

CHILD-TO-CHILD (C2C): DESIGN OF INTERACTIVE 3D BOOK SPACE FOR CHILDREN'S MUSEUM

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ABSTRACT

In this paper, we present a Child-to-Child method (C2C) for co-designing with children for younger children. The method is illustrated using a design case, where an interactive space for young children in Children's Museum was designed. Three-dimensional interactive books are envisioned and explored with children, and consequently embedded into the 'Book Nook' exhibit. This interactive environment was developed and prototyped by an intergenerational design team. The paper reflects upon challenges and opportunities provided by working with C2C method and presents results of preliminary investigation of an interactive space design that employs a novel concept of a 3D book.

KEYWORDS

Participatory design, children, co-design, interactive spaces, storytelling.

1. INTRODUCTION

Including children in the design of interactive installations for small children is challenging for many reasons. Children are different from adults both as users and designers, and many of the existing design methods do not account for these differences. Several researchers have involved children in designing technologies for children e.g. (Druin 1998; Druin 1999; Dindler et al. 2005; Druin 2002; Iversen and Nielsen 2003; Iversen and Smith 2012), also in the interactive space settings (Alborzi et al. 2000a; Dindler et al. 2010; Alborzi et al. 2000b). Our research aimed at finding good organizational principles for involving older children as co-designers in designing for young children. Their memories of the time when they were younger are still alive and thus, they can better represent the young children in design processes. We further explored how to include the children as close as possible to the ideal of the Scandinavian Participatory Design (PD) tradition.

PD is a design approach that emphasizes users' influence in all stages of the design process. Future users are not only given a voice in the process, they are also given power to make concrete design choices (Bratteteig et al. 2012; Bratteteig et al. 2010; Simonsen and Robertson 2012). Their influence impacts all parts of design from problem setting to problem solving, as well as design goals and design form. The design solution thus builds upon, and aligns with, the logic of its future users. Given that the target user group involves quite young children, PD in this sense is difficult to achieve. Small children cannot speak for themselves adequately, and cannot fill the role of a committed design team member on equal terms. This

makes it difficult for them to influence the design process directly. Thus, in order to understand actions and interests of these young children as well as possible, we involved a group of older children to represent the child perspective and interpret the actions of the young children in the design team. The older children were involved in a co-design process (Walsh et al. 2013) as members of the design team with the power to influence the process.

The paper presents an organization of design work with young children, through Child-to-Child (C2C) method by describing a particular design case. We explored a design of an interactive space that we call the 'Book Nook', where a 'book' itself has a new form consisting of separate, interactive 'pages' that may be joined into in a 3D structure, allowing for a story to be told in many different ways. The new book form was grounded in young children's story telling activities. The Book Nook is intended as a public space exhibit within Children's Museum, designed with and for children. Further, the paper argues that the older children did influence the design result considerably through their participation in the design process, as did the young children who tested diverse ideas and concepts.

The paper is structured as follows: first, we review the main research literature that we build upon, on designing with and for children. There is a large body of research in this field; we present the research most relevant to our case. Next, we present C2C design method and continue with description of a design process with children. We then summarize and present lessons learned from this design case. The final section contains conclusion remarks and reflections on future work.

2. DESIGNING WITH CHILDREN

There are several obstacles to PD with young children ranging from difficulties in understanding abstract concepts and verbalizing thoughts, see e.g. (Piaget 1973; Lincoln 1985; Markopoulos et al. 2008), to a perceived lack of authority as compared to the adults involved in the design process. In order to design solutions aligned with young children's logic, we have built on participatory and co-design methods described in (Druin 1999; Druin 2002; Guha et al. 2004; Guha et al. 2005; Walsh et al. 2010; Iversen and Dindler 2008; Iversen and Nielsen 2003), as well other methods and techniques. A good overview and a way to compare methods is given in (Walsh et al. 2013). Walsh et al. (2010) describe their teamwork with children designers as follows: "At the University of Maryland, our inter-generational design team meets two times per week during the school year". With such an approach, it is possible to develop ways of representing children's logic in a manner that enables the design team (consisting of adults and children) to design in line with the children's logic. Co-design or partnering with children also entails that both adults and children go through a mutual and reciprocal learning process.

