A Case for Intergenerational Distributed Co-Design: The Online Kidsteam Example

Greg Walsh
University of Baltimore
1420 N Charles St
Baltimore, MD 21201
gwalsh@ubalt.edu

Elizabeth Foss
Google
1600 Ampitheatre Pkwy
Mountain View, CA 94043
foss@google.com

ABSTRACT
As more children's technologies are designed to be used with a global audience, new tools need to be created to include more children's voices in the design process. However, working with those children who are geographically distributed as design partners is difficult because existing technologies either do not support distributed design, or are not child-friendly. Industries that produce items for children to consume have begun using traditionally academic co-design techniques in order to design new products and experiences for children. As these groups need to reach out to more diverse and global populations, they will begin using technologies that support distributed co-design. As child-computer interaction researchers, we have a duty to understand this concept and identify recommendations for others to use that incorporate the ideals of our field. In order to do this, this paper describes the design process of an online environment to support geographically distributed, intergenerational co-design. Within this environment, children can work together despite differences of time zones, geographic location, or availability. The online environment was deployed for eight weeks during the summer and was modified each week throughout that time to better support the participants. Based on the experiences of participants within the environment, we make suggestions for new technologies including user management tools, creative expression tools, and ad hoc team membership that encourage more voices in the design process.

Categories and Subject Descriptors
D.2.2 Design Tools and Techniques: Evolutionary Prototyping

General Terms
Design

Keywords
Children, Design, Participatory Design, Distributed, Environment, co-design

1. Introduction
Increasingly, children's technologies are designed by academic and industry researchers, engineers, and other adults to attract and address a global audience. However, these technologies often do not include children from across the globe during the design process. Large groups of child users are therefore underrepresented, never given the opportunity to share their requirements and desires for the technologies with which they will interact. In contrast, for children located in the same geographic area as technology designers, many widely-accepted methods exist for empowering users to direct the creation of the products they will ultimately use [3, 14, 20]. Accomplishing the work of collaborative technology design with children who are widely geographically distributed is difficult because existing online tools do not support the iterative and social design process or are not child-friendly. In this paper, the authors describe the wide adoption of co-design from academic to industry settings, highlight the need for distributed cooperative design (co-design) and then take a Research through Design approach to developing an online environment that enables geographically distributed and intergenerational cooperative design.

The authors would like to frame the work presented in this paper within the large research area of Participatory Design. Within Participatory Design lies a smaller focus area known as co-design. When this paper refers to co-design, we mean Participatory Design with a group who has an active role in the design process. This work followed the particular research method of Cooperative Inquiry, nested within the area of co-design. Of these three areas, the authors chose to use the term "co-design" when discussing children co-creating technology designs to emphasize that the problem of how to support this type of work is not specific to one research method. Rather, successfully supporting distributed co-design has broad implications and benefits to any number of methods, ranging from equalized participant representation in the technology design process to the invention of tools that enhance children's ability to express themselves creatively, problem solve, and collaborate.

2. Related Work

2.1 CSCW and Design
Computer-supported Cooperative Work (CSCW) is "an endeavor to understand the nature and requirements of cooperative work with the objective of designing computer-based technologies for cooperative work arrangements" [25]. It is difficult to discuss distributed Participatory Design before understanding distributed design within a CSCW context.

Rodden and Blair [22] describe that CSCW technologies take place over two dimensions: form of cooperation, and geographical nature. The forms of cooperation deal with the temporal aspects of collaborative work as being synchronous, asynchronous, or mixed. Synchronous is defined as work being done at the same time and asynchronous is defined as work being done at different times by team members. The geographical nature dimension describes where the participants are in relation to each other.

IDC '15, June 21-25, 2015, Medford, MA, USA
ACM 978-1-4503-3590-4/15/06.
http://dx.doi.org/10.1145/2771839.2771850

Saad and Maher [23] investigated the role of CSCW in distributed design. They found that collaborative product design, when attempted by distributed contributors, required more complex interactions and information than other types of collaborative work. Another investigation into the use of collaborative technologies developed a tool call Slice [21]. Researchers then observed a geographically distributed team using the tool as they designed a more cost-effective rocket engine. In TeamSCOPE [11], a project that relied on distributed design, researchers determined that a number of tools were necessary to help create a centralized place for distributed teams to keep their designs.

In all of these previously mentioned projects, the main users of the CSCW systems were experts: engineers or professional designers with jobs depending on successful collaboration with other professionals. In terms of Participatory Design, the lack of involvement of end-users is a shortcoming in this body of work. However, these projects are all extremely important in the context of geographically distributed participatory design as they set the stage for future work and provide guidance into the types of technologies and frameworks that would be necessary for distributed co-design.

2.2 Participatory Design and Expansion to Industry

Methods including end-users in the design process of technology are called Participatory Design [24]. According to Read et al. [19], "The Interaction Design and Children (IDC) community considers Participatory Design (PD) as an accepted, and often preferred, method for engaging with children in activities where new technologies for children are being developed." In this spirit of inclusion, children have often been involved in the technology design process, acting in various roles in academic and industry settings. These roles provide a framework for design researchers to follow when eliciting feedback from children or when working with them as full partners and stakeholders in the cooperative design (co-design) of new technologies.

Intergenerational co-design has most often occurred within an academic setting, and working with some kind of government or educational entity or toward a pro-social outcome is common. As examples, in Spain, schoolchildren participated in the design of an exertion interface to encourage physical activity [13] while in Denmark, teenagers co-designed a museum exhibit [10] about Digital Natives.

Academic intergenerational co-design methods are expanding into industry settings, with the successful design of new technologies occurring as a result. The creation of child-focused media company Nickelodeon's app, which won the Emmy Award for Outstanding Creative Achievement in Interactive Media, was aided by the University of Maryland's intergenerational design team [15]. An interesting development has been the privatization of co-design groups in industry; co-design groups that claim no academic ties at all. For example, the global education publisher Pearson has developed their own intergenerational co-design team in 2014 [12]. The team is located in Chandler, Arizona in the United States and is focused on designing a reading app for toddlers. The design firm IDEO [2] uses a similar approach by designing products in a lab with children and then embedding them in households in a similar method to design probes [7].

