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My Workshop

● **MAS.714 Technologies for Creative Learning :: Prof. Mitchel Resnick**
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acknowledgements

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[the] abstract

My Workshop proposes a starting rationale for developing future Pico Cricket kits, a set of digital manipulatives¹ developed by the Lifelong Kindergarten Group (LLK Group) at the MIT Media Lab. We study the range of non-computational materials that can be combined with Crickets and the spatial configurations that can be achieved with the kits in order to introduce the idea of the workshop in children's play activities. In this context, we define workshop as the sphere of personal space that a child physically occupies during playtime. In making our suggestions, we draw on two conceptual themes. The first theme addresses how "tactile intelligence" can be encouraged in the activities of children. Drawing on the importance of defined spatial configurations in human psychology, our second theme examines design guidelines for a Cricket workshop space that fosters bricolage² and creative tinkering. These two themes – tactility and bricolage – permeate the paper and support our recommendations on how carefully designed spatial configurations and carefully selected materials can enhance the potential of Cricket technology.

[the] background

Our backgrounds in architecture and planning drove us to observe the Life Long Kindergarten Group's (MIT Media Lab) Cricket world with a designer's lens to apply our spatial synthetic abilities towards enhancing children's play-worlds. We hope that our effort will render architecture an enlightening consultant to LLK's current challenge.

The design process in architecture can be described through a variety of metaphors acting as conceptual points of departure for *My Workshop*. Design can be seen as exploration, as problem-framing, as problem-solving, as calculating, as language, or as a game. Regardless of their ability to cover the wholeness of the design process, all of the aforementioned source domains for the design metaphor have one thing in common: they suggest conceptual and physical inventories – including tools and materials – that challenge the designer's ability to make appropriate selections among them.³

¹ "Digital manipulatives" refer to "computationally-enhanced manipulative materials" that expand the domain of materials available for children to play with their hands. See Mitchel Resnick, "Technologies for Lifelong Kindergarten," *Educational Technology Research* (1998) Vol. 46, No. 4.

² In this paper, we use bricolage to invoke the creative act of recognizing, collecting and storing objects and materials for use in creative constructions and explorations.

³ The example of Design as Exploration metaphor can be understood as a systematical correspondence, a tightly structured mapping, according to which entities from the source domain of exploration correspond to entities in the target domain of design. George Lakoff, (1993) "The Contemporary Theory of Metaphor", in A. Ortony, ed. *Metaphor and Thought*. (Cambridge: Cambridge University Press, 1993), pp. 202-251.]

Developmental psychologists and educators emphasize the importance of materials for supporting creative play: “Simply having the objects to play with appears to be an important component of later intellectual development. Why? Toys and play materials provide the stimulus for children’s exploration. When these toys are interesting to them, you are more likely to see children coming together and united in a common activity.”⁴ In the case of the Cricket workshops, the objective is to engage children in deep play and to introduce them to a design process where they can use tools and materials for their own creative explorations.

My Workshop addresses the concrete challenge of combining Crickets⁵ with a variety of materials from the world of arts and crafts as well as with found, ready-made objects to create a repertoire that spans categories as diverse as LEGOS and construction paper. Until now, Crickets have been used in group activities facilitated by the MIT Media Lab and the MIT Museum in after-school-programs and weekend workshops⁶ and have yet to be available in kits like their predecessors, the programmable LEGO Mindstorms bricks.^{7, 8} Currently, the LLK Group is developing a rationale for future Cricket kits similar to the Mindstorms product which has raised many questions about the types of materials, the system of organization and the degree of instruction to be included in the finalized kits.

An initial proposal for a kit, developed by LLK as a prototype, suggests a series of craft materials used in sample projects developed by the LLK Group and the Playful Invention and Exploration Network (PIE Network⁹). This selection hints at the wide range of materials that might

⁴ From “Play: The Crucible of Learning” in K. Hirsh-Pasek and R. Golinkoff. (2003). *Einstein Never Used Flash Cards*. (Rodale Press) pp. 240-241.

