# Modular Robotics as Tools for Design

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**ABSTRACT**

The act of design is fundamental. In various forms, it permeates engineering, management, architecture and the arts. Design aptitude separates the visionary from the technician. Although many skills, like math or technical writing, are straightforward to quantify and teach, the creativity and processes inherent in design are both more difficult to instill and more difficult to understand.

Design in an unconstrained environment is almost impossible. Noted late graphic designer Paul Rand speaks to the benefits of a constrained system as something "without which fruitful and creative work is extremely difficult." [2] Papert addresses this with his concept of the *Microworld*, [1] a domain-specific constrained environment for experimentation and design education. Microworlds have been shown to be effective tools for design education in domains from creative art to mathematics.

The advent of tiny microcontrollers and inexpensive rapid prototyping technologies has made it easier to create tangible Microworlds outside of the computer screen.

My research focuses on the design of modular robotic systems that allow users to play and experiment freely in computational domains.

roBlocks [3] is a computational construction kit that allows children as young as nine to design and build functional robots by snapping together magnetized plastic modules. roBlocks is a distributed system, with a microcontroller embedded in each 40mm cube. By assembling combinations of Sensor, Actuator and Operator blocks, young users are exposed to advanced ideas like feedback control, logic and kinematics before they learn to solder or program in C. More advanced users can reprogram the behavior of each module, exploring distributed control and communication.

StickyBricks is a mobile modular robotic system designed as a tangible tool to explore locomotion constraints. Each StickyBrick is a 30mm cube with two circumferential adhesive belts powered by a tiny geared DC motor. Users can write very simple Python instructions to control the movements of each module, exploring the integrity of various configurations and lattice structures.

The Egglet was developed to enable musicians to add additional dimensions of expression to extant instruments of any type. Comprised of an 8cm plastic egg-shaped "brain" into which various sensors can be plugged, the Egglet is a wireless, battery-powered system which uses a microcontroller to synthesize input from a simple sensor network in order to control audio, video or MIDI data. Musicians with little technical knowledge can snap together various sensors and use motion, light, and touch to control the parameters of audio effects.

These three projects represent an effort to understand the design process – on one hand, the design of modular robotic systems and on the other hand, designs within the constrained environments they create.

## BIOGRAPHICAL SKETCH

Eric Schweikardt is a PhD student in Computational Design at Carnegie Mellon University. He is a designer – of tools, robots, architecture and software. After completing an undergraduate degree in architectural design, Eric taught digital modeling and animation at the University of Colorado's College of Architecture and Planning. He founded the Allegory Design Group, a web development studio specializing in 3D user interfaces, and worked as a consultant creating architectural renderings and animation for Michael Tavel Architects, Hobbs Design, Wolff Lyon Architects and DKahn Studio.

Eric's undergraduate research was concerned with pen-based interfaces and the apparent divide between sketching and design development in architecture. This work resulted in Digital Clay, a program that interprets isometric (3D) sketches as digital models. Eric has presented work at conferences on Human Computer Interaction (ICMI), Computer-Aided Design (ACADIA), and Intelligent Toys (DIGITEL).

## REFERENCES

1. Papert, S. *Mindstorms: Children, Computers, and Powerful Ideas*. Basic Books, New York, 1980.
2. Rand, P. Design and the Play Instinct. in Kepes, G. ed. *Education of Vision*, George Braziller, New York, 1965, 154-173.
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