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## From Homebrew Computers To Biohacking: Innovators Of Two Generations

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When synthetic biology pioneer Andrew Hessel wonders aloud what the next killer biotechnology app might be, 74-year-old Stewart Brand quips, “Resurrection.” Considering that Brand, the tech industry and ’60s counterculture legend, is exploring the use of recovered DNA for repopulating the earth with hundreds of thousands of woolly mammoths, millions of passenger pigeons, and other extinguished species, bringing humans back from the dead might not be so far-fetched. Our capabilities in biology and technology are “moving from the impossible to the expensive to the routine,” he says.



From left, Andrew Hessel, Stewart Brand, Eri Gentry. (Photo by Asa Mathat)

Brand, president of the Long Now Foundation, joined Eri Gentry, cofounder of the BioCurious hackerspace in Sunnyvale and a research manager at think-tank Institute for the Future, for a wide ranging conversation about “Life 2.0” at Techonomy 2013, moderated by Andrew Hessel, a distinguished researcher at Autodesk.

Brand is credited with coining the term “personal computer” and his collaborators have included tech industry pioneers Danny Hillis, Douglas Engelbart, and Larry Brilliant. The Whole Earth catalog that he published in the ’70s is now considered by some to have been the print precursor to surfing the web for information, and it captured the interests of the makers of the day. Today, Brand is working with Harvard genomics researcher George Church to rebuild entire genomes of extinct creatures.

Thirty-year-old Gentry has gained acclaim, including a White House Champion of Change award, as a leader of the DIY biology movement that aims, [as described by Techonomy in 2011](#), to democratize access to the tools of modern biology. As visionaries of their respective generations’ maker-

movements, Gentry and Brand see eye-to-eye on the transformative potential of technology in the hands of everyman.

When PCs first came along, Brand says some wondered why hackers were so fascinated. It was “because we can do whatever we want” with computers, he says. Gentry’s generation’s passion for using the latest technologies to hack biology is history repeating itself.

In fact, the night before arriving at Techonomy13, Gentry had rubbed shoulders with many of Brand’s contemporaries at a 38-year reunion of the Homebrew Computer Club at the Computer History Museum in Mountain View, Calif. “Do you think your crowd is going to be cackling together like the Homebrew guys 30 years from now?” Brand asked her. Some Homebrewers she met predicted it, she says.

Gentry, who has no formal science training but set up a lab in her garage with a friend, scientist John Schloendorn, to analyze cancer-killing cells, says she’d like to see policies that enable individuals who want to participate in biological research but don’t want to be at a university or Genentech. “There are radical shifts in the ways we’re learning today. Some of us talk about how the university will not exist in 20 years,” Gentry says. “Finding cures really matters and we’re not getting to the place we need to be quickly enough.”

She says many like her would participate in the biology revolution if they could get the resources they need. “The game changers are the ones we’re not aware of,” she says.

The BioCurious lab she started with five friends and \$35,000 in Kickstarter funding, hosts anywhere from 10 to 40 individuals’ research projects at a time, and offers community educational and biohacking events. Meanwhile, Gentry says, thousands worldwide engage in discussions about conducting biotech research at home through the DIYbio.org mailing list. About half of the list is comprised of artists, she says. “Some are turning into biologists, getting the skills they need to do work they think needs to be done. They look at the world in a very different way.”

One example, she says, is an engineer-turned-artist who conceived a photoluminescence synthetic biology project at BioCurious. A plant scientist on the team spun out [GlowingPlant](#) and has become a lightning rod for bioethics debate by raising half a million dollars on Kickstarter to breed plants that provide natural light and offering to mail supporters packets of seeds for growing glow-in-the-dark Arabidopsis plants.

Brand’s response to a Techonomy participant who says the idea of introducing genes to places they don’t naturally appear “scares the living daylights” out of him: “A gene from a different place is not at all like a species from a different place. Genes have been swapped for millions of years, and are being swapped right now inside our bodies.” Genome swapping is the norm, Brand says. “We’ve had GMO foods since 1996 with exactly no environmental or health harm, and the outlier science doesn’t hold up.”

As for concerns about public reaction to his plan to re-create extinct animals, Brand says, “There are going to be glowing plants out there drawing fire away from us.”

Known as a writer and technology visionary, but not for doing biological research, Brand has pulled together 15 venture capitalists and digital

technologists to contribute \$10,000 each to support his [Revive & Restore](#) project to genetically rescue endangered or extinct species.

His funders, he says, are “folks who want to have a foot in what they see as the next platform. They know it’s going to be a century-long story. “Digital code is complicated, but it’s so easy and Minecraft-y compared to genetic code,” he says.

Even if he were able to produce a female woolly mammoth today—by reconstructing the genome and fertilizing an Asian elephant with an egg—she wouldn’t reach child-bearing age for 20 years, Brand notes.

To be clear, the scope of de-extinction work is far broader than could be undertaken in a DIY lab. “For us to bring back a species, we’re not going to do it at Biocurious,” he says. “We’re probably going to do it at the Wyss Institute at Harvard with George Church’s multiplex automated genome engineering machine that generates multiple genes at once, which we need to do ... to move hundreds of genes from one species to another.”

The reaction of biohacker Gentry? “As soon as people see a video of this, they’re going to think about how they can recreate George Church’s machine and make it open source and hackable and for the people.” That’s OK, says Brand. The technology is open source.

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