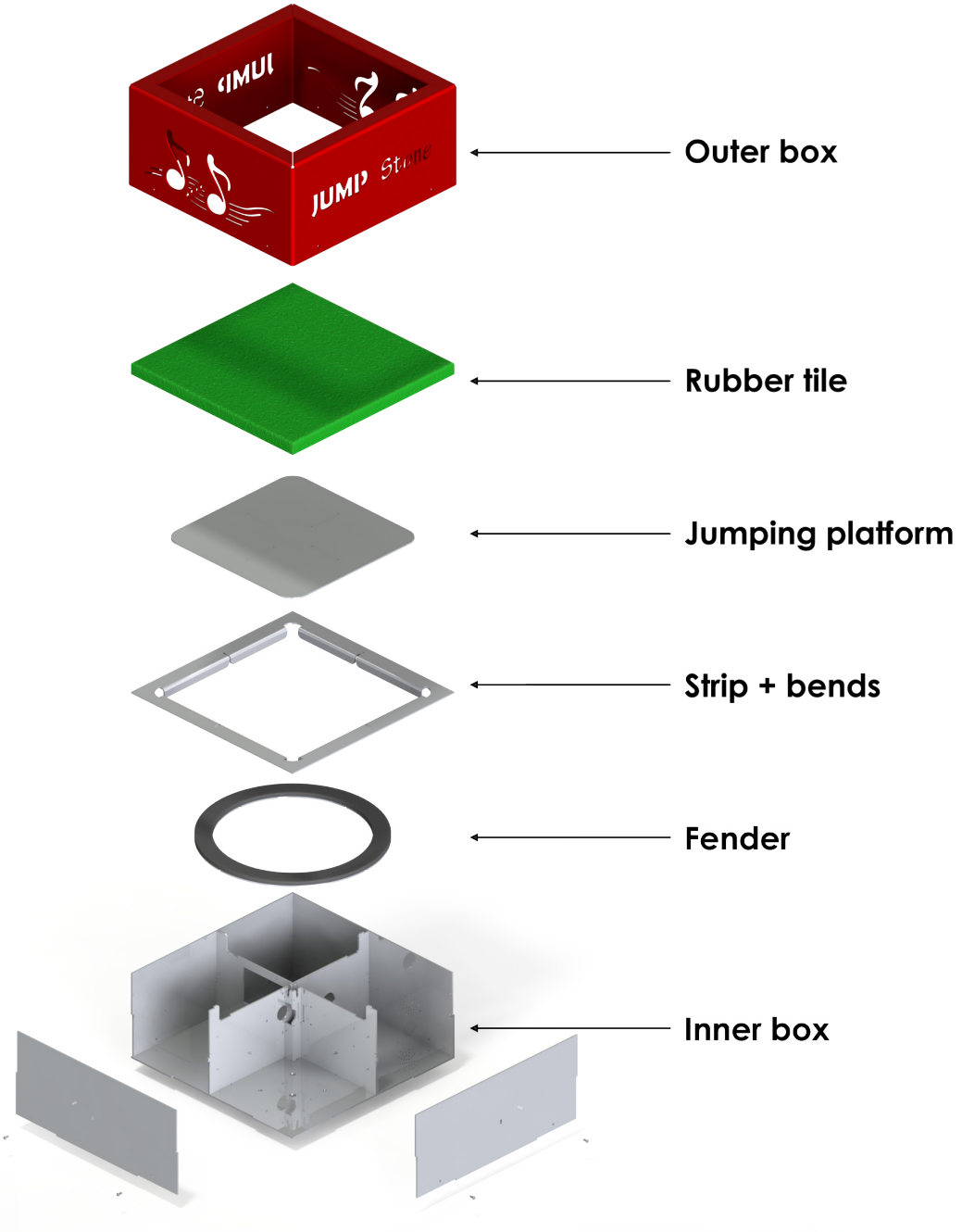


figure 4.2 Jumpstone construction

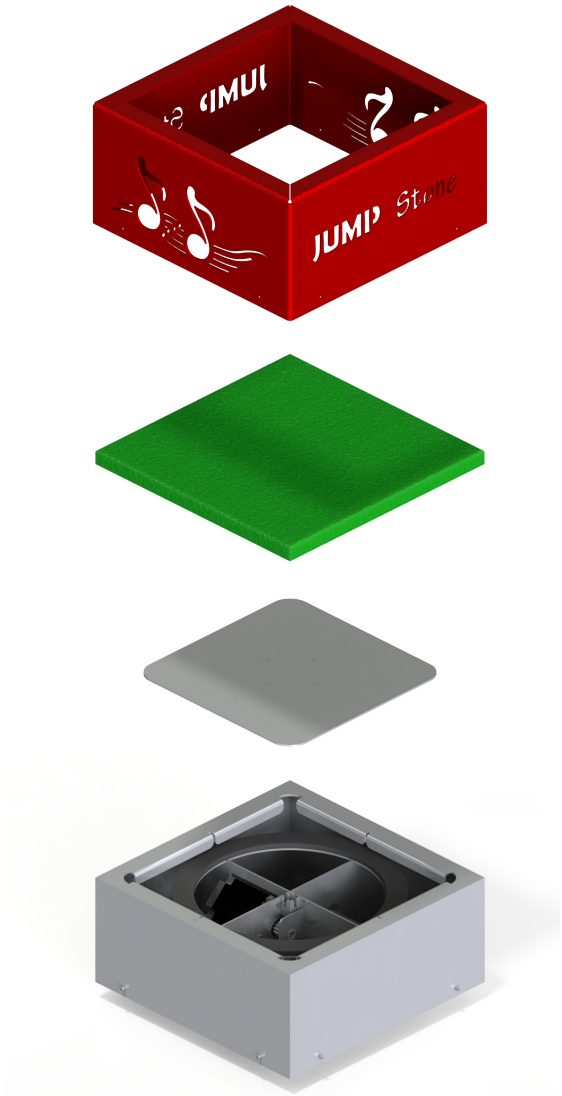


figure 4.3 Jumpstone's four major components after assembly

sharp 90 degrees edge, the rubber tile would be cut as well and eventually succumb to wear and tear (figure 4.4). As a solution, bends were added to the strip, visible in figures 4.2 and 4.3.

