Guidelines to Design Interactive Open-ended Play Installations for Children Placed in a Free Play Environment

Gordon Tiemstra, Renée van den Berg, Tilde Bekker, Mark de Graaf
TU Eindhoven, Department of Industrial Design
P.O. Box 513, 5600 MB, Eindhoven
g.j.tiemstra@student.tue.nl, r.m.v.d.berg@student.tue.nl, m.m.bekker@tue.nl, m.j.d.graaf@tue.nl

ABSTRACT
In this paper we describe a study in which we examine how children play with an interactive open-ended play installation. The idea behind open-ended play solutions is that children can create their own game goals and rules. However, what design parameters help children in being able to do this? Challenges include how to get children started with creating games, and develop rules as they play, and how an interactive open-ended installation can be flexible in including different amounts of children and play objects. We processed the observations of children playing with SmartGoals (an open ended play installation) into a series of guidelines that can be used as inspiration for the design of future open-ended play installations.

Keywords
Open-ended play installations, free play environment, self-developing games, social interaction.

INTRODUCTION
Since the introduction of the first game console the market of interactive gaming has grown rapidly. In the last couple of years there has been an increasing variety of gamers, interactive games and ways to practice these. Play in general is considered to be important for the development of children (Piaget, 1962; Parten, 1932; ,Vygotsky, 1977). Although the negative effects (Gentile et al., 2004) of playing computer games are predominantly emphasized, several studies also mention specific benefits of gaming (Ferguson, 2007; Rauterberg, 2004;). Due to intensive research on different types of players, designers have become acquainted what the requirements are per group type and how these could be met within game designs. This development has resulted in very particular games for specific types of (young) players, making the need to be creative and develop own games of lower priority.

Over the last few years, different types of interactive games have emerged, resulting into the development of specific sub-groups of gamers. One of the most recently developed and relatively unexplored categories is referred to as *open-ended play*. In open-ended

Proceedings of DiGRA 2011 Conference: Think Design Play.

play, there are no predetermined game rules or objectives; it regards playing games that are not based upon predetermined game rules and predefined objectives; there is no goal set on forehand neither a fixed path of how this could be reached. The *openness* of the *game* comes to the fore by allowing players to create and define rules and goals themselves resulting into self developed games (Sturm et al., 2008). This openness could be facilitated by a game installation (that could either be analog or digital) by making its functionalities dynamic and interpretable in various ways according the imagination and creativity of its players; the open-ended play installation should offer opportunities that are to be filled in by its players (Bekker et al., 2010). The reason why open-ended play installations are coming up recently is because contemporary technologies offer the opportunity to develop qualitative solutions for complex systems, which an open-ended installation is due to its multi-functionalities and the requirement to live up to the players wishes. Since the open-ended play installations, and the interest people have for it, are recently coming up, its field is somewhat understudied and hence regards relatively much potential for investigations.

Because of the differences in the physical, cognitive, emotional and social development of children miscellaneous types of play behavior exist. The developed games and types of play behavior that result out of using an open-ended game installation is therefore very likely related to the age of children and their type of development. (Therrell, 2002) In the early ages [0-2 years old], children mainly explore their own capabilities and the capabilities of their environment. Since an open-ended play installation aims to trigger creativity and requires an amount of thinking in order to be used effectively it would be an unnecessary complex tool for this age category to play with. We have the notion that an open-ended play installation becomes increasingly interesting upward of 2–3 years old as from this age on children start becoming able to pretend play and develop the understanding that objects can represent more than what they merely look like; elementary characteristics to use an open-ended installation. Between being 3-5 years old the ability to practice imaginative play develops rapidly, making it that from the age of 6 children become able to think more complex and hence develop own games and rules into a certain level of depth, which might result in using the open-ended play installation more effectively by developing various types of games. As described by Therrell et al.: children who are in the age of 9-12 strongly develop their skills by practicing various types of sports and participating in other physical activities. Since these children transcend the level of their early childhood as well mentally as physically, games that previously used to be enjoyed become predictable and unchallenging. Therefore, children start looking for a new range of activities to challenge their increasingly developed motor and thinking skills. Instead of preferring predefined products and interactions these types of children look after raw materials to create their own worlds and develop ways to interact within. Children of this age enjoy a variety of activities at a more complex level of performance, making the open-ended play installation specifically interesting for them and hence form an interesting group to incorporate in the investigation.

