O. CATTS, I. ZURR & G. BEN-ARY

Science for art's sake

In several labs around Boston, the techniques of genetic and tissue engineering are being used in the name of art. Steve Nadis asks the artists and scientists involved what they gain from this fusion of high culture and cell culture.

Visitors entering one of the tents set up at last month's Ars Electronica, an international art festival in Linz, Austria, were greeted by an unusual sight. On display, behind the locked glass doors of a refrigerator, sat petri dishes containing *Escherichia coli* bacteria. But these were no ordinary *E. coli*. Their genes included artistically engineered elements of DNA. In one work, called *Microvenus*, the DNA bases constituted a code that, when properly deciphered, provided a symbolic rendering of female genitalia. In another dish, the DNA-encoded message read: "I am the riddle of life. Know me and you will know yourself."

These artistic DNA molecules are the work of sculptor Joe Davis, who for the past decade has been a research affiliate in the laboratory of Alexander Rich, a structural biologist at the Massachusetts Institute of Technology (MIT). Davis, one of a handful of artists using the tools of cell and molecular biology in their work, is the leader of an emerging 'new Boston school' of bioartists.

The relationship between science and art has been explored extensively in recent years. But most ventures in this area have involved artists working in traditional media, inspired by the theories or practice of science. Davis, on the other hand, directly engages the techniques of science in his art. "Drawing a picture of something you don't understand is just not good enough," he says. "Art is about communicating. How can you convey something you don't have a clue about?"

Over the years, Davis has devised a series of ambitious projects. In 1992, in an attempt to find a new way of communicating with extraterrestrials, Davis started to search for

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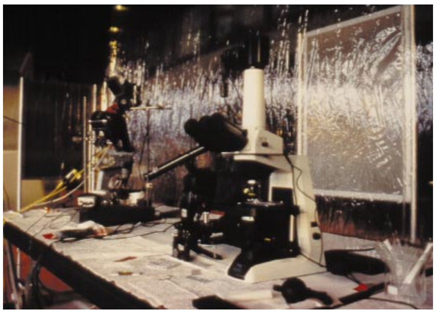

Art attack: muscle tissue grown over a hydrogel in the shape of a spearhead (opposite) by Oron Catts, Ionat Zurr and Guy Ben-Ary. Clockwise from top left, Joe Davis, father of the Boston bioart movement; a representation of the DNA code in Davis's *Riddle of Life* bacteria; Adam Zaretsky, one of Davis's recruits, in the lab; muscle grown over a hydrogel by Catts and Zurr; and Davis's audio microscope, which converts the movements of microorganisms into sound.

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bacterial spores that might be resilient enough to carry his DNA codes into space. Working with Stefan Wölfl — a former Rich-lab biologist now at the Hans-Knoll Institute in Jena, Germany — and Michael Shia of Boston University, he collected samples of cooling water from MIT's nuclear reactor. The team hoped to find microorganisms that could withstand the radiation and temperature extremes of the reactor's environment. They identified six different bacterial strains in the reactor water.

Another project, called *New Wave Ruby Falls*, involved a plan to put an electron gun on a space shuttle to generate artificial Northern Lights that would be visible from Earth. And in 1993, Davis won another shuttle slot for a project called *Norton Rings*, named after Ed Norton, a fictional sewer worker on the popular US TV show *The Honeymooners*. Davis claims the Earth is orbited by rings of urine and faeces expelled from spacecraft over the years. He plans to install 'fishing gear' in the shuttle's cargo bay to trawl the rings for microorganisms. But all of Davis's space-based projects are still waiting to fly due to a lack of funds.

Still, Davis has managed to secure the intermittent help and interest of dozens of researchers from various institutions including MIT, Harvard University and Boston University. "Joe is able to attract so many scientists because his ideas are fascinating," says Shuguang Zhang, associate director of MIT's Center for Biomedical Engineering. "He's not confined to the normal dogmas of biology. All of his thinking is outside the box."

One of the latest inventions to spring from Davis's fertile mind — the audio microscope — fits that mould. Lasers are beamed onto a conventional microscope slide holding microorganisms. As they move around they alter the light reflected from the slide. These changes are converted into sound, which is broadcast through speakers. At the same time, the microscopic image is projected onto a video monitor, so viewers can correlate a microbe's motion with its characteristic 'sound'. Using a frequency analyser, the sound's spectrum is determined and is also displayed — showing, for instance, that all paramecia share a similar acoustic signature.

A bacterial cell darting across the screen "sounds like a herd of buffalo", Davis says. "It's exciting. Every time we get our hands on a new organism, we're the first people in the world to hear these sounds. Someday I'd like to incorporate them in an opera or symphony."