⁵ The MIT Media Lab’s Life-Long Kindergarten Group introduces Cricket technology with the following basic description: “The Cricket is a tiny computer, powered by a 9 volt battery that can control two motors and receive information from two sensors. Crickets are equipped with an infrared communication system that allows them to communicate with each other. Crickets are the latest version of the Programmable Brick, with the important new dimension of their tiny size. Because they are so small, Crickets can be used in new and different ways.” Currently, the Crickets come equipped to handle nine possible sensors, four of which can be attached at the same time. They include a light sensor, a reflectance sensor, motors, a magnetic switch, a temperature sensor, touch switches, lights, a digital display and a galvanic skin response sensor. (Life Long Kindergarten, MIT Media Lab, <http://llk.media.mit.edu/projects/bbb/sections/crickets.html>)

⁶ MIT Museum, Emerging Technology, <http://web.mit.edu/museum/>, <http://emergingtech.mit.edu/>

⁷ LEGO Mindstorms, <http://mindstorms.lego.com/eng/default.asp?domainredir=www.legomindstorms.com>

⁸ The following description shows how challenging it can be to provide the right mix of materials for successful Cricket workshops: “Of course, Crickets are only one component of the construction kits that we provide for the BBB [Beyond the Black Box] projects. Many BBB projects make use of LEGO materials (including not only the traditional building blocks but also gears, wheels, and motors) for building structures and mechanisms. We provide a variety of different sensors that enable users to monitor everything from temperature and light to heart rate and galvanic skin response. [...] When organizing BBB activities, we make sure to supply a wide range of arts-and-crafts materials, including everyday objects such as pipe cleaners, popsicle sticks, and cotton balls. This blend of high-tech devices and art supplies makes possible precise explorations and investigations while simultaneously fostering a spirit of creativity, exuberance, humor, stylishness, and personal experience.” See Mitchel Resnick, Robbie Berg, Michael Eisenberg, “Beyond Black Boxes: Bringing Transparency and Aesthetics Back to Scientific Investigation,” *Journal of Learning Sciences*, (2000).

⁹ Playful Invention and Exploration Network, <http://www.pienetwork.org/>

be incorporated into future collections to achieve the best possible environment for play which begs the following question: How can we most effectively combine Crickets with non-computational materials ranging from craft materials through smart materials to enhance play and exploration? Several additional questions can be derived from the general problem: How do certain materials encourage open-ended exploration? Which materials can be effectively combined with crickets in order to “create something”? What kind of spatial infrastructure encourages creative tinkering?

[the] idea

Choosing the appropriate materials forms an iterative (design) process which resembles the type of creative exploration and play that Crickets are intended to encourage. We bring both these preoccupations of design – materiality and process/function and experience – to *My Workshop* to expand the game. In this spirit, the following paper provides:

- An initial design proposal for the “workshop space”
- A reference card system acting as a materials’ catalogue for the Pico Cricket kits
- Project themes rooted in material characteristics

● Who’s your bricoleur?

In the simplest definition, a bricoleur¹⁰ collects objects and raw materials which may be useful in the future. The process of selectively collecting, storing and retrieving components for building imaginary worlds captures the essence of the exploratory mode *My Workshop* seeks to encourage in children and youth. Several important characteristics in the spirit of bricolage can be highlighted in this context:

- Ready-made objects and malleable materials are all part of a bricoleur’s repertoire.
- A bricoleur recognizes the inherent potential of a material.
- Materials are not necessarily collected to be reused in the same way that they were initially designed.
- A bricoleur knows where his or her materials are stored.

Bricoleurs move in and out of the space where they store their collection and experiment with their precious materials. In such creative endeavors, the workplace supports the overall goal. Artists, scientists, engineers and architects, all rely on a repertoire of materials inside the protective shell of their workshop.