Over the years extensive research has been conducted on play resulting in miscellaneous taxonomies of types of play. Brian Sutton-Smith describes nine categories of play in *Ambiguity of Play* (Sutton-Smith, 1997). Regarding his description open-ended play can be considered as a type of *subjective play* that is applicable if children use objects to support imaginative play. Through the children's imagination objects could have various representations and functions, e.g. the ball is now a 'piece of gold' or a 'fireball'. Through this imagination a blank play installation could be colored in various ways. For which counts that the more the imagination is triggered, the more colorful an

installation becomes. Therefore the imagination, and triggering it, is considered crucial for open-ended play in order to be perceived interesting. The second category of Sutton-Smith that is applicable to open-ended play is *playful behavior*. The open-ended play installation is designed to be played with, the *playful behavior* of children brings it to live and makes it meaningful. As there are no predefined rules neither preset games for the open-ended installation, the strength of the children's *playful behavior* should be relatively high in order to be motivated to play with the SmartGoals. A certain amount of energy is asked if playing, which the children see back in their enjoyment and freedom. The open-ended play objects are designed to challenge the children to involve the objects in their play and to create rules how to play with the objects. If combining the two previously described categories games will come to exist which are described in Sutton-Smith's *contest* category. This third category that is elementary for open-ended play is based upon the competitive play of games and sports, which of high importance for open-ended play in order to integrate a level of depth and keeping the installation continuously interesting and challenging. Another researcher who investigated in play is Fromberg (Fromberg, 1999) who describes in *The Early Childhood Curriculum*, that play is rule-governed, which is either implicitly or explicitly expressed. Implicit rules do not particularly focus on game rules, the rules function more as guidelines to integrate structure in the game. By giving a game a specific goal (e.g. the goal to score 3 goals to win), rules become explicit as well as the outlines of the game's structure. Defining both types of rules and find a combination between is essential for open-ended play to result in successful outbalanced play.

Investigation

Recent research in the field of open-ended play (Bekker et al., 2010) has investigated the different types of play behavior that emerges among children, the creativity of children while playing games and how the lack of rules influences the social behavior of children while playing games. However, so far the investigations took place in environments in which the *open-ended play installation* was the only object and thus the only point of attention. Although valuable results are offered, contemporary research does not illustrate how these installations are related to 'ordinary' interactive play facilities that are based on predetermined rules and goals. The investigations limit themselves to merely *open-ended play* and do not take the bigger perspective into account of positioning it in a *free play* context. A free play context is an environment in which a number of game opportunities are available to play with. In addition, in such environment children are able to make decisions themselves what they choose to play with, for how long and with whom. By offering children more opportunities to play with insights could be obtained about how an open-ended play installation relates to ordinary installations regarding what its promising and missing aspects are to be considered more/equally interesting as the ordinary.

This paper presents the set-up and results of a study that examines players' behavior with an open-ended installation that is placed in a free play environment (i.e. being able to choose between different play installations). The conducted research continues where others stopped, as it takes open-ended play to a less-artificial context. We examine types of play behavior that emerge if playing with an open-ended play installation placed in a free play environment and deduce design guidelines. Similar to the description of Korhonen (Korhonen et al., 2009), the main purpose of the playful experience research is to understand what aspects (design qualities) constitute the enjoyment of using an open-ended game, what kinds of experience (observations) the open-ended game can elicit and how to design something that elicits a certain experience (guidelines). This outcome keynotes what the future perspective of open ended play installations could be, how the

two (*open-ended* and *normal)* could compete, or strengthen, each other and what has to be taken into account to reach this. The objective of this paper is to share our insights that are to be interpreted as inspiration for future developments in the field of open-ended play installations.

RELATED WORK; OPEN-ENDED GAMES

The motivation to conduct this investigation resulted out of existing research on interactive games and open-ended games. In this section a selection of existing projects are described.

The first example is the Morels (Iguchi et al., 2006). The Morels are play objects that allow for a variety of physical interaction. The play objects are able to detect different players and by "charging" a Morel and transferring this "energy" to Morels that are close-by, they launch themselves. The Morels give audial feedback, e.g. if charging and when other Morels are near. For this investigation the play with the objects has been observed, through several user tests in various play conditions (e.g. differences in age, amount of players). The study indicates that the players were able to develop different types of games with the Morels.

The Interactive Pathway (Seitinger et al., 2006) is a different example of an open-ended game. The installation exists of two pathways in which sensors are integrated, making it that objects can turn at both sides of the pathways. Even with this relatively simple type of interacting children were able to use their fantasy to create different games and playful scenarios.

The work of Bekker and colleagues gives examples of playful and social interaction through open-ended games. One of the first projects was with the LEDball (Sturm et al., 2008). The LEDball is an object that through shaking or rolling changes its color. A follow-up study has been done with the ColourFlare (Op't Hof, 2010). These objects regard more interaction possibilities, with the likelihood that the created games are more elaborated. Besides the change in color by movement, the objects are connected wirelessly and react upon each other according certain types of behavior. Also in this case there are no predefined games and game rules. The user tests of both projects, in which the playful objects were the only point of attention, showed how these open-ended games allow children to create their own games and support social interaction.

