Program-a-Ball: A programmable play space

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ABSTRACT
We present the idea of an interactive programmable spherical device named *Program-a-Ball, PaB,* and the idea of a scalable construction set of *n* possible *PaBs*. One *PaB* allows a child (4-to-99-years old) to design, program, and test fantasy-world or real-world interactive applications; more *PaBs* increase the possibilities. A specific *PaB* can be programmed to trigger a pre-specified response when it senses a specific stimulus. *PaBs* are designed to be programmed by the direct physical manipulation of its parts which are simple, tangible, and robust input sensors and output devices that children can easily manipulate to establish desired settings.

Keywords
Constructivism; programmable; interactive toy, set, play space; tangible interface; fantasy world, real world application.

INTRODUCTION
Creating and transforming worlds. Children can create their own characters, their own settings, and their own plots. At times, while they are playing, by themselves or with others, they externalize their creations 'in real time.' We remember having seen and listened to children doing it, and we remember having experienced it ourselves.

The child's play space, in this paper, includes the child's creations that can be seen as taking place somewhere along a continuum that has, at one end, the child's fantasy world, and at the other end, the child's real world. A fantasy example is a child imagining a speaking bird that asks you to find its egg and then to warm it. A real world example is the same child imagining an alarm that goes off when her sibling tries to come into her room unnoticed.

Prototyping my interactive place space. Papert points out that when we "construct" we turn our abstract ideas into concrete attempts. These concrete attempts permit us to see our abstract ideas under a new light. New ideas are then constructed. The process fosters more significant learning [3]. A concrete interactive play space, a prototype of it, can be created with a Program-a-Ball set. Children can make it 'feel' specific phenomena and respond in pre-specified ways to external stimuli. A given stimulus can be provided by the child, playmates, or other animate beings (a plant, a pet, a sibling) or inanimate things or phenomena (alarm clock, sunlight, wind).
Individualized and personalized difficulty range of the applications can go from absolute beginners to advanced computer programmers or analysts.

The relevance range can go from 'just for fun' to 'seriously experimental.'

Potential play patterns & corresponding technical features. First generation *PaBs* will contain simple robust input sensors that can sense luminosity, sound or movement and output devices that can react to stimuli by producing sounds (voice included), LEDs (on, off, or flashing), and movement of (of a limb, displacement of the whole). With them children can build simple play space surprises, games, for themselves to play, and interactive fantasy or real world spaces.

Even with the most basic elements—a single sensor and output device– a child can create engaging surprises for friends and observational tools to study the environment. A child can know when a light is turned on or off, when a door is opened, and when a person sits or steps on something. He might use this to create a sister spy sensor or a pet monitoring device.

More complex and sophisticated interactions can be built by combining multiple inputs and outputs. Children can build puzzles based on a particular sequence of behavior. These games might be similar to games like Simon or Boppit in which children repeat the sequences the machines generate, except that children could use their entire bodies and entire rooms and design the interaction themselves. They are able to build treasure hunts for their friends or enhance fantasy worlds and play.

A SCENARIO
This scenario describes an example built and installed at our lab. We used the Tower System prototyping tools developed by the Media Lab's Grassroots Invention Group as a platform and central processor [5] and the Cricket-bus devices developed by the LifeLong Kindergarten Group as sensors and outputs [4].The cricket sensors used were light, sound, and proximity. The outputs were speakers (sound), tricolor LED's and servos (motors) as shown in Figure 1.

Figure 1: Elements used in the prototype scenario. Sensors and outputs are circled red.

In this scenario a room is transformed into a fantasy world: a jungle in which a child's friends must go on a treasure hunt. When the door is first opened, we hear jungle sounds such as birds and rustling leaves. After a few moments, a speaker behind a stuffed bird says, "Find my egg." We search for the egg and when we pick it up, our action is sensed by a light sensor. The bird says, "Warm my egg." We try putting it on the radiator, but nothing happens. Then we try putting it in the bird's nest, which is sensed by another light sensor. Then a chair says, "Allie is hungry." The children notice a cutout of an alligator on the trashcan and decide this must be Allie. We throw the egg in the trash, a distance sensor senses the movement, and the LED eyes of the alligator blink. The alligator says, "yummy" and a servo makes the alligator's mouth open and close as he chews the egg. Finally, the creatures all over the room howl, bark and cackle.

THE INTERFACE

After running the prototype simulation, it became evident that the key to making this highly generic system support successful interactive and programmable play-spaces is to design a simple, yet robust programming interface.

In the final interface, each sensor or output device is a separate object and both the sequence of actions and the behavior of individual objects are programmed by physically manipulating the object. Since programming is not something that happens at a computer or someplace distinct from where play occurs, fantasy play and imaginative thought can occur while programming.

Each sensor or output device, as shown in Figure 2, is embedded into a small creature called a *Program-a-Ball.* A Program-a-Ball (*PaB*) is a plush fabric creature approximately 5 inches high. All the *PaBs* are wireless and all of them (except two, which will be discussed later) have a dial and button as controls and a small LED embedded between the antennae as a display. The dial is the foot of the creature.

Children can program the sequence of the interaction between the inputs and outputs, along with the sensitivity of the sensors and the content of the display of the outputs. Both sensors and outputs can be used multiple times by simply activating them again later in a sequence. The sequence of sensors and outputs is programmed by the order the individual Program-a-Balls are activated. When a child wishes to run the sequence, he presses the single button off a special Program-a-Ball called the *Programama*. This device is a master switch for starting and stopping the interaction. The Programama also contains electronics that wirelessly coordinate all of the sensors and output activity.

Figure 2: Three Program-a-Ball sensors (from left to right): LightBall, Programama and SoundBall.

Programming Sensors

All sensors are programmed in the same way. First, the button is pressed to indicate that this sensor is the next in the sequence. Then, the dial in the foot is turned until the appropriate threshold is reached. When the threshold is reach, it is indicated by the LED on the device. Once a sensor is programmed, a child can then activate the next Program-a-Ball in the sequence by pressing the dial on that second creature.

Programming Output

To program the LED, the child turns Program-a-Ball upside down to reveal circular rainbow running around the foot. As the child turns the foot-dial the colors change at the same speed. To program the speaker (which reproduces up to 12 sounds), the child presses the second button to record the sound and then presses it again to end the recording. To program the servo, the child turns the foot-dial at the speed and direction (clockwise or counterclockwise) he wishes the servo to move.

CONCLUSIONS

The strength of the design of the Program-a-Ball is that it allows for great interactivity while limiting the complexity of programming. Since objects are programmed by manipulating them in a natural way, playing with them should be encouraged by the features of the tool, rather than limited by the difficulty of interacting with the device.

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