¹⁰ Claude Lévi-Strauss, *The Savage Mind (La pensée sauvage)*, (London: Weidenfeld and Nicolson, 1966): p. 17. “His [the bricoleur’s] universe of materials is closed and the rules of his game are always to make do with ‘whatever is at hand’, that is to say with a set of tools and materials which is always finite and is also heterogeneous because what it contains bears no relation to the current project, or indeed to any particular project, but is the contingent result of all the occasions there have been to renew or enrich the stock or to maintain it with the remains of previous constructions or destructions. The set of the ‘bricoleur’s’ means cannot therefore be defined in terms of a project...”

Even the most abstract mind is affected by the surroundings of the body. No one is immune to the impressions that impinge on the senses from the outside. Creative individuals may seem to disregard their environment and work happily in even the most dismal surroundings...But in reality, the spatiotemporal context in which creative persons live has consequences that often go unnoticed.

(Mihalyi Csikszentmihalyi, *Creativity*, (New York: Harper Collins, 1996) in Mitchel Resnick, Robbie Berg, Michael Eisenberg, "Beyond Black Boxes: Bringing Transparency and Aesthetics Back to Scientific Investigation," *Journal of Learning Sciences*, 2000.)

Having a space for conceptualizing and manifesting one's ideas is crucial which renders the workshop essential for the creative process. They are personal, customizable spaces that adapt readily to project needs. They can support both individual- and group-work and they are a safe space for the creator to explore tangents. The workshop stimulates creative activities both physically and mentally. As a result, we emphasize the physical space of creation in our design principles and recommendations and derive the title for our whole project from it: *My Workshop*.¹¹

¹¹ In the MIT Museum's Cricket database the activities are announced as taking place in the "playshop", for example the MIT Invention Studio on November 3 and 17, 2001 was introduced in the following way: "Inventors of all ages can come to this playshop to build, create, and discover in the MIT spirit. Design and construct contraptions using a variety of building materials, including motors, sensors, and programmable bricks called "crickets," invented right here at MIT." <http://learningtech.mit.edu/FX/index.php>

In its capacity to support bricolage, *My Workshop* constitutes a platform for constructing micro-worlds whose vivid nature increases with the diversity and inherent potential of the materials they incorporate. Michael Eisenberg makes the case that more materials lead to richer micro-worlds as supported by construction-kit-like toys:

The main purpose of providing this list [of materials] is to suggest the ways in which the notion of a “*micro-world*” may be profitably rethought as a partly computational, partly tangible entity. (...) The argument here has focused on construction kits as the foundational “objects-to-think-with”, as these provide plausible examples of children’s artifacts that can be, at the same time, simple, self-contained in the choice of primitive pieces and means of combination, rich in content, connected with languages and symbolic notations, and suggestive of comfort.

(Michael Eisenberg, “Mindstuff: Educational Technology Beyond the Computer,” *Convergence*, (2003), p. 17-18.)

At a deeper level, these construction kits are powerful because they relate to the importance of tactile sensations in human experience. Research about our senses, the hand and the emotional connections with materials provides evidence at many levels for the importance of touch.

● **Touch Don’t Look**

The challenge described in the introduction implies a strong normative position that tactility should be supported in children’s everyday environments. Even though children play with a variety of materials on a daily basis, their experiences, as those of grown-ups, are mediated by increasingly uniform and standardized surfaces. Research conducted by the Reggio Emilia Schools criticizes the relative homogeneity of the world around us: “the coldness of metal, the linear cleanness of plastics and wood smoothed by machine precision, creating a material landscape in

which contrasts are generally reduced or, at most, handled with difficulty (also in design).¹²
Inspired by the Reggio Emilia Schools, we support the tactile experience as an important basis for cognitive development.¹³

Like the Emilia Schools, Maria Montessori, the developer of the Montessori teaching method at the beginning of the 20th century, proposed tools for enhancing children's sense of touch.¹⁴ Montessori tools imply the deep-seated nature of our sense of touch which Aristotle interpreted as an amalgamation of many senses.¹⁵ Children use their hands to gain these tactile experiences through sensory stimuli: "Children touch, caress, rub, and play; with one hand or two, with their fingertips, palm, the back of their hand, the knuckles, the edge."¹⁶

¹² The Reggio Emilia Schools in Italy are internationally acclaimed infant-toddler centers and preschools dedicated to building successful learning environments for children. Their research is specifically aimed at developing better physical spaces which they call "relational space" for children to flourish. Ceppi and M. Zini, eds. *Children, Spaces, Relations. Metaproject for an environment for young children*, (Milan: Reggio Children, 1998), p. 72.

