An Assessment Framework for Interactive Installations in Public Spaces to Encourage Playfulness in Adults

Espen Strømme
Department of Design
NTNU, Norwegian University of Science and Technology

ABSTRACT

Playfulness is an important aspect of an adult's life, but social and cultural constraint can limit its expression, especially in public settings. Interactive installations can be used to introduce adult playfulness to such settings. This article proposes an *Assessment Framework*, consisting of important themes to consider when designing an interactive installation with such an intention. Two public interactive installations were assessed to analyze the themes importance, and to uncover relevant correlations. Through the analysis, it is clear that the *Assessment Framework* will be beneficial for any design process to not only ensure adult playfulness, but also to ensure intended user experience, communication and interaction.

KEYWORDS: Interactive Design, Interactive Installation, Adult Playfulness, Assessment Framework.

1. INTRODUCTION

Playfulness is a characteristic most often associated with children, and it's an important factor for a developing child (Solnit, 1998). Solnit (Solnit, 1998), suggests that it evolves into a more socially acceptable and 'grown up' playfulness in adults. This playfulness is often socially useful and efficient, or is placed within a special constrained setting where it is allowed. How can one allot time for activities that might seem so frivolous, when adult life is supposed to be so efficient and serious? Research within this field reflects this, where the majority is focused on adult playfulness and work. However, research on how to encourage playfulness in adults purely for the sake of their personal development, is lacking.

There are many positive effects related to playfulness, such as feelings of well-being, (Proyer, 2013), enhanced creativity (Bateson, Bateson, & Martin, 2013), morale, motivation, problem solving (Guitard et al., 2005), and performance in work and the academia (Proyer, 2011; Yu, Wu, Chen, & Lin, 2007). Despite these positive effects, social constraints can hamper its expression and application in social and public settings (Solnit, 1998). Using digital technology to create playful installations in public spaces, playfulness could be encouraged in the middle of people's everyday activities.

This article aims to bring focus to the encouragement of adult playfulness, and uncover important themes and aspects to consider when designing an interactive installation with such an intention. A proposal for an *assessment framework*, consisting of themes relevant to adult playfulness, tangible interaction and design, was created to assess two chosen interactive installations. An analysis of these assessments was used to evaluate the value of the assessment framework and its themes, and to suggest areas for further development and research.

2. ADULT PLAYFULNESS

Different studies define playfulness and its components in different ways. Guitard et al (Guitard, Ferland, & Dutil, 2005) collects these definitions, compare them, and alongside their own research, conclude on a definition of adult playfulness: "… playfulness is a state of mind, an internal predisposition that is composed of creativity, curiosity, sense of humor, pleasure and spontaneity." (Guitard et al., 2005, p. 19). These five components make up adult playfulness: Creativity, curiosity, sense of humor, pleasure and spontaneity.

2.1. Creativity

Guitard et al (2005) distinguishes between artistic and intellectual creativity. Artistic creativity is connected to expressing emotions through creations. Intellectual creativity is the ability to approach ideas, thoughts, concepts and situations in different manners. Self-confidence is an important aspect of creativity, as when doing something novel, something 'outside the box', there will always be risks.

2.2. Curiosity

Curiosity, or the need for new and novel experiences and knowledge, is "…closely associated with interests, openness, a willingness to try new things, the desire to live new experiences, and the ability to observe…" (Guitard et al., 2005, p. 15). It requires an open mind and to be ready for new and challenging inputs. It is the ability to explore and can be seen as the driving force behind creativity.

2.3. Sense of humor

'A sense of humor represents one's ability to understand the amusing side of situations, the ability to laugh at one's self, and, for many, the ability to make others laugh' (Guitard et al., 2005, p. 17). This ability is heavily influenced by both the personality of each individual, e.g. mood, self-confidence and personal values, and the social culture, environment and context.

2.4. Pleasure

Pleasure can be seen as a positive sensation, satisfaction, joy and being content (Guitard et al., 2005). Throughout one's life, sources of pleasure will change depending on age, interest, personality, context and other factors. Through interviews, Guitard et al (2005) found that adults find more pleasure in the process, rather than in results, and that regarding adult playfulness, pleasure is a core force for motivation.

