

The Future as I See It

Gerald Jay Sussman
Matsushita Professor of Electrical Engineering
Massachusetts Institute of Technology

How will the future unfold? Of course, we cannot know the future for certain, but we can make educated guesses based upon our reading of history and our understanding of the forces that guide course of events. I believe that it is important that we try to make these projections, however unreliable, because there may be alternative paths that we can choose, for good and for evil. In this short essay I will lay out how I see the future of humanity over the next few hundred years.

As I see it, the principal force determining the way things go is competition. Much of this competition is for actual economic value, but there is also competition for more abstract value, such as recognition and personal power.

The spear made the hunter more effective. The existence of more effective hunting technology made the prey more scarce, and as a consequence, anyone who did not take up the use of a spear was squeezed out of the ecological system. The later development of agriculture made the hunter-gatherer society obsolete in a similar way. In more recent memory, the development of the fax machine made business communication more effective. As a consequence, any business that does not have a fax machine is squeezed out of the business ecology. We are now seeing a similar development with the development of cell phones and Web sites.

An important deduction to be made here is that any development that improves the effectiveness of effort rapidly becomes a necessity for individual survival. This is even true in the case of labor that has only social value. It is well known that the invention of "labor-saving" artifacts such as vacuum cleaners and washing machines does not lead to less work, but rather to cleaner houses, clothes, and dishes. The invention of computer word processing did not lead to decreasing the total time spent in preparing documents; instead the documents became prettier, and it is now almost true that authors must do the typesetting, because publishers will not accept a manuscript that they have to typeset.

The force of competition has made us increasingly dependent on technology. Now humans are symbionts in a growing association with technological artifacts. We cannot survive without them, and they do not get produced without us.

This is true on the biological scale as well. Most of us are vision-impaired without glasses. Most of us would not be alive without the occasional intervention of modern medicine, or especially without the support of modern sewage-disposal systems. Technology provides prosthetic devices, ranging from glasses to commodes, that make life possible. (I extend the idea of "prosthetic" to devices

that are not permanently attached to the user.) This trend will continue, and I expect it to be the dominant influence in our existence.

The 19th century was the century of applied classical mechanics: The use of stored chemical energy to drive the machines of industry, and the consequential development of effective means of transportation, such as railroads and steamships, transformed the society. This development of motor prosthetics continued into the 20th century with automobiles and airplanes, but the main thrust of technology in the 20th century was applied atomic physics (as electronics). This century was spectacular in the invention of communication and information prosthetics, such as telecommunication, broadcast media, and most recently the Internet.

We are now nearly at the end of the electronics revolution, and we are passing into the age of information and applied biology. Employing information technology, the future holds promise for the development of means to control biological processes that are just as effective as our current control of electrical physics.

This will be an astonishing time. Besides the obvious application of control of biological processes to medicine, we will also be able to coopt biological processes for manufacturing of novel materials (Of course, we already can make beer!) and structures at a molecular scale. But what is most important from the historical perspective is that this will allow us to make an even more intimate symbiosis between our biological bodies and our technological artifacts -- and we will be driven to do so. We will begin to interface our electronic world directly to our nervous systems: we already have the ability to provide cochlear implants for profoundly deaf people. With the rapidly growing understanding of artificial intelligence and neurophysiology, and with the development of better biotechnology, we will be able to provide intellectual prosthetics, as well as sensory and motor prosthetics. What mathematician of the 22nd century will be able to survive and publish a novel result without the help of a "Macsyma" chip embedded in his brain? I would be happy to buy one now if I could.

Over the next few hundred years, I expect this development to continue unabated. We will probably find that the ratio of biological material to much higher performance nonbiological material (but synthesized by biological processes) in the sentient organism will decrease rapidly, and by 500 years from now it may be relegated to the molecular-scale repair and maintenance of our immortal electronic selves.

This is basically wonderful, but it has a scary part: what prosthetics will be developed when, and who will control them? If we do not act now, the ordinary course of events will give control of these processes to the entertainment media. It will be very easy to sell the public on the indwelling boom box, or perhaps some other form of soma. However, I want the Macsyma chip in my head. We have to take a stand now, to avoid a dark age, and ensure an interesting and intellectual future for our descendants, whatever the proportions of electronic and biological matter that they may be made of.