¹³ The richness of the sensory experience; investigation and discovery using your whole body. Sensory navigation that exalts the role of synesthesia in cognition and creation, fundamental to the knowledge-building processes and the formation of the personality. A complex environment made up of sensory contrasts and overlapping that are phenomenologically distinct: polysemy and balancing, negation of the patchwork effect or *mélange*, maintaining the perception of the differences between the parts.
G. Ceppi and M. Zini, eds. *Children, Spaces, Relations. Metaproject for an Environment for Young Children*. (Milan: Reggio Children, 1998): p. 16.

¹⁴ Thomas Mueller, and Romana Scheinder, *Montessori: Teaching Materials 1913-1935 Furniture and Architecture*, (Prestel: Munich, 2002), pp. 89-97.

¹⁵ "Aristotle himself doubted whether the sense of touch was a single sense or actually more than one, a sort of constellation of sense, giving it priority in the sensory hierarchy. According to the naturalist philosophers, in fact, a keen tactile sensitivity corresponded to a keener intelligence (...)" In Ceppi and M. Zini, p.72.

¹⁶ Ceppi and Zini, p. 76.

Research on the complexity of our hands reinforces the importance of providing as many developmental opportunities as possible. In his book *The Hand*, Frank Wilson provides a vivid description of the hand as a source of human development:

The handyman's hand was more than just an explorer and discoverer of things in the objective world; it was a divider, a joiner, an enumerator, dissector, and an assembler. The handyman's hand could be loving, aggressive, or playful. Eventually, it found in the intimate touch of grooming the secret to the power of healing. It may also have been the instigator of human language. (...) a new physics would eventually have to come into this brain, a new way of registering and representing the behavior of objects moving and changing under the control of the hand. It is precisely such a representational system – a syntax of cause and effect, of stories and of experiments, each having a beginning, a middle, and an end – that one finds at the deepest levels of the organization of human language.”

(Frank R. Wilson, *The Hand: How Its Use Shapes the Brain, Language, and Human Culture*. (New York: Pantheon Books, 1998): pp. 59-60)

Along similar lines, Diane Ackerman discusses the emotional depth we experience through touch and its importance in supplementing our visual capabilities. The ability for fingers to fully replace sight in systems like Braille further reinforces the power of touch and consequently our hands.¹⁷

Given these complex relationships between tactility and materiality, we address the practical questions of incorporating diverse materials in construction kits. In our case, not all materials are easily combined with Crickets and not all materials are readily accessible to users. In many ways, the traditional LEGO bricks represent one of the most difficult materials to integrate into a Cricket kit because the smooth surfaces and predetermined connection points pose a problem in attaching to other elements.