Designs for life

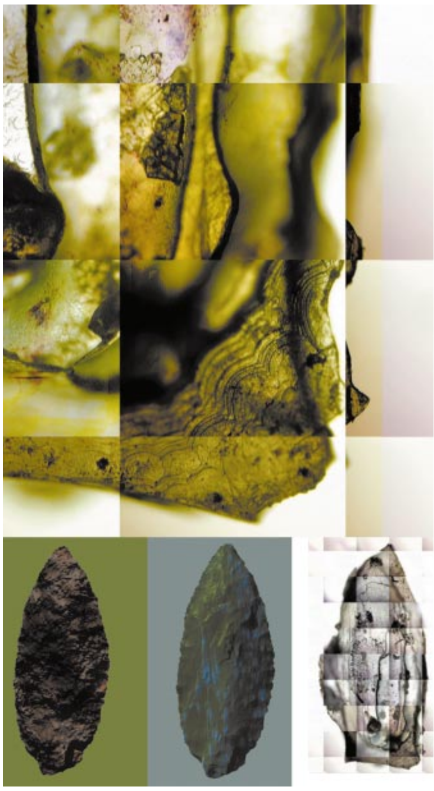
Davis's enthusiasm for his work is infectious, but do the scientists who rub elbows with him gain any real advantage from the association? In terms of conventional measures of scientific success, the benefits are hard to quantify. "I'm not aware of any spillover effect of his work into science at our lab," Rich says. "But Joe has lots of unconventional imagination and it's fun to have somebody like that around. He adds another level of interest to this place."

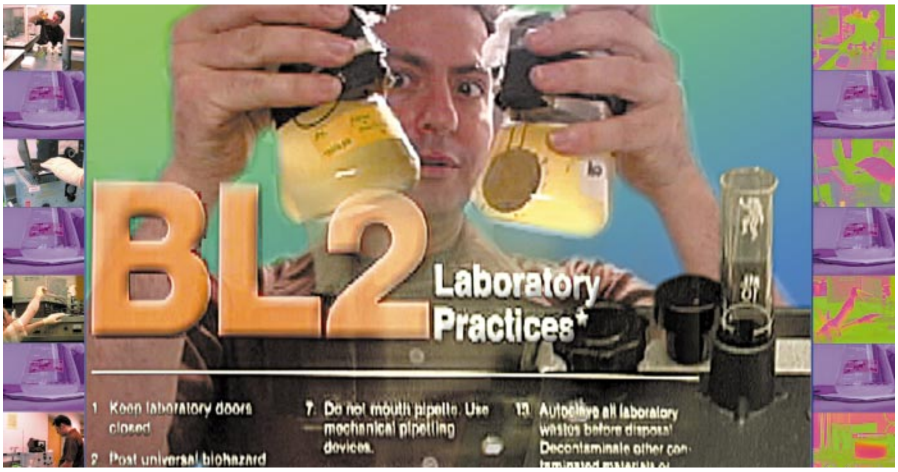
Biologists who have teamed up with Davis find it refreshing to exchange ideas with someone whose thinking deviates from the narrow channels encouraged by traditional scientific training. "Joe takes on projects that are well beyond the scope of what most scientists would consider," says Alan Herbert, a biologist at the Boston University School of Medicine who worked alongside Davis in Rich's lab for about a decade. "He stretches the boundaries of what is possible."

And aspects of Davis's thinking can rub off on his collaborators. After cooperating with Davis on several projects, Harvard Medical School biologist Dana Boyd says he began designing vectors for gene transfer in the "most elegant fashion, as if they were pieces of craftsmanship, rather than doing it in the usual fastest and cheapest way".

But there are detractors. One biologist in Rich's lab, Yang Kim, considers Davis a "disruptive element", whose bench space would be better used by a scientist. "He acts like this is a playground," Kim says. Another MIT biologist, who asked not to be named, considers it odd that Davis's artwork "is not evaluated with the same scrutiny as the scientific output of the postdocs here". He admires Davis's sculptures, which are on display at MIT and elsewhere in Cambridge, and likes him personally. But in the competitive world of molecular biology, he cannot justify granting precious lab space to an artist. "If every lab had a Joe Davis, the university would probably raise a stink about overhead costs," he says.

There is little risk of that, says Rich. "There aren't that many Joe Davises running around. He's a rare bird, not a widespread phenomenon." Yet Davis is actively encouraging other bioartists to move to Boston. At the moment he is working with artist Katie Egan on various projects including the audio microscope, while trying to expand his circle of colleagues. Plans for the field's first meeting, which is to be held at MIT, are in the works. ▶





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Would you let this man loose in your lab? Zaretsky sets out his art agenda.