A third example that relates to open-ended games is the Jogo (Creighton, 2010). The Jogo is based on free play. The Jogo is a platform with different colored Ping-Pong balls and by placing them on a platform, music is given as feedback. The aim of the design was to observe how a physical playful experience could stimulate free play and social interaction. Observations illustrate that children of all ages are attracted to the Jogo. The natural playful affordance of the balls and the use of color encouraged them to playful behavior. The colors and sounds provide the children, apart from opportunities for explorative play, also possibilities to create other games. This project illustrates an example of free play and social interaction, rather than encouraging children to create games with self-developed rules.

STUDY SET UP

In order to formulate guidelines to be used for the design of future open-ended installations a contemporary open-ended installation, the SmartGoals, was placed in a free play environment and observed while being used by several groups of children. This

free play environment was created by three ordinary play installations that differed from the SmartGoals in terms of openness as their games were predefined and could not be changed on the spot. By placing the SmartGoals in such environment a context was created in which children had the free choice to start or stop playing with the SmartGoals and motivate their decisions.

SmartGoals

For the study, an open-ended play installation that includes interactive elements was required. Such installations are not commercially available. Instead, an existing research prototype, the SmartGoals, was used. The SmartGoals (de Graaf et al., 2009), originally designed as a training tool for football players, are six interactive small goals (see Figure 1) with a light on each of the poles. The lights, which are embedded in the poles, are interactive and respond on objects (or persons) that are passed through the goal. All goals communicate with each other, making it that if an object is passed through a goal its lights will turn off and another goal will light up; an infinite process without start or end.

The combination of an existing play environment enriched with a SmartGoal system was expected to facilitate interactive, open-ended play. The SmartGoals allow to be used in miscellaneous ways triggering creativity and improvisation. Furthermore, it included such a level of interactivity and professional design that it could be integrated in an ordinary play installation and not having the children becoming biased beforehand.

Figure 1: SmartGoals

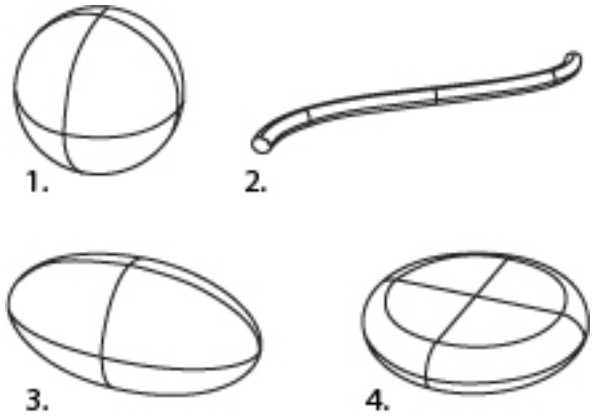

Figure 2: Play objects made of foam
1. Ball 2. Tube 3. Oval ball 4. Frisbee

Besides the SmartGoals, objects were provided that could be used to interact with the SmartGoals (see Figure 2). The assumption was that all the objects would trigger different play behavior, interaction with the SmartGoals and possibly different types of interaction between the players.

Game Installations

As the study should be conducted in a free play environment, a number of ordinary game installations had to be located next to the SmartGoals. The game installations had to contain equal qualities as the SmartGoals in terms of interactivity, game play and play intensity in order to have a series of game installations that could be considered as the same category. A number of three other installations were chosen as the amount of children and the number of possible players should match; the Nintendo Wii, Swinx and CosmicCatch.

Nintendo Wii

The Nintendo Wii is a video game platform that includes controllers that are position and motion sensitive. Activity, and often collaboration with other players, is required to play predefined games.

Swinx

Swinx is a game platform developed to support (authentic) outdoor games, such as hide and seek. All players use a bracelet that communicates with the Swinx-console making it aware of their behavior. Swinx includes a number of interactive games for which physical activity is required to be played.

CosmicCatch

The CosmicCatch is an interactive ball that provides rules how games should be played and through an integrated voice explains to whom, and how, the ball should be thrown. Playing the games requires physical activity combined with effectively processing the information provided by the CosmicCatch.

Participants

The test sessions were conducted during the gym lessons of five different groups all from the same primary school in Eindhoven (see Figure 3) (1x class 5, 2x class 6, 1x class 7, 1x class 8). The motivation to test five different groups is because differences between

the groups could be captured relatively well and would provide a general overview of behaviors the installation triggers. Next to this, with five sessions the focus on qualitative information would remain. We decided upon taking the selected groups as test subjects as we assumed children in the age of 9-12 would provide most information on playing with an open-ended play installation since they are in possession of the specific characteristics to effectively use an open-ended play installation and thus provide valuable and complete information, as described in this paper's introduction. During the gym class a selection of each group participated in the test while others took part in their ordinary gym class. Each selection consisted of 10 children, which were randomly picked. In total five sessions were held, each session within a group of which all children were familiar with each other, making communicating smoother. All children who participated were familiar with the Nintendo Wii but unfamiliar with the Swinx, CosmicCatch and SmartGoals.