[the] proposal

● *My Workshop*


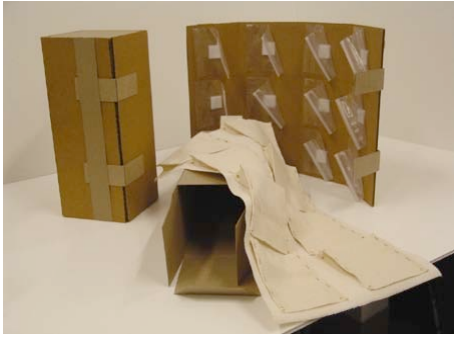

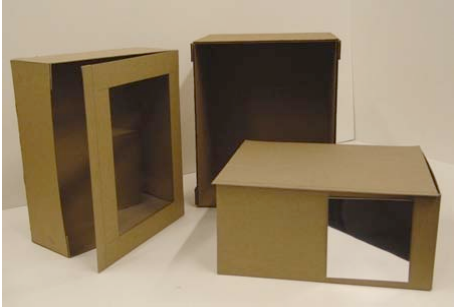


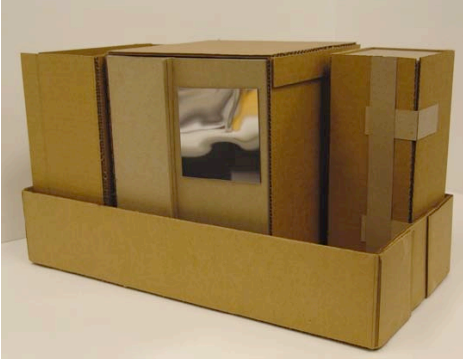
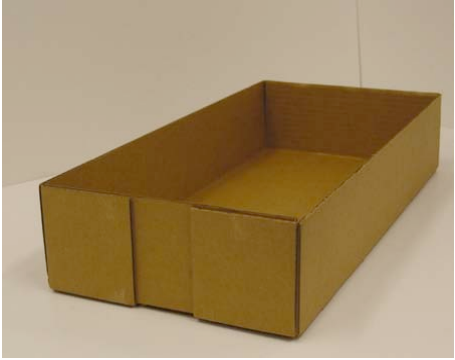
My Workshop represents a user's place for creative exploration with Crickets and non-computational materials. Our key recommendation is that future Cricket kits should be designed as a portable system of containers that creates space within space. In our design proposal, the packaging transforms itself into a dual system of storage and workspace that can be deployed and utilized in many different ways depending on the problem at hand and the user's personal preference.

¹⁷ “Touch, by clarifying and adding to the shorthand of the eyes, teaches us that we live in a three-dimensional world. (...) Touch allows us to find our way in the world in the darkness or in other circumstances where we can't fully use our other senses. By combining eyesight and touch, primates excel at locating objects in space. Although there's no special name for the ability, we can touch something and decide if it's heavy, light, gaseous, soft, hard, liquid, solid.” See p. 94 in Diane Ackerman, *A Natural History of the Senses*, (New York: Random House, 1990), pp. 65-123.

Our suggested system of containers fulfills the following guidelines:

- The system is portable, lightweight and compact.
- It is made out of cardboard which is a cheap and readily available model-making material.
- It utilizes space in a creative way without imposing a singular use.
- The workshop comes into being as the system of containers explodes into its subcomponents.
- The containers differ in size and material facilitating customization of use.
- The assembly of the system encourages the user to develop his or her own organizational scheme.
- Each part of the system can be replaced individually.
- The system's design logic is evident and each part is easily reproducible.
- Users can add new construction materials to their kits.
- Children can get together and connect their workshops (or parts of their workshops) to conduct explorations together.

Four main components constitute our design proposal, each one having different subcomponents that can be used either independently or within the "family". The table on the following page provides a detailed description of each component and subcomponent and how the system coalesces. The child is presented with a system of boxes waiting to unfold their hidden spaces. Inspired by the very first definition of architectural space as a container for life, we facilitate a variety of spaces created by the combination of different packaging design techniques and materials. The suggested design scheme represents a generic typology for *My Workshop*. The system of boxes is specifically not defined in terms of its exterior material in order to encourage customization on the part of the user through added materials, colors, and other forms of notation.

	Main component	Subcomponents
<ul style="list-style-type: none"> - A set of twin boxes, each one includes a deployable part and an interior container. The first twin carries arrays of plastic and textile pouches used for storing small-scale objects. The second twin contains a set of drawers meant for storing the Crickets. 		
<ul style="list-style-type: none"> - A crate used for transporting and storing bulkier materials. Within the crate we have placed two sub-containers, one intended for personal items (the one with the mirror) and another one with a transparent lid for showcasing objects. 		
<ul style="list-style-type: none"> - A flat storage box holds papers, foam sheets, cardboard as well as the proposed materials' portfolio. On the outside of this container, we placed a pin wall. 		
<ul style="list-style-type: none"> - A base holds the whole system together and it can also be used independently. 		