The next challenge was to fix the rubber tile on top of the box. Fixing a bolt through the rubber tile or some other solution where the rubber tile has to be pierced is not a solution as it would eventually cause the rubber tile to tear. Different solutions were explored, mostly looking at metal profiles which covered the rubber tile while keeping it fixed in its position. Eventually, another solution was created which offered additional advantages over using metal profiles. An outer box was created, completely covering the metal inner box and the rubber tile (figure 4.2). By placing an outer box over these components, the product gains double thickness side panels; it becomes more robust and thus more vandal proof. Secondly, if the outer box is coloured differently from the inner box, text and images cut out of the outer box become visible, something which is easy to create through laser cutting. The only downside of this solution is the extra use of materials, slightly increasing the costs. The outer box is created from two parts of sheet metal which are bent on the sides to remove sharp corners and subsequently welded together. It is fixed to the inner box with eight bolts and rests directly on the rubber tile.

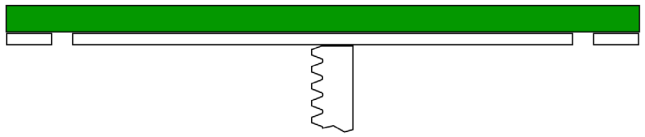
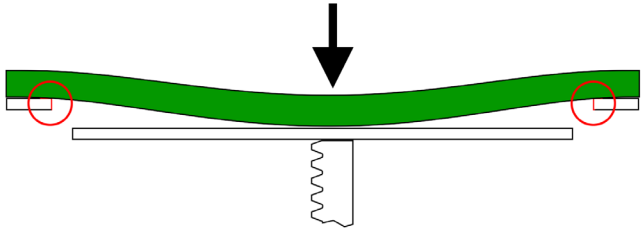


figure 4.4 Sharp edges on strip will cut into the rubber tile

Lastly, a fender was added inside the inner box. It is a metal ring with an open cell rubber foam ring on top of it, attached to the inner cross just below the jumping platform. The fender makes sure that when jumping on the Jumpstone, the platform does not hit any parts or compresses the spring to its minimal height. By adding a fender, the Jumpstone is more robust, has an increased stability in use and protects components such as the spring from wear and tear. In addition, as the top layer of the fender is made out of rubber foam, it acts as a sound dampener for the jumping platform.

After welding the Jumpstone together, four major parts remain: the inner box including all the electronics, the jumping platform, the rubber tile and the outer box (figure 4.3). To install the Jumpstone at a location, the inner box is bolted to the standard concrete base which Playnetic uses for its other products. Afterwards, the jumping platform is inserted into the inner box and the rubber tile is positioned on top of it. Lastly, the outer box is placed over the components and bolted to the inner box at the bottom.

Combined, the Jumpstone is an easy product to fabricate and assemble. The core of the product is created from steel sheet material through laser cutting. Three of the steel sheet components require additional bending operations (the two outer box pieces and the metal strip at the top of the inner



box). The electronic components such as the generator and speaker are the same components used in other Playnetic products. The electronic module is different from Playnetic's current products, it requires a new design, but is still housed in the same container as other electronic modules. However, the current electronic modules that Playnetic uses in the Audionetic can be used in the Jumpstone as well, but these do not support all the required functionality as explained in chapter 3.4. Holes to fix these electric components in the inner box are included in the laser cutting process. The sprocket and toothed rack are standardised parts which are used by Playnetic.

The setup of the product allows complete standardisation; while the Audionetic and GameNetic require USB drives to upload new audio files or software, the Jumpstone has an electronic module with all the necessary material and software pre-uploaded and includes switches to change the audio fragment. The inner box therefore is exactly the same for all Jumpstones, but by differentiating the colour of the outer box and the rubber tile, a range of different Jumpstone setups can be created (figure 4.6).

Appendix J provides a detailed exploded view of the Jumpstone design as well as technical drawings of its parts.

figure 4.5 Assembled Jumpstone

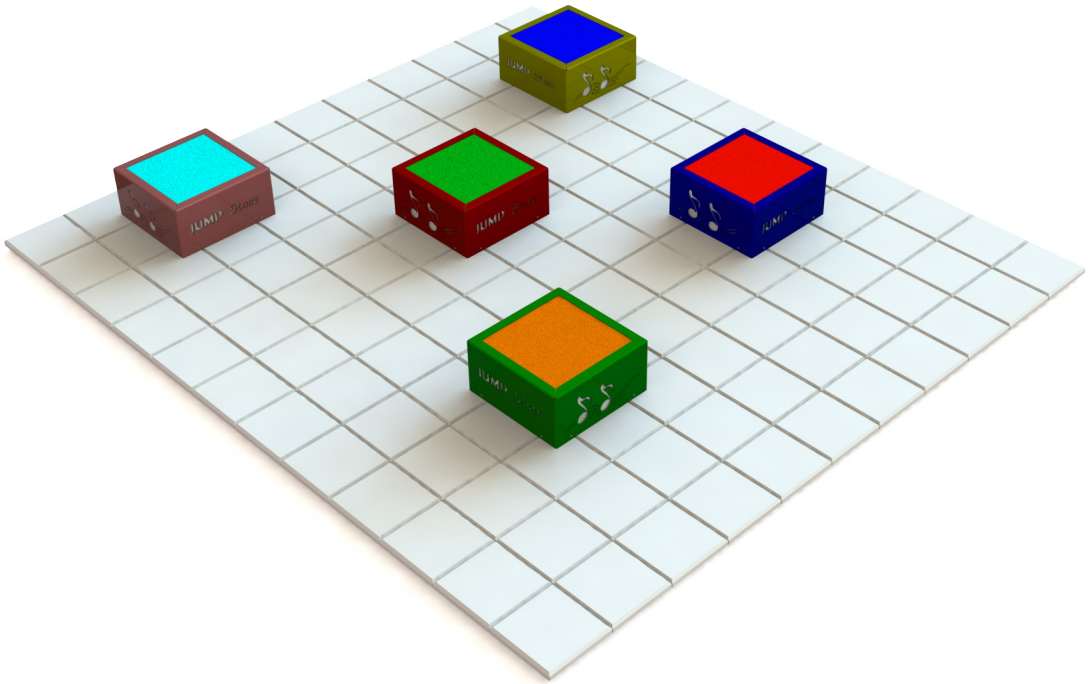


figure 4.6 Jumpstones in different colour styles

figure 4.7 Steel parts of the prototype

figure 4.8 Inner box assembled

4.2 Prototype construction

With the design of the Jumpstone finished, all the necessary parts were ordered and gathered. After the parts arrived, the entire set of components turned out to fit perfectly, no adjustment had to be made in order to create a working prototype.

With help at Playnetic, the prototype was assembled and welded together. In addition, the new electronic module providing the required functionality of the Jumpstone was designed by Playnetic's electro technician.

