



SYNTHETIC BIOLOGY

NEWS

Visions of Synthetic Biology

Artists embrace synthetic biology as a tool and an inspiration, but not necessarily as a promising way for the future

Inside Vienna's Museum of Natural History, the Bio:Fiction film festival and its sister art show, Synth-ethic, abound with living fantasia. The world's first art exhibition specifically devoted to synthetic biology, its exhibits are a gamut of interpretations of the emerging field, ranging from the celebratory to the alarmist. One short film sings the praises of a synthetically engineered future complete with glowing trees, a cure for cancer, and a biologically grown spaceship. Another shows how synthetic biology could lead to the devaluing of life. In it, a gamer uploads a superhero's genetic code into a piece of meat through a USB cable, directs the resulting humanoid around with a videogame controller, and eventually suffocates him in a plastic baggie. The art show is similarly diverse, showcasing "Nanoputians"—organic chemicals whose molecular structures resemble human stick figures—a sparkling arrangement of tubes and glassware that recreates the Miller-Urey origin-of-life experiment, and slimy, semiliving "worry dolls": cells on scaffolds to which visitors whisper their concerns about biotechnology.

But it's no accident that the show takes place in a museum of natural history, not art. "They're not just evocative objects," says Synth-ethic curator Jens Hauser. Nor are they simply educational illustrations of synthetic biology. "They're cynical design," using synthetic biology to critique synthetic biology.

As the field has grown during the past decade, so has interest in using its tools

for nonscientific purposes. These are early, heady days for a field that promises to revolutionize medicine (see p. 1248), the chemical industry, and genetic engineering, to name just a few. A growing number of artists are attracted to it as a technique and also because of the interesting ethical questions it raises.

Many of these artists work directly with research scientists. Their creations add a cultural counterbalance to the field's tendency to view life like circuitry, a utilitarian perspective that increasingly drives synthetic biology and, they say, informs the public's understanding of it. They find themselves uniquely placed to ask hard questions about the ethical and social issues raised by synthetic biology. While special interests that want to either promote or condemn the nascent science have been eager to fund artistic interpretations of it, they are finding they may not get the results they hoped for.

Yet unlike engineers focused on solving a problem, "artists are the ones in a position to ask questions of 'why?' or 'should we?'" says Richard Pell, an art professor at Carnegie Mellon University in Pittsburgh, Pennsylvania. Continuing in that role is critical, he adds, because synthetic biology "should be thought about much longer than it takes to say 'Frankenfood' or 'cure for cancer.'"

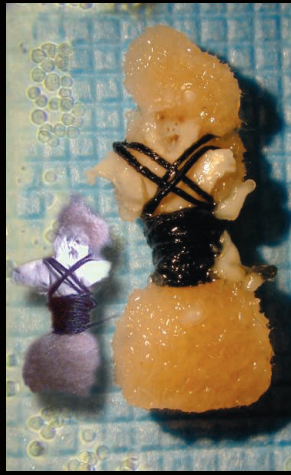
Artists in the lab

With the advent of streamlined genetic and tissue engineering, interest in science-

inspired "bioart" has exploded. Synthetic biology itself provides a "wet palette of possibilities" as both a technique and a topic, says Oron Catts, co-founder and director of the SymbioticA program at the University of Western Australia in Perth. SymbioticA has hosted more than 70 resident bioartists since 2000 and even offers a Master of Biological Arts degree. Synthetic Aesthetics, a collaboration between Stanford University and the University of Edinburgh, funds six pairs of scientists and artists to work together exploring one another's world. Programs such as these, as well as the emergent do-it-yourself biology movement (see p. 1240), allow artists to work alongside scientists in order to learn both the molecular techniques and the realities of the field.

Joe Davis, an artist and researcher at the Massachusetts Institute of Technology and Harvard University who has been in the bioengineering business for decades, is a perfect example. In the 1980s, annoyed with what he called the "absurdist" attempts by Search for Extraterrestrial Intelligence efforts to talk with extraterrestrials through radio waves, he encrypted the Arecibo Institute's famous binary message in DNA code, cloned it into spore-producing bacteria, and proposed launching them into space. Although it remained Earth-bound, this "Microvenus" project was his early claim to fame. Nowadays, he works in the lab of Harvard synthetic biology maven George Church (see p. 1236), sitting in on lab meetings, brainstorming with scientists, and interpreting ideas. Supported by his own art grants, he sees himself as the quintessential tinkerer, similar to the technically competent backyard rocket builders and radio enthusiasts of the past century.