Prior to designing the containers, we analyzed existing construction kits. Most of them tout the inventor's ability to make almost anything, however, the descriptions neglect the physical space of invention. For example, LEGO introduces its Inventor kit by saying: "If you had the most amazing workshop of gadgets and gizmos you could imagine... then what would you make?"¹⁸ None of the kits fully exploit the potential for the box to be a creative construction itself.

A very characteristic example is the Playdoh Creativity Table, which is marketed as a place for creative activities: "The Playdoh Creativity Table is the ultimate all-in-one Playdoh play station. The huge workspace provides a place for lots of creative play with markers, crayons, and of course, Playdoh. Kids will enjoy endless fun in this contained play place, featuring such Playdoh favorites as the Fun Factory Extruder and Fuzzy Pumper. This toy really gives Playdoh a home with lots of storage for tools and Playdoh cans in the table legs. The Playdoh Creativity Table includes four Playdoh crayons, four Playdoh markers, 12 sheets of paper and eight cans of Playdoh."¹⁹

The vivid description of a "contained play place" approaches our idea of *My Workshop*; but it differs in essentials because it is product specific and thus cannot be customized or support other materials.

¹⁸ LEGO Inventor, <http://www.lego.com/eng/create/inventor/default.asp?x=x>

¹⁹ Play-Doh Creativity Table, <http://www.yenra.com/play-doh/>

● The Materials' Catalogue

The proposed materials' catalogue organizes one possible subset of things to build with while discovering the hundreds of paths Crickets enable. In an effort to enhance these explorations, we proposed taking materials beyond their affordances into the domain of dreams where the representational and material qualities of different substances can be explored.²⁰ Our initial categorization is inspired by the work done in the Reggio Emilia Schools and is summarized in the table below:

Material Families		Wood Plastic Metal Paper Fabric Ceramics Stone
Characteristics	Responses/Gradients	Soft / hard Warm / cold Glossy / matt Transparent / opaque Lightweight / heavyweight Absorbent / sonorous (sound) Waterproof / absorbent (liquid) Durable / delicate Flexible / rigid

The Reggio Emilia Research Group developed families of materials which we have supplemented with a series of scales and characteristics. With these categories and principles in mind, we studied an extensive database of 27 Cricket workshops developed at the MIT Museum under the supervision of Stephanie Hunt. The Museum's sample projects cover a wide array of activities that reflects how Crickets support hundreds of possible exercises. Extrapolating from the Cricket experiences and the materials' studies, the following general guidelines for selecting materials emerge:

²⁰ Affordances refer to the perceived and actual properties of objects that determine how they can be used. For example, a light switch affords illuminating a room. D.A. Norman, *The Psychology of Everyday Things*, (New York: Basic Books, 1988), p.9. and E.J. Gibson, et al., "Affordances" (1999) in Wilson A. Robert and Keil C. Frank, eds. *The MIT Encyclopedia of the Cognitive Sciences*, (Cambridge, MA: MIT Press, 1999).

- Avoid materials that encourage only one use.
- Include materials that allude to a spectrum of sensations (e.g. hard-soft).
- Differentiate between replenishable and non-replenishable materials, that is those materials which parents or caregivers will have to replace in the kit and those which should continue to be in use.
- Ensure sufficient materials for joining and connecting disparate components are included.

The materials included in the kit would be described on an individual card. A full set would be included in the kit with several blank cards that slide in and out of the box. Five prototypical cards demonstrate how we imagine the cards to be included in the packages. (Please refer to the appendix for the example cards.)