Figure 3: Children interacting with the SmartGoals

Procedure

The sessions started by one of us introducing all the game installations and the explanation of a few rules that were needed to integrate a certain degree of structure in the sessions. The SmartGoals were introduced as a new game installation that they were free to use. In addition, the combination of the SmartGoals and its objects was explained by showing a possible type of interaction, showing that it was completely open how they would use them. After the introduction the children were allowed to play with all four game installations for 40 minutes. During these 40 minutes children had the possibility to decide themselves which game installations they wanted to play with and for how long. Via this way the decision to play with the SmartGoals or not was left up to them making their motivations more valuable.

For two installations the amount of players was fixed (Nintendo Wii, Swinx) but to assure that all children could play, and did not have to wait, a maximum amount of players was defined. In total 12 play spots were provided for 10 players, providing the opportunity to always change to another game. By having relatively small groups (3/4 persons) the occurring situations around the game installations would be controllable as well as observable. Finally, the small groups allowed for quicker identification of certain types of social behavior and emerging play patterns.

Physical Set up

All sessions were held in a sports hall in which the game installations were placed, all having enough space to be function properly. Three SmartGoals were used that were randomly placed in the environment and were allowed to be replaced by the players. In two corners of the area in which the SmartGoals were placed two cameras were positioned to capture the sessions. These cameras were of such size and placed in the environment in such way that they did not intrude the games neither be strongly present in the field. By entering the game area, children paid attention to the cameras for a number of minutes after which it was considered as part of the lesson and decreased as point of attention. Next to this, we, the facilitators of the sessions, were walking around in the sports hall to help children wherever needed (to a certain extend that helping them creating games for the SmartGoals was avoided).

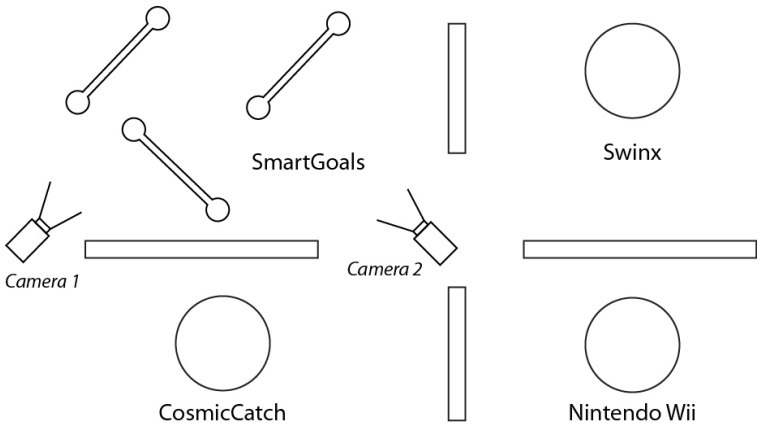

Figure 4: Map of set up of the installations

Pilot Test

Prior to the main study, two pilot sessions were performed at E-fitzone, Eindhoven. In this center a number of interactive game installations are located as an alternative for ordinary gym classes. During the pilot session the SmartGoals were placed between the other game installations.

The outcome of the pilot sessions provided insights in the way the SmartGoals should be presented towards the children in order to receive as much as valuable information. Most interesting was the placement of the goals, which seemed to influence the creativity of the children as some placements reminded them of existing games, such as football, having a negative influence on their creativity. Another important insight was the manner the SmartGoals should be presented towards the children. During the pilot sessions they were introduced as prior football training tool, resulting in children coming up with merely football related games. In order to let the children create games from scratch no input, or information, about the goals should be provided than merely how they function. Finally, some of the objects seemed to trigger 'aggression' and inappropriate collaboration between the children, which was avoided for the main study by choosing the objects that were smaller and lighter.

Observations
Besides the decision to capture all the final test sessions on video, the session leaders also noted valuable observations down. These observations could be categorized as events that frequently occurred, important situations that could not be captured by cam (such as whispering, discussions out of the area, etcetera), etcetera. All observations that were made were later on processed together with the results of the video analysis and the questionnaire.

Questionnaire
Once the sessions were finished all players were asked to fill in a questionnaire. This questionnaire was structured in two parts, each with a specific interest. In the first part open questions were asked that related to the types of games the children developed and how these were set up. The second part of the questionnaire consisted of smiley-o-meter's (Read, 2008) that were used to capture the experiences of the children about developing games themselves. While taking the questionnaires, dialogues between the children and the session leaders was triggered of which the most important information was written down and taken into account during the overall analysis.