2.5. Spontaneity

Spontaneity relates to a natural behavior, purely produced from internal processes ("Definition of "spontaneity"," n.d.). Guitard et al's (2005) test-subjects often associated spontaneity as the freedom to be flexible, to adapt and change behavior during an activity. It is deeply related to self-confidence and can be constrained by social and cultural contexts.

3. TANGIBLE INTERACTION

Oxford Dictionary defines interaction as "the process of two people or things working together and influencing each other" ("Definition of interactivity in English," n.d., para. 1). In other words, interaction is both how a machine, or installation, interacts with its users, its environment, and how the users interacts with each other. A relevant specification of interaction in regards to interactive installations is *Tangible Interaction*. It encompass interaction where physical objects or interfaces that represent data and data manipulation are placed in real spaces for users to interact with (Hornecker, n.d.). Hornecker (Hornecker, 2004) suggests a framework for designing for tangible interaction. This framework contains four main themes.

3.1. Tangible Manipulation

Tangible Manipulation is described as the interaction where users use their body to interact with tangible objects and user interfaces (Hornecker, 2004). These objects and user interfaces are connected to a computer, so that interaction with them will cause manipulation of data within the computer program. Hornecker (Hornecker, 2006) mentions important questions

to consider within Tangible Manipulation. How do users use their body to interact with the relevant objects and interfaces? "Can users grab, feel and move 'the important elements?'' (Hornecker, 2006, p. 22). At the first encounter between user and object, do the user have the ability to take experimental steps? Does the machine facilitate for such steps, through e.g. rapid feedback? How intuitive do the users find the connection between their interaction with objects and the result?

3.2. Spatial Interaction
Tangible Interaction is described as physical interaction in real space, and *Spatial Interaction* refers to how the user moves and interacts with, and within, this space (Hornecker, 2006). By using a real space, the interaction is not restricted to only interacting with objects and interfaces, but can also rely on the users moving their body. Hornecker (2006) mentions important questions to consider within Spatial Interaction. How does the space the object is placed within affect the interaction between user and object? Do the users have the ability to configure the space's, objects', or their own, position within the space? Can the users use their entire, or just parts of, their body in the interaction?

3.3. Embodied Facilitation
Embodied Facilitation is described as how individual behavior, group behavior, directions and structure can be manipulated through configurations of the real space, and interfaces and objects within it (Hornecker, 2006). Hornecker (2006) mentions important questions to consider within Embodied Facilitation. To what degree will the configuration of objects within the space constrain the users' behavior? Is it possible for multiple users to interact with the central elements of the activity and the same time? Is the activity tailored to a certain set of users and skillsets?

3.4. Expressive Representation
Expressive Representation is described as the object's ability to represent the results and consequences of interacting with it (Hornecker, 2004). Hornecker (2006) mentions important

questions to consider within Expressive Representation. How intuitive and important is the link between the object with its representation of the result of interacting with it? Can this link be used as a means to create and facilitate thoughts, discussions and decision-making?

4. INTERACTIVE INSTALLATIONS
There are no clear definitions of 'interactive installations'. Through the collection of various sources on the subject, my definition of an 'interactive installation' is a physical construction in a space (Trifonova, Jaccheri, & Bergaust, 2008) or a part of architecture ("What is an interactive installation?," n.d.). Through digital elements this construction responds to users' interaction.

In this article, two interactive installations were chosen to be assessed: Piano Staircase and 21 Swings. These were chosen on the grounds of available documentation, in both written and video format, as well as how they were implemented. Both were placed in a public setting where their design successfully encouraged play despite constraining social contexts.

4.1. Piano Staircase
The Piano Staircase was a part of Volkswagen's "The Fun Theory" initiative in 2009 ("Piano Stairs - From Movement To Mozart," n.d.). This initiative was founded on the idea that "something as simple as fun is the easiest way to change people's behavior for the better" ("Piano Stairs - From Movement To Mozart," n.d.). In the case of The Piano Staircase, users were motivated to take the stairs rather than the escalator, by making the steps into piano keys that, upon interaction, plays piano sounds ("Piano stairs - TheFunTheory.com - Rolighetsteorin.se," 2009). The Piano Staircase was created in a subway station in Stockholm, Sweden.

