Administrative Information

Grant Award: MG-45-16-0011-16
Institution: Children's Creativity Museum
Project Name: Thinking Outside the Sandbox: Adapting an Augmented Reality Tool for New Audiences
Amount Awarded: $24,915
Project Dates: 1 August 2016 – 31 July 2017
Project Director: Carol Tang, Executive Director

Project Summary

The Children's Creativity Museum was founded in 1998 as Zeum, an art-and-technology youth studio, but pivoted in 2012 with a re-branding and new focus on younger audiences. CCM maintains a strong commitment to deploying appropriate technology and digital media that enhances children's creativity in innovative ways beyond passive consumption of screen time.

The Augmented Reality Sandbox is a project designed by U.C. Davis to model the interaction between topography, precipitation, and watersheds. AR Sandboxes are deployed in hundreds of institutions around the world, ranging from permanent installations to temporary outreach opportunities. The Children's Creativity Museum adapted the use of the AR Sandbox for early childhood learning and created exhibition supports that make it feasible for museums to include an AR Sandbox at their own sites. These supports included:

- Casework that can be disassembled and transported in a minivan for outreach purposes.
- A design that allows for usage by toddlers and preschoolers.
- A design that allows for interaction through all four sides of the sandbox for a stand-alone exhibit.
- Accessory items including special flooring, a hand cleaning station, and trays to catch sand and prevent it from being tracked outside of the exhibit.
- Interpretive materials including graphics and training guide to facilitate the experience with young children.
- Software recommendations to allow for two different content-based experiences.

With the grant, CCM was able to build the original proposed interactive as well as a second one offering a second experience. Upon opening, the AR exhibition became the most visited exhibit in the museum with 88% of all visitors rating it as "Excellent." In a small observational tracking study with 30 family units, the average dwell time was 15 minutes with over half of caregivers engaging with the sandbox with their children.

Process

CCM staff visited existing AR Sandboxes and consulted with Dr. Sherry Hsi, formerly of the Lawrence Hall of Science, who helped create the AR Sandbox for educational purposes with U.C. Davis. Tom Durkin, CCM's Exhibits Manager, conducted a thorough review of current open access software and designs from AR Sandbox community website: https://arsandbox.ucdavis.edu/about/. CCM purchased off-the-shelf hardware—projector, sensor and CPU—based on recommendations by AR Sandbox community and original project directors. The coding modifications needed to implement a unique and innovative design were accomplished by in-house Exhibits staff with no consultants needed, and the resulting code was shared on a public, open source repository on GitHub: https://github.com/tdurkin1/Magic-Sand/tree/Magic-Sand-CCM-Mod/Magic-Sand-CCM-Mod.xcodeproj

Similarly, when it came time to build the casework housing the hardware and the sandbox, CCM staff modified existing designs to create an original design. The designs were prototyped by staff, museum members, and members of the general public in different design stages. A major design factor that emerged from the prototyping process was optimal height. Through deploying the sandbox at multiple different heights with several age groups, we discovered that two optimal heights would allow us to serve the wide range of visitors at CCM.

Given the resources saved by using in-house expertise for modifying the software code, CCM decided to build two interactives and test different software programs to offer two distinct experiences appropriate for the range of age groups visiting the exhibit. One is at a lower height and features an activity where children can move the sand to create land mass or bodies of water and observe impacts on animal movements projected onto the sand (i.e., biogeography, bridge/barriers to migration). On this interactive, land imagery is projected on higher levels of sand and water imagery is projected on lower levels of sand. On the higher interactive, we installed the original AR Sandbox software where topography and hydrographic conditions can be modeled with layers of color projected onto mounds of sand in the sandbox.

CCM exhibits staff used the design and construction documents at TechShop, a for-profit membership-based makerspace located near the museum, to build the casework.

We understood that along with lack of technical capacity in most children's museums, another barrier that prevents museums from installing the AR Sandbox is the concern about sand. Thus, CCM designed, tested, and built several elements to decrease sand trackingand make it more feasible for a children's museum: (1) a hand cleaning station where visitors can brush off sand before leaving the exhibition, (2) spillover troughs along the edges of the exhibition to prevent sand from spilling out of the sandbox, and (3) flooring that allowed for the sand to be trapped in the exhibition and not tracked elsewhere in the museum.