Traditionally, co-design sessions have been co-located, meaning all the team members are physically in the same place at the same time. Because co-design sessions are co-located, the diversity of their membership is dependent upon those that are able to physically attend a pre-arranged location.

Much like co-design, distributed co-design is being used in industry as well. LEGO is another company that has notably turned to users of their products for design directions [17]. Originally using the online crowdsourcing design platform Cuusoo.com, LEGO has been encouraging people of all ages to submit design new products since 2008. In April 2014, LEGO's CUUSOO BRICK platform transferred to LEGO IDEAS. Users at home can build their ideas for potential LEGO products and then log in to LEGO IDEAS to upload images of their projects. The platform additionally streamlines how projects are classified, asking the user to identify the potential cost, number of sets people would buy, target audience, and difficulty of building for the proposed project. Users can also vote on the ideas submitted by others, and proposed products with a high number of votes are moved into later stages of development.

2.3 A Real-World Co-Design Problem

Besides in a company like LEGO, the need to work with geographically distributed co-design partners is a real-world problem. The International Children's Digital Library [9] was designed by children around the world and required heavily modified techniques to succeed [4]. The ICDL has reached a large number of users and has broad global impact, and their mission is, "to support the world's children in becoming effective members of the global community - who exhibit tolerance and respect for diverse cultures, languages and ideas -- by making the best in children's literature available online free of charge" [9]. As of February 2014, the ICDL has had more than 9 million visitors. It has won numerous awards, such as the American Library Association's President's award for International Library Innovation in 2010 [8] and a Digital Education Achievement Award in 2009 [1]. An international Kidsteam helped develop the ICDL using co-design methods.

Kidsteam, a group of adults and children at a large research university in the United States, has the goal of improving children's technology design and empowering children by including them in the process. Adult stakeholders, often from outside organizations, approach Kidsteam with their design problems. In response, the team collaboratively builds low-tech prototypes or gives product feedback in order to elicit the children's requirements and provide new directions for future iterations to explore. In a typical Kidsteam design session, the team splits into small groups and uses techniques, or creative endeavors that are meant to facilitate the communication of design ideas and system requirements [29]. The children of Kidsteam self-select themselves for one American school year (September through May) and are between the ages of 7 and 11. Kidsteam design sessions occur twice a week after school for the school year.

For the ICDL project, the design team leaders had to modify their traditional co-design techniques (e.g., sticky-noting, low-tech prototyping, and idea frequency analysis, or "Big Ideas") [5], to work with a geographically dispersed group. For example, instead of sticky notes to denote likes, dislikes, and design ideas, a paper matrix was created for design partners to write the same thoughts. The feedback was then physically mailed back to the design leaders at the project's home university. Similarly, instead of low-tech prototyping with art supplies, children from the participating geographically dispersed areas drew pictures on paper and mailed them back. Once a year, a lead team member would travel to the different countries to interview the children about their designs to

get additional insight and context [4]. Ultimately, in order to use co-design with a distributed audience, the ICDL project made compromises to the method and utilized considerable amounts of time and financial resources in order to succeed.

2.4 The Need for Distributed Co-Design

There is a definite need to have broader participant representation when designing products that will reach audiences in different countries and from different cultures. However, a number of problems arise when attempting to accomplish co-design work with a geographically distributed participant group.

Synchronous design activities are difficult when participants' local time zones are far apart. For example, if one participant is in London while another participant is in Los Angeles, they are separated by over eight hours. One participant's morning is another's evening and their window to collaborate online together is small. Carnegie Hall's Weil Institute of Music was interested in distributed co-design in order to improve one of its programs [30] but had difficulty due to the time-zone differences. The children in the program could not work on prototypes together because of time zone differences as one group was in New York City and the other group was in New Delhi, India.

The ICDL team ran into different, yet important, challenges in distributed co-design. The quality of interaction between co-designers usually experienced was reduced because of communication media and distance. The meaningful interpersonal relationships that develop among members of a co-design team did not have the same length of time to develop. Likewise, the quality of the design artifacts was reduced on the ICDL project due to distance. Rather than creating robust 3D prototypes as reflections of design ideas, the international Kidsteam relied only on 2D drawings. Finally, the investment of time to scan and email documents, the cost for researchers to travel to a site, and the lack of iterations and elaboration by all parties in a timely manner reduced the speed of development of the project.

Co-design and participatory design began in industry and were largely concerned with industrial settings [16]. They become a popular topic of study in academia and have come full circle to industry again. Global companies developing products for global consumption have increasingly recognized the benefits of involving end-users in the product design cycle and in recent years, the wide acceptance of co-design into industry settings has resulted in companies frequently relying on co-design input from local users. As a result, people who live close to a company's research centers become the voice for users scattered around the world. As important, industry has begun to incorporate distributed co-design into its design toolkits. Unfortunately, distributed co-design with children has not been explicitly studied.

In order to help alleviate problems such as those described above, the authors developed an online environment to enable geographically distributed, intergenerational co-design. The environment established in this work is important because it enabled intergenerational, distributed co-design by children in different time zones. These contributions can lead to underserved and hard-to-serve populations participating in the co-design process by giving a voice to those who, frequently, cannot participate in the design process of technology due to location, availability, or access to transportation.

3. Method

To investigate the use of distributed co-design methods with children, the authors developed an online design team based on Kidsteam. This group used previously designed tools [28] to collaboratively design over an eight week period. The environment was designed with a Design Research approach to better understand what tools and techniques are necessary to conduct distributed co-design in an online environment.

3.1 Design Research

Horvath [6] described design inclusive research as a methodology framework in which design becomes a vehicle for research. The context is grounded in practice and seeks to create knowledge by generating prototypes. The goals and contexts of this methodology are similar to Research through Design (RtD) [31] in which researchers' prototypes are informed by outside disciplines in order to generate knowledge. Design by research should lead to the identification of a concrete problem and an ideal state that solves the problem. RtD is useful because it provides a lens for those investigating the design processes of different kinds of technologies, including children's technologies. An example of RtD was the development of the reverse alarm clock [18] which was a new way to help children understand when it was acceptable to get out of bed.

3.2 Sessions Structure

The research goal was to develop a set of technologies to support distributed co-design, enabling children in different physical locations to design technologies together. In order to solve this problem within the framework of design inclusive research and RtD, the authors created a web-based online design environment, called Online Kidsteam, as their embedded prototype that an intergenerational co-design team used over an eight-week period. During the eight-week time period, the team's use of the environment informed weekly design changes.