Figure 1: Two users walking up the Piano Stairs in Stockholm [Photograph]. (n.d.). Retrieved from: https://www.designoftheworld.com/piano-stairs/

4.2. 21 swings (21 balançories)

21 swings (21 balançories) is an annual installation in Montreal, Canada, created by Daily Tous Les Jours, where users can explore music and cooperation through musical swing sets ("21 Balançoires," n.d.). By using the swings alone, only certain musical notes can be achieved, but by cooperating a far greater range of musical notes and melodies can be achieved ("21 Balançoires (21 Swings)," 2012). The goal of the installation is to create a sense of community and ownership of the city.

Figure 2: Oliver Blouin (n.d.). 21 Swings in action in Montreal [Photograph]. Retrieved from: http://www.dailytouslesjours.com/project/21-balancoires/

5. METHODS

5.1. Creating the assessment framework

The assessment framework was created by combining themes important to design of interactive installations. These are adult playfulness and tangible interaction, which both are detailed in *chapter 3. Adult Playfulness* and *chapter 4. Tangible Interaction*, and physical design, detailed later in *chapter 6. Assessment Framework*. These themes are grounded in literature found through online articles, as well as through Google Scholar's and NTNU University Library's databases.

5.2. Assessing the installations

When assessing the installations, the following method was used:

1. Collect all available sources for the respective installation. These sources consist of online articles, videos and promotional material for the respective project.
2. For each framework theme consider:
   a) Is the respective theme implemented or not?
   b) Are there elements that limit the implementation of the respective theme?
   c) Are there any clear positive or negative consequences of implementing or abstaining from implementing the theme?
3. Based on an average of the arguments used to assess a specific theme, each interactive installation implementation of a theme will be weighed as either negative, neutral of positive. This means that the implementation, or lack of implementation, of a specific theme has a negative, neutral or positive impact on either the intent of the installation, playfulness, interaction, or a combination of these.

6. ASSESSMENT FRAMEWORK

A user's experience with an interactive installation consist of three parts. First, when approaching the installation, it's important to consider how its design captures the user's attention and what it communicates. Second, when the user interacts with the installation, it's important to consider how the configuration of physical objects, space and activities affect the user. Third, throughout the entire user journey, it's important to consider how all elements affect the user's experience of, and disposition towards, playfulness. Therefore, the proposed Assessment Framework consists of themes regarding adult playfulness, tangible interaction and physical design.

6.1. Adult playfulness

When creating an interactive installation to encourage playfulness in adults it is important to capture the various aspects of adult playfulness. The definitions of Guitard et al's (Guitard et al., 2005) five components of adult playfulness was therefore used to assess whether or not the chosen installations utilized them in their designs. These five components are creativity, curiosity, sense of humor, pleasure and spontaneity.

6.2. Tangible Interaction

Interactivity is the main aspect of interactive installations. When assessing interactive installations, it is important to consider Tangible Interaction: the interaction between users, the computer's physical objects and interfaces, and the physical space. Hornecker (Hornecker, 2004) defines Tangible Interaction and its four themes to be used when designing for it. The four themes were therefore used to assess the configuration of interaction in the installations. These are Tangible Manipulation, Spatial Interaction, Embodied Facilitation and Expressed Representation.

6.3. Physical design:

Installations that needs to capture the attention of users going through their everyday activities, has to be able to express interactivity and play. Interaction and playfulness can easily be hampered by social, cultural and personal constraints. Affordance, a term defined by Norman (Norman, 2013), is therefore an important aspect to consider. Affordance describes a relationship between an object's perceived and actual properties. Any interactive installations should be designed in such a way that it affords play and interactivity.

6.4. The Assessment Framework

Figure 3 is an overview of the Assessment Framework and its eleven themes.

