

Designing Nature-Inspired Smart Nanobots

By Jeffrey Johnson '15



Have you ever wondered what it would be like to have a machine that could create any object you desired? Although this machine is still a dream of the future, Jeremy Blum and other researchers in the Creative Machines Lab, formerly the Computational Synthesis Lab, are developing the initial technology required for such a machine.

One of the goals of the lab is to redefine how people think of robots. In Blum's own words, "We make robots that are both creative ... and creatively different than what you would usually conceptualize as a robot." He says that genetic algorithms and neural networks inspire many of the robots and software programs in the lab. The researchers operate under the philosophy that "nature got it right." Blum is a senior in the Engineering College majoring in Electrical and Computer Engineering. Working with Jonas Neubert, a former graduate student at Cornell, he recently completed a project researching communication in self-reconfigurable robots.

The goal of the research was to develop molecule-sized robots that could communicate with one another and assemble themselves into a given structure. In the early experiments, the robots that represented large-scale individual molecules were cubes. The six faces of the cubes consisted of a flexible circuit board sandwiched between two rigid ones. The flexible circuit board contained many of the electrical components, such as microprocessors. The outer rigid circuit board had contacts coated in Field's metal, a metal similar to solder, but with a lower melting point.

The cubes floated around in a tub of vegetable oil, which was used because it does not conduct electricity, with seed cubes on the bottom to which any subsequent cubes would attach. Blum and the others then used suction, regulated by a computer program that opened and closed valves, to attract the floating cubes to the seed cubes. Once they were adjacent to each other, power was turned on in the base of the tub and melted the Field's metal, fusing them together. At this point the Field's metal connected the cubes mechanically and electronically. The power running from the base of the tub then turned on the microcontroller in the attached cube and it would report back its identification number and was then able to attract others.

The research concluded with the robots communicating and the cubes attaching, but a full structure was never created because the research was discontinued so that resources could be dedicated elsewhere. Blum believes the project still had potential and could be made to work, and thus he does not consider it a failure. According to him, they gained knowledge and developed technology that now forms the foundation for other research going on at the Creative Machines Lab.

These other projects include experimentation with machine metabolism, with which Blum first became involved as a sophomore. The researchers "The researchers operate under the philosophy that 'nature got it right.'"

hope to develop a robot that can autonomously deconstruct and construct objects. Blum said it is accurate to think of the, "robot like an enzyme and the structure like a protein." He helped develop electronics and write code for the second generation of the metabolic robot. The ultimate goal of the project would be a robot that could use materials from its environment to modify and improve itself. The researchers on this project have written a paper that is currently pending publication.

Furthermore, Blum is involved in the development of 3D printing technology. He designs electronics for MakerBot and even has one of their 3D printers at home. The MakerBot printer can be used to design and print in plastic anything that is smaller than 96mm x 108mm x 115mm. Additionally, he just started work with another 3D printer at the Creative Machines Lab, called Fab@Home, for which he will also design electronic components.

When he is not working on one of these projects, Blum runs Cornell University Sustainable Design (CUSD). He also enjoys freelance blogging, press work for an electronics distribution company called element14, and video production. His YouTube channel has over ninety videos and two and a half million views! Blum's adventures can be followed on his website, jeremyblum.com, or his YouTube channel, [scigu14](https://www.youtube.com/channel/UC14).

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