A New Playground Experience: Going Digital?

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Abstract
We explore how an interactive pathway impacts children's play patterns in outdoor playgrounds. The paper describes our experience designing and testing the prototype at various stages of development with twenty children age three to five enrolled in a preschool childcare center. We provide examples of the children's diverse play patterns and conclude with initial reflections on the design of responsive playground elements.

Keywords
Education, Playground, Technology and Children, Outdoor Play.

ACM Classification Keywords
K4.m. Computers and Society: Miscellaneous.

Introduction
Digital technologies have entered almost all areas of children's lives including entertainment, museums, and toys. Until recently, playgrounds stayed technology-free. With the increasing availability of technologies for outdoor interaction, we envision that digitally enhanced equipment will be incorporated into playgrounds in the near future. In an effort to explore this emerging field, we designed an interactive prototype, conducted

figure 1. Interactive pathway prototype on site.

(participatory) field probes, and categorized observed play patterns.

Background and Related Work

The most familiar play installations we find in playgrounds today, such as swings and seesaws, originated for the amusement and physical training of the wealthy. Play was an adult activity among the upper classes with ample leisure time. In the 19th century, the public play yard was designed in response to a lack of open space in urban settings depriving city children of physical activity outdoors [5]. Urban planners now consider playground spaces generic utilities which should be available to all city residents [6, 8]. Various design philosophies have determined playground design. For example, the 1970s gave rise to adventure playgrounds where children design and build their own play environments [2]. Today, we see many examples of designers and artists developing playful and stimulating outdoor spaces [1].

Working outdoor poses an additional challenge for children's technology developers, but some like the *Ambient Wood Project* have successfully integrated new tools for learning into the natural environment [11]. Fewer researchers have addressed outdoor playspaces. In Spain a group of researchers designed an interactive, outdoor water play installation for the "Universal Forum of Cultures" held in Barcelona, 2004. Users could activate the fountains by forming rings and spinning around them. This natural interaction was supported by an unobtrusive artificial vision system [10]. A holistic strategy for digitally-enhanced playground technology was developed by a group of artificial intelligence researchers in Denmark. *Playware* is a reconfigurable system of responsive building blocks that provide feedback for children on their motions [9].

The Prototype: The Interactive Pathway

We designed a simple prototype for exploring the problem space of outdoor playgrounds in the digital era. The interactive pathway consists of two separate path sections. Each path section is composed of two wooden beams with a series of five pressure-sensitive mats attached to the wood at a distance that is approximately the length of a 4 year-old's gait. Each mat has a motor attached to the wood next to it. When a child steps on a mat the associated motor spins. When a child walks or runs through the pathway, the motors spin one-by-one accompanying the child on a short journey across the path (see Figure 1).

Technical Implementation

The prototype uses a mixture of custom-made and commercially available materials. A 20 MHz PIC16F876 microcontroller is mounted on a dedicated printed-circuit-board that handles power distribution, local

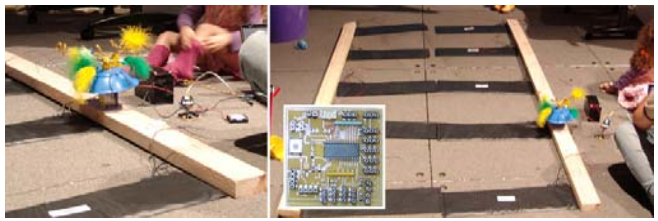

figure 2. Technical implementation.

processing, A/D conversion, and motor control. Two 12V batteries power the system. The pressure-sensitive pads are commercially available stair alarm pressure mats. The motors are part of LEGO Mindstorms. LEGO parts form the structure of the spinners (see Figure 2).

Participatory Process and Evaluation

We worked with 20 three to five year-old boys and girls from international backgrounds enrolled in a university's on-campus preschool. We met with the same children in their classroom and on their enclosed playground. Throughout the process we documented via notes, video and photographs so that we could review our experiences later when developing design recommendations. We tried to understand the existing play in the playground and investigated what the children and teachers considered essential about the space and activities.

Phase 1: Observing Play

In order to gain a good understanding of the benefits and drawbacks of computational elements in the playground, we emphasized observation prior to implementing a prototype. In our summer-long study of the existing playground, both physical play and fantasy play were evident. For example, riding the tricycles while pretending to drive a bus, or trying to hold to the edge of the 'ship' (the slide) to prevent from falling into the 'water' (the woodchips on the ground).

Phase 2: Listening to the Children

In the initial phase, participating children were invited to draw their playground in groups of three. We asked the children what they were drawing and what they did in that part of the playground. Since the children were young, the adult distinction between fantasy and reality was joyously blurred and many children drew objects in the playground, but from their own distinct perspective. Some children drew equipment and props from their playground while others drew items they imagined in their playground, they also described other places where they played outside or simply things they had seen outside recently. The most popular item, the playground playhouse, was described through images and words as being a playhouse, a "magic-carpet" vehicle to other locations, and a place to make sand-soup. One girl, who loves flowers, drew a flower that she found growing beneath a bench.