DATA ANALYSIS
During the study the playground in which the SmartGoals were positioned, was video recorded with two cameras, each positioned at a different angle in order to capture the entity. In addition, noticeable observations that were made during the study were noted down. After finishing the session, each player was asked to fill in a questionnaire.

Video Analysis & Categorization
As the roles of the session leaders predominantly was to overview and structure the sessions, the total area in which players used the SmartGoals was captured by video cameras. This offered the possibility to review situations and analyze behavior into detail. By using video cameras, that were positioned non-intrusively, the players would not be distracted, resulting in a natural as possible type of behavior.

We applied a qualitative analysis approach with open-ended coding (Adams et al., 2008). During the analysis, all sessions were extensively reviewed, by which situations were listed of remarkable, repetitive or in other ways valuable types of behavior of the children. Thereafter, together with the outcome of the questionnaire and the observations that were made while conducting the sessions, all valuable information was categorized. These categorizations happened by having all interesting situations noted down on post-its that allowed to be easily, and physically, stacked and discussed. Structuring the qualitative information supported in creating overviews and relations between and within categories (see Figure 5). Decisions that were made regarding which behavior was interesting and could contribute to the design of open-ended installations, or not, was purely based on the notion of the observers. As it regards qualitative information, to be used as inspiration, this process would be valid enough to proceed with towards the definition of guidelines.

Out of the six main categories, that came out of the analysis of all captured material, most important and elementary aspects were taken that thereupon could be translated into design guidelines to improve or remain aspects in future open-ended installations. These translations were totally based upon our own interpretations of the information of which we personally thought would be valuable and contributing to this field.

Figure 5: Post-it analysis

INSIGHTS & GUIDELINES

In the upcoming section insights are described that were obtained from the observations of the test sessions. All insights are supported by short observations that function as mere illustration of the event. During the data analysis the observations were critically analyzed and thereupon processed into design guidelines, which are presented in this section as well. The design guidelines function as inspiration for the design of future interactive open-ended game installations and all that is related.

Guideline 1: Product Semantics

Children start playing with the emplacement of the goals as it is at the moment of entering the scene. They are not stimulated to change the positions of the goals neither it is discussed amongst the children. Possible reasons are that it has not explicitly been explained that the goals may be repositioned and the lack of indication (form semantics, augmented information) on the goals that different emplacements could result in various types of games.

Observation 1: All first groups of children, who kick-off playing with the objects, merely discuss which objects are to be used and how. None of them pay attention to the goals, they are perceived as they are and are considered non changeable in position.

In addition, the form of the decentralized modules should clearly communicate its action possibilities. The advantage of the SmartGoals is that they are mobile and could be positioned all over the play area; an aspect that should support the development of games. As they are heavy and not easily reportable the goals were almost never repositioned during the tests. In order to support the development of new games the installation should have a modus in which games are defined and in which they are played. In other words, it would be favorable that the installation has a mobile modus in which modules/objects are easily moved (e.g. if a new participant enters the stage) and a play modus in which the modules are fixed. In order to make the installation dynamic and easily adaptable it should be able to switch from one modus into the other in little time.

> *Guideline 1: Communicate the action possibilities of the installation through clear and consistent semantics.*

Guideline 2: Interaction Semantics

When confronted with the objects, the children seemed occasionally being confused about how they were supposed to use the objects for interacting with the SmartGoals. The relation between the objects and the SmartGoals was thin due to their abstractness and a lack of coherency in form and used materials. Therefore, participants were given a hard job to combine the two, resulting into confusion and less spontaneous enjoyment.

Observation 2: A child enters the playground and, as everybody has one, she picks an object to play with the SmartGoals. Since she seems to be confused what to do with it, and thus makes interacting with the SmartGoals more complex, she decides to put the object away and physically run through the Smart Goals to interact with them.

Guideline 2: provide feedback and feed-forward on interaction opportunities.

Guideline 3: Social Interaction

Only once during the sessions, the children explicitly deliberated on what game was about to be played and how the process should be like. In all the other cases children first explored the playground, which gradually transformed into a type of game. The verbal communication during such game was brief and mainly with the intention to shortly give comments on an undefined rule or to challenge other players. The development process of the game was merely based on non-verbal communication, mainly through imitation and gesturing.

Observation 3: A child challenges another child to steal the ball. 'Grab it then!' This is the start of a competitive game.

Although the distributed SmartGoals successfully communicate with each other, children perceive them as individual physical modules instead of a series of interrelated goals. Children seem to encounter difficulties with the distance between the goals, not in terms of literally bridging the distance between them, more the global positioning (decentralization) of all children. As the children are mostly equally distributed over the play area, and because all of them have their individual object to play with, intensive and dynamic interaction between players and objects is not stimulated. This results in a scenario of multiple players approaching individual game play while all being active in the same play area.