Adult playfulness	Tangible Interaction	Physical design
1. Creativity	6. Tangible Manipulation	10. Affordance of play
2. Curiosity	7. Spatial Interaction	11. Affordance of interactivity
3. Sense of Humor	8. Embodied Facilitation	
4. Pleasure	9. Expressed Representation	
5. Spontaneity		

Figure 3: Overview of the Assessment Framework.

7. ASSESSMENT OF INTERACTIVE INSTALLATIONS FOR PLAYFULNESS

In this chapter, I assess the two installations presented in *chapter 4. Interactive installations* through the Assessment Framework presented in *chapter 6. Assessment Framework*.

7.1. Piano Staircase

Creativity: is facilitated through giving the users a range of possibilities in how to interact with the installation. It is possible to play a melody or just a range of notes individually, or cooperate to create something more complex.

Curiosity: can be invoked when approaching the installation. Normally, the staircase in a subway is a location you quickly rush past while thinking about everyday tasks. It doesn't stand out, and can be mundane and boring. Combining such a location with something that looks like a piano, which is a familiar and universally known item, creates a novel installation. This novelty invokes curiosity, which is increased upon receiving musical feedback on the first step taken.

Sense of Humor: can be expressed through playful movements while interacting, and through the type of sound created, e.g. creating a set of discordant notes to irritate a friend.

Pleasure: can clearly be invoked, as seen in the promotional video for the project ("Piano stairs - TheFunTheory.com - Rolighetsteorin.se," 2009). Smiles, laughter and joy are visible reactions to using the installation themselves, watching others do it, cooperation. This is also sometimes expressed through joyous movements like jumping and dancing.

Spontaneity: or the possibility to spontaneously execute actions or change behavior, is facilitated. This is possible both when passing by and spontaneously choosing to take part in the activity, or within the activity itself, because of its large degree of freedom.

Tangible Manipulation: Playing the piano, is an analogy most people know. Using such a familiar analogy as the foundation for the installation makes for an intuitive link between step and sound. This feedback is also so rapid, as expected with such an analogy, that it allows for experimentation and exploration.

Spatial Interaction: The setting where users meet the installation is one where there is not much else that battles for their attention. Stairs, and its steps, visually fits the analogy. Interacting with the steps requires use of most of the body, which will limit the user group. The movements needed to interact with the installation is the same as the natural movements of walking up a set of stairs. This allows for avoiding social constraints for shy users, where exploratory steps can be hidden within these natural movements.

Embodied Facilitation: The universally known analogy of a piano helps the user to quickly gain an understanding of the interaction. It facilitates discussions, cooperation and decision making.

Expressed Representation: Through both analogy and the visual design, the interactive objects, piano key steps, and the result of interacting with them, is clearly expressed.

Affordance of play and interactivity: is both achieved through the visual design and the analogy the installation is based upon. A piano is an item most people associate with experimentation, jokily playing despite lack of skill and beautiful melodies. These associations can make the installation afford both playfulness and interactivity, regardless of piano skills.

7.2. 21 Swings (21 Balançories)

Creativity: 21 Swings facilitates a range of possible creative outlets, whether alone or as a group, creating harmonious, or discordant and off-beat, melodies and notes.

Curiosity: In of itself, outside of use, the installation looks like a normal set of swings, although with a modern appearance. Finding swing sets in such a setting, on the side of a bustling street, might invoke curiosity. However, when the swing sets are in use, and notes and music are playing alongside users' movements, it's very likely that curiosity is invoked. This might come from combining something known, like the swing sets, and a new, not expected element, like sound, and create a novel experience.

Sense of Humor: There is not many ways sense of humor can be expressed by interacting with 21 Swings. It is possible to work against cooperation, and find humor in it, but this might have a negative effect on the larger user base.

Pleasure: can be invoked through various possible creative outlets, sense of mastery, or reminiscing about past memories brought up by the swing set.

Spontaneity: 21 Swings doesn't facilitate for spontaneity outside of motivating people to spontaneously take a break in their ongoing activity by using the installation. As mentioned in Sense of Humor, 21 Swings give users the ability to spontaneously go against group behavior, but it

is not possible to say if this will have a positive or negative impact on the interactive installation.

