ABOUT THE COVER

The Game of Slime

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Michael Sedbon seeds the *Game of Life* with slime molds. The results might be out of control.

Originally from France, Sedbon studied design at the University of the Arts in London before spending several years as an interactive artist and designer. His work has made the rounds at festivals and won awards like the STARTS prize of the European Commission and the Lumens Prize. Now he's back in school, studying synthetic biology at CRI in Paris.

The cover, as well as Figures 1–3, are from Sedbon's project, CTRL, an installation in which ten Physarum Polycephalum—unicellular organisms also known as slime molds—send control signals to a machine running Conway's *Game of Life*. Developed by British mathematician John Conway, the *Game of Life* is a cellular automaton, a grid of cells that evolves by itself via rules based on various initial conditions.

Sedbon built the CTRL environment to monitor the slime mold activity via electrical potential differences. Two stacks of five Petri dishes contain slime molds that grow and reach out toward food via protoplasmic vein-like tubes that conduct electricity. The slime mold can sense light and color information, which it then transmits to the rest of its body by densifying the tubes. Sedbon's installation measures this densification as electrical resistance and then uses the signal to define the initial conditions, the spatial coordinates, for the *Game of Life*.

At the end of ten rounds, the Physarums' moves are analyzed and compared. The onboard artificial intelligence then sends signals back to the slime molds in order to alter their behavior, that is, to manipulate and optimize their game technique for future rounds. At least that's the intention. Since biological organisms adapt to situations differently than their digital counterparts, the results may not happen as intended.

This is why the slime mold becomes a fascinating organism to work with. Even though it is unicellular and thus without a central nervous system or brain-like infrastructure, it does exhibit a sense of locomotion, giving it a type of decentralized intelligence. Computer scientists have studied slime molds for years, just for this reason.

"People who study cognition use this organism as a model to conduct basic experiments to derive a theory about how computing exists in biology," Sedbon says. "It does locomotion, which is one behavior usually associated with animals or things that have brains."

Thus, the title of the piece, CTRL, provides double, if not triple meanings. Who or what is in control? Is the computer controlling the biological world or vice versa? Can biology be triggered to evolve in the same way, with the same results, as when electrical circuits are controlled? Can digital systems accurately mimic biological systems? Can societies be controlled in the same way that hardware or software stacks are controlled? Who or what controls the possibility of immortality? What about free will? All of these questions emerge from such a simple project.

THE ORIGINS OF CTRL

Sedbon discusses other projects at length in this issue's Art on Graphics section *(see page 58)*. For CTRL, he says the influence came from his own basic interest in the histories of both computer science and biology.

"It was really clear to me that since the beginning, when we started to make computers, like modern computers, let's say the late 19th century, most of what we were trying to do was biomimicry," Sedbon says. "So for me, it looked like the first goal was to make some sort of artificial intelligence since the very, very beginning. And this artificial intelligence was mostly trying to reproduce what we can see in things we usually consider intelligent, like animals, or things that are biological."

In a sense, computers were always trying to imitate biology, he says. The man was always trying to conquer nature. Even today, though, as people continue to build computers and robots inspired by biological paths, the results are never quite what anyone expects. No one can truly control the outcome.

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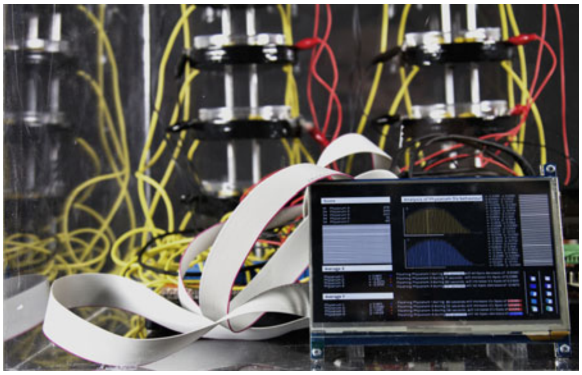

FIGURE 1. Analysis of the slime mold's behavior. (Source: Michael Sedbon; used with permission.)

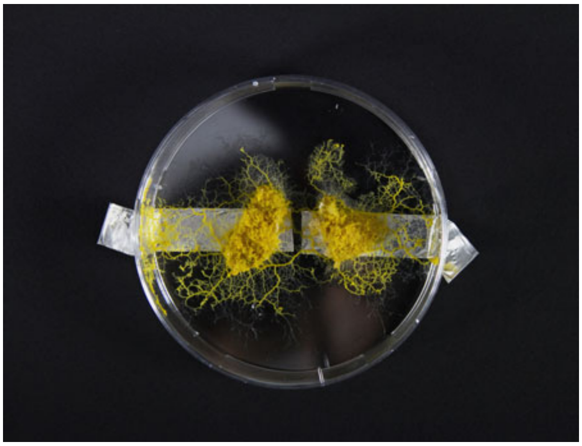

FIGURE 2. Close-up shot of the slime mold. (Source: Michael Sedbon; used with permission.)

"That's what I was looking at," Sedbon says. "How culture and knowledge in biology influenced culture, knowledge and the tools of computer science. That was the beginning of it."

The beginning of CTRL, one could say. The problem is that the real biological world features all sorts of extraneous noise that actually plays a more important role, and a more fun role, in the evolution of processes. Slime molds, for example, are quite noisy and indeterministic, so connecting them to a very deterministic process like the *Game of Life*, becomes an interplay of opposites, a balance between control and indeterminacy.

"It's also true of other kinds of systems—social systems or human systems," Sedbon says. "Like things that involve humans in their activity. For example, one of the biggest assumptions of design and architecture is that if you produce spaces or devices that are for

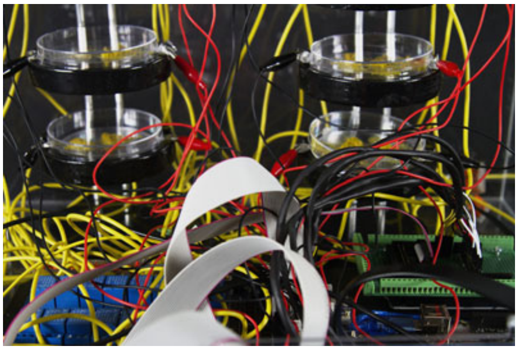

FIGURE 3. Hardware and electrodes measuring slime mold activity. (Source: Michael Sedbon; used with permission.)

some [specific] uses, then your user is going to use it this way. However, we know that's not true. History has proven that cities are not used in the way that the city planners think about it. And that's what's beautiful about them."

ELECTRO-GENETICS

Right now, Sedbon is taking a break from art and design to focus more on engineering. In particular, he spends more time on synthetic biology projects. He enthusiastically talks of another subject area, that of electro-genetics, a set of tools that allow electricity to interact with bacteria.

"This means that you could give an electrical input to bacteria and trigger the expression of some genes," he says. "These genes do some biochemical processing inside the cells and output an electrical signal that you'll be able to retrieve electronically with a microcontroller. In of itself, this turns the population of bacteria into bioelectronic components."

So instead of a normal electronic component, a material object, transforming a signal, which can then be assembled into a circuit, we would see biochemical processes transforming the signal. We would see bacteria converted into a circuit board. The artistic potential is enormous.

In the end, Sedbon may or may not end up measuring slime molds again. If he does, it would be for a project more like his other work, focusing on the slime's potential for memory storage. Nevertheless, the Physarums are fun to take care of.

"They make good pets," he says.

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