After the construction of the Jumpstone prototype was completed, one problem was spotted. The dimensions of the square profile which create the vertical shaft where the toothed rack and spring are placed in were based on a standardised steel profile. Although earlier tests showed otherwise, the created profile turned out to be too loose; the toothed rack had some rotational freedom within the vertical shaft. As a result, the top platform also had rotational freedom, meaning that the platform could twist and hit parts of the inner box, producing noise. To solve this issue, the platform shape was adjusted, from an overall rectangular shape to a curved shape based on two ellipses (visible in figure 4.8), preventing the sides from hitting the inner box during use. In addition, a guidance component was created and added to the platform; a V-shape component fabricated from steel sheet and placed over one of the sides of the cross inside the inner box, limiting the rotational freedom of the toothed rack and the attached platform. A thin rubber sheet was added to the inside of the guidance component, in order to dampen sound. The combination of the platform adjustment and the extra component solved the noise problem to an extent, but insufficiently.

To solve this issue for the tests, an alternative construction to generate the concept's energy was created. The jumping platform was replaced by a much smaller platform, shown in figure 4.9. This new platform was connected to a circular toothed rack instead of a toothed rack with a square profile. The functionality of the platform was not altered. Additionally, the sprocket was replaced by a rubber wheel. A thick rubber foam ring was placed directly beneath the new platform as sound dampener, also visible in figure 4.9. A wooden plank was added to support the rubber tile, placed directly on top of the construction, in case children would jump and miss the smaller platform. This construction did solve the noise production problem.

While the change of prototype's construction was mostly aimed to solve the noise production, the new jumping platform was deliberately placed higher to be able to generate more energy. The initial test of the prototype showed that the difference in sound output was barely noticeable, although

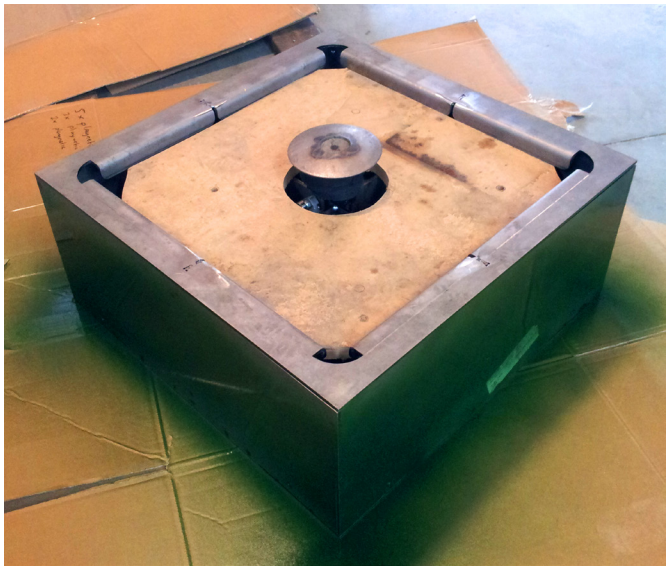


figure 4.9 Alternative prototype construction

the noise production interfered with this assessment. The construction change allowed the software on the electronic module to be adjusted, resulting in a higher maximum output volume.

Unfortunately, all these changes resulted in the evaluation of the prototype to be postponed until close to the project's deadline. As a result, only a single evaluation was executed.

4.3 Prototype evaluation

The Jumpstone prototype was constructed to be able to test one of the concepts. Do children find it fun? Do they use it to create their own play while incorporating the play set?

Therefore, when Playnetic conducted a photo shoot for a different product, the prototype was brought along and placed at an outdoor public environment. For the photo shoot, five children were gathered, ranging from the age of five to twelve. Four out of the five children were ten years or older. Therefore, the children who participated in the evaluation were not an optimal representation of Playnetic's target group. The children did not know that an evaluation of the Jumpstone concept would take place, nor had they seen the Jumpstone before. For the evaluation itself, there were clear instructions not to provide the children with play or game suggestions.

Although a single Jumpstone is imagined to function as a central point in a hide and seek game, the Jumpstone concept is based around the use of multiple Jumpstones at a location. Therefore, evaluating the single Jumpstone should be considered as a limited evaluation towards the use of the product, especially considering that the participating children were not an optimal representation of Playnetic's target group. Since the Jumpstone prototype also served as a technical prototype to test the construction and power generation, evaluating with only a single Jumpstone was unavoidable.

Nevertheless, it was expected that children would experiment with the Jumpstone during the evaluation. Subsequently, it was expected that children would create their own play and that they would incorporate the Jumpstone in that play.

Observations

The Jumpstone was first presented to a five year old child before the photo shoot at a different location. She first walked around the Jumpstone and investigated it. Afterwards, she stepped on the rubber tile and was surprised by the sound, an electric guitar chord, generated by the Jumpstone. After noticing the sound, she started to wiggle her body, moving up and down. Soon after, she jumped once on the Jumpstone. She subsequently started to continuously jump on the Jumpstone, creating a rhythmic sound, and continued this behaviour for a while.

For the planned part of the evaluation, the Jumpstone was placed at a test location; a skate park on the edge of a new built neighbourhood in Zutphen. After the other four children arrived, the five year old child immediately explained to the other children that they had to jump on the Jumpstone. The children looked intrigued and wasted no time to jump on the Jumpstone, interested in the effect it would produce. While the first child took careful jumps, the second child started to take high jumps and jumped with full force on the Jumpstone. Unfortunately, the children did not notice the higher output volume resulting from the higher jumps. All children took

figure 4.10 Location of the evaluation

figure 4.11 Child jumping

figure 4.12 Girl 'resuscitating' the Jumpstone

figure 4.13 Boy demonstrating 'resuscitation'

turns in experimenting with the Jumpstone. On occasions, a child was observed to simultaneously jump with the child jumping on the Jumpstone. Additionally, one child started to jump deliberately in mixed intervals, stating that he was jumping on 'Tsunami' (a popular radio song at the time of the evaluation) and other children joined in the beat by humming the song's tune.

After this play had calmed down, one boy said that the shape of the jumping platform reminded him of his first aid course. The mechanism change of the Jumpstone prototype caused the rubber tile to be slightly pushed up, creating a convex shape of the surface (visible in figure 4.11). Therefore, the shape reminded the boy of his resuscitation course. While explaining this association, one of the girls started to perform this resuscitation (figure 4.12). This led to the boy's statement that she was doing it wrong and to him showing how it should be done (figure 4.13).