Observation 4: Children are individually running towards the SmartGoals that lighten up. The one who hits it first has no interaction with others and continues its play.

The components of a decentralized installation can be designed in such manner that even though they are distributed over a larger playground, certain system behaviors only occur when multiple users perform a coordinated action. If for example pressing a button on multiple objects at the same moment activates special colors or sounds, coordinated activity is rewarded. Not only at the moment of pressing the buttons, but especially proceeding it social interaction is needed to get enough players involved.

The objects that were used to activate the SmartGoals are static in their appearance and do not trigger any type of interaction. Although there were children who tried to impede others, the effect was not significant, as it did not hold the other back from normal functioning; the interaction between the objects did not trigger any type of competition neither it challenged.

Observation 5: One child tries to impede one of the others by hitting his object with his own, resulting in a short moment of the two, which did influence the other's process.

Tangible objects that belong to the open-ended installation should have the possibility to influence each other. This can result in manipulating their functioning, form or whatever type of manner that can have consequences for the game's process. By having this integrated, gameplay will become more dynamic as object's functioning become variable and hence offer competition; participants can influence each other and might start working together or against each other.

> *Guideline 3: Social interaction should provide advantages for the game that is played*

Guideline 4: Multi-player Design

The amount of activity and competition is strongly influenced by the amount of players present on the playground. By having three SmartGoals set up, the types of games children come up with are influenced by the amount of children present. While this could theoretically probably result into a higher variety of games, it has in fact the opposite effect. With the number of children equal to the number of modules the gameplay becomes static, making the children less motivated to be active.

Observation 6: With three children present on the playground, they all start protecting 'their' goal, which results in the fact that they stop running and stick to their position. "This is boring, some more kids should join us" is what of the children calls.

Once new players start participating in an ongoing game, or start a new game, all they come up with is based upon predefined functionalities of the SmartGoals. In other words, the type of interaction with the SmartGoals, to receive feedback, is predefined and 'the only material' for children to build new games with. As this has already been defined before entering the playground, children unconsciously start playing games they already now and fit the opportunities to the opportunities offered by the installation.

Observation 7: By entering the playground children predominantly start playing football, once they have been said that this is prohibited they yell "then we play rugby or baseball!"

For a decentralized installation it is recommended to have a variable amount of (active) modules present in order to have a more dynamic playground. The modules could continuously vary in either their physical presence as their functioning to provide each number of players same possibilities. This makes the playground equally interesting and not specifically depending of others in order to reach a certain level of enjoyment.

> *Guideline 4: The enjoyment the installation triggers should be subordinate to the amount of players that are engaged.*

Guideline 5: Amount of Participants

It was clear that the amount of children that were playing with the SmartGoals, determined the type of games that were played. As there was a fixed number of objects and modules, different games would be created when fewer children than this number was engaged in plays than a higher amount of children.

Observation 8: At a certain moment, the game that was played, with four players present in the field, went fairly well as everybody participated actively. At the moment one of the players left, this significantly influenced the game that was played and indirectly the enjoyment the three players that were left had. "Now this game is not exciting anymore" is what one of them shouted and subsequently left.

Elementary for an open-ended game installation is that it provides an equal level of enjoyment for e.g. two players as for five or more. The fun of playing with the game installation, and the elements it consist of, should be independent of the number of players involved .

In a period of 5-8 minutes, children participated in ongoing games a number of times as they jump in and out of the playground. Their presence in the playground is dynamic, alternates frequently and is rather explosive; no introduction is required making it that children become extremely active once they enter the playground.

Observation 9: A child that just stopped playing and decided to wait in the queue for the Nintendo Wii jumps back in, runs through a goal twice and continues waiting in the queue again.

If you want to allow for easy joining and parting the play activity, a system without clear boundaries is favorable. This can be achieved when only interactive objects that are actively used are part of the installation. In a setting with a multitude of interactive objects spread over a larger area, children simply define the active area by using or ignoring objects. Joining in such a case can be as easy as finding an unused object adjacent to the active play area and start interacting.

> *Guideline 5: If designing for a system that allows easy joining during ongoing games, physical boundaries should be eliminated.*

Guideline 6: Ambiguity

The objects the installation consists of should regard a level of abstractness that does not demotivate children to intuitively search for affiliations and thus inspiration for developing games. They should speak for themselves and trigger imagination through well considered, and coherent, semantics. By having a variety of abstract objects, users are given a hard time to relate and concretize all of them.