In some professional design communities, there is a strong disinclination to include children in design processes both because of their non-professionalism and because of doubt in their abilities to contribute to design (Nesset and Large 2004). We sought the middle ground, inspired by those who include children as close as possible to the traditional PD or co-design, while enabling the professional designers in our team to be professional in some areas, e.g., working with technology as a design material during prototyping.

Research on design and design methods normally requires the researchers to adopt reflective practices as a way to develop knowledge about design processes and methods (Bratteteig et al. 2012; Markopoulos and Bekker 2003). We have taken an experimental approach: the first version of the C2C method was inspired by some of the above-mentioned literature. Further, through many both master and bachelor student projects related to children's museum exhibit design (Culén 2012), we varied parameters such as organization of work, age of children and like, until the present form of C2C was reached.

User-centered design is often used in the children's museum field. However, much of the design does not actively include children in museum exhibit planning and programming, design or development processes. Curators have traditionally documented well and extensively how they envision learning and play in an exhibition to take place, how they support educational goals and help children develop skills through play. By exploring the ways in which children can be included in the design and development of public exhibits to a larger extent and in a more equal role, our research has a potential to contribute to the children's museum field (Anderson et al. 2002; Culén 2012). By trying to understand and appreciate the existing practices in designing for children's museums, we hope to open up for the creation of new practices and for giving children a voice in building and exploring their own future spaces for play and learning. Children museums

can also be seen as a new arena representing a different approach to learning, in accordance with a view presented in (Sefton-Green and Sinker 1999), fun, collaborative, exploratory and experimental. It is, therefore, interesting to explore how children can help in forming and defining these spaces.

3. THE C2C METHOD

A technology design method is a coherent set of guidelines for how to carry out a design process from start to end, often called a methodology. A method is characterized by its:

- Application area: small administrative systems require different methods than large industrial machinery
- Perspective or worldview: on IT, systems design, design values, and the roles of designers and users
- Guidelines: techniques, tools and organization principles, see (Bratteteig et al. 2012).

The application area in our case is a design of public interactive installations in the context of children's museum. Our focus is both in exploring how children can participate in making general contributions to planning of a museum space as well as the design result itself. The perspective is that of co-design, trying to come closer to PD by finding ways to represent children's views as accurately as possible. The guidelines include a set of techniques and tools from co-design and PD, adjusted for use by children. The techniques used were common: prototyping (mainly low-fidelity, both with and without technology), design workshops, scenarios, contextual inquiry, generative tools, mixing of ideas, and brainstorming.

The C2C method is mainly characterized by its principles for organizing the design process, which makes it different from other methods. In order to involve young children and represent them well in the decision making in design, we developed a two-step model. The first step is to form a design team by establishing a core group of school children, all with interest in design, and give them experience in participating in design activities with adults as co-designers. The second step is a design process where the design team – which includes the core children group and adult designers – engage in a design process with young children. The young children's participation enables exploration of ideas and testing of prototypes developed by the design team. Several iterative cycles of design with both groups of children participating in different parts of the analysis-design-evaluation cycle are typically needed in order to arrive at a final design, see Figure 1.

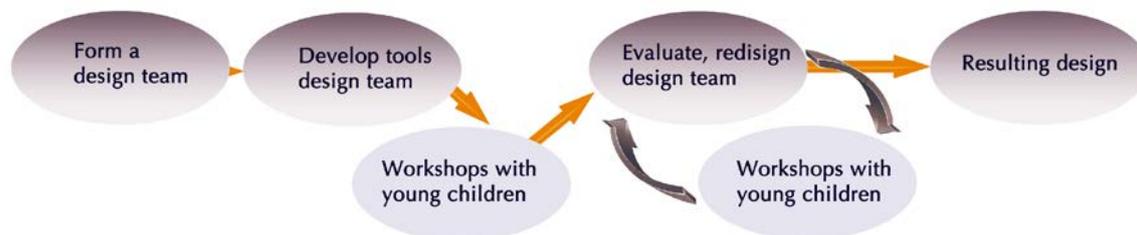


Figure 1: Overview of the C2C process by its organization.

We suggest including children aged 8-11 in a core design group. They are at the developmental stage when a gradual shift from fantasy to reality occurs, sense of logic and reasoning grows, and they are capable of making abstractions (Markopoulos et al. 2008). Yet, they remember how it felt to be young, usually all the way to when they were a baby. We find that, for C2C method, children aged 3-5 are the best choice in terms of age for testing the ideas and prototypes with. Children younger than three years may be difficult to recruit and engage for an extended period of time. Children aged six and seven may be developmentally too close to the age of the core design team children. We next discuss how the method was used in practice.

