Computers and Mud

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During the summer of 1999, I spent a week on Deer Isle, serving as a faculty member at the Stonington Retreat, an annual workshop at which teachers and educators explore creative uses of new technologies. One afternoon, Laura Allen, who organizes the Stonington Retreat, took us on a field trip to Haystack Mountain School of Crafts. Like many first-time visitors, I was stunned by the beauty of the natural surroundings and inspired by the activities and creations I observed in the Haystack workshops.

But what I remember most from that visit was a conversation I had with Stu Kestenbaum, the director of Haystack and a friend of Laura's. To many people, the MIT Media Lab (where I work) must seem like a totally different world from Haystack. After all, the Media Lab specializes in the latest in digital technologies, while activities at Haystack are firmly rooted in the physical world, drawing on traditions that are centuries old. The virtual worlds of the Media Lab seem far removed from the glass-blowing, clay-sculpting, and paper-making activities of Haystack.

But as Stu and I talked, we felt a connection. We recognized that the worlds of Haystack and the Media Lab are not as far apart as they might seem, and each has a lot to learn from the other. Digital technologies need not be seen in opposition to the physical world. Rather, digital technologies can be integrated with physical objects to create new types of dynamic materials that react and respond to the world around them. And these new materials, just like more traditional materials, can serve as the basis for new types of craft activities.

In my own work, I am interested in how these new materials can open up not only new craft opportunities but also new learning opportunities. Research has shown that many of our best learning experiences come when we are engaged in designing and creating things, especially things that are meaningful to us or others around us. When children create pictures with finger paint, for example, they learn how colors mix together. When they build houses and castles with building blocks, they learn about structures and stability. When they make bracelets and necklaces with colored beads, they learn about symmetries and patterns.

Like finger paint, blocks, and beads, computational technologies can also be used as a material for making things. For example, my research group has developed a family of "programmable bricks": tiny computers embedded inside children's building blocks. Our latest programmable bricks are called "crickets," since they communicate with one another via infrared "chirps." With crickets, children can build computational power

directly into their physical-world constructions. Children can program the crickets to control motors, receive information from sensors, and communicate with one another.

Children have used our crickets to build a variety of creative constructions. An 11-year-old girl named Jenny, for example, decided to use crickets to build a new type of bird feeder. She started by making a wooden lever that served as a perch for the birds. When a bird landed, it would trigger a touch sensor, sending a signal to a cricket, which turned on a LEGO mechanism, which pushed down the shutter of a camera, taking a picture of the bird. The design-oriented nature of the project was clearly very important for Jenny. As she described it: "The fun part is knowing that *you* made it; *my* machine can take pictures of birds." At the same time, the project served as a rich context for engaging in scientific inquiry and learning science-related concepts. Jenny developed a deeper understanding of some concepts (such as mechanical advantage) that she had previously studied in school but had never really appreciated. And she began to work with some engineering concepts (related to feedback and control) that traditionally have been taught only at the university level.

Our hope is that people will come to see crickets as just another type of craft material. We started to see that happening at the Digital Dialogues workshop, where participants used crickets in many different types of projects. Sally McCorkle, a sculptor from Penn State, used a cricket, a small fan, and a distance sensor to create an interactive sculpture that blew gold dust in interesting patterns whenever anyone approached. Therese Zemlin created a series of hand-made paper lanterns with small lights inside, and programmed the lights to change color and intensity based on the movements of the people around the lanterns. My Media Lab colleague Justine Cassell, along with two of her students, collaborated with blacksmith Tom Joyce to create a vessel that could "talk for itself," telling the story of its own making. When you reached into the vessel, sensors activated videos showing how the metal had been forged and riveted.

These projects represent a first step in the integration of the digital and physical worlds. But there is still a long way to go. At one dinner during the Digital Dialogues workshop, I sat next to Bill Daley, the great clay artist. He asked me about my work, and then summed up his own work: "Well, I work with mud." With this description, Daley seemed to be emphasizing the big gap between his work and mine. But I took Daley's comment as a challenge. If digital technologies are going to be truly useful as a new craft material, we need to make them feel a bit more like mud.