Tangible Manipulation: By using the swing, sound will play according to the specific speed and frequency of the swing. This feedback is well implemented and leads to a clear understanding of how to manipulate this interaction. This facilitates experimentation and exploration.

Spatial Interaction: The users meet the installation in an everyday setting, on the side of the street in a city. Sets of swings is not something one expect to find in such a setting, and the combination creates a novel experience that can invoke curiosity. However, placing the installation in such an open setting might also hinder some users to participate, because of social constraints. Interacting with the installation requires use of the entire body, something that will limit the user group to able-bodied users.

Embodied Facilitation: The installation facilitates for both individual interaction, and cooperation. It doesn't allow for individual interaction without interference from the neighboring swings. The musical feedback creates an intuitive connection between sound and interaction, and leads to a clear understanding of the installation. This facilitates decision making and further interaction, both individually and as a group.

Expressed Representation: If a user were to approach this installation without anyone using it, the connection between swinging and sound is not expressed. Exploration is needed. However, if a user where to approach it when someone is using it, the implemented feedback of sound will create an intuitive understanding of interactivity.

Affordance of play and interactivity: The physical appearance of a swing set, creates associations to memories of play and unconstrained interaction. Through these associations, the installation will afford both play and interactivity.

7.3. Assessment summary

Figure 4 is an overview of both interactive installations' success, or failure, in implementing the specific themes. This weighing represents an average of all arguments used to assess a specific theme. Symbols used are '−', '0' and '+', representing negative, neutral and positive average assessments. This means that the implementation, or lack of implementation, of a specific theme has a negative, neutral or positive impact on either the intent of the installation, playfulness, interaction, or a combination of these.

Assessment Framework	Piano Staircase	21 Swings
Adult playfulness		
1. Creativity	+	+
2. Curiosity	+	+
3. Sense of humor	+	−
4. Pleasure	+	+
5. Spontaneity	+	−
Tangible Interaction		
6. Tangible Manipulation	+	+
7. Spatial Interaction	+	0
8. Embodied Facilitation	+	+
9. Expressed Facilitation	+	−
Physical design		
10. Affordance of play	+	+
11. Affordance of interactivity	+	+

Figure 4: Overview of the weighted assessments of the Assessment Framework's theme's implementation in Piano Staircase and 21 Swings.

8. DISCUSSION

8.1. Adult playfulness

Adult playfulness and its five components are valuable to consider when assessing or designing an interactive installation. It can shed light on elements that create different experience in different users. It is important to be aware of these different experiences, and to assess whether the possible positive outcomes might outweigh the possible negative ones.

Some of adult playfulness' five themes was more difficult to assess than other. As these themes will be affected by the users' diversity, it might be difficult to see the entire picture. This is also affected by there being relationships between components, such as how creativity, sense of humor, curiosity and spontaneity can all be sources for pleasure. *Spontaneity*, behavior based on internal reactions, was especially difficult to assess. When assessing interactive installations based on spontaneity, two different types of spontaneity is possible. Spontaneity within the activity, and spontaneity in taking a break from the ongoing everyday activity and participating in the interactive installation. Sometimes these two types of spontaneity can be difficult to separate. I would suggest that the important aspect of spontaneity brings up is whether or not there is room for spontaneity within the activity itself, and how the activity facilitates for such actions. How to motivate users to participate in the activity, is something the themes of affordance of play and interactivity focuses on. I suggest therefore, that spontaneity in this framework should only concern spontaneity within the activity itself.

When designing an installation, it is common to choose a specific user group, but it is also important to research how other users might react to the design, and how they, and their reactions, might affect the chosen user group. One example is *sense of humor*. In the case of 21 Swings, one expression for sense of humor could be for one user to work against the group and ruin the cooperation. For some, this might be a harmless, funny action, but there might be some within the group, or outside, that reacts negatively on this action, and could create a negative social environment.