There were four activities, or modules, available within the online environment. These four modules were online representations of the parts of a traditional co-design session: snack time, circle time, design time, and Big Ideas. The modules were intended to replicate the experience of traditional co-design. For example, during in-person Kidsteam, snack time allows team members to freely and openly discuss any topic, and online snack time allowed the same by providing a chat tool. The four activities were iteratively modified and evolved as the experience unfolded.

3.2.1 Completely Asynchronous Co-Design

In the first six weeks, adult and child participants connected to the online environment at their convenience. Most weeks had an introductory video from an adult researcher to the design team explaining the design challenges for the week. The video appeared on a home screen with links to the four different modules of the environment. There was no set way in which the design team was asked to interact with the modules, despite the linear session agenda in which team members would engage in the lab setting.

During this asynchronous period, the design team worked on the following design problems: vacation of the future (Week 1), photography web site for children (Week 2), Online Kidsteam itself (Weeks 3 and 6), and a video game to help young children learn to read (Weeks 4 and 5).

3.2.2 Mixed Synchronous and Asynchronous Co-Design

In the last two weeks of the research period, the environment was used as part of two in-person design sessions that each extended for one week in the online environment. Instead of all of the participants connecting when and from where they wanted, some participants designed in co-located groups while others, unable to join the larger group, continued using the tool as before. During

this period, the design team worked on developing technologies that would help children to be more environmentally friendly.

3.3 Participants

The research was broken up into two parts: one six-week period where participants were at a place of their choosing and used the system as they wanted and one two-week period where the environment was used in conjunction with face-to-face design sessions. In the first part, there were 12 child participants with ages ranging from 7 to 11 (M= 8.9) and 10 adult participants ranging in age from 20 to 48 (M=32). There were six boys, six girls, seven female researchers, and three male researchers. In the second period, there were an additional three girls and two boys who participated: 10 participated in the co-located environment and seven children participated exclusively from their own location within the online environment (M =9.18, N = 17, SD=1.33). All but two of the child participants were or had been members of the design team.

3.4 Data Collection and Technologies

Each week, the design process was documented by the research team in a research journal in three ways: a summary of the week, ideas about the environment that were generated from that week, and an attempt to reframe the problem based on the previous two items. Also used as data for this project were parental communications, interviews, and artifacts generated during each week's design sessions.

Online Kidsteam required a suite of tools to enable participants to design in the distributed environment. The four previously mentioned modules (snack time, circle time, design time, and Big Ideas) were used as the original framework for the tools. The tools were built with a combination of Drupal, PHP, JavaScript, HTML, MySQL and Adobe Flex.

Flex is an open source variant of Adobe Flash. Its language is similar to Java and was designed to aid in the development of Web-based applications. Conversely, Flash was designed as an animation tool although it has been used as a development platform. Flex is compiled into a Shockwave Flash File, or SWF, and embedded as an object within an HTML page. SWFs can communicate with HTML objects through JavaScript. The use of Flex and the AWave MP3 library enabled a web-based application for recording audio. This functionality has traditionally been difficult in Web-based tools. With the addition of this component, asynchronous notation through voice was possible.

There were semi-structured, open-ended interviews with the child participants that took place at two points in the research period: the mid-point and at the end. Some participants were asked all of the questions at the same time due to their inability to be interviewed earlier in the project. All interviews were conducted with the internet-based voice tool Skype and recorded to an audio file. The interview at the mid-point asked participants about their experiences as members of the online environment. There was a pre-survey about expectations. This survey used a Likert Scale modified for use by children.

An open coding system in the style of Grounded Theory [27] was utilized. Interviews were transcribed. After one-third and two-thirds of all of the interviews, a code-check was completed with two adult members of the online environment to see if the coding scheme was accurate.

4. Findings

4.1 Distributed Co-design Sessions

4.1.1 Initial Design Directions

The first version of the environment began with an existing version of a tool previously designed for intergenerational design called DisCo [28] combined with a Drupal content management system to support online cooperation. This was a basic version of the environment. The design challenge for the first week was to create a vacation of the future.

At the end of Week 1's design session, the participants wanted social interactions in ways that hadn't been anticipated. Participants wanted the addition of avatars and a list of participants to create a sense of physical presence that was lacking in the online environment. Also, making the environment more child-friendly by changing the formats from the default settings of time and date was a recommendation resulting from the session. In Week 2, several parents contacted the authors to let us know that the screen was too big for small laptops. Due to the non-responsive design nature of DisCo, the tool was being cut off on small laptops such as the MacBook Air and the Intel Classmate PC. More frustrating for users, the environments reliance on Flex prevented the environment from running on the Apple iOS devices.

In week 1, the authors noticed that only one of the child participants initiated designing prior to an adult contributing. In order to investigate this observation, the adults were asked to not participate in the design sessions for the first few days of week 2 to give the children a chance to initiate designs, and surprisingly, no child participants did. The adults were then prompted to participate. Consequently, two of the children added their ideas to several of the designs. The lack of participation in the design time module on the part of the children was in contrast to their participation in the snack time and circle time modules. The low levels of participation within the design time module led to the addition of a motivation system for all module activities.

In Week 3, the authors added functionality to the online environment that awarded points for various actions on the site to increase motivation. The design time activities gave the most points and the most popular activity, snack time, awarded no points. There were two rewards for the most active user: the top point earner per week would be congratulated on the homepage, and was awarded a virtual badge that appeared with his or her avatar. The ability to directly message another user was granted if a participant scored a low entry level of points. In other words, if a participant added an idea to the design session, they received the ability to message other users. This functionality was included in order to prevent the design environment from becoming a communication-only environment.

During Week 3, the authors received emails from two parents about the environment. Both suggested that the typing required by the environment was extremely difficult for younger participants and the parents were typing for the children. The parents also mentioned that the design activities were too abstract for their younger children. One articulate parent stated that his child thought it wasn't as fun as the face-to-face Kidsteam because it was asynchronous and another parent thought the entire site relied too heavily on words and suggested using pictures and video for instructions. Although the authors had used videos in weeks one and two, they did not use them in week three, and this had proved to be problematic for some of the participants.