A crystal radio was precisely what Davis displayed in the Synth-ethic art show—one



Mixed media. Artists' reactions to synthetic biology, from left: Daisy Ginsberg imagines the medical implications of synthetic biology as organs coated in biological crystals and a diagnostic suitcase of colorful poo. Joe Davis powers a crystal radio using bacterial nanowires. Tuur van Balen builds a window trap for pigeons to catch them and turn them into soap dispensers. And Oron Catts grows cells into the shape of "worry dolls" ready to listen to concerns about biotechnology.

built of bacteria that naturally create their own communication lines, or nanowires. Engineered with a modified gene from a sea sponge that builds its own skeleton from silicon in seawater, the silicon-producing bacteria grow to form an electrically conductive circuit and are hooked to an antenna and speakers. The "radio" still has a few kinks, he says; he hopes to get it working soon. He and others in Church's lab are now trying to clone the modified gene into silkworms to see if the caterpillars will spin glass cocoons as art pieces.

Davis wishes more artists were willing to spend extended time in labs—where they experience both the excitement and constraints of cutting-edge science. Too many bioartists, he says, are more interested in shocking people than seeing what science is really about.

Yet bioengineers are not always welcoming of the input—and potential criticism—of artists. The International Genetically Engineered Machine competition (iGEM), an annual program in which undergraduates create useful life forms from standardized genetic components, is often touted as the future of synthetic biology. But in 2009, art infiltrated this bastion of utilitarianism when a team from Bangalore, India, entered *Escherichia coli* they had engineered to produce the smell of rain before a monsoon. "It was the angle I'd always hoped to find at iGEM," Pell says. Not everyone agreed, however, leading to a minor debate among the judges about whether such an impractical creation belonged at iGEM. In the end, the team got a "Best Presentation" award, and several other art pieces have since been entered.

Catts says that this kind of creativity and "irrational design" have been providing a much-valued counterweight to the stolid

logic of the field's many engineers and computer scientists. "There's a nice amount of mutual respect when a field is still embryonic and territories haven't been carved out yet," Pell says. But as synthetic biology matures and becomes a lucrative area for investors and entrepreneurs, he expects there will be growing pressure on artists to present particular perspectives on the field. He fears this sweet period of artists freely cooperating with scientists may be nearing its end.

Shades of ethical gray

Eager to avoid the mistakes made with the introduction of genetically modified organisms, which drew irreparable backlash from the public, the scientific world, particularly in Europe, hopes to enlist the aesthetic contributions of bioartists to their cause. Institutions such as the U.K. Royal Academy of Engineering, in discussions about how to engage the public, have called on artists to help illustrate synthetic biology in outreach programs. And it's common practice for European companies, including some biotech firms, to include artists in their public outreach budget—with, Catts says, unspoken PR expectations.

So Catts has been hard at work fighting what he sees as a concerted and premeditated effort to co-opt artists into helping engineer public acceptance of synthetic biology. "I think they've got a misconception about the role of artists in society," he says. "It's art's place not just to make sense of [science] but to critique it."

But insofar as artists are interpreters, informing a society that gets its science in sound bytes, their messages span the range. For each shock artist who makes dire predictions and illustrations of "spider-goats"—inspired by a scheme to put a spider gene

into goats—there exists what Catts calls a "technofetishist" who revels in humans' ability to modify the world and themselves.

Yet most of those who have talked to scientists and learned about synthetic biology inhabit a middle ground. "It's an ethical gray zone I like to explore in my work, and I like people to engage with," says designer Tuur van Balen of the Royal College of Art in London.

Humor also plays a role: One of Van Balen's projects, Pigeon d'Or, consists of a window trap with pigeons. He envisions them eating a gut bacterium that he would "engineer" to produce a biological soap that could pass through the pigeon gut intact, spreading sudsy excreta. The idea? Feeding the bacteria to pigeons could draft them as the ecosystem's windshield washers. This absurd flight of fancy should make people stop and think about how synthetic biology might turn ecology on its ear.

The question of how synthetic biology will affect larger organisms and ecosystems intrigues Alexandra Daisy Ginsberg, one of the founders of Synthetic Aesthetics. "There's something not so threatening about microbes," she says. So she decided to make "something visceral: What will synthetic biology actually look like?" she asks. One of her projects, Synthetic Kingdom, explores environmental health effects. For instance, future organisms designed to make telltale red crystals when exposed to carbon monoxide might inadvertently colonize human lungs. In smokers, this could produce an artistic result: red lungs.

Another Ginsberg piece, *E. chromi* (see image), imagines a future in which we ingest synthetic bacteria that turn our feces different colors according to the diseases we have. The project is a response, Ginsberg says, to the personalized medicine that synthetic biology promises. This "suitcase of poo" has won numerous art awards and is now being displayed in the Museum of Modern Art in New York City. For Ginsberg, who says she's "frustrated by misinformed visions" of the future, getting people to think about the technology's day-to-day implications is the most important issue.

Her fellow artists also want to be thought-provoking. "I'm not a science communicator," Van Balen says. "I don't want people to see my work and learn what synthetic biology is; I hope their reaction would be to walk away and scratch their heads and be a bit puzzled."

—SARA REARDON