4. DESIGNING A BOOK NOOK

The Book Nook is part of Children Museum's conceptual master plan. It is situated under the roots of 'The World Tree' climbing exhibit. The Book Nook is envisioned by the Children's Museum as a repose space for parents and young children while the older siblings climb the tree. As depicted in Figure 2a), the basic

planned interaction in this space involves a parent reading a book to a child, or a child browsing books alone. A design brief from the Children's Museum was to make interactions in the Book Nook richer.

4.1 Forming the team

Two product designers with specialization in interaction design, an interaction designer with human-computer interaction background and a museum curator were the adult participants in the study. The traditional design practice approach was used to understand the problem space: context mapping and brainstorming. The outcome was the understanding that reading would be difficult in the Nook. With noise from the World Tree climber, and potentially several parents reading at the same time, it would not be a quiet place. Thus, already after the first session it was clear that the concept of the Nook would have to change.

The next task for the adults was to select and include the children into the design team. Since there were four adults, we decided to engage four children. With eight members of the team, we could also work in groups of 2 adults and two children per group. The children were aged 8, 10, 10 and 11. The oldest child participated in a single iteration of the process, while the others participated for the whole period of 12 weeks. The team meetings took place in part at home of one of the researchers and in part at the university lab. They lasted around 2 hours (45-minute prototyping sessions, followed by a 30-minute break and then 45-minute evaluation sessions).

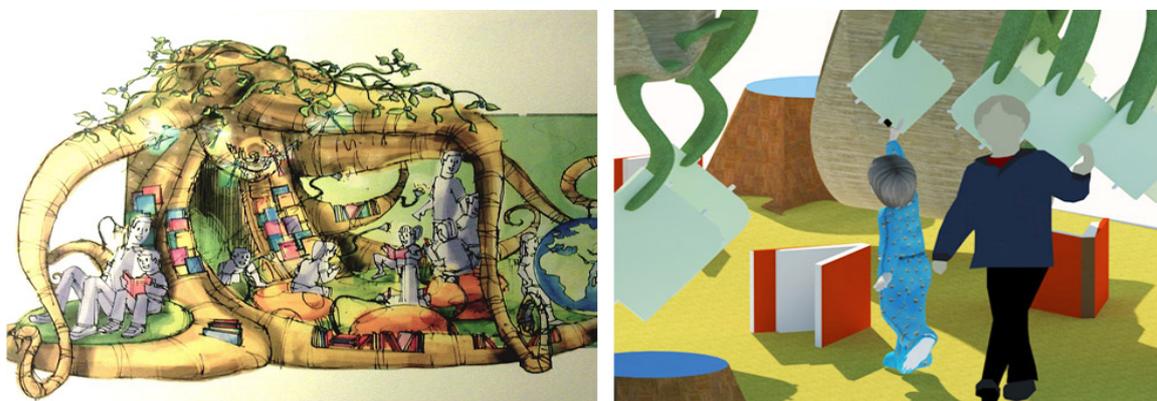


Figure 2. a) The Book Nook – as conceived by Children's Museum, copyright Oslo Children's Museum project.
b) The Book Nook as envisioned and prototyped.

4.2 The Design Modules

The design teamwork was organized in modules. One module consisted of a design and evaluation session conducted by the intergenerational team, followed by roughly 2 weeks of developing prototypes and tools for the workshop with young children. The workshop with young children signified the end of one module. Each module built on the key lessons learned from the previous module. This process was repeated in four iterations, followed by the final prototype testing. We describe the modules and the final testing next.

4.2.1 Module 1: exploring the concept of a book

The first design team session had as an agenda getting to know all the design team members and discuss the concept of the Book Nook. We used an iPad as a tool to talk about books and interactive books with children. We tried the ICDL application based on (Druin et al. 2003), an interactive version of Alice in Wonderland (Alice for the iPad n.d.) and, finally, Puppet Pals (Puppet Pals n.d.), an application that enables children to direct a puppet theater piece with preset character sets with the possibility to make one's own characters and scenes. The children participants were familiar with these applications from before, but not all the adults. We discussed what kind of 'reading' is more fun: browsing a book, using an interactive book like Alice, or actively creating a story with Puppet Pals. Our older children team members gave us the following insight: Alice gives fewer interaction possibilities and modalities of interaction than Puppet Pals, therefore was less interesting after a while. In Puppet Pals, they could combine the voice, the movement, different backgrounds

and objects of their choice, which encouraged more actively making stories of their own. Making something of their own, they thought, would also be of interest for young children. Thereby, we got the first hypothesis to test with young children.