While this counts for the objects, the abstraction of modules is also applicable on the installation itself, which can already be considered as an example of ambiguous form given object. The SmartGoals were designed as interactive football goals, and the semantics are accordingly. If, with the same functionality, the design would have been more abstract, they could also be interpreted as gates, fire places, creatures, or anything else that children could come up with. If the form giving would be that of a small size soccer goal, it would be much less likely that one of the children would have picked up the tube-attribute to trigger a SmartGoal. Ambiguity leaves room for interpretation, phantasy, and even storytelling. On a lower level, it can for example support the setting of sub-goals in play. For example, the “active” state lights from the SmartGoals might be a monster to be chased, a treasure to be defended, a start trigger, or simply as it was designed for an opportunity to score. How these sub-goals properties of the interactive objects are used in the gameplay is still open to the players.

Guideline 6: Design for ambiguity.

Guideline 7: Taking Open-Ended Games into Depth

The majority of the developed games started by exploring the objects and their possibilities, without a clear goal or rules. Children ran through the SmartGoals and randomly used a number of objects. The transformation from this explorative process towards one that included more competition was predominantly initiated through social contact, albeit the threshold to act socially was relatively high. Contact was either established verbally through naming each other or via physical (body-body) interaction.

Observation 10: Two boys are playing on the same side of the playground. When the light of the goal on the other side of the playground lights up, the boys shortly have eye contact and start challenging each other; who would be first at the other goal?

The average participation of the children in their self-developed games was relatively short (1-3 minutes). After the explorative period and a few competitive challenges later, the interest and excitement of the children quickly disappeared. This could be the result of a lack of depth in the games. The games the children came up with were mostly simple and had often only one goal, e.g. to score or to switch off the light as quickly as possible. However, rules about when a player would win, e.g. a time or score limit, or other types of rules that would take the games into more depth, were not defined by the children. The absence of levels/stages in the games was clearly illustrated as the children predominantly chose for other games in which these levels of goals were predefined and clearly communicated.

Observation 11: Four children are playing a game similar to football. When one of the boys passes a tube-attribute, which was left by another player, he decided to use it in the game. Shortly after, the other children imitate him, the game changes and the children play with refreshed enthusiasm.

Games can be infinitely ongoing and do not have a set start or finish, as this is not provided by the SmartGoals as well it is mostly not integrated in the games children come up with. The games that were played can therefore be considered as marathons that were relatively slow and static performed.

Observation 12: A child that is actively engaged in playing a game wonders 'When does this game stop and do we proceed to the next? This might take ages!'.

In open-ended play, the characteristics of the activity are not static but are subject to continuous change. An interactive installation that supports this change, allows implementing a variety of stages in the games the children develop. With this opportunity children can decide themselves how to implement stages/levels and how to relate it to the game they came up with. These stages can for example be an adjustable scoring service that can be adapted to the game that is played. By having a variety of levels the games could reach more depth and provide competition, which indirectly results in increasing enjoyment, a longer stay on the playground and a higher commitment.

An improved design might actively offer triggers to change the play activity. To give an example for the used setup: suppose the color of the light would be influenced by the reaction time of the users: first green, then orange, then red. A small variation in game rules could be that more points are assigned to scoring red than yellow. A more

fundamental reaction would lead to a different color and players would be invited to invent a play in which not scoring, but controlling the colors would become the next play activity, like “try to keep all lights orange”.

> *Guideline 7: Provide opportunities that support change in the characteristics of the play activity.*

DISCUSSION AND FUTURE WORK

Research Set-up

Where many other (ethnographic) studies of play focused on traditional play situations (e.g. see Meire, 2007) this is a first study that examines how children play with open-ended installations that are placed in a free play environment. However, it is still doubtful how completely free this environment is. The used context was set on forehead and the test was conducted during a gym class in which the children were supposed to do sport activities. This situation is different compared to an outdoor playground, where they can enter and leave the playground as they like and manipulate the installation, and all that is related, according their wishes. On the other hand, our setting was appropriate to examine whether children would be creative in developing games, and what their reasons would be to quit playing, which essentially was the focus of this investigation. However, in future research it might be valuable discussing what the definition of a free play environment is and how this influences the enjoyment of using open-ended play installations.

Furthermore, it is discussable on what level the SmartGoals are open-ended as they have initially been designed as a support for football training. Because of their predefined functionalities, children were possibly withheld from being creative in coming up with new games. However, even if this counts, the SmartGoals proved to be an effective platform as an interesting series of guidelines was defined. Essentially, using the SmartGoals to form guidelines seemed to be the easiest and most effective as a first step to investigate this field. A logical next step is to validate the outcome with an installation that has especially been designed for open-ended play.

Finally, the SmartGoals were structurally presented in the same way to the different groups of children. The manner the SmartGoals are introduced might be elementary in the way they are perceived and interpreted. Therefore, it might be an interesting variable to see how the type of introduction of an open-ended play installation plays a role in the children’s creative thinking.

