THE DRAWBOX PROJECT

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The Drawbox Project is a children-oriented, interactive audio-visual installation. Visitors are invited to draw colourful sketches on paper and then use the Drawbox—a special workstation installed at the exhibition space—to deliver their drawings into a dynamic physically-simulated world. Participants witness their drawings come to life, as shapes receive real-world physical properties, propel in motion and collide with drawn shapes of other participants in an imaginary drawn world. When two DrawBoxes are installed in remote locations, the drawn shapes from both locations are presented in a shared world, creating an ambient, creative connection. We describe the development and deployment of the DrawBox in two locations simultaneously.

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1 INTRODUCTION

The DrawBox Project was born out of an invitation received from two museums to create an interactive experience that would connect children in two remote locations for a shared, playful manner. Seeking an activity that would be easily achieved, inclusive and enjoyable, we chose drawing. Drawing is a simple yet rich form of self expression. We start drawing as early as we can hold a crayon, we sketch and doodle through life. Drawing is both an intra-personal endeavor, used within an internal dialog, and an inter-personal endeavor, used to convey ideas and present oneself to others. In the Drawbox project, a pen-on-paper drawing is the starting point for a playful transition between the physical and digital worlds, and for a new type of connection between children.

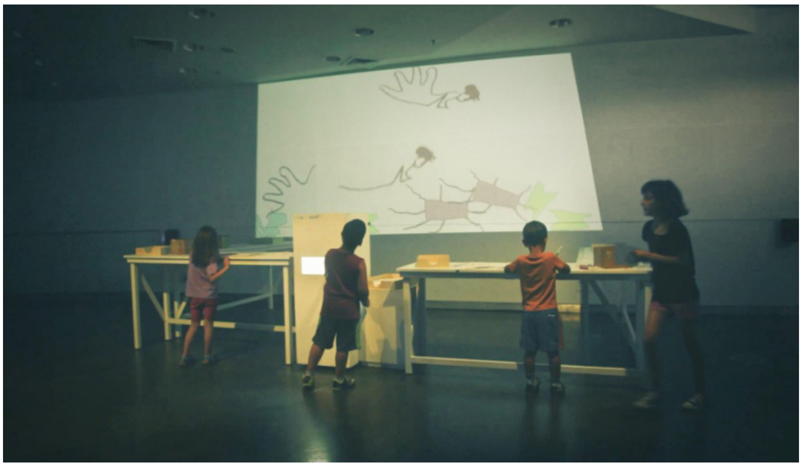


Fig. 1. Children interact with the Drawbox.

2 THE EXPERIENCE

Participants in each location are invited to draw with colored pens on paper. They then place their paper drawings into a box with an opening, and press a large button on the box. The drawn shapes instantly fall into a projected, graphical world inhabited with shapes drawn by other visitors. The shapes collide, break up, bump and jump, retaining enough of their form to be identifiable, but changing enough to surprise and delight. The projected world is in constant motion: shapes that exit to one side of the world enter at surprising times and orientations on the other side. Sounds of collisions between shapes extend the materiality of the drawn world, creating a dense, heterogeneous landscape-soundscape.

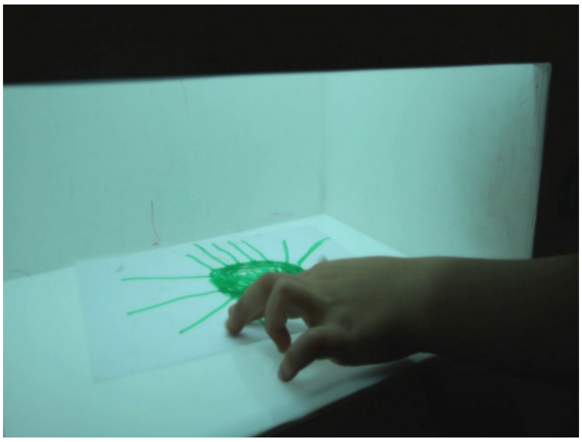
The installation can be either run in only one location (“mono mode") or in two locations concurrently (“stereo mode”). In stereo mode, visitors in remote locations all contribute to a single, shared world. Shapes delivered from each local station are color-coded in order to identify their origin within the shared world (e.g. yellow shapes from one location, green from the other). In this mode, participants witness each others’ creations; they can relate to the drawings of others with their own, and correspond with each other through drawing, creating a form of artistic dialog. In contrary to stereo mode, in mono mode the shapes partially retain their original color characteristics (see “Implementation”).