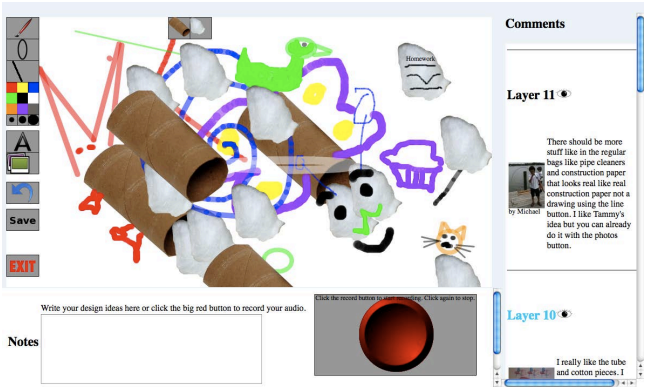

Figure 1 - Screenshot of Design Tool with Found Objects

The topic for Week 3 was helping to design the Online Kidsteam environment to better suit participants. The weekly design challenge was broken up into three sub-challenges: tools to help communicate with other team members while designing, tools to design within the environment, and tools to help participants make new technologies instead of merely designing them. For example, participants would actually use a tool to develop fully functioning software instead of theoretically designing that software.

During the design time from Week 3, many of the ideas the participants added in the environment for communicating with other participants while designing were focused on synchronous communication. There were suggestions for both audio and visual communication, as well as the novel idea of using three-dimensional technologies to communicate with other participants through their televisions. One participant, age 7, did think about the problem of communicating with other participants asynchronously. In her design, as transcribed by her mother, there would be "a discussion area to plan that is separate from the project." This suggestion is interesting because though design time area was intended to act as a work area to describe and iterate on ideas, the system didn't support participants communicating to plan activities. This is not unlike previous findings that children are less forgiving of what they create with a computer than what they build with arts supplies [28] and they seem to want to get it "right" before they start.

The ideas from Week 3 for new ways to design were centered on improvements to the existing environment and novel interaction design by both the child and adult participants. For example, one participant, an adult, wanted three-dimensional images to appear over real objects while designing; when designing a new shoe, the designer could overlay the mock-up over his real foot. Another participant, age 11, wanted a projector and touchscreen interface that appeared on a wall. Finally, ideas from Week 3 about tools to make new technologies were inconclusive as only two children participated in this section.

Because Week 3 was self-reflective on the design environment, there were many ideas generated to improve the Online Kidsteam experience for participants, including the ideas generated through analysis of the parental communications: the need for audio in the design session, the need for a motivation system, explicit instructions for the children through video, incorporating live communication, scratch pad functionality to enable refining designs before placing them into the main design area and to enable more creative expression, bringing three-dimensional design tools and interaction to the design area, and reducing ambiguity in the design prompts in order to reduce confusion for the participants.

4.1.2 New Tools for Expression

In Week 4, the design team returned to designing new technologies for children. The topic of the week was to design a video game that could help young children learn to read. The three sub-tasks were: What kind of game would children like to play?, What characters should be included?, and Which stories should children read? In order to address the problem without the design challenges being too abstract, per the lessons from Week 3, the authors posed the design sub-task as questions.

In this week, the authors added the ability for participants to record audio during design time. In order to simplify the design and make it easier for all participants to use, the authors added a large-sized audio recording tool in the shape of a red button to the area where the designers write about their ideas. The designers could then speak their ideas into a microphone and the system captured their voices, encoded the audio into an MP3, and uploaded the audio file to the server. The system required designers to either write in the text box or record audio to describe their contribution.

When another designer came to the design module area after a previous participant/designer recorded audio, the timeline of comments would display a standard play button instead of text. In order to demonstrate this feature to participants, one author made an audio recording for each sub-task prompting and describing the activity.

To address the design idea from Week 3 of using video as instruction and as a motivator to contribute to the online environment, one author recorded a video with a recap of the previous week's design ideas and then described what the group would be doing this week. The video described the background on the challenge and announced the prior week's high scorer. The video also gave instructions on how to use the play and record buttons and reminded the group about scoring points. In this way, the design prompt and the new feature were introduced to the participants using two modalities to ensure that the new feature could be easily used and that the design prompt was clear.

During Week 4, parents reinforced that there was an unforeseen limitation for younger participants beyond typing. In synchronous Kidsteam, younger children (ages 7 and 8) work with older children (9 to 11) or adults to complete the design tasks. In an online environment, the younger participants were at a disadvantage if trying to accomplish the design challenges independently, as they often did not know how to overcome the technical challenges posed by their computer use.

4.1.3 New Design Tasks

In Week 5, the design team had two design challenges. The first design challenge asked the participants to use the current Online Kidsteam tool to express their likes, dislikes and design ideas of the low-fidelity prototype of the children's reading game created based on the group's designs from Week 4. The design ideas from Week 4's design session were used to create a drawing of the game with a text description using actual paper, pencils, and crayons. Then, the authors took a digital photo of those drawings and inserted them into the Online Kidsteam environment canvas using the photo tool. In all previous weeks, participants had designed on a blank canvas, so this addition of their actual design represents not only a deviation from what the participants were used to, but also a step forward in the design of the reading game.

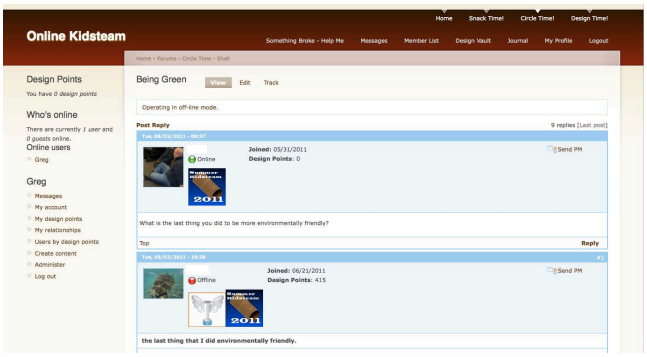

Figure 2 – Screenshot of the virtual Circle Time

When the Stickies technique is used as an in-person activity, the design partners write one like, dislike, or design idea on a sticky note and place it on a surface. A member of the design team organizes the sticky notes into general commonalities, or trends, which draw the attention of the group to areas of the design that need improvement or that should remain the same. For the online activity, the authors asked the design team to only put one thought into the design tool and to preface the comment with the words "like", "dislike", or "design idea".