The children's input in this session was significant. It helped the adults to ask what makes a book vs. what makes a story and how young children who still do not write tell a story. If a book is a collection of pages bound together, could we build entirely different books, whose pages occupy space in a different manner than in traditional books? If so, how would stories be told? As a consequence, the adult part of the team designed a generative tool set, inspired by (Sanders 2000; Sanders and Stappers 2008) and shown in Figure 3a), that could help us research these questions.

The next step in the module was to hold a workshop with young children and collect empirical data on young children's experiences and interactions with books and stories and the overall domain understanding. Keeping in mind the behavior patterns of young children (Montemayor et al. 2004; Sanders 2000), we allowed the tools, which were carefully chosen to open for creative involvement and open-ended activities, to work their magic and reveal young children's play patterns, story building and storytelling behaviors.



Figure 3. a) The first workshop with young children. b) The second workshop and the stories made.

The initial workshop with young children was not very different from what is described in literature, e.g. (Alborzi et al. 2000b; Montemayor et al. 2004). Our generative toolbox was carefully designed with attention given to aesthetics and personalization, each box made for a specific child participant. The desired effect was achieved: the children experienced a sense of curiosity, interest, and, later, ownership – they kept the boxes. Each box contained materials such as colored sheets of paper, felt, yarn and some re-used articles with unique textures such as egg boxes, a hand-shaped piece of velvet, plastic eyes, crayons, etc. Everything was easily recognizable and instantly usable, no instructions or tools needed. As the children explored the content, we observed passively for approximately 30 minutes. After that, the children were handed additional tools: hobby scissors and glue. They were asked to make a character and then tell a story about that character.

As expected for its age, each child made his/her own character without collaboration. One of the children made two objects: a character and a spaceship. When done, the children spontaneously began to play with their characters and each other, speaking for the character they made. The children lost interest in answering questions or telling us stories about their characters. Instead, they became engaged in making environments for their characters, possibly inspired by the spaceship. The remaining materials were used for this purpose. We found this behavior pattern to be of interest and wanted to explore deeper how characters might move through the story, physically in this case.

4.2.2 Module 2: design team building and tool improvement

During the second meeting with our older children group, we showed video-clips from the workshop and discussed what we saw with the whole team. Then, sitting around a table, we used an iPad again, plus several additional paper representations of the iPad. We all started playing with making scenes on the iPads. The children used two paper iPads for which they created different backgrounds, kept them next to each other, and then user real objects to move them from one iPad to the other. This extension across space was another key factor that shaped the 3D book design. It led to the design of connectable boards.

The second workshop with young children was again exploratory in nature, using connectable boards, images, crayons and glue as tools. The boards were brightly colored, see Figure 3b). In addition, the children got some images of common things such as houses, trees etc. printed on the paper. These could be glued onto the boards. We were interested in finding out how these tools, along with the characters they made previously, could be used to tell a story. We imagined that they would be making a story as they connected the blocks. A lesson we learned from this workshop was that the connectable boards were used fully in the spirit of Lego blocks: to build. The pictures were not used for storytelling– they were used as decoration. As can be seen in Figure 3b), some images were placed upside down. The hand drawings on the boards were not connected to any story either.

4.2.3 Module 3: exploring the concept of a 3D book

In the third session with the design team, after discussing the workshop, Munari's book (Munari 1994) was used as a prop to bring the further the discussion around the book form. The book consists of many loose pages with differing levels of transparency, so that one could add elements to the story by placing an opaque page at the bottom and then adding other transparent pages on top in order to create a scene around which stories may be told. Subsequently, the mixing of ideas approach (Guha et al. 2004) was used and the design team was split into two groups. One group included two children and two adults, and the second included two adults and one child. Both groups got the same tools as were used in the workshop. The only difference was that the majority of the boards for our discussions were plain cardboard, not very colorful. The task was to turn boards into 'book pages' that may be placed in three dimensions, but at the same time, represent parts of the story. We wanted to encourage using fewer boards, yet enabling richer content.