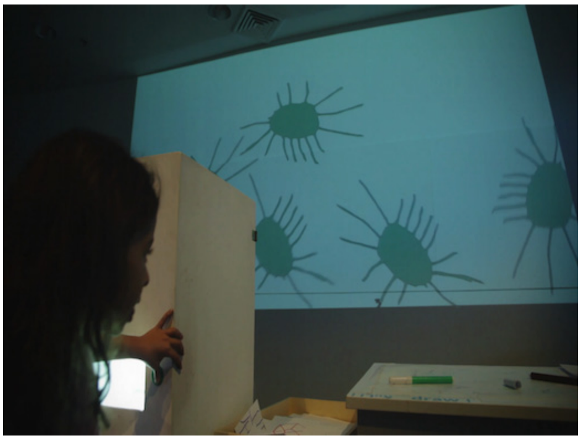
2.1 DESIGN VALUES

In a world of wide-band communication and digital “everything”, we sought to create an interaction based on the beauty and simplicity of the physical drawing, and an opportunity for a calm, gentle channel of communication with others. The themes that the Drawbox Project explores: self- expression, storytelling, and the connection with the other, are universally fascinating to children in a wide range of ages and regardless of national identity.

The Drawbox project enables children to experience spontaneous interaction with other children through the act of drawing—both co-present children and children in a remote location. Contrary to screen-based interactions, where it becomes increasingly harder to distinguish between real and virtual agents interacting with a user, Drawbox affords a kind of personal, embodied play and interaction scheme analogous to a playground setting. Simplicity is a main design value in the project, and one single button constitutes the entire interface, making it inclusive to children of young age and of varied abilities.

Fig. 2. One button press sends the drawing into the projected world.





3 IMPLEMENTATION

The Drawbox is built from off-the-shelf materials and custom software built with Processing. The implementation is hereby described in detail.

3.1 PHYSICAL BOX

The physical Drawbox is a rectangular standing structure built of wood. At its center is an opening, a cavity in which the drawing is placed. The cavity is well lit from above using flourescent lamps. A high-resolution web camera is installed at the top of the opening, concealed from children's reach. The 35mm concave momentary push button is connected to a MacMini computer via a simple hardware interface (an iPac controller); pressing the button causes the capture of the image by the camera and the initiation of the algorithmic analysis.

3.2 IMAGE PROCESSING

Contour, dominant color, and morphological analysis are performed. Each contour is converted to a vectorized polygon and added to a physics engine simulating rigid body dynamics in 2D. The new virtual shape is initiated with physical parameters corresponding to the morphological features of the drawn shape. Shapes are analyzed to retrieve their relative size, total area, density, calculated as the ratio of drawn area relative to the bounding box area (Bourke 1998), and shape symmetry, as judged by the center-of-mass position relative to center point of the shape's bounding box (Loncaric 1998).

3.3 PHYSICAL SIMULATION

The shape features are mapped to physical world parameters—body mass, body friction and restitution (the strength with which the body bounces back from a collision). Then, the newly created virtual shape is tinted by the dominant color of the drawn shape (in the mono version), computed from the hue histogram of the original drawing (Androutsos et al. 1998). A shape entering the world gradually breaks apart, separating into the loose contours comprising the original drawing. Drawings from all locations are joined through a shared cloud-based data folder, which allows an easy installation and enforces no limit on the number of Drawboxes which can be connected in a network.

Fig. 3. Screen shots of the Drawbox virtual world.

3.4 SOUND DESIGN

We designed sounds that enhanced the materiality of the drawn objects, giving them a quality of realness while also adding a slightly comic aspect, in line with the quality of the colorful drawn shapes and their bouncy motions. We utilize the detection of object collisions within the virtual world for constructing a sound generation engine which sonifies the world dynamics through collision triggering and velocity to amplitude mapping. This reflects the language of physical motion dynamics, such as acceleration, velocity, mass, collision, elasticity, etc. Equipped with a library of custom-made sound samples, the engine scales the force of objects collisions to a relative amplitude of sample playback. Furthermore, dynamic features of the virtual world, such as the peak velocities of object's motion are mapped to relative amplitudes of continuously playing samples, creating an additional layer of sonification.

4 INSTALLATION

The project was installed for four months in the Design Museum Holon, and concurrently for a weekend at the Victoria and Albert museum in London. The installation proved to have an enormous attraction for children and adults alike - over 55,000 shapes were drawn during the period it was installed.

4.1 LOCAL INTERACTIONS

Children enjoy drawing on their own on one of the installation tables, and then having their creations gain the center stage as they place their drawing in the DrawBox. They often press the button many times to fill the drawn world with multiples of their creations. Beyond the deep engagement of children with the installation, we observed strong motives of iterative exploration throughout the interaction. As children view the effect the Drawbox has on their drawing, they are often compelled to refine their drawing and make new ones, seeking to enhance the effects, or to “outwit” the system and draw their shapes such that they will break and scatter in a certain way. Throughout, a spontaneous dialogue emerges between participants as they look at each other’s drawings and try to experiment with the principles that govern the transformation from paper to the digital shape.