The participants posted their likes, dislikes, and design ideas. This resulted in 20 comments from 12 different participants. Some of the participants wrote their design ideas but then drew something to augment the mock-up. Both writing a design idea and then creating a drawing of the design idea was unique to the Online Kidsteam environment. Participants are rarely observed drawing and writing during this activity in a synchronous session with paper materials. Instead, the Online Kidsteam environment enabled designers to augment the designs even during design stages of evaluation and critique.

Although this feedback generation tool worked well, there were problems that need to be addressed in future revisions based on the design artifacts. Based on the interviews, the research team learned that the back and forth within the browser required of participants to make multiple comments was difficult, as participants needed to hit their back buttons in order to make a new comment. There was also no way to easily manipulate the likes, dislikes and design ideas into clusters for analysis as is done in synchronous sessions with paper artifacts.

The second challenge for Week 5 was to play with a reconfigured Online Kidsteam environment that used graphics of three-dimensional found objects such as cotton balls and toilet paper rolls. These graphics mimicked the tools and objects available in the low-tech prototyping activity called Bags of Stuff. By prompting participants to use this reconfigured Online Kidsteam environment, it was possible to expand the repertoire of design activities available within the environment. Up to this point, participants had only been able to mimic some of the synchronous Kidsteam design activities, such as providing feedback or generating two-dimensional drawings, and iterating on each other's designs. The addition of found object graphics attempted to mimic the use of the Bags of Stuff technique within the online environment. (See Figure 1). This version of the design tool was not well received because it looked three-dimensional but didn't have the affordances of three-dimensional objects.

Week 5 was the first week in which the Online Kidsteam environment needed to be more than just an extension of paper prototyping tools and instead move into a new direction by incorporating different design activities that do not exist in in-person co-design sessions. It was also an example of how the online environment can surpass instead of mimic the paper-based methods on which it is based, as the participants were able to draw out their design ideas, which is not possible with the traditional feedback activity of likes, dislikes, and design ideas

Based on Week 5's design ideas, Week 6's topic was a new e-Bags of Stuff tool that included additional objects with which to design. Squares of virtual construction paper, pipe cleaners, and popsicle sticks were added to the toilet paper rolls and cotton balls. The pipe cleaners and popsicle sticks were each available in four different angles. When a designer used the pipe cleaner tool, the system randomly chose one of three colors. All the previously existing DisCo features were also available (drawing tools, etc).

The e-Bags of Stuff tool was still not well received by the designers even after incorporating many of their suggestions while maintaining the same user interface as the previous DisCo tool. This was not surprising, as experiences with face-to-face Kidsteam have shown that Bags of Stuff is one of the favorite activities of the children. Much of the feedback involved the limitations of the two-dimensional graphics and the desire for true three-dimensional assets that are movable and can be rotated.

This week was also a lesson on the shortcomings of two-dimensional workspaces. The concept of Bags of Stuff did not work with the Online Kidsteam paradigm of flat layers and the two paradigms (three-dimensional objects and two-dimensional renderings on paper) are not compatible in this context. This problem may be due to the fact that there was already a positive attachment to Bags of Stuff because of in-person use that the child designers did not enjoy the translation to in the online environment.

4.2 Co-located Design Sessions

4.2.1 Initial Co-location

In week 7, the Online Kidsteam environment was used in a different way than the previous six weeks. Instead of all of the participants connecting when and from where they wanted, some participants designed in co-located, intergenerational groups while other continued using the tool as before. Other changes included the entire co-located design team logging into Online Kidsteam and answering their questions of the week within the environment instead of partaking in a traditional circle time (See Figure 2). This was called virtual circle time.

After virtual circle time, the children were split into three smaller groups made up of participants of Online Kidsteam, exclusively face-to-face Kidsteam members, and adult participants. The goal of the week was to design something to help more children be environmentally conscious at home, school, and while visiting the White House. The groups were assigned to the topics, given discrete amounts of time to design for one context (home, for example), and then were asked to move on to another design context (school, for example). This was repeated so that all of the groups were able to add to each of the design contexts. All of the design work was conducted within the Online Kidsteam environment, but some participants were synchronous and co-located. Using the online environment enabled non-co-located participants to elaborate on the designs created during these sessions as well. After the co-located group had finished, participants in remote locations were able to add to the designs as well. One participant in Online and face-to-face Kidsteam who was unable to attend this particular design session added her ideas to the three contexts at a later time.

In previous versions of the environment and the DisCo tool, only one person was credited with authorship if multiple designers

Figure 3 - Children around a computer while accessing the online environment using the multi-person "clumping" login.

were working on the same creation at the same computer. For example, if three participants sat together at the same computer and added their design to the environment, the only one that would be attributed in the notes section would be the one that was logged in. In order to prepare for co-located design work by some participants, a new author attribution system that allows multiple users to log in to the design tool was implemented, enabling multiple attributions. We call this a "Clumping" login because the phrase clumping is sometimes used by the authors in face-to-face design sessions to describe children gathering around one machine. (See Figure 3). The problems previously experienced, such as difficulty typing or drawing, seemed as though they began to disappear in a synchronous multi-user environment.

4.2.2 A New Tool to Support a New Task

In Week 8 of using the Online Kidsteam Environment, the design team elaborated on the Week 7's ideas by expressing their likes, dislikes, and design ideas about their designs for environmental stewardship in different contexts. This activity was similar to Week 5 and based on Week 5's design ideas. A new tool was designed to be used within Online Kidsteam called LaDDI (laddie) that captured likes, dislikes, and design ideas and displayed them as virtual sticky notes to allow for clustering analysis.

Although the screen layout was based on the existing design time experience, there was a difference in functionality. The screen was divided into four sections: attribution, prototype, design section, and existing comments. The attribution section displays who is associated with this design session and enables users to add other co-located co-designers in the same way that DisCo does. The prototype section demonstrates the low-fidelity prototype being worked with. In the design section, participants can chose "Like", "Dislike", or "Design Idea" from a drop down menu and then fill in their idea. The existing comments section displays the feedback and design ideas from other participants (See Figure 4).

