

Research Statement

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Dissertation Work

My current work investigates how children design and construct mechanisms and how that process affects their mechanical reasoning and spatial cognition. To do this I have built an integrated CAD/CAM system called *MachineShop* using principles from Task-Centered User Interface Design and Cognitive Science. This work seeks to understand some of the changes that children undergo when they use sophisticated technologies in domains for which they have little or no prior knowledge. It further seeks to identify techniques and approaches for making sophisticated technologies accessible to and adoptable by young users.

This work comes from my interests in math, science, and technology education, constructionist educational practices, and developmental psychology issues concerning reasoning about complex physical objects. It builds directly on the HyperGami project of Ann Eisenberg [3] but is different both in the complexity of the created artifacts (dynamic versus static) and in its approach to the process. Where HyperGami has no traditional ancestors, *MachineShop* inherits from a vast array of professional engineering tools. The interdisciplinary nature of the research further sets this work apart from much of what has come before and allows for a rich set of questions to be proposed which are relevant to Computer Science (human-computer interaction, complex representations, tutoring systems), Education (math and technology education, manipulatives and activities), Psychology (reasoning and decision making, developmental processes), and Sociology (communities of practitioners, social currency of artifacts).

Research Plan

MachineShop is just an initial foray into the rich and relatively unexplored intersection of children and technology. Future directions that I would like to take this research include:

- Involving children not only as the consumers of technology but also as designers of that technology. Initial work in this area [2, 5] has shown that a great deal still remains to be understood. Virtually none of the technology created for children benefits from obtaining their input and therefore forces a particular view of the technology onto its users. What might be the face of this technology if its users were also its creators?
- Creating tools for children to support both collaborative learning and play. Many of the tools available to support the former tend to demarcate work done with and without the tool [1]. Discovering ways to leverage technology to enhance the classroom experience rather than replace it may help us design more effective and stimulating classrooms and curricula [7].
- Creating technology to support and enhance the Design and Technology component of the curricula in Great Britain and Canada. My contacts with teachers in England and Ontario has convinced me that a reasoned approach to technologies to support teaching this subject would be warmly welcomed by both educators and students. The breadth of skills needed will provide a variety of projects with a common focus and an opportunity to integrate and standardize tools for a diverse range of disciplines.
- Revisiting traditional approaches to math and science technology in light of the technologies now available with an eye toward providing students with more *hands-on* technology supported activities to supplement the current technology provided virtual activities [4, 6].

- Adapting MachineShop and tools like it to support engineering education for elementary school children. Anecdotal evidence suggests that in order to increase the admission and retention rates for undergraduate engineering students we need to engage them in engineering topics and activities as early as possible. Tools like MachineShop can provide authentic activities for even young children to stimulate and hold their interest in engineering as a vocation.

Student Involvement

Clearly, these are only a few of the directions in which my research might go and I would expect that my students would contribute their ideas and interests to its course. While any of the above could become major research agendas or theses, there is nothing inherent here that would preclude undergraduates, in teams or individually, from making significant contributions. In fact, I believe that these domains are ideal as vehicles for undergraduates to put into practice many of the things that they are concurrently discovering in the classroom.

References

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