Phase 3: First Play Activity Outdoors

After the initial stages of observation and discussion, we created a prototype to enhance the most basic playground activity – walking and running. We built the initial prototype of the interactive pathway and tested it in the preschool's playground. The prototype was easily transported by hand from one test site to another and proved to be robust. In small groups, the children investigated the new equipment, tinkered with the motors and LEGO spinners, and started to interact with the pathway in a traditional way, such as walking at different paces and some running.

figure 3. *From craft activity to design iteration.*

Phase 4: Design Iteration
From the initial project conception, we intended to give the children an active part in the design of the new playground equipment drawing inspiration from participatory design methods [3,4,10]. Using a selection of standard craft materials including glue, glitter, paper plates, pipe cleaners, bells, and feathers, the children designed their own spinners (see Figure 3).

Phase 5: Second Play Activity Outdoors
Returning the next day, we assembled the pathway with the new self-made spinners. We placed it in the same location in the playground where the children had encountered it earlier. The children then played in same-gender pairs. Compared to the first activity, the larger self-made spinners attracted much more attention from the children. They inspected them and tried to find the ones they had made the previous day. The spinners promoted more diverse, unexpected play activities and increased running across the pathway.

Observations

Key Interactions
After initial hesitations to step on the pathway, all the children enjoyed the spinning elements, especially after they were redesigned to make a more significant visual and audio impact (the children attached small bells to their spinners). This aspect of the pathway was also the only one the children could truly articulate after the play activity.

In the second play session, we observed a rich set of play activities. Children started with the traditional types of physical play activities such as walking, running, skipping, jumping and standing on multiple steps at a time. The children also showed spontaneous collaboration, for example racing down the two lines of the pathway together, or running in circles through and around the pathway. When we arranged the two sections in a linear way, creating a long-and-narrow path, it further encouraged the running-based games.

Among the unexpected play activities we observed some interesting examples within the realm of physical play. For example, some children did more complex activities such as somersaults across the mats, lying down in order to trigger several mats simultaneously, or crawling across the pathway. While running and jumping, the children incorporated fantasy play into their physical activities. Two girls pretended the pathway was a train-track and choo-chooed while they ran through the pathway and around it in circles. The children also used their favorite props from the playground, such as pushing a toy truck through the pathway, rolling a ball through, or throwing objects on the mats, to see if the spinners would be triggered.

Play Patterns
These interactions provide evidence for the many diverse play patterns children develop. We observed at least four styles: active play, fantasy play, exploring how things work, and game-building.

figure 4. Children engaging in multiple play patterns on the prototype at the same time.

Physically active play as the name suggests involves walking, running, skipping, jumping, climbing, and more. During this type of play, children enjoy feeling their bodies move and often engage in repetitious behaviors with which they build physical competencies. This type of play, since it is externalized, is easy to recognize.

Fantasy play can be subtler because children imagine they are doing something beyond their physical actions. This fantasy can take the form of being in another place (such as imagining a play house is a portal to another world) or materials being something beyond what they are (such as making soup out of sand and water.) Often they speak or gesture to themselves. If they are playing with others, they may negotiate the fantasy (e.g., "you be the princess and I'll be the fairy.") Fantasy play may be the subtlest of all the categories.

Exploring how things work is characterized by carefully watching, tinkering, and experimenting with materials. This play is characterized by a combination of testing, often through physical manipulation, and observing objects in the world. In the case of our pathway, unfamiliar causal connections intrigued some children, leading to experimentation with how the pressure-sensitive mats and motors worked.

Game building ranges from spontaneous development of simple games such as follow-the-leader to creating more complex games with changing rules such as hopscotch. These activities are often characterized by a mix of body motion and the creative act of designing the game rules.

A child at play rotates between these different styles and engages multiple styles at the same time. For instance, a child might be moving across monkey bars (physically active play) and at the same time talk to himself or herself about escaping alligators (fantasy play). These styles manifest themselves when children play in groups or alone.

Reflections

Following the play activity we conducted interviews with the preschool teachers. They were excited about the project, and had precise observations about the interaction. One teacher emphasized the increased physical activity seen in the less active children. Another pointed out the high engagement level of the children and the exploratory nature of the activity.

All teachers felt that the craft activity (letting the children design their own 'spinners') contributed to the children's engagement and were impressed by the idea of incorporating the children's creations into future playground equipment. Future work should incorporate more participatory elements [3,4].

In connection with questions about appropriate age groups, one teacher thought the prototype could also be appropriate for younger children (two to three years old) and might engage their natural curiosity in different ways than the older preschool children. Overall, the teachers were excited to see that the benefits of the interactive pathway outweighed the drawbacks, thereby acting as a natural extension to their school's playground without compromising the children's natural play patterns.

Conclusion

The diverse play patterns observed resulted from a simple design which enabled open-ended play patterns instead of predetermining any one or two activities. Just like children use slides as imaginary waterfalls or hiding spots, they used the pathway for everything from simple running to playing choo-choo trains. This type of open-ended play benefits children significantly in many aspects of their development [7] and is extremely important to successful playgrounds. Future iterations of responsive playground technologies should take this insight into account and lead to more detailed design recommendations for developing open-ended, responsive playground elements that employ digital technologies to enhance outdoor play.

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