Negroponte, Nicholas. 1995. *Being Digital*. New York: Alfred A. Knopf.

Selected Excerpts:

Most of our information is delivered to us in the form of atoms: newspapers, books. We measure trade and we write our balance sheets with atoms in. GATT is about atoms. A bit has no color, size, or weight, and it can travel at the speed of light. It is the smallest atomic element of the DNA of information. For practical purposes we consider a bit to be a 1 or a 0. Over the past 25 years we have been able to digitize more and more types of information, like audio and video, rendering them into a similar reduction of 1s and 0s. For a black and white photo, an electronic camera lays a fine grid over an image and then recording the level of gray it sees in each cell. If we set the value of black to be 0 and the value of white to be 255, then any gray is somewhere between the two. Conveniently, a string of 8 bits (called a byte) has 256 permutations of 1s and 0s, starting gradations and with a fine grid, you can perfectly reconstruct the picture of the human eye.

First, bits commingle effortlessly. They start to get mixed up and can be used and reused together or separately. The mixing of audio, video, and data is called multimedia; it sounds complicated, but is nothing more than commingle bits. Second, a new kind of bit can also tell you about the other bits: 'headers'.

Broadcast television is an example of a medium in which all the intelligence is at the point of origin. The transmitter determines everything and the receiver just takes what it gets. But computers designed to filter, sort, prioritize, and manage multimedia on our behalf allow to have intelligence live in both the places: transmitter and receiver.

Bandwidth is the capacity to move information down a given channel. Copper telephone wires (twisted pair) are considered a low-bandwidth channel. Nonetheless, there is a $60 billion installed base of phone lines in America, capable of carrying up to 6 million bits per second with the appropriate modem (modulator-demodulator). Fancy modems can run at 38,400 baud, which is still more than a hundred times slower than the potential capacity of copper wire to most American homes. Think of the capacity of fiber as if it were infinite. Today,

fiber is cheaper than copper, including the cost of the electronics at each end. The only real advantage of copper is the ability to deliver power. Telephone companies are very proud of the fact that during a hurricane you may lose electric power, but your telephone is still likely to work. Many people are ignoring the copper stepping-stone. They are buying into the wholesale and immediate need for, and provision of, fiber for limitless bandwidth to maintain a major competitive edge, instead making fiber happen naturally. In fact, unlimited bandwidth can have the paradoxical and negative effect of swamping people with too many bits and of allowing machines at the periphery to be needlessly dumb. Because you compute at both ends, compressing and decompressing it, you use less channel capacity and save money in the transmission.

There is no proof to support the premise that consumers refer better picture quality rather than better content. Digital TV is the future as opposed to analog TV. Japan knowing fully well that digital TV is the future still supported good old analog Hi-Vision due to the cost already incurred. More and more we will see systems that have the ability to adapt, not just to 110 or 220 volts, 60 Hz and 50 Hz, but to the number of scan lines, the frame rate, and the aspect ratio. The digital world is intrinsically scalable. It can grow and change in a more continuous and organic way than former analog systems. If your TV does not speak a particular dialect, you may have to visit your local computer store and buy a digital decoder, just like you buy software for your PC today.

The growth of personal computers is happening so rapidly that the future open-architecture television is the PC, period. The set-top box will be a credit card size insert that turns your PC into an electronic gateway for cable, telephone, or satellite. In other words, there is no TV industry in the future. It is nothing more or less than a computer industry: displays filled with tons of memory and lots of processing power. Most TV programs, with the exception of sporting events and election results, need not be in real time, which is crucial to digital television and largely ignored. This means that most TV is really like downloading to a computer.

In analog days, the spectrum allocation part of the FCC's (Federal Communications Commission) job was much easier. It could point to different

parts of the spectrum and say: this is TV, that is radio, this is cellular telephony etc. But in a digital world, these differences blur or, in some case, vanish: they are all bits. In the near future, broadcasters will assign bits to a particular medium (TV or radio) at the point of transmission. This is usually what people mean when they talk about digital convergence or bit radiation. The transmitter tells the receiver, here come TV bits, here comes radio, or here come bits that represent the Wall Street Journal. In the more distant future the bits will not confined to any specific medium when they leave the transmitter.