● **Open-ended Explorations**

Most precedents for Cricket activities have been driven by themes or scenarios that spark the imaginations of participants. In our workshop, we suggest a series of themes that can perform a similar function while taking their point of departure in material characteristics. The guide of themes should support children in their own mode of exploration that can range from deeply constructionist leanings through a strong narrative predisposition. In effect, we hope that both forms of play and exploration will take place simultaneously as demonstrated by anecdotal evidence of children's games. No natural limit for the number of themes exists; therefore, we have selected those which emerged during our exploratory research:

- **Wearables**
Wearables use crickets to construct elements that can be worn on the body, for example jewelry, hats or measuring devices.
- **Contraptions**
Building a contraption can include anything from car-like objects through imaginary machines that perform as-yet-unimagined functions. They are called contraptions because they do not necessarily correspond to items we find in our everyday-world.
- **Monsters**
Mythical members of the imagination could be described as monsters. In other words, this theme encourages children to think of creatures that might exist in their imaginations.
- **Musical instruments**
Different materials absorb or transmit sound in very different ways that might provide inspiration for a host of musical explorations.

These themes support users who enjoy constructing physical objects and those who build narratives.

The Cricket workshop activities range from chain reaction contraptions to doodling devices. Using the set of sensors depicted above children develop imaginary creations, examples of which are shown on the right. The top right image shows the cross country chain reaction studio and the bottom right image shows a workshop for creating doodling devices.

[conclusion]

In *My Workshop*, we attempt to start a conversation about shaping children's spaces for creative exploration. Thus the project introduces a customizable spatial organization that users can adapt to their own style of bricolage. In this system, materials perform an essential part as support and driving forces in all forms of play. The material organization ultimately selected should lead to a mix of elements that encourages open-ended activities in line with the Cricket philosophy. Several challenges will certainly arise as this research continues. First, child safety can be a difficult topic in the context of materials. While we support the most diverse selection possible, *My Workshop* will most likely be used with, but perhaps also without supervision. Thus, safety hazards will have to be carefully considered before final selections are made. Second, a potential problem is that the box could be construed as packaging diminishing its potential power as a support for design activities.

My Workshop forms a pilot proposal that introduces spatial organization and tactility into discussions around children's creative activities. But our suggestion merely represents the tip of the iceberg. We are convinced that there is enormous potential for further developing the Cricket philosophy along the themes introduced in the paper. We believe that there is a place for architectural design thinking in strengthening the relationship between the Crickets and the physical environment in which children play.

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Examples, Cases, and Precedents

Artists

Ganson, Arthur. Artist creating kinetic sculptures

Logue, Joan. Artist creating wearable jewelry

Pico Cricket Workshops

MIT Museum, <http://web.mit.edu/museum/>, <http://emergingtech.mit.edu/>

Non-public Website compiled by Emerging Technologies at the MIT Museum for the facilitation of Pico Workshops,
<http://learningtech.mit.edu/FX/index.php?ID=2&&pullDownChoice=Materials&pullDownText=cricket¤tQuery=Go%21>

Public Invention and Exploration Network, <http://www.pienetwork.org/>

Toys

Creativity for Emotional Intelligence: Ideas and Activities
<http://www.kidsource.com/kidsource/content4/creativity.eq.html>

History of Technical Construction Kits, http://www.deutsches-museum.de/ausstell/dauer/techsp/e_spiel.htm

Knex Construction Kits, <http://www.knex.com/>

LEGO Clikits, <http://www.clikits.com/default.asp?bhcp=1>

The Nature of Children's Play
<http://www.kidsource.com/kidsource/content2/nature.of.childs.play.html>

The Toy Manufacturers of America Guide to Toys and Play
http://www.kidsource.com/kidsource/content/toys_ply.html

National Association for the Education of Young Children, <http://www.naeyc.org>

Playdoh Creativity Table, <http://www.yenra.com/play-doh/>

Tinkertoys,
http://www.gregiswrong.com/essays/how_my_tinkertoys_got_to_heaven/how_my_tinkertoys_got_to_heaven.htm

Topobo Project at MIT Media Lab, <http://web.media.mit.edu/~hayes/topobo/index.html>