After this first part of the evaluation, the Jumpstone was moved to a green area just next of the skate park. Before the Jumpstone was placed on the ground, one of the children suggested to run behind each other and to include the Jumpstone in their path. Without hesitation, the children followed this idea and started to simply run in a large circle, while continuously jumping on the Jumpstone. During this play, the children started to use the Jumpstone as if it was a trampoline; they tugged in their legs and started to jump as high as possible. Not much later, one of the boys combined a kick in his jump while a girl combined her jump with a pirouette. This evolution of their play continued for quite a while until one child said he was tired and stopped. The other children followed his example and stopped as well.

Since the children were not engaged with the Jumpstone at this point, they were asked what they thought of the Jumpstone. The four older children responded that they were intrigued by the Jumpstone and found it fun to play with the object now. However, they also stated that they thought the object would be more suitable for younger children. The younger child was too shy to respond, but seemingly enjoyed using the Jumpstone throughout the evaluation.

figure 4.14 Children incorporating the Jumpstone in a running game

Conclusion

Even though the evaluation was performed with only a single Jumpstone, it showed exactly what was expected. The children were intrigued by the Jumpstone and experimented with it. The example of children 'resuscitating' the Jumpstone showed that children use play objects in unintended ways; this type of use was not expected nor imagined during the design of the concept.

The children subsequently engaged in a play where they ran around in circles while including the Jumpstone in their path. This running game showed exactly what was expected; the children incorporated the Jumpstone in their play. Furthermore, the children's play behaviour was consistent with the play behaviour definitions from both Brown and Vaughan as well as Rubin, Fein, and Vandenberg as explained in chapter 1.2. Applying Brown and Vaughan's definition on the observed running game results in:

- Apparently purposeless: the children did not gain anything from this play. In fact, they were exhausting themselves.
- Voluntary: the running game was suggested by one child and the others followed; they chose to engage in it.
- Inherent attraction: the children seemed to thoroughly enjoy themselves during their running game. All taken photographs (for example figures 4.11 and 4.14) feature smiling children.
- Freedom from time: the children did not seem to be bothered with the time. In fact, after their running game was over, one child checked the time and stated that she should have already gone home.
- Diminished consciousness of self: while the children started to make their jumps more complex, some jumps looked funny or awkward and caused other children to laugh. However, the child performing these jump did not care and laughed with them.
- Improvisational potential: the addition of more complex jumps was seemingly irrelevant to the play, yet these were important for the children to perform.
- Continuation desire: the children only stopped because they were exhausted, they did not stop because they did not want to continue their play.

All in all, the evaluation was limited, but consistent with the expectations. It showed promising results towards the Jumpstone concept and provided Playnetic with extra stimulation to develop the Jumpstone into a product within a short time frame.

4.4 Prototype recommendations

Two design recommendations are given in regard to the Jumpstone prototype related to its functionality. These result from tests while constructing the prototype and from its evaluation.

Noise production

The noise production and the prototyped solution to this problem were evaluated and discussed. As a result, it is recommended to use a similar construction as the prototyped solution; a toothed rack with a circular profile and a larger version of the circular jumping platform. The sprocket or rubber wheel, depending on what the final design uses, should still keep the circular toothed rack aligned correctly. However, any rotational freedom is not even a problem if it does exist; the platform cannot hit any components as a result of the

figure 4.14 Child jumping on the Jumpstone

rotational freedom and therefore cannot produce noise. The jumping platform in the prototyped solution is however too small; the children noticed that they had to aim their jump to the middle of the platform. One child even mentioned that the prototype worked better when landing in the middle of the Jumpstone with one foot instead of two.

Output volume

The fact that the children did not notice the higher output volume resulting from the higher jumps was allocated to the prototype electronics. Adjustments were made to the levels of output volume throughout the construction of the prototype. However, the settings used during the prototype evaluation were unsatisfactory. These settings were chosen to be safe from the point of power generation; with these settings, the generated sound could always be heard for about one second. However, the evaluation also showed that more energy was generated by the Jumpstone than used by the electronics; at times the Jumpstone did not function after children repeatedly jumped on it. This was allocated to the capacitors being completely charged up; the output sound used less energy than the energy generated. Therefore, the maximum level of output volume can be pushed higher. In addition, lowering the minimum output volume for conservative triggers of the Jumpstone should create a larger, noticeable difference in output volumes during use.

05 OVERALL CONCLUSIONS

The purpose of this project was to develop a range of conceptual interactive play sets for Playnetic in order to be introduced between now and ten year's time. The range of these new concepts had to push Playnetic's interactive play sets to the next level of interactivity.

What the next level of interactivity would be was unknown at the time. Based on the extensive research phase, open-ended interactive play sets were defined as the next level. These interactive play sets should make it possible for the user to engage the play set in different ways and should make it possible for the user to choose how to engage the play set. Subsequently, this view was captured in a renewed vision statement for Playnetic. This vision statement therefore describes Playnetic's focus on open-ended interactive play sets towards the future; interactive play sets which can be used in various ways, for extended lengths of time and without a fixed use pattern. Furthermore, the vision statement expresses that this type of play sets should be simpler rather than complex and should be affordable. Lastly, the vision statement describes an outdoor public environment where there is no distinction between formal and informal play areas. The renewed vision statement provides Playnetic with direction towards their future product development.

The deliverables of the design project were defined as:

- A future outlook on the outdoor public environment with respect to playgrounds and its play sets
- A range of conceptual interactive play sets
- A roadmap on how to further develop and introduce these products over time

All three deliverables of the design project were realised. A future outlook was created, presented through future scenarios, looking ten years ahead in regard to play in the outdoor public environment. The future outlook serves as a reference point for Playnetic. It provides context for product development and the means to respond to developments in society.

Six conceptual interactive play sets were created in line with the renewed vision statement. Each of the concepts is developed and presented to the point where the functionality is known, where solutions to achieve the functionality are explored, where starting points for further development are stated and where the detailing phase of the design process for each concept can be started. Consequently, the presented conceptual interactive play sets can all be introduced in the next ten years. Besides providing Playnetic with concepts to develop, the concepts also serve as examples of products fitting within the renewed vision statement, therefore providing Playnetic with additional reference points.

Lastly, a roadmap was created in regard to the six conceptual interactive play sets. The roadmap advises on the time windows when introduction to the market of each concept should be pursued. Furthermore, the roadmap explains dependencies of each concept in regard to current Playnetic products and other concepts. The roadmap therefore serves as a guide, supporting Playnetic in their sequential product development planning.

As an added result not included in the original deliverables, a prototype of the Jumpstone concept was developed and constructed. The design of this prototype provides Playnetic with a solid foundation to continue and finalise the Jumpstone's design. Additionally, the evaluation of the prototype showed promising and satisfying results in regard to the use of the Jumpstone. The participating children used the Jumpstone in unintended and unexpected ways and showed all characteristics of play behaviour while incorporating the Jumpstone within their play. The evaluation provided Playnetic with extra stimulation to develop the Jumpstone into a product within a short time frame.