But the sparse funding for bioart means that recruitment has been difficult. Sympathetic scientists such as Rich might help out by offering a lab berth, but they cannot offer financial assistance. Davis admits to being broke, and bemoans an art establishment that has yet to embrace new, biological forms of expression. "The current funding system is set up to support bygone ways of art," he says.

Prevailing attitudes within the scientific establishment are also imposing limits on bioart's development. For example, Davis is trying to find a laboratory position for Graham Smith, chief technology officer with Telbotics, a robotics company in Toronto. Smith and Davis plan to design robots controlled by individual cells. The Canada Council for the Arts has even promised to fund Smith's work if Davis can get him installed in a Boston lab. But one local biologist, who initially was intrigued with the idea of taking on an artist, eventually declined. "As a junior faculty member, that's not the sort of thing that will help me get funded or tenured," he says. "When I'm as established as Alex Rich, it might be a possibility."

Indeed, for the time being, it seems that only senior scientists such as Rich — who was awarded the National Medal of Science in 1995 for his work on the structure of nucleic acids — can afford to ignore the attitudes of colleagues and bring artists into their labs.

Despite the obstacles, Davis is succeeding in enlisting artists to his Boston movement. Another recent recruit is Adam Zaretsky. As a graduate student at the Art Institute of Chicago, Zaretsky first heard Davis speak there in 1998 and was "blown away". After earning his masters degree in fine art, he came to MIT last year. Once Davis was satisfied that the young artist had fully embraced the bioart philosophy, he helped Zaretsky obtain a position in the lab of Arnold Demain, an MIT biologist who had once entertained dreams of becoming an artist himself. "Maybe Adam's here because I was a frustrated artist early in my life," Demain says.

Sound science?

Zaretsky received a two-year unpaid appointment to pursue a project that Demain describes as "too wild for any postdoc to take on". The idea, which is an offshoot of Davis's audio microscope, is to see whether sound or music can influence the behaviour of an *E. coli* strain engineered to produce the antibiotic microcin B17. "If we could stimulate or inhibit antibiotic production, that would be fantastic," Demain says, acknowledging that this project is an incredible longshot that would be viewed by many scientists as a frivolous endeavour.

Applying the scientific method has not come easily to Zaretsky. "The hardest part is learning to be meticulous, when as an artist you're supposed to be just the opposite," he says. In one experiment, Zaretsky played the music of Engelbert Humperdinck to his bacterial subjects for two days straight. He thinks he just might have observed a response in the cells — the details of which are being kept quiet, pending verification. If Zaretsky can reproduce these results, which he jokingly calls 'the Humperdinck effect', Demain will get one of his postdocs to try to replicate them. "We have to worry about artefacts," Demain says. "With something like this, you don't want to go into the literature unless you're sure you're right."

Growth industry

Across the Charles River, two other members of Davis's Boston school are spending a year as research fellows in Joseph Vacanti's tissue engineering lab at the Massachusetts General Hospital. Vacanti's lab is famous for creating grafts for transplant surgery by growing tissue, such as cartilage and muscle, on polymer scaffolds. But Oron Catts and Ionat Zurr, who were previously based at the University of Western Australia in Perth, use tissue engineering technology to create living, growing sculptures. With their Perth colleague Guy Ben-Ary, Catts and Zurr showed their work at Ars Electronica next to Davis's exhibit.

Catts and Zurr are, so far as Vacanti knows, the first artists-in-residence in the hospital's 189-year history. "I see part of their role as trying to reduce the barriers between the science world and the world that artists represent," says Boris Nasseri, a researcher in Vacanti's lab. "When I tell my colleagues we have artists working here, first they are sceptical, then curious, and then enthusiastic," adds Vacanti. But, like Rich, Vacanti approaches the collaboration safe in the knowledge that his lab is already recognized as a world leader in its field. Consequently, he does not have to worry about whether the scepticism voiced by his colleagues will damage his career prospects.

Vacanti relishes the unpredictability of Catts and Zurr's work, hoping that their presence will add "a new dimension" to his lab. "They can illustrate the beauty that we gloss over while doing quantitative research," he says.

Catts agrees, but says that from the artist's point of view, there is a more fundamental motivation for linking up with leading scientists. "Artists need to comment on the world around them," says Catts. That world, he adds, should include science and technology — and biological research in particular — which are emerging as key driving forces behind the development of twenty-first-century society. "We can't go on painting landscapes forever, as if nothing has changed," he says. ■

Steve Nadis is a writer in Cambridge, Massachusetts.

Ars Electronica ➧ **http://www.aec.at/festival2000**
Tissue Culture and Art Project ➧ **http://www.tca.uwa.edu.au**