Open-ended play was used as a method to get everyone involved in a brainstorming process. The older children, quite like the younger ones, found the connectible cardboards very interesting and began playing with them. One child found scissors and started cutting through the boards to make movable parts like doors and windows. Suddenly, the characters could move within the structure, adding new interactions to the play. The whole team recognized this as the next key improvement to generative tool, see Figure 4.



Figure 4. a) The team, discussing the group work. b) The detail of the witches' house

Taking inspiration from pop-up books, the design team decided to make story elements using origami. Origami was chosen as the medium for story elements since it is three-dimensional and could be moved across the blocks. Origami could easily be placed on and taken off the board. Together with movable parts such as the doors of a house or the tail of a dog, richer interactions with of the board could be enabled. This time, connectible boards were given a neutral color in order to bring attention to origami.

Testing this approach with young children was carried out in two workshops. The second one continued where the first one stopped with a minor change in the toll set. We simply needed a bit more time with young children. We started by observing how young children use plain boards with detachable origami as 3D storytelling elements. The change in the way children played was significant. None of the children attempted to build houses and all included origami as elements of the story, sometimes drawing things in addition, see Figure 5. The boards were connected so that their stories unfolded. Also, the way they connected the boards in three dimensions was different. This time, the placement of the boards followed the spatial logic e.g. a board with an airplane was placed highest conveying that the airplane was high in the sky. Or, the board with

a monster was placed behind the board with a house, indicating that the monster was inside the house. They were starting to create book pages, creating physical connections following the story, but pages were not connected linearly, they had spatial placement in three dimensions.



Figure 5. The third workshop, children starting to tell stories using the boards.

The data gathered and behavior observed at this workshop led us to believe that the concept of creating books in three dimensions might be an exciting direction to take. For the second workshop with the same tools, we slightly changed the boards, making them a little more complicated to connect but allowing for a greater variety of connections. Rubber bands were used as connectors. The children were able to do this, but it took a bit more time and required greater focus. As a result, the interest weakened. This session helped to understand how complexity of form directly influences the play, and the interest in the play.

4.2.4 Module 4: concept development for the Nook

The module 4 started as usual with review of the workshops. The task for the design team this time was a concept development. Until this point, story elements used in the workshops with young children were elements from their environment, a house, a dog, a sun and like. Next, we wanted to investigate the idea of mixing stories children already knew in order to produce funny hybrid stories.



Figure 6. a) Testing the high fidelity prototype b) Details. At the bottom, right, the next generation of the blocks.

The older children immediately assumed the role of storytellers. They all told their favorite stories and drew the favorite characters from those stories. Their eagerness and enthusiasm contributed to decision that the final concept for the Book Nook should use such hybrid stories and characters they were familiar with. The team chose two well-known stories ‘Hansel and Gretel’ and ‘The Mole’ to work with further, and develop prototypes for those, see Figure 6. Low fidelity prototypes for the book pages were conceptualized. It was agreed that these would be more exciting with sounds and light added. Metaphorically, the book pages would turn into theatre sets of sorts, on which stories could be staged.

4.3 The Final Concept and its Evaluation

The final concept for the installation is shown in Figure 6. It consists of blocks that function like book pages. These pages have connectors that enable the child to connect them in three dimensions. Each page has a

character from a famous story permanently attached to the block. In addition, a set of ‘free characters’, equally well known, is available for use in storytelling. As mentioned, ‘Hansel and Gretel’ and ‘The Mole’ were used as prototypes. The circuit inside the boards is designed so that it can identify the character placed on the surface of the board and when the character is moved around on the surface, the board generates unique sounds specific to the character and in some cases light and vibration as well, adding to the overall interactivity and engagement of the child in the system. When the child pokes the fixed characters, they trigger a sound and light response specific to them as well.

The product designers on the team made the high-tech prototypes. When all blocks and characters were made, an evaluative workshop with the adults, older children and one young child was organized. The aim of the workshop was to evaluate the children’s interest in the interactions, cooperation possibilities as well as the overall quality of experience while playing. We also wanted to see if interactive characters from different stories would be used together to make hybrid stories new stories that expand the existing ones.