Discussion

The overall results of the project are very useful for Playnetic, but are not all set in stone. For example, the future scenarios are an exploration of the outdoor public environment in relation to play. However, there is always a level of uncertainty in regard to the future. It is likely that future developments follow similar but still differentiating directions as presented through the future scenarios, resulting in deviations of the scenarios. In case of alternative developments, the scenarios still provide Playnetic with reference points to easily and quickly respond to these developments.

The six conceptual interactive play sets provide Playnetic with concepts to develop and examples of products fitting within the renewed vision statement. Similar to the future outlook, these concepts should not be considered as final; an iterative process of designing and testing should be applied to develop these concepts into products. Furthermore, future developments determine if the Colour tiles and Audiozone 3.0 concepts become commercially viable when based on the solutions of electrochromic polymers and a large raster environment respectively. Therefore, simpler solutions are provided for these concepts, but tests are needed to find out if these solutions adequately fulfil the functionality of the concepts.

Similarly, the roadmap should be considered as a dynamic document. Hence, it is serves as a guide for Playnetic in their sequential product development planning. The roadmap advises time windows to introduce each concept of the market. Both controllable choices and uncontrollable developments, such as the technology behind the Colour tiles becoming affordable, determine if and when the concepts are developed and introduced to the market.

Lastly, it must be said that the evaluation was limited; only a single evaluation was executed and the participating children were not an optimal representation of Playnetic's target group. Furthermore, a single Jumpstone element was used in the evaluation, while the Jumpstone concept was created around the use of multiple Jumpstones at a location. Although the evaluation showed promising results, these should be considered as positive indications.

All in all, the results of the project provide Playnetic with direction, reference points and support towards the next ten years.

Recommendations

Several recommendations in regard to the concepts and the prototype are stated. Besides these design recommendations, one general recommendation can be given: test the concepts or the functionality of the concepts. While the concept ideas are based on extensive research and are thoroughly thought through, knowing is better than thinking. Therefore it is recommended to test the concepts and learn from their evaluation. Questions to answer in these tests are:

- How are children engaging the concept?
- Do children experience this use as fun?
- Do children understand how the concept works?
- Is this use consistent with the expected use?
- Do children use the play set in unexpected ways?
- Does the concept allow or support this unexpected use?

To answer these questions, it is recommended to present prototypes of concepts to children without providing them with any instructions on how to engage with it and to observe how they use the prototype. If possible, the children should not be informed that they are testing a concept beforehand. Furthermore, it is advised to remove any boundaries during these tests, such as a fixed time frame. In addition, it is recommended to perform these tests multiple times with children of different ages. Each individual test should include children of roughly the same age. Subsequently, observations of the children's use of the prototypes should provide qualitative insight into weaknesses and opportunities to solve and exploit within the concept design.

REFERENCES

Books & offline articles

Bekoff, M. (2001). Social play behaviour. Journal of consciousness studies, volume 8, no. 2, pages 81-90

Belle, D. (1989). Gender differences in children's social networks and supports. In Belle D. (Ed.), Children's social networks and social supports (pp. 173–188). John Wiley and Sons, Oxford, England

Bodrova, E., Leong, D.J. (2003). The importance of being playful. Education leadership, the first years of school, volume 60, no. 7, pages 50-53

Brown, S., Vaughan, C. (2010). Play: how it shapes the brain, opens the imagination, and invigorates the soul. United States of America, New York: Penguin Group

Eger, A.O. (2007). Evolutionaire Productontwikkeling. Boom Lemma Uitgevers, The Hague, the Netherlands.

Fitton, D., Read, J.C., Horton, M., Little, L., Toth, N., Guo, Y. (2012). Constructing the cool wall: a tool to explore teen meanings of cool. PsychNology Journal, no. 2, year 10, p. 141-162. University of Padova, Padova, Italy

Goleman, D. (2006). Emotional intelligence. United States of America, New York: Random House Publishing Group

Hewes, P. J. (2006). Let the children play: nature's answer to early learning. Canada, Montreal: Early Childhood Learning Knowledge Centre

Hughes, B. (2002). A playworker's taxonomy of play types, 2nd edition. United Kingdom, London: PlayLink.

Hughes, F. P. (2010). Children, play and development. 4th edition. United States of America, Thousand Oaks: SAGE Publications Inc.

Jones, E., Reynolds, G. (1992). The play's the thing: teachers' roles in children's play. United States of America, New York: Teachers College Press

Kalliala, M. 2006. Play culture in a changing world. United States of America, Columbus: The McGraw-Hill Companies

Kapferer, J.N., 2008. The New Strategic Brand Management. 4th ed. United Kingdom, London: Kogan Page Limited.

Klein Haneveld, J. (2001). Het belang van buitenspelen. Pharmaceutisch weekblad no. 48, year 136, The Hague, the Netherlands.

Meyer, M. H. & Lehnerd, A. P. (1997). The Power of Product Platforms: Building Value and Cost Leadership. New York, NY: Free Press.
NUSO (1973). Jaarverslag 1973. Utrecht, the Netherlands

Parten, M. (1932). Social participation among preschool children. Journal of Abnormal and Social Psychology. Volume 28, no. 3, pages 136–147. American Psychological Association, Washington D.C., United States of America

Pelligrini, A.D. (2010). The Oxford handbook of development of play. Oxford University Press, Oxford, United Kingdom

Reinders, A., Diehl, J.C., Brezet, H. (2012). The power of design: product innovation in sustainable energy technologies. John Wiley & Sons Ltd, Chichester, United Kingdom

Rubin, K. H., Fein, G. G., Vandenberg, B. (1983). Play. In E. M. Hetherington (Ed.), Handbook of child psychology, Vol. 4 (pp. 693–774). United States of America, New York: Wiley

Selten,P., Adriaanse, C., Becker, B. (1996). Af en toe met pa en moe, de speeltuinbeweging in Nederland 1900-1995. De Tijdstroom B.V., Utrecht, the Netherlands

Vandenberg, B. (1998). Real and not real: A vital developmental dichotomy. In O.N. Saracho & B. Spodek (Eds.), Multiple perspectives on play in early childhood education (pp. 295-305). United States of America, Albany: State University of New York Press

Internet

Akkerman, R. (2004). Beleidsnota speelvoorzieningen in de gemeente Tytsjerksteradiel. Retrieved on the 11th of June 2013 from http://www.t-diel.nl/document.php?m=19&fileid=109&f=62a5482a0354aef28df2297e75a0d41e&attachment=&c=459