In order to organize the notes developed with the LaDDI tool, a second tool was designed that puts each of the pieces of feedback on to a virtual "sticky" note and arranges them in the order that they were entered. When all of the likes, dislikes, and design ideas have been entered into LaDDI, a designer can organize and lay them out in a virtual whiteboard to group the similar items. This enables designers to develop frequency counts of ideas and concepts in order to inform the next iteration of the design.

The entire group used the LaDDI tool to evaluate and expand upon the ideas generated by Week 7's design session. After reviewing the Big Ideas generated in that design session, the authors developed a video animation of one of the ideas that was thought to be both novel and practical: a park-based smart recycling bin that sends a message through the Twitter service when it is used correctly and incorrectly. The video featured paper animations of the main features of the recycling bin while maintaining a feel that it was very easily changeable in order to encourage a design discourse.

The design partners were able to watch the video and then enter a like, dislike, or design idea. This was different than the workflow used in Week 5 because the LaDDI tool forced them to choose a category for their feedback. Also different from the previous version was the fact that the designers stayed on the same page after submitting their input and did not need to leave and re-enter the design tool in order to add a new idea.

The tool was successful in capturing many generated ideas for the next iteration of design. There were over 100 pieces of design feedback from the design partners who were both co-located and distributed, many more than in comparison to earlier weeks. In one case, one design partner displayed such high engagement that he worked in the co-located group during the lab-based activities and then went home to form another co-located group with his brother who was only participating in the online activities.

Many of the design partners were driven to earn points during this activity and asked clarifying questions to ensure they would receive points even if they continued to use the clumping login implemented the week before. Based on the author's journal, the level of engagement displayed by the design team using the LaDDI tool surpassed that of observed engagement during any traditional Kidsteam session in which the Stickies technique was used.

5. Discussion

The Research through Design framework combined with the co-design method worked well in the iterative design of the geographically distributed co-design environment. Research through design contributed the iterative design through prototyping, while the co-design method allowed the author a baseline of design activities from which to draw into the online environment. The iterative design of Online Kidsteam happened in three phases: the overall environment, the refinement of a major tool, and the development of additional tools to support the environment.

In order to support distributed co-design, the first few weeks saw multiple changes to the overall environment from the original design. Most of the environment changes were content-based, meaning creating additional content and tailoring the content to meet the needs of an intergenerational design team. The additional content was in the form of instructional videos, graphic badges, and new sections of the environment.

The Online Kidsteam environment went through major revisions during this project. New drawing tools, such as additional colors and e-Bags of Stuff, were added in order to support creative expression and to meet participant requests, as well as to allow for additional design activities within the environment. An audio tool was requested and implemented, although not often used, in order to meet the needs of young design partners who have difficulty typing. A novel way for multiple design partners to indicate

authorship for group designs was developed to support co-located group design that may occur in homes or dedicated design spaces.

In terms of additional tools, the LaDDI tool was added to the Online Kidsteam environment as a way to expand the kinds of design activities available in a distributed, asynchronous environment. By enabling small amounts of design ideas to be expressed quickly and easily, the number of ideas generated was increased to about five times those generated through the DisCo tool. The LaDDI tool also opens up new research opportunities with the field of Natural Language Processing and Machine Learning to develop visualization techniques and automated organization of the ideas.

This environment enabled distributed co-design and addressed many of the limitations identified in the previous literature. For example, had an environment that supported distributed co-design existed during the development of the ICDL, the turn-around times on ideas could have been reduced by not requiring items be sent in the post. Interpersonal relationships between the child participants could have been more easily established with the computer supported communication inherent in an online environment. Carnegie Hall could have used an environment like this to enable co-design between children in New York City and New Dehli who were separated by a large time zone difference.

5.1 Technology Recommendations

Based on analysis of each week's design session and interest in supporting both the co-design aspects as well as the positive experiences for children and adults, the authors have developed a list of functionalities that need to be included in an online environment to support geographically-distributed, intergenerational co-design. Some of these features were implemented throughout the development cycle of this work, but some participant problems were not described until after the 8-week period had finished and those interviews led to the suggested design. The authors feel that these recommendations are the first steps to continuing the investigation of online distributed co-design.

5.1.1 User Management

Like many modern online systems, distributed co-design tools needs to maintain a database of users. The database stores information about each user including login and password, roles the user can perform, and if creating a reward system, points the user has earned and awards that the user has achieved. Users could have a profile page, which is useful if members of the team are not familiar with other members, as is likely for many projects with wide geographic distribution. User management needs to be flexible to incorporate the addition of others into the design team in order to address the needs of children who would like to invite friends or family to participate.

5.1.2 Malleable Creative Expression Tool

The current online environment supports creative expression through the drawing and LaDDI tools. The existing tools enable intergenerational co-designers to create, elaborate, share, and evaluate designs from within the environment. Different designers and contexts will no doubt give rise to the need for new tools for creative expression. These new tools need to be developed to enable participants to express their designs in ways that are fitting to the design space and maturity of the design problems. These tools also need to be malleable and support designers that want to change their designs. The request for a planning area reinforces the notion that some children view something made on a computer as "final" and feel like they need to prepare ideas in a separate area before committing to the design.

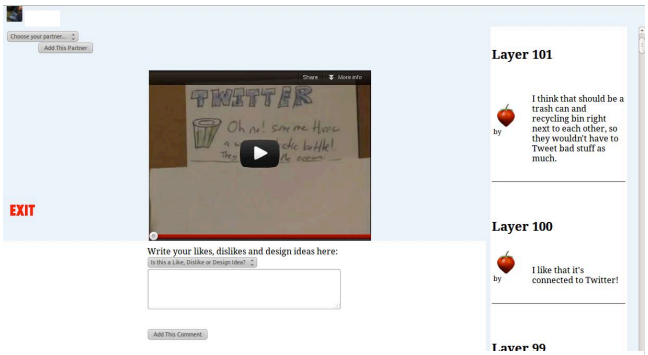

Figure 4 - Screenshot of the LaDDI tool.