8.2. Tangible Interaction
Tangible Interaction's themes shed light on very important aspects of interaction, and especially digitally enhanced interaction. Because of their clear definitions and specific related questions, they were all easy to use. However, a few questions were related across themes, which could make them difficult to separate. Both

Tangible Manipulation and Expressed Representation considers how intuitive the link between object, interaction and result is. A clearer distinction between these two was needed to correctly use them. Tangible Manipulation considers the link between the interaction with the physical object and the corresponding result. Expressed Representation, however, considers the link between the visual clues of the objects and the result from interacting with them.

8.3. Affordance
Affordance is a simple concept to evaluate, and a difficult one to design for, but a powerful tool when implemented correctly. It has a clear and important role within the framework, and focuses on a theme that no other introduces, especially with the further specification of spontaneity. Affordance of play and affordance of interactivity are two different affordances, with different impacts on the user, but it seems that they can often have the same source. When assessing for them, they weren't clearly separated by that very reason. But was that a good idea? When considering the two different types of affordance, the goal is to find their sources, and how they affect the respective affordance and the users' behavior. By not separating them, I feel that I lost an opportunity to find more specific key elements regarding each respective affordance. For future use, I would therefore suggest keeping these two clearly separated and assess, or design, for each individually, as to not lose important elements.

8.4. Relationships between themes
As mentioned earlier, I experienced there to be relationships between the eleven themes. These relationships made it more difficult to focus on assessing only one specific theme, but it also forced me to consider them together, and how they affected each other. By themselves, *adult playfulness* and its five components focus on how the implementation of certain elements will affect how, and whether, users will experience play. When considered in a larger framework with e.g. *Tangible Interaction*, it also sheds a light on how *Tangible Interaction's* themes also will affect playfulness. Elements that affect a theme in a

specific way can also affect another theme in a different way. Take the example of how expressing sense of humor by working against cooperation in 21 Swings might lead to negative responses. This ability is also the one that facilities creativity and pleasure in the users. So, something that might create a positive response in one theme, might create a negative one in another. It is therefore important to assess all these themes to uncover correlations between their sources, and to weigh both the positive and negative consequences when deciding whether to implement it into the design.

8.5. Weighing of themes:

The three levels of weighing used in *Figure 4* gave a way of communicating and structuring the success of implementing each theme. It highlights interesting correlations between successful, or failed, implementation of themes and a successful interactive installation. Despite this, a larger set of levels, and a clear set of requirements for each level, would benefit the assessment by locating and defining nuances and smaller correlations, and increasing the assessment's validity.

From weighing the themes' implementation in both interactive installations, some interesting elements were highlighted. 21 Swings did not implement *Expressed Representation well*, and users would therefore most likely not intuitively understand the link between the installation's objects and the result from interactive with them. But will this have a negative effect on the user experience? Will interacting with such an installation invoke more curiosity, exploration and as a result, pleasure, as the users must interact to gain knowledge? On the other hand, will abstaining from implementing *Expressed Representation* result in less curiosity and interest, as the novelty of the objects and interacting with them is not communicated?

There isn't enough evidence to conclude whether there is a need to implement most, or all, of the *Assessment Framework's* themes for an interactive installation to be successful, or to create a good user experience. I would suggest

that different configurations of implementations of themes creates different types of interactive installation. When designing an interactive installation, it would be beneficial to consider most, if not all, of the themes to ensure that communication, playfulness, experience and interaction are implemented as intended.

Some themes do distinguish themselves as key themes for a successful interactive installation. I would suggest that when considering *adult playfulness,* three themes, *curiosity, creativity* and *pleasure*, captures most of the important elements of adult playfulness. They are also connected to, and will clearly be facilitated through, *Tangible Interaction's* four themes. On the other hand, the impact of *spontaneity* and *sense of humor* on the success of an interactive installation are difficult to assess. How they are invoked in users are dependent of diverse and personal elements. Within *Tangible Interaction* two themes distinguish themselves, *Tangible Manipulation* and *Spatial Interaction.* Tangible Manipulation, how intuitive and clear the connection between interaction and result is, is a key element for user enjoyment and the overall 'feel' of the activity. For public interactive installations, *Spatial Interaction* considers key elements for making the installations fit into its environment, make it natural to interact with it, and combat constraining social settings.