Copyright law is totally out of date. In contrast to a musician, a painter more or less kisses a painting good-bye upon its sale. Pay-per-view would be unthinkable. In the digital world it is not just a matter of copying being easier and copies more faithful. You may mail a clipping to a whole mailing list.

Interface (where people and bits meet)

The burden of interaction today has been placed totally on the shoulders of the human party. This will change. Talking, pointing, and looking should work together as part of a multimodal interface that is less about messaging back and forth and more like face-to-face, human-to-human conversation.

In the same way that it is the atomic element of information, pixel (picture and element) is the molecular level of graphics (represented by more than one bit). Pixels tend to require a lot of memory.

Virtual Reality: VR can make the artificial as realistic as, and even more realistic than, the real. The idea behind VR is to deliver a sense of "being there" by giving at least the eye what it would have received if it were there and to have the image change instantly as you change your point of view.

Personal computers will increasingly become vision-ready. Teleconferencing system designers did not think of using the camera for the personal computer to enjoy face-to-face communication, but why not?

Speech can be produced by a computer in two ways: by replying a previously recorded voice or by synthesizing the sounds from letters, syllables, or phonemes.144. We are now seeing some systems that combine synthesis and storage. As with most things digital, the long-term solution will be to use both.

The Internet provides a worldwide channel of communication that flies in the face of any censorship and thrives especially in places like Singapore, where freedom of the press is marginal and networking ubiquitous.

The Industrial age, very much an age of atoms, gave us the concept of mass production, with the economies that come from manufacturing with uniform and repetitious methods in any one given space and time. The information age, the age of computers, showed us the same economies of scale, but with less regard for space and time. The manufacturing of bits could happen anywhere, at any time, and, for example, move among the stock markets of New York, London, and Tokyo as if they were three adjacent machine tools. In the information age, mass media got bigger and smaller at the same time. In the post-information age, we often have an audience the size of one. Everything is made to order, and information is extremely personalized. In the same ways that hypertext removes the limitations of the printed page, the post-information age will remove the limitations of geography. Digital living will include less and less dependence upon being in specific place at specific time, and the transmission of place itself will start to become possible. In the post-information age, since you may live and work at one or many locations, the concept of an "address" now takes on new meaning. It is a virtual address; more like a Social Security number than a street coordinate. Not only you don't know where @aol.com is, whosoever sends a message has no idea of where either it or you might be. In all likelihood, in the next millennium e-mail (by no means limited to ASCII) will be the dominant interpersonal telecommunications medium, approaching if not overshadowing voice within the next fifteen years. We will all be using e-mail, provided we all learn some digital decorum.

People already wear active badges for security purposes. A novel application is being developed by Olivetti in England. Wearing one of their badges allows the building to know where you are. When you have a call, the phone nearby rings.

As we move more toward such a digital world, an entire sector of the population will be or feel disenfranchises. When a fifty year old steelworker loses his job, unlike his twenty five year old son, he may have no digital resilience at all. When a modern day secretary loses his job, at least he may be conversant with the digital world and have transferable skills. 238. Like a force of nature, the digital

age cannot be denied or stopped. It has four very powerful qualities that will result in its ultimate triumph: decentralizing, globalizing, harmonizing, and empowering. 239

Thinking Machine Corporation, a great and imaginative supercomputer company started by electrical engineering genius Danny Hillis disappeared after ten years. In that short space of time it introduced the world to massively parallel computer architecture's. It demise did not occur because of mismanagement or sloppy engineering of their so-called Connection Machine. It vanished because parallelism could be decentralized; the very same kind of massively parallel architectures have suddenly become possible by threading together low-cost, mass-produced personal computers.

While this was good news for Thinking Machines, it is an important message to all of us, both literally and metaphorically. It means the enterprise of the future can meet its computer needs in a new and scalable way by populating its organization with personal computers that, when needed, can work in unison to crunch o computationally intensive problems. Computers will literally work both individuals and for groups. I see the same decentralized mind-set growing in our society, driven by young citizenry in the digital world. The traditional centralist view of life will become a thing of the past.

The nation-state itself is subject to tremendous change and globalization. Governments fifty years from now will be both larger and smaller. Europe finds itself dividing itself into smaller ethnic entities while trying to unite economically. The forces make it too easy to be cynical and dismiss any broad-stroke attempt at world unification. But in the digital world, previously impossible solutions become viable.