CCM also created a facilitation guide and interpretive signage designed for parents with young children. These materials were prototyped before final deployment. The facilitation guide will be used to train about 30 interns and volunteers annually.

CCM was able to share this project, lessons learned, and preliminary results at two presentations at the Association of Children's Museums Annual Conference (Pasadena, September 2017) and in an article for the Association of Children's Museums Hand-to-Hand member publication (Fall 2017). Lastly, the blueprints for the exhibition have been shared with the AR Sandbox Forum with open-source permissions.

Results

Goal 1:
- Adapt the AR Sandbox software and interactive for use by young children.
- Create an engaging digital exhibition for young children featuring STEAM principles and concepts.

Upon launch in April 2017, the AR Sandbox immediately became the most visited exhibition in the museum with 88% of visitors in Summer 2017 reporting that they had visited (Morey and Associates evaluation). It is also the second most popular exhibition in the museum (according to our Morey and Associates Summer 2017 evaluation report) with 88% of visitors reporting the experience as "Excellent" (i.e., virtually everyone who visited the exhibit reported it as "excellent."). In open-ended comments, the AR Sandbox was often cited as something parents liked with adjectives such as, "amazing," "cool," and "fascinating." The criticisms included that there was not enough sand in the exhibit, that there should be more interpretive signage about landscapes, and that they wanted more exhibitions like it.

Staff conducted a small observation study of 30 children across weekdays and weekends. The average length of stay was 15 minutes and the median was 10 minutes. Of the children in the exhibit, 25 interacted with the shorter table and 11 of them used both.

The majority of caregivers were also engaged with the interactive with their children, and only one was observed reading the interpretive panels. Several caregivers played with the sand and a few knelt down with their children at the small sandbox. Many groups found their own unique ways to expand on the experience. In one example, the caregiver, a 4-year-old girl, and a 7-year-old brother discovered where the projector was located. Another group—a mother with a toddler and a pre-schooler—brought their own shovel and stayed for 65 minutes. One family—mother, a four-year-old, and a seven (?)-year-old—used the tall sandbox as a setting for pretend play with their doll.

Goal 2:
- Share lessons through professional opportunities and materials through open-source forums.

The results of this project were presented during two presentations at the annual Association of Children's Museum conference in September 2017 in Pasadena, California. One was an evening talk focusing on the AR

Sandbox and one was during a panel discussion, "Appropriate Screen Time for Children" where the AR Sandbox was used as an example of deploying digital technology for young children without traditional screens.

The AR Sandbox was also featured as one example in an article written by the Project Director (Tang) for the Association of Children's Museum publication, *Hand to Hand* (Winter 16/17 issue), entitled "Digital Technology: Use it or Not—One Museum's Guiding Principles." The article even featured a photo of the AR Sandbox.

Lastly, the software modifications have been shared via the free online open-source community, GitHub: https://github.com/tdurkin1/Magic-Sand/tree/Magic-Sand-CCM-Mod/Magic-Sand-CCM-Mod.xcodeproj

Next steps
CCM has received a few inquiries from museums—including an emerging rural museum—that are interested in building an AR sandbox. We host several museum professionals from around the world monthly who observe how the AR Sandbox functions at CCM. We intend to continue introducing museum professionals to the advantages and challenges of building this exhibition and providing open access to the software modifications, the construction drawings for the casework, the interpretive graphics, and the facilitation guide.

Recommendations
As digital media becomes ubiquitous in our society, CCM's strategic vision is that children and caregivers become empowered through technology, rather than becoming passive consumers. We adapted and adopted the AR Sandbox as a way to deploy cutting-edge technology paired with analog and tactile experiences, all without a traditional screen.

CCM hopes that our successful installation along with the software modifications, the original casework design, the facilitation guide, and the unique elements that address museums' concerns about sand will allow other museums to consider deploying the AR Sandbox. We believe that by disseminating the designs and use case for free, we are decreasing the cost barrier for small museums. The open source community that CCM is a part of can help other organizations deploy cutting-edge technology that visitors and children find highly engaging.

5. Resources
GitHub project and source code: https://github.com/tdurkin1/Magic-Sand/tree/Magic-Sand-CCM-Mod/Magic-Sand-CCM-Mod.xcodeproj

AR Sandbox Community: https://arsandbox.ucdavis.edu/forums/forum/ar-sandbox-forum/