8.6. Limitations

This article has limiting factors. Only two interactive installations were assessed. With a larger set of interactive installations more varying implementations of themes would occur, and could therefore lead to more interesting findings. The interactive installations assessed were also successful in both participation and achieving their goal. Both installations consider, whether intentional or not, most of the Assessment Framework's themes. A non-successful installation might have implemented fewer themes, or all, and could therefore shed light on interesting correlations between them, and consequences of implementing them versus not implementing them.

The Assessment Framework contains only eleven themes, chosen from a small research scope, as the field was unknown for the researcher prior to this article. With a larger research scope, and with a larger set of themes, more, and other, interesting findings could occur.

8.7. Further research
For future research, some topics should be considered. The *Assessment Framework* has a need for themes considering the interactive installations' environments, and the effect of them harmonizing or not. Social constraints, how they affect the installations, and elements to influence them, are important elements for a successful interactive installation. Research of more levels of assessment, with defined requirements, are important to further help structure interactive installations and increase the validation of the method used.

9. CONCLUSION
The Assessment Framework clarifies important and pivotal elements within interactive installations, and could be a useful tool for both designing and evaluation such an installation, to secure intended results. By themselves, each of the eleven themes highlights important aspects of playfulness, interaction and design. Together, however, they highlight relationships between them that is important to consider when designing for an interactive installation that successfully facilitates for adult playfulness . Despite this, it has a need for further research of new themes, assessments of less successful interactive installations, and validity of the framework.

10. REFERENCES

21 Balançoires. (n.d.). Retrieved from Daily Tous Les Jours website: http://www.dailytouslesjours.com/project/21-balancoires/

21 Balançoires (21 Swings). (2012, 31.10.2018). [Video] Retrieved from https://vimeo.com/40980676

Definition of "spontaneity". (n.d.). *Collins Dictionary*. Retrieved from https://www.collinsdictionary.com/dictionary/english/spontaneity (27.09.2018)

Definition of interactivity in English. (n.d.). *Oxford Dictionaries*. Retrieved from https://en.oxforddictionaries.com/definition/interactivity (27.09.2018)

Guitard, P., Ferland, F., & Dutil, E. (2005). Toward a better understanding of playfulness in adults. *OTJR: Occupation, Participation and Health, 25*(1), 9-22.

Hornecker, E. (2004). *A Framework for the Design of Tangible Interaction for Collaborative Use*. Paper presented at the Proc. of Danish HCI Research Symposion.

Hornecker, E. (2006). Physicality in tangible interaction: bodies and the world. *First Steps in Physicality*, 21-25.

Hornecker, E. (n.d.). Tangible Interaction. *The Glossary of Human Computer Interaction*. Retrieved from Interaction Design Foundation website: https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/tangible-interaction?fbclid=IwAR2XViKdZmvSTHKfGU-0ZII7KjgYGiQVacDRE7TnntZv9m-QP7ihYOnDoug

Norman, D. (2013). *The design of everyday things: Revised and expanded edition*: Constellation.

Piano Stairs - From Movement To Mozart. (n.d.). *the exploration of thoughtful designs from Europe*. Retrieved from The Design of the World website: http://www.designoftheworld.com/piano-stairs/

Piano stairs - TheFunTheory.com - Rolighetsteorin.se. (2009, 10.09.2018). [Video] Retrieved from https://www.youtube.com/watch?v=2lXh2n0aPyw

Solnit, A. J. (1998). Beyond play and playfulness. *The psychoanalytic study of the child, 53*(1), 102-110.

Trifonova, A., Jaccheri, L., & Bergaust, K. (2008). Software engineering issues in interactive installation art. *International Journal of Arts and Technology, 1*(1), 43-65.

What is an interactive installation? (n.d.). Retrieved from ijsfontein website: https://www.ijsfontein.nl/en/faq/what-is-an-interactive-installation