Interpretation

The guidelines that resulted from our test sessions are meant for inspiration for future investigations. The idea of the guidelines is that it is not merely to be applied on the design of open-ended game installations, but can as well be used as an inspiring, innovative and fresh perspective to design for 'normal' game consoles and other types of game installations that are based upon physical activity. The guidelines are formulated in such way that they are multi-interpretable and applicable on a variety of installations, under which normal game consoles.

Future Work

This qualitative study led to a series of initial design guidelines to be used for the design of open-ended play installations. Since these resulted out of the examination of a single

installation (SmartGoals) it is in favor of their value to be validated by examining their applicability to other types of open-ended play installations. By doing so, valuable answers could be found for a range of interesting topics, such as: In what way can the guidelines essentially add something to the design process for such installations, how can they be processed further on, what seems to be elementary in a similar type of research in the future and what could be a possible next step after implementing the guidelines successfully?

BIBLIOGRAPHY

Adams, A., Lunt, Peter and Cairns, Paul (2008). "A qualitative approach to HCI research" in *Cairns, Paul and Cox, Anna L eds. Research Methods for Human-Computer Interaction*. Cambridge: Cambridge University Press, pp. 138–157.

Bekker M.M., Sturm J., and Eggen B.. (2010) "Designing playful interactions for social interaction and physical play", *Personal Ubiquitous Comput.* 14, 5, 385-396.

Creighton E. (2010) "Jogo: an explorative design for free play" in *Proceedings of the 9th International Conference on Interaction Design and Children* (IDC '10). ACM, New York, NY, USA, 178-181.

Gentile D.A., Lynch P.L., Linder J.R., Walsh D.A. (2004). "The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance." *Journal of Adolescence* 27, 5-22.

de Graaf, M. van Essen, H. and Rijnbout, P. (2009) "Goals: a Hybrid Human-Agent Soccer Training System" in *BNAIC 2009, Benelux Conference on Artificial Intelligence, PROC. OF THE TWENTY-FIRST BENELUX CONFERENCE ON ARTIFICIAL INTELLIGENCE*, Eindhoven, pp. 391 – 392.

Iguchi, K. and Inakage, M.. (2006) "Morel: remotely launchable outdoor playthings" *in Proceedings of the 2006 ACM SIGCHI international Conference on Advances in Computer Entertainment Technology* (Hollywood, California, June 14 – 16, 2006) ACE '06,

Fromberg, D.P. "Chapter 2: A Review of Reseach on Play" in: The Early Childhood Curriculum: Current Findings in Theory and Practice M, Teachers College Press, NY, (1999), pp. 27-28

Fromberg, D. P., & Bergen, D. (2006). "Play from birth to twelve: Contexts, perspectives, and meanings.", New York: Routledge

Korhonen, H., Montola, M., & Arrasvuori, J. (2009). "Understanding playful user experience through digital games." International conference on designing pleasurable products and interfaces, DPP109, 13-16 October 2009, Compiegne University of Technology, Compiegne, France

Meire, J. (2007). "Qualitative research on children's play: a review of recent literature. Several Perspectives on Play." T. Jambor and J. v. Gils. Antwerp, Garant: 29-77.

Op't Hof L., de Pee J., Sturm J, Bekker T., and Verbeek J. (2010) "Prolonged play with the ColorFlares: how does open-ended play behavior change over time?" *in Proceedings of the 3rd International Conference on Fun and Games* (Fun and Games '10). ACM, New York, NY, USA, 99-106.

Parten M.B. (1932) "Social participation among preschool children*" in Journal of Abnormal Psychology*, 27, 243-269.

Piaget, J. 1962. "Play, Dreams, and Imitation in Childhood." *New York: Norton*.

Read, J. C. (2008) "Validating the Fun Toolkit: an instrument for measuring children's opinions of technology." *Cogn. Technol. Work 10*, 2, 119-128.

Seitinger, S., Sylva, E., Zuckerman, O., Popovic, M., Zuckerman, O. (2006) "A new playground experience: going digital?" in *CHI '06 extended abstracts on Human factors in computing systems*, pp. 303-308. Montréal, Québec, Canada

Sturm, J., Bekker, T., Wesselink, R., Groenendaal, B., and Eggen, B. (2008) “Key issues for the successful design of an intelligent, interactive playground”. In *Proceedings of the Interaction Design and Children Conference (IDC’08*), Chicago, IL, USA, June 10-13, 2008, 258-265.
Vygotsky, L.S. (1977) “Play and its role in the mental development of the child” in *Play: Its Role in Development and Evolution*. Bruner, J.S., Jolly, A. And Sylva, K. (eds). New York, Basic Books.
Sutton-Smith, B. “The Ambiguity of Play”, Cambridge, MA: Harvard University Press (1997)
Therrell, JA. (2002). “Age determination guidelines: Relating children’s ages to toy characteristics and play behavior.”