Fig. 4. Museum visitors interact with the Drawbox.

4.2 REMOTE INTERACTIONS

While we had only a few days of “stereo mode” to observe the interaction between remote participants, the initial observations are promising. Once told that shapes with the unfamiliar color are arriving from a different place in the world, children expressed deep curiosity towards the children there, and actively sought ways to communicate. Two recurring examples were: writing a greeting (e.g. “Hello”), and responding to a drawing with another drawing (e.g. drawing a spider in response to a spider that arrived from the other location).

Fig. 5. Sending a message

5 DISCUSSION

We observed a great interest by visitors of all ages in the Drawbox. It seems that the ease of participating (making a simple line drawing), coupled with the temptation of seeing what happens to the drawn shapes when they fall into the world, collide and break, was a good combination. While some participants created refined drawings, most created quick, playful sketches. It may also be that the partial scattering and disbanding of the shapes as they fell into the drawn world reduced people's shyness in presenting their creations to others, and allowed them a playful sketching experience.

In the current design, locations were identified by color, and the remote presence of children in the other location was verbally explained to the participants (e.g. "the Yellow shapes are being drawn in London!"). Achieving the optimal level of awareness to the remote others—enough to enhance curiosity and communication, not too much to take away the pleasure of the simple, local drawing experience—is an interaction design question of great interest. One option we believe holds promise is to show - in each location - a real-time video stream showing hands and papers, but not faces, of children in the other location.

Witnessing the unfolding interaction between children over distance has highlighted the potential of exploring a genre of interaction design we name "connected playgrounds"—shared playful interactive experiences which transcend physical distance. The framework of connected playgrounds aims at the design of intuitive interactions which connect children through self-expression, storytelling, collaboration and synchronization.

Designers have been exploring, in recent years, the possibilities of interactive playgrounds: environments with sensor-enriched objects that react to the interaction with the children and actively encourage children to play (Soler-Adillon and Narcis 2009, Tieben et al. 2014). The research in this area identifies key issues regarding the design of these playgrounds: social interaction, simplicity, challenge, goals and feedback (Sturm et al. 2008). However, the connected playgrounds research agenda invites a novel perspective on both interaction design principles and the afforded communication over distance. Insights should pertain to the mechanisms of joint action over distance, and to the conditions necessary to permit an unbiased, positive and curious sense of the other. On a societal level, connected playgrounds can be seen as a unique tool to promote and foster a playful channel of interaction between people from different cultures, driven by spontaneous exchange and discovery of a common language, regardless of national identity. In this regard, the Drawbox project provides a platform for exploring how children discover a common language through imagination, experimentation and communication.

Fig. 6. A child working on a drawing.

6 FUTURE WORK

Motivated by the acknowledged appeal of the Drawbox project, we plan to continue its development, and envision future developments which could expand and refine it further. We see exciting perspectives for future work in both the research and the applied domains.

6.1 THERAPEUTIC ENVIRONMENTS

Foremost, we envision an application of the Drawbox project within hospitals for children, as means to employ the therapeutic power of drawing. Studies which examined children's hospital-related fears and coping strategies highlight that children express these experiences and fears through drawings (Salmela 2010). In assessing children's coping strategies, studies employed children's drawings (Brewer et al. 2006) as well as draw-and-tell conversations (Driessnack 2006). Although tele-presence systems have been proposed in a hospital context (e.g. Fels et al. 2001), they have been largely pedagogical in nature, rather than open-ended and playful.

The Drawbox project installed in a network of children's hospitals will offer a connected playground where children can be given a joyful experience, both as a form of distraction as well as a means for expressing their feelings and coping through drawing. Furthermore, interacting with children in other locations may provide an opportunity for a normative dialogue and exchange, reconnecting with everyday ordinary child concerns, and drawing away from the context of hospital stay. We are now at work to pursue these developments.

6.2 EXPRESSIVITY ANALYSIS

A research agenda can aim at characterizing and quantifying the creative process of participant's drawings, namely through a morphological analysis of drawn shapes, uncovering features of expressivity, versatility and individuality throughout iterations of drawings (Noy et al. 2012). Expressivity analysis may consist of computing the Kolmogorov complexity of drawn shapes—measures of randomness and entropy, in order to derive the shape's complexity measure. Structural shape complexity may be estimated using entropy of the global distance distribution (GDD), entropy of the local angle distribution (LAD) and a randomness measure (Page et al. 2003). The effect of the interaction setup on these parameters—namely, the effect that co-present and remote participants have on the drawing style, can be highly revealing.

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