Information Technology and Artificial Intelligence

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Introduction

"I could feel – I could smell –
a new kind of intelligence across the table."

Gary Kasparov

This chapter deals with computer and information technology and the economic, social, and psychological changes being brought about by this new technology. First, I chronicle the development of computers and predictions concerning the future evolution of computers and artificial intelligence. Next I turn to the history and future possibilities of robots. After describing these technologies, I introduce a central theme of the chapter: the evolving relationship between humanity and information technology. I examine in depth how information technology is infusing into the human sphere, creating an ever more intelligent environment, and transforming human reality. In this section, I look at the promises and perils of virtual reality. Next I focus on the emergence of an information technological web or network that is encircling the globe, highlighting the Internet, the World Wide Web, the communications revolution, and the Global Brain hypothesis. Then pulling the pieces together, I look at the social and economic implications of information technology. I describe the transition from an industrial society to an information society and review various predictions regarding the information society. I consider the views that the information society is evolving into a knowledge society and that the global information network is generating a global mind. Based on this discussion, I consider the more far-reaching idea of a technology based cosmic intelligence and a cosmic mind. Throughout the chapter, I look at both advocates and critics regarding the effects information technology is having on humanity, and I discuss whether the Information Age theory of the future is both an accurate and preferable framework for understanding and guiding our evolution.

The central theses of the chapter are:

- Computers and robots will develop conscious, intelligent, personified minds. Further, information technology devices and systems will be implanted into humans, enhancing psychological and behavioral abilities and allowing for direct communication with artificial intelligent minds. There will be both artificial intelligence (AI) and intelligence amplification (IA) in the relatively near future.
- Overall, there will be an ongoing multi-faceted integration of information technologies and human life. Humans and information technology will co-evolve. Humans will increasingly immerse their lives and minds in systems of technological intelligence and virtual reality. The distinction between humanity and technology will increasingly blur.
- The environment will be infused with information technology, becoming animated, communicative, and more intelligent. The distinction between the artificial and the natural will increasingly blur.
- The scope and richness of existence will expand through virtual reality. Simulated and virtual reality will increasingly blend and intermix into “normal” reality.
- The Information Age embodies a discontinuous and revolutionary jump beyond the Industrial Era. Information Age thinking and technology, coupled with other pervasive and interdependent technological and social changes, are transforming society into a different type of human system.
- As the overarching global expression of the evolving human-technology integration, a "World Brain" and "World Mind" will emerge on the earth. This psychophysical system will enhance and enrich the capacities of both individual and collective cognition. This system is a potential starting point toward the evolution of a cosmic brain and cosmic mind.

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I have included a list of relevant websites on computers, artificial intelligence, robotics, and Information Age thinking in the notes for this chapter.[1]

Computers, Robots, and Artificial Intelligence

"Can an intelligence create another intelligence more intelligent than itself?"

Ray Kurzweil

"It is the 'wild' intelligences … those beyond our constraints, to whom the future belongs."

Hans Moravec

The rapid rise of electronic and information technology has led to more intelligent, intricate, and efficient machines. The **computer** lies at the center of information technology. It is interesting to note that futuristic projections earlier in the century saw the rocket ship or spaceship as the paradigm machine of tomorrow. The rocket ship, though, was a creation of the Industrial Era - a big machine generating vast amounts of force. The technological power of the computer lies in its versatility, intelligence, connectivity, and complexity rather than in its energy thrust. The computer can be integrated into almost any human activity, providing for better storage, organization, and speed of operations. It is transforming how we communicate, work, plan, entertain ourselves, and even select a mate. The computer is both an extended and external nervous system, as well as a new environmental enrichment that has significantly transformed the world in which we live. Further, the computer is infusing itself into all other technologies. Progressively, every machine will have a computer (or computers) at its core and be connected with other machines with computers. At a global level, computers are networking into a web of communication and integrated processing. The computer is perhaps the most powerful machine humanity has ever created.

As noted above, from one perspective, the computer is an artificially constructed nervous system with input and output systems. Information can be inputted into a computer, often from other computers, and this information can be stored. Further, this stored information can be used for processing, manipulating, and outputting new information. Information can be displayed via a monitor (or other output device) or it can be transmitted to another computer. Though there is considerable debate on this point, the computer, in some sense, perceives, remembers, thinks, and communicates.

In the past, most of our machines and instruments have been extensions or enhancements of basic physical activities of the human body or physical processes observed in nature. But what makes humans