A Perfect Archive

Dr. George Church Interviewed by Lynn Hershman Leeson

Harvard Medical School, March 23, 2017

GC: We have been developing, exponentially improving technologies to read and write DNA, and so putting those together into a system for archival storage of digital and analog information seemed like a natural thing. My lab and Microsoft and Technicolor have stored a number of videos in DNA. We have converted this 1903 movie 'Voice of the Moon' to digital zeros and ones and into DNA and back to zeros and ones and back into a displayable movie and you can't tell the difference. In the best possible way they're probably stable for a million years, so as long as we're a DNA based life form, its likely we'll be able to read DNA.

So this [film] was chosen by Technicolor, it was possibly their most precious film. The director and producer towards the end of his life tried to destroy all of his films. This classic, the first colorized film, each frame was hand colored, they eventually found a copy that wasn't in great shape and so they manually, through great labor restored it and made digital backups, but they're in the business of archiving. This is something they wanted to archive in a way that would be as permanent as possible. So as long as we're a DNA based life form, it's likely we'll be able to read DNA. That's the idea.

Most of my career we've been exponentially improving technologies to read and write DNA, and so putting those together into a system for archival storage of digital and analog information seemed like a natural thing in 2012. We can store that either in biological systems, or in completely non-biological systems where they're just stored.

It's very important that we keep track of history in an archival sense, in a living sense. It's better if we can keep it in an intact eco-system because we don't know enough about eco-systems to recreate them from frozen storage. Historical versions and living versions of everything, cultures, languages, some of our technological progress has to include setting aside those refuges, those archives. The idea of having to store something in a form that would have to persist for a million years maybe presupposes that we're going to lose our current technology or maybe our civilization as this planet will get destroyed by an asteroid or a supervolcano. But I wouldn't be surprised if we get off the planet in the next century in terms of viable sustainable colonies where people don't expect to come back. It could be sooner.

The fastest and most impactful evolution today is cultural evolution and culture now includes technology and technology now includes genetics. So our genetics might catch up to the speed and impact of culture because it is now part of culture. If we have a good idea, it can spread through the internet in a day. DNA can't spread that fast especially because if you insist on it going through babies, because it takes twenty years for every cycle of innovation.

It used to be that one person couldn't do that much damage, but now with nuclear, biological, and chemical weapons one person can have an impact, in particular biologically because they can spread from a single cell or a single virus, and one person can invent something that is of global significance. So I think that you have to be proactive, and come up with technologies that are good at surveillance, that are good at removing some of the psychological and social motivation for abusing existing technologies.

Surveillance should be one of our top priorities. The earlier we can detect it the earlier we can start reversing it. We want to do surveillance on the environment for emerging diseased. We want to do surveillance on all researchers, official or unofficial as to what they're doing. It's not the right of any person to do whatever they want with synthetic biology. You have a sensor network which can include animal or plant sensors, mechanical electrical sensors. If they're cheap enough they can be distributed worldwide and they can have real time monitoring, and you should be able to detect the first instances of something unusual. You have to have know what you're looking for to some extent, but even any change in the natural frequencies of things could tip you off that something is happening.

We could get better and better at having distributed surveillance throughout our bodies that will anticipate and help us to practice preventative medicine. If every person had their own personal sensor or maybe had several personal sensors just like the average United States citizen has multiple electronic devices. Each of those devices can have a sensor built into it. If we have sensors that tell us that we have great risk for cancer, feedback on senescent properties that can be corrected real time, in particular sensors that can detect infectious agents, then we can stop epidemics at patient zero. We don't have to wait until there are a million people flying around in airplanes each of them spreading around their contagion. We can stop it as soon as we see it. We're getting faster, seeing devices like nanopores that could be real time, so you can actually sense it as you walk into a room. As you sample the water or the food you can see whether you are allergic to it, whether it has pathogens in it, whether you've been vaccinated against those pathogens, all of this could be real time through your cell phone network. So we have the technology to do some of that slowly, but its improving rapidly. One of my postdocs describes this field as sculpting evolution.

LH: It is, I mean this is the artform not of the future but of right now, but people don't see it.

GC: It's a four-dimensional sculpture that includes every part of our eco-system.

LH: and time.

GC: That's the fourth dimension, time.