Bergen, M. Van den (2002). De speelplaatsen van Aldo van Eyck. Retrieved on the 30th of January 2013 from http://www.archined.nl/nieuws/de-speelplaatsen-van-aldo-van-eyck/

Both, K., Bogaard, J. van den (2008). Buitenspelen is ook bewegen. Retrieved on the 12th of June 2013 from http://www.jenaplan.nl/cms/upload/docs/buitenspelen_is_bewegen.pdf

Bros, J. (2008). Speelruimteplan in de Hof van Twente. Retrieved on the 11th of June 2013 from http://www.hofvantwente.nl/fileadmin/files/docs/wonen_en_leven/plannen%20en%20projecten/Algemeen_Hof_van_Twente/Speelruimtebeleidsplan_HvT.pdf

Brown, S. (2008). Play is more than fun, it's vital. Retrieved on the 29th of February 2013 from http://www.ted.com/talks/stuart_brown_says_play_is_more_than_fun_it_s_vital.html

Brown, S. (2009). The wisdom of play. Page 10. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

CBS (2012). Grote verschillen in gemiddelde huishoudensgrootte per buurt in de vier grote steden. Retrieved on the 11th of June 2013 from http://www.cbs.nl/nl-NL/menu/themas/dossiers/nederland-regionaal/publicaties/artikelen/archief/2012/2012-bevolkingstrends-huishoudensgrootte-steden-art.htm

CBS Statline (2010). Overgewicht en ernstig overgewicht bij kinderen van 2 tot 20 jaar. Retrieved on the 24th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=70848ned&D1=a&D2=a&D3=0&D4=a&HDR=T&STB=G1,G2,G3&VW=T

CBS Statline (2013a). Bouwvergunningen naar bouwkosten, inhoud woning en projectgrootte. Retrieved on the 11th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=70171ned&D1=a&D2=a&D3=0&D4=a&HDR=G3&STB=G1,G2,T&VW=T

CBS Statline (2013b). Nieuwbouwwoningen; bouwvergunningen, gereedgekomen, 1995-2012. Retrieved on the 11th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=37548&D1=0,3-11,13-22&D2=0,128,317,609,690&D3=16,33,50,67,84,101,118,135,152,169,186,203,220,237,254,271,288,l&HDR=G2&STB=T,G1&VW=T

CBS Statline (2013c). Arbeidsdeelname; paren met en zonder minder- en meerderjarige kinderen . Retrieved on the 14th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=71854ned&D1=0-2,7,12,17,26&D2=a&D3=a&HDR=G2&STB=T,G1&VW=T

CBS Statline (2013d). Detailhandel; omzetontwikkeling, 2000 - 2012. Retrieved on the 14th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=72001ned&D1=a&D2=27&D3=a&HDR=G1,T&STB=G2&VW=T

CBS Statline (2013e). Motorvoertuigen; aantal voertuigen en autodichtheid per provincie. Retrieved on the 27th of June 2013 from http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=7374hvv&D1=0-3&D2=0&D3=a&HDR=G2&STB=G1,T&VW=T

Clemens, G.C. (2009). The wisdom of play. Page 6. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

CPB (2012). Juniraming 2012: de Nederlandse economie tot en met 2017, inclusief begrotingsakkoord 2013. Retrieved on the 12th of June 2013 from http://www.cpb.nl/sites/default/files/publicaties/download/cpb-policy-brief-2012-01-juniraming2012-economie-tm-2017-begrotingsakkoord2013.pdf

Eggink, W. (2011). Disruptive images: stimulating creative solutions by visualizing the design vision. Retrieved on the 14th of August 2013 from http://doc.utwente.nl/78409/1/110527_epde2011_DisruptiveImages.pdf

Elkind, D. (2009). The wisdom of play. Page 2. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

Enk-Wielemaker, I. Van (n.d.). Jonger beginnen met vioolspel past bij kinderen van nu. Retrieved on the 24th of June 2013 from http://www.adestra.eu/pdf/jonger_beginnen_met_viool.pdf

Ferrara, K., Hirsh-Pasek, K., Golinkhoff, R.M. (2009). The wisdom of play. Page 14. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

Geeve (2011). Openbare schoolpleinen moeten meer speelruimtes opleveren. Retrieved on the 11th of June 2013 from http://www.sportknowhowxl.nl/nieuwsberichten/5845

Gemeente Amersfoort (2011). Werkdocument aanpak speelvoorzieningen. Retrieved on the 11th of June 2013 from http://www.platformbuitenspelen.nl/files/Nota_Speelvoorzieningen_september2011.pdf

Gemeente Barendrecht (2013). Schoolpleinen in beheer gemeente. Retrieved on the 11th of June 2013 from http://www.barendrecht.nl/actueel/nieuws_43565/item/schoolpleinen-in-beheer-gemeente_33575.html

Gemeente Haarlemmermeer (2013). Spelen, sporten en ontmoeten in de buitenruimte. Retrieved on the 12th of June 2013 from http://www.haarlemmermeer.nl/Jeugd_en_onderwijs/Jeugd/Vrije_tijd/Spelen_sporten_en_ontmoeten_in_de_buitenruimte

Gemeente Leidschendam-Voorburg (2004). Geef ze de ruimte!. Retrieved on the 12th of June 2013 from http://www.leidschendam-voorburg.nl/public/download/speelrumteplan.pdf

Gemeente Vlaardingen (2012). Spelen in Vlaardingen. Retrieved on the 12th of June 2013 from http://www.vlaardingen.nl/download/200913460/_vers_200913461/cd/Speelruimteplan+2012.pdf

Grob, R. (2009). The wisdom of play. Page 18. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

Hofman, B. (n.d.). Speeltuincentrale. Retrieved on the 21st of January 2013 from http://www.groningerarchieven.nl/historie/stadsverhalen/gebeurtenissen/speeltuincentrale-ontstond-75-jaar-geleden-door-ons-belang

International Play Association (2009). Article 31 of the UN convention. Retrieved on the 4th of March from http://article31.ipaworld.org/fundamental-information/article-31-of-the-un-convention/

Jantje Beton (2012). Het openbare schoolplein volgens Jantje Beton. Retrieved on the 11th of June 2013 from http://www.platformbuitenspelen.nl/kennis/inrichting-en-ontwerp/het-openbare-schoolplein-volgens-jantje-beton.html

JSO (2013). Een natuurspeeltuin voor kinderen in Maassluis. Retrieved on the 11th of June 2013 from http://www.jso.nl/3/Actueel/Actueel-2013/Actueel-2013-Maart/Actueel-2013-Maart-Een-natuurspeeltuin-voor-kinderen-in-Maassluis.html