The prototypes were given to young children. Our team members engaged the children in story making and demonstrated the features of the system. The children started to connect the boards and make stories in three dimensions, like they did with the low level prototypes. The sound and light responses added value to the play for the youngest child. This child thought that the effects were cool and repeatedly played the sounds and recreated the scenes over and over again. Other children playing with prototypes (Figure 6c)) narrated the stories and increased the effect of their words with sounds. For example, one child said: ‘It was raining hard, and you could hear the lightening’ – at this moment, the child pressed on the cloud with lightening and the sound played for a few seconds. Cross narratives between the two stories were made instantly and spontaneously.

The final concept for the Book Nook is shown in Figure 2b). We envision an immersive environment that will stimulate creative and engaging storytelling, both by children and adults.

5. DISCUSSION

The C2C method is designed as a PD method (Bratteteig et al. 2012; Bratteteig et al. 2010) utilizing PD techniques and tools (Walsh et al. 2013) aimed at involving children as co-designers. The principles of organizing the design work were inspired by (Guha et al. 2010) and authors’ long-term work with children as design partners but with a more pragmatic and short-term approach. Workshops were arranged with young children, involving the same children in subsequent workshops, to provide for the possibility of deeper commitment to the design result. However, their role remained that of users and testers. The older children in the design team played a crucial role in the process and contributed major insights. Some examples of such insights are movement of objects across pages (interactive surfaces) providing a novel way to structure the story, the insight that the interest is better kept with objects that are self-constructed, etc. The younger children, even though they were in the role of a testers still influenced the process. The younger children’s actions and reactions had to be translated by the design team. Even the young children, however, influenced design decisions. A good example is their rejection of the modified board design for the second workshop, described in the Section 4.2.3. The design input that this age group made was embedded in their actions and attitudes rather than words; nonetheless, their message was very clear. As users and testers in the design process, their participation was invaluable for the project. They gave us first-hand experience of how they approach storytelling and which elements could be used as design elements, leading to the decision to make a story character-based – a concept based on the children’s current undeveloped reading ability. Some of the contributions to design by the design team children, such as cutting windows and doors on the witches’ house (Figure 4b), were key contributions to our final design. The true test of how well the design team children interpreted and represented younger children’s logic was very visible in the first workshop in Module 3. The result was a full success, encouraging further explorations of the 3D book idea. Another direct and important contribution by older children was the sound and light effects on the boards. The children and the adults worked well together, learned well from each other and showed mutual respect during the entire project. Careful anchoring of what transpired in workshops, and the sharing of visions throughout the project was crucial for making the Book Nook fit with the logic, and abilities, of the young children.

As can be seen from Figure 2, the idea of what the Book Nook is has undergone major changes. Our work demonstrates that it is feasible to engage children in real exhibit design processes. The two-group

organization of the C2C design method provided good workflow, showed important contrasts and balance between all participants, leading to great input to the process. We believe that children were more adequately represented in the Book Nook design process using the C2C method, than they would be with any other method given the time constraints and without a well-established lab with regular meetings throughout the year. C2C, with its two-group organization, is a method for involving less articulate or more vulnerable user groups who do not fulfill the preconditions for standard methods or organizing principles. Young children is one such user group, who cannot read or write, and whose cognitive development is different from the abilities presupposed for most tools and techniques for systems description and presentation. The translation and representation made by the older design team children enabled the design team as a whole to get a better grip on the young children's logic and perspective, hence 'translating' the visions into forms and functions that young children could understand and use.

We therefore argue that C2C is a PD method that enables the participation of less articulate groups – in this case very young children – to participate in and influence design on more equal terms and within a reasonable time frame. The two-group organization strengthens the represented logic of the primary user group by having a secondary group with more articulate users representing the primary group – this is a way to give both voice and decision power to such groups. We believe that the same organization of the design process can support the participation of other vulnerable user groups, e.g., ill, disabled or elderly people.

6. CONCLUSION

We have presented a Child-to-Child (C2C) design method for designing with children for children based on co-design and PD guidelines and principles. The method employed two different age groups of children: the target group of young children, and a group of older children, acting on behalf of the younger ones. An intergenerational team, adults and children equally represented in numbers, carried out design and evaluation. We found our method to be well suited for design of interactive installations in the context of design for a children's museum.

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