5.1.3 Multi-Device Support

The most important technological requirement is the need to support portable, tablet devices, and not just the traditional computer with a browser. Our users did not want to draw with the computer. Several times through the design sessions and in post-participation interviews, children mentioned that they wanted to draw with their finger on a touchscreen device. Some parents also requested the environment be usable on the iPad or iPhone because of the difficulty with recording audio on a traditional computer. Due to these reasons and the growing number of users of tablets and smartphones, an online co-design environment should be available for multiple devices.

5.1.4 Design Forking

During in-person design sessions, the design partners are encouraged to create one solution per group, although that does not always happen. Instead, the individuals in each group sometimes create their own design and those designs are combined with others at the end to determine the requirements of the design. In Online Kidsteam, creating an individual design was difficult. Some participants mentioned in the interviews that seeing the designs of others made their work harder. One participant even wanted to be able to start from scratch. A system feature that allowed designers to "fork" the design or start with a blank canvas would be beneficial even though it has the possibility of stifling collaboration if each designer did this every time. This would support the ideas of Read et al [19] to track individual contributions. If the goal of the design session is to come up with only one idea via the group, a solution would be to limit how often this act can be done through points or some other system. That way, forking a design would consume a resource and design partners would need to consider the benefits and costs of not being collaborative. Current tools such as Scratch [26] that allow users to remix others' designs in a similar manner.

5.1.5 Ubiquitous Audio and Video Recording

Audio recording, as well as Speech-to-Text, has the potential to help level the difficulties that younger design partners had with typing and mouse control while drawing. In this work, some participants had expected the audio recording to be throughout the environment and not just in the design session. Also, participants had mentioned that they would like to have the option of recording videos for the more discussion-based interactions instead of relying on text only. The system should support audio or video recording wherever there is a text input. This could alleviate some of the text input problems that participants had throughout the project.

5.1.6 Ad-hoc Intergenerational Design Teams

A challenge to overcome was the difference in design partners' abilities to communicate in an online tool and their ideas on what would help them to better communicate. The most logical conclusion to difficulty in typing would be to enable the designers to record their voices. As mentioned, this was added in the final prototype and was available for over two weeks of design sessions. But, very few participants took advantage of it. The adult participants only used it when asked to try it out and only two children used it. The prototype used the Adobe Flash Player, which enables audio recording once end-users make a change in their security settings—a change that required technical knowledge. Some parents and children took a decidedly low-tech approach and had a parent type for the child. We suggest that any type of intergenerational distributed co-design must be able to include the ability to add family members to the design team in either a formal or informal way in order to enable co-located design. Family members could be added to the design team through an informal, ad hoc mechanism that extends the clumping login by enabling new membership. In this way, participants can add family "on-the-fly" while creating a design. This way would be useful for including family members in the design team who do not want or cannot make the commitment to regularly participate. It could also be used as a way to include friends or introduce new members to Online Kidsteam.

5.1.7 In-Environment Tracking, Communication, and Synchronous Design

Although the asynchronous nature of the design environment exists in order to accomplish the goals of geographically distributed audiences, it would be best to support real-time communication between those participants who are on at the same time. In order to accomplish this, there needs to be reporting of who is online and "where" they are in the environment. The system currently lets users know if others are online but it doesn't display a way to contact specific users in real-time.

To accomplish this, the online environment would present all users with a list of other users logged in and the module of the environment that each one is interacting with at that time. The location would be important in case users wanted to participate in the same section as other designers concurrently. Participants would be able to click on a name and message that user in real-time.

Communication between adult researchers and child-designers would also occur within the design environment due to the lack of email addresses for the child participants. Participants would be able to define some other contact medium, for example a parent's email or phone number with text messaging, that the environment could push messages to as events happen or other users try to contact them.

The final requirement that the online environment needs to satisfy is the ability for all design partners to synchronously design regardless of geographic location. Synchronous co-design is not mutually exclusive from distributed co-design and scenarios where distributed intergenerational co-designers in adjoining time-zones working with intergenerational co-designers in geographical areas several time-zones away are foreseeable. In this scenario, the designers in adjoining time-zones could synchronously work together and then designers in a different time-zone could add to those designs at a later time by synchronously working together amongst themselves regardless if they are co-located or not. We call this co-synchronous co-design. In co-synchronous co-design, the online environment supports asynchronous co-design through a persistent design area that also enables synchronous design. This is not dissimilar to the way the tool was used in the last two weeks of Online Kidsteam except that the synchronous designers were co-located. Co-synchronous co-design extends Rodden and Blair's ideas of synchronous, asynchronous, and mixed states of cooperation by more explicitly describing the elements of the "mixed" cooperative state and what kinds of activities are being included in this mix.

6. Limitations

The Participatory Design method employed throughout the research period was Cooperative Inquiry. This method focuses on children and adults working together as partners in the design of new technologies for children. Because this method was used as the basis for the online tools and techniques during this study, other methods that are used to gather requirements for children's technologies may not work with the online environment without some modification or customization of how the tools are utilized. That being said, there is no reason why these tools and lessons learned could not apply to any number of methods of co-design.

The timeframe for this research was eight weeks in the summer. Of the eight weeks, six of those weeks tried to replicate the in-person Kidsteam experience within the online environment and two of the weeks tried to augment in-person Kidsteam with Online Kidsteam. This time period was relatively short compared to other Cooperative Inquiry instantiations. In-person Kidsteam takes place twice a week over one academic school year. The shorter time frame for Online Kidsteam was necessary to enable participation in the summer when the child participants were not in school and to not interfere with in-person Kidsteam's schedule.

Ten of the twelve child participants of Online Kidsteam had participated in in-person Kidsteam at one point in time. Experience with Kidsteam methods was necessary to work within the time frame available. As all the participants were familiar with the Kidsteam model, it is impossible to tell if the design environment would be applicable and approachable to all children without modification and tutorials.

7. Future Work & Conclusion

In this project, the authors developed a tool and tested the tool with a group of experienced designers. Iterative design was important as technical specifications allowed for incremental changes and were in line with RtD approach. The tool enables a previously difficult design situation in which physical distance and problems surrounding time planning (time zones, daily schedules) created obstacles to co-design. This research opens the door for more research into new tools that enable creative expression, new ways for intergenerational groups to work together and an opportunity to explore the experiences of the participants.