Keurmerkinstituut (n.d.). Warenwetbesluit Attractie- en speeltoestellen. Retrieved on the 27th of June 2013 from http://www.keurmerk.nl/NL/Keurmerkinstituut/Speelgelegenheden/Warenwetbesluit-Attractie-en-speeltoestellen

Kleuver, J. de, Abraham, M., Soomeren, P. van (2010). Buurtfunctie terug naar de speeltuin. Retrieved on the 12th of June 2013 from http://www.dsp-groep.nl/getFile.cfm?dir=rapport&file=14pvnuso_Buurtfunctie_terug_naar_de_speeltuin.pdf

Koert, R. van (2008). De Ruige Speelplek. Retrieved from the 4th of February 2013 from http://www.geheugenvanwest.nl/13907/nl/de-ruige-speelplek

Kompan (n.d.). Icon. Retrieved on the 20th of January 2014 from http://www.kompan.nl/media/465469/Icon.pdf

Koster, T. (2009). Monumentaal skatepark. Retrieved from the 5th of February 2013 from http://www.tacky.nl/skateboard/article/?id=103675

Lappset (2013). SmartUs Manual. Retrieved on the 5th of February 2013 from http://www.lappset.com/loader.aspx?id=94686205-0add-4878-b7f7-3607e5e72837

Lewis, R. (2009). The wisdom of play. Page 8. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

Mobiliteitsmuseum (n.d.). Massamotorisering. Retrieved on the 31st of January 2013 from http://www.mobiliteitsmuseum.nl/ont_massamotorisering.htm

NOS (2013a). DNB: 6-8 mrd bezuinigingen nodig. Retrieved on the 12th of June 2013 from http://nos.nl/artikel/516316-dnb-68-mrd-bezuinigingen-nodig.html

NOS (2013b). Rabobank: geen groei in 2014. Retrieved on the 12th of June 2013 from http://nos.nl/artikel/517164-rabobank-geen-groei-in-2014.html

NOS (2013c). Tablet vervangt schoolbord en krijt. Retrieved on the 12th of June 2013 from http://nos.nl/artikel/469551-tablet-vervangt-schoolbord-en-krijt.html

NSGK (2011). NSGK Project 'Samen Spelen' levert eerste toegankelijke speeltuin op. Retrieved on the 4th of February 2013 from http://www.nsgk.nl/actueel/nieuws/nsgk-project-samen-spelen-levert-eerste-toegankelijke-speeltuin-op

Oberon (2011). Jaarbericht brede scholen 2011. Retrieved on the 11th of June 2013 from http://www.oberon.eu/Beheer/DynamicMedia/publicaties/BS-jaarbericht2011.pdf

Opstal, M. van (2009). Een (te) vaak gemiste diagnose. Retrieved on the 24th of June 2013 from http://www.meandermedischcentrum.nl/files/5/6/2/7/4/Diagned.pdf

Oudenampsen (2009). Aldo van Eyck and the City as Playground. Retrieved on the 30th of January 2013 from http://www.flexmens.org/drupal/?q=Aldo_van_Eyck_and_the_City_as_Playground

Oxford Dictionaries (2013). Play. Retrieved on the 5th of March 2013 from http://oxforddictionaries.com/definition/english/play

Platform 31 (2008). Roep om meer speelruimte voor kinderen. Retrieved on the 11th of June 2013 from http://kennisbank.platform31.nl/pages/10281/Nieuws/Roep-om-meer-speelruimte-voor-kinderen.html

Platform 31 (n.d.). Betekenis van de openbare ruimte. Retrieved on the 12th of June 2013 from http://kennisbank.platform31.nl/pages/27824/Betekenis-van-de-openbare-ruimte.html

Playdale (2007). iPlay, intelligent play by Playdale. Retrieved on the 20th of January 2014 from http://www.playdale.co.uk/files/uploaded/iplaybrochure12.pdf

RAI vereniging (2013). Autoverkopen Nederland gedomineerd door kleine auto. Retrieved on the 27th of June 2013 from http://www.raivereniging.nl/actueel/press/2013-q1/20130219-autoverkopen-nederland-gedomineerd-door-kleine-auto.aspx

Reactable (n.d.). Change the way you think of music. reactable live! s4. Retrieved on the 25th of June 2013 from http://www.reactable.com/products/live/

Renault UK (2013). Renault Twizy. Retrieved on the 27th of June 2013 from http://www.renault.co.uk/cars/model/twizy/product.aspx

Reynolds, J.R., Argun, A.A., Schwendeman, I., Aubert, P., Welsh, D.M., Thompson, B.C., DuBois, C. J., Gaupp, C.L., Reeves, B.D., Grenier, C., Walczak, R., Hwang, J., Nikolou, M., Tanner, D.B. (2003). Electrochromic Polymers for Easily Processed Devices. Retrieved on the 19th of November 2013 from http://www.phys.ufl.edu/~tanner/PDFS/Reynolds03electrochemical-soc.pdf

Snel, N. (2010). Buitenspelen, kwaliteit van de speelomgeving in de eigen buurt. Retrieved on the 19th of April 2013 from http://www.jantjebeton.nl/wp-content/plugins/download-monitor/download.php?id=4

SP (2008). Voorstel van wet houdende regels met betrekking tot de bevordering van de aanleg en het behoud van buitenspeelruimte voor kinderen. Retrieved on the 11th of June 2013 from http://www.sp.nl/nieuws/kamernieuws/div/wetbuitenspeelruimte_MvT.stm

Staten Generaal (n.d.). Mensenrechten. Retrieved on the 30th of January 2013 from http://www.statengeneraaldigitaal.nl/themas/thema?document=mensenrechten

Stichting Mijn Kind Online (2013). Iene miene media: een onderzoek naar mediagebruik door kleine kinderen. Retrieved on the 14th of June 2013 from http://mijnkindonline.nl/sites/default/files/uploads/iene-miene-media.pdf

Teunissen, R. (2013). De toekomst van gamification in Nederland. Retrieved on the 24th of June 2013 from http://www.marketingfacts.nl/berichten/de-toekomst-van-gamification-in-nederland/

Valck, M. de (2013). Buiten spelen. Retrieved on the 14th of June 2013 from http://www.speelgoedadvies.nl/internet/blog/234-buiten-spelen.html

Valck, M. de (n.d.). De schijf van vijf. Retrieved on the 14th of June 2013 from http://www.speelgoedadvies.nl/kennismaking/de-schijf-van-vijf.html