This research has just scratched the surface of geographically distributed, intergenerational co-design. Including more voices into any design process is extremely important especially as more projects involving children become international and global in reach. This ability to collaborate will become more integrated into Child-Computer Interaction. Just as important to academia, these tools and techniques are becoming more important to industry as well. It is important that Child-Computer Interaction continues to investigate and innovate in this field.

8. Acknowledgements

We would like to thank the children and adults who participated in Online Kidsteam, including Mona Leigh Guha, Jason Yip, Beth

Bonsignore, Evan Golub, Tammy Clegg, Emily Rhodes, and especially, Allison Druin for her guidance through the project.

9. References

[1] 2009 Digital Education Achievement Award Winners Announced!: *http://www.convergemag.com/awards/education-achievement/2009-Digital-Education-Achievement-Award-Winners.html*. Accessed: 2011-03-19.

[2] 3 Secrets To Designing Great Toys, From LeapFrog and Ideo: *http://www.fastcodesign.com/1673340/3-secrets-to-designing-great-toys-from-leapfrog-and-ideo*. Accessed: 2015-02-04.

[3] Druin, A. 1999. Cooperative inquiry: developing new technologies for children with children. *Proceedings of the SIGCHI conference on Human factors in computing systems: the CHI is the limit* (New York, NY, USA, 1999), 592–599.

[4] Druin, A. et al. 2009. From New Zealand to Mongolia: Co-Designing and Deploying a Digital Library for the World's Children*. *Children, Youth and Environments*. 19, (2009), 1.

[5] Guha, M.L. et al. 2004. Mixing ideas: a new technique for working with young children as design partners. *Proceedings of the 2004 conference on Interaction design and children: building a community* (2004), 35–42.

[6] Horváth, I. 2007. Comparison of three methodological approaches of design research. *International Conference on Engineering Design, ICED 2007* (2007).

[7] Hutchinson, H. et al. 2003. Technology probes: inspiring design for and with families. *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems* (New York, NY, USA, 2003), 17–24.

[8] ICDL - Library News: *http://en.childrenslibrary.org/press/current_news.shtml*. Accessed: 2011-03-19.

[9] ICDL - Mission: *http://en.childrenslibrary.org/about/mission.shtml*. Accessed: 2011-03-19.

[10] Iversen, O.S. and Smith, R.C. 2012. Scandinavian participatory design: dialogic curation with teenagers. *Proceedings of the 11th International Conference on Interaction Design and Children* (2012), 106–115.

[11] Jang, C.-Y. et al. 2002. Virtual team awareness and groupware support: an evaluation of the TeamSCOPE system. *International Journal of Human-Computer Studies*. 56, 1 (Jan. 2002), 109–126.

[12] Kids help design reading app: *http://www.fox10phoenix.com/story/27379572/2014/11/13/kids-help-design-reading-app*. Accessed: 2015-02-04.

[13] Landry, P. et al. 2013. Design strategy to stimulate a diversity of motor skills for an exergame addressed to children. *Proceedings of the 12th International Conference on Interaction Design and Children* (2013), 84–91.

[14] Large, A. et al. 2006. "Bonded design": A novel approach to intergenerational information technology design. *Library and Information Science Research*. 28, 1 (2006), 64–82.

[15] Marentette, L. 2013. Interactive Multimedia Technology: Allison Druin and the HCIL Team Win Emmy for Nick App: Outstanding Creative Achievement in Interactive Media-User Experience and Visual Design. *Interactive Multimedia Technology*.

[16] Muller, M.J. and Kuhn, S. 1993. Participatory design. *Commun. ACM*. 36, 6 (1993), 24–28.

[17] Naranjo-Bock, C. 2012. Co-designing with Children. *UX Matters*.

[18] Ozenc, K.F. et al. 2007. Reverse alarm clock: a research through design example of *designing for the self*. *Proceedings of the 2007 conference on Designing pleasurable products and interfaces* (New York, NY, USA, 2007), 392–406.

[19] Read, J.C. et al. 2014. Giving ideas an equal chance: inclusion and representation in participatory design with children. *Proceedings of the 2014 conference on Interaction design and children* (2014), 105–114.

[20] Read, J.C. 2010. MESS Days: Working with Children to Design and Deliver Worthwhile Mobile Experiences. *UPA User Experience Magazine*.

[21] Rice, R. et al. 2000. Computer Mediated Interorganizational Knowledge Sharing: Insights from a Virtual Team Innovating Using a Collaborative Tool. *Knowledge Management and Virtual Organizations*. Y. Malhotra, ed. Idea Group Inc (IGI).

[22] Rodden, T. and Blair, G. 1991. CSCW and distributed systems: the problem of control. *Proceedings of the second conference on European Conference on Computer-Supported Cooperative Work* (Norwell, MA, USA, 1991), 49–64.

[23] Saad, M. and Maher, M.L. 1996. Shared understanding in computer-supported collaborative design. *Computer-Aided Design*. 28, 3 (Mar. 1996), 183–192.

[24] Sanders, E.B.N. et al. 2010. A framework for organizing the tools and techniques of participatory design. *Proceedings of the 11th Biennial Participatory Design Conference* (2010), 195–198.

[25] Schmidt, K. and Bannon, L. 1992. Taking CSCW seriously. *Computer Supported Cooperative Work (CSCW)*. 1, 1 (1992), 7–40.

[26] Scratch - Imagine, Program, Share: *http://scratch.mit.edu/*. Accessed: 2015-02-05.

[27] Strauss, A. and Corbin, J.M. 1990. *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications, Inc.

[28] Walsh, G. et al. 2012. DisCo: a co-design online tool for asynchronous distributed child and adult design partners. *Proceedings of the 11th International Conference on Interaction Design and Children* (New York, NY, USA, 2012), 11–19.

[29] Walsh, G. et al. 2013. FACIT PD: A Framework for Analysis and Creation of Intergenerational Techniques for Participatory Design. *Proceedings of the 31st international conference on Human factors in computing systems* (Paris, France, 2013).

[30] Walsh, G. et al. 2011. Social networking as a vehicle to foster cross-cultural awareness. *Proceedings of the 10th International Conference on Interaction Design and Children - IDC '11* (Ann Arbor, Michigan, 2011), 209–212.

[31] Zimmerman, J. et al. 2007. Research through design as a method for interaction design research in HCI. *Proceedings of the SIGCHI conference on Human factors in computing systems* (2007), 493–502.