VanBerlo (2011). UI+Interaction Trend Report '10-'11. Summary retrieved on the 25th of June 2013 from http://www.bluehaired.com/2011/01/360-ui-interaction-trend-report-this-baby-is-finally-done/

Vereniging van Nederlandse Gemeenten (2006). Oproep minister Dekker voor voldoende buitenspeelruimte. Retrieved on the 11th of June 2013 from http://www.vng.nl/onderwerpenindex/ruimte-en-wonen/nieuws/oproep-minister-dekker-voor-voldoende-buitenspeelruimte

Volkskrant (1997). Veel speeltuinen met sluiting bedreigd. Retrieved on the 1st of February 2013 from http://www.volkskrant.nl/vk/nl/2702/Reizen/archief/article/detail/507310/1997/01/16/Veel-speeltuinen-met-sluiting-bedreigd.dhtml?utm_source=scherm1&utm_medium=button&utm_campaign=Cookiecheck

VPRO (2010). Naar de Speeltuin!. Retrieved on the 29th of January 2013 from http://www.geschiedenis24.nl/andere-tijden/afleveringen/2010-2011/Naar-de-speeltuin.html

Wardle, F. (2009). The wisdom of play. Page 20. Retrieved on the 28th of February 2013 from http://www.communityplaythings.com/resources/articles/RoomPlanning/WisdomOfPlay.pdf

Yalp (2006). Yalp Sona. Retrieved on the 20th of January 2014 from http://www.yalp.nl/fjc_documents/dec2006leisure.pdf

Yalp (2011). Project in beeld: natuurlijk spelen in Den Haag. Retrieved on the 5th of February 2013 from http://www.yalp.nl/564-Project_in_beeld_natuurlijk_spelen_in_Den_Haag.html

Yalp (2011). Voetbalmuur Sutu. Retrieved on the 20th of January 2014 from http://www.yalp.nl/60-Voetbalmuur_Sutu.html

Zenlea, D., Lorio, J., Cumberford, R. (2010). Current Trends in Small Cars - Small is Big. Retrieved on the 27th of June 2013 from http://www.automobilemag.com/features/news/1004_current_trends_in_small_cars/viewall.html

Photo Material

AVO Speeltoestellen (2013). 08.11 Schommel 3,50 meter 4-Persoons. Retrieved on the 14th of February 2013 from http://www.avospeeltoestellen.eu/product/08-11-schommel-350-meter-4-persoons/

Bergen, M. van der (2002). Retrieved on the 14th of February 2013 from http://www.archined.nl/nieuws/de-speelplaatsen-van-aldo-van-eyck/

Blazer (1950). Kinderen in een schommel. Retrieved on the 14th of February 2013 from http://www.beeldbank.amsterdam.nl/beeldbank/weergave/record/?id=vol00030003_0_17_00000170

Derkink, T. (1979). Skate Park Hulsbeek. Retrieved on the 14th of February 2013 from http://www.tacky.nl/skateboard/article/?id=103675

Houtplezier (2010). Duo frame nestschommel – groep 3 tot 8. Retrieved on the 14th of February 2013 from http://houtplezier.wordpress.com/2010/04/28/duo-frame-nestschommel-groep-38-schommel/

Kerncollectie Fotografie (1899). Retrieved on the 14th of February 2013 from http://www.geheugenvannederland.nl/?/nl/items/VKM01:A131-28

Kids Playground Almere (2013). Retrieved on the 14th of February 2013 from http://www.vandaagopstap.nl/activiteiten/26343/Kids-Playground-Almere/

Koningsberger, V. (2012). Speelplaats ontworpen door Aldo van Eyck, jaren ‘60. Stadsarchief Amsterdam. Retrieved on the 14th of February 2013 from http://www.nieuwwestexpress.nl/8686/nl/speelplaats-ontworpen-door-aldo-van-eyck-jaren-60

Koert, R. Van (2008). De ruige speelplek. Retrieved on the 14th of February 2013 from http://www.geheugenvanwest.nl/13907/nl/de-ruige-speelplek

Kuijkens, L. (2011). Wipkippen. Retrieved on the 14th of February 2013 from http://www.geheugenvanwest.nl/15935/nl/wipkippen

Lappset (2013). Cloxx. Retrieved on the 14th of February 2013 from http://www.lappset.com/loader.aspx?id=0767dd1a-a609-4824-9250-0ebc598a6aa5

Lappset (2013). Angrybirds playground. Retrieved on the 14th of February 2013 from http://www.sureplay.com.au/images/AngryBirdsPlayground.jpg

Playnetic (2013). GameNetic. Retrieved on the 14th of February 2013 from http://www.gamenetic.nl/Zware_kwaliteit

Selten,P., Adriaanse, C., Becker, B. (1996). Af en toe met pa en moe, de speeltuinbeweging in Nederland 1900-1995. De Tijdstroom B.V., Utrecht, the Netherlands

SmartUs (2006). Retrieved on the 14th of February 2013 http://www.upgreengroup.com/upgreen/1349.html

Stege, M. der (1969). Retrieved on the 14th of February 2013 from http://www.vakantiekolonie.nl/fotopagina/fotopagina.htm

Unknown (2010). Lekker Krölleren & Mülleren. Retrieved on the 14th of February 2013 from http://selmasalo.wordpress.com/2011/08/02/lekker-krolleren-mulleren/

Utrecht in Woord en Beeld (1937). Retrieved on the 14th of February 2013 from http://www.hetutrechtsarchief.nl/collectie/beeldmateriaal/fotografische_documenten/1930-1940/98212

Wal, S. van der (2008). Jaren 60: Massamotorisering. Retrieved on the 14th of February 2013 from http://www.mobiliteitsmuseum.nl/ont_massamotorisering.htm

VPRO (2010). Naar de Speeltuin!. Retrieved on the 29th of January 2013 from http://www.geschiedenis24.nl/andere-tijden/afleveringen/2010-2011/Naar-de-speeltuin.html

Wibit (2013). Sports Park 60. Retrieved on the 14th of February 2013 from http://www.wibitsports.com/products/combinations/246/sports-park-60

Yalp (2010). Project in beeld: natuurlijk spelen in Den Haag. Retrieved on the 14th of February 2013 from http://www.yalp.nl/564-Project_in_beeld_natuurlijk_spelen_in_Den_Haag.html

Yalp (2013a). Sona Geluidsboog. Retrieved on the 14th of February 2013 from http://www.yalpinteractive.nl/fjc_images/959.sona_home-slider02.jpg

Yalp (2013b). Sutu Voetbalmuur. Retrieved on the 14th of February 2013 from http://www.yalp.nl/fjc_images/19434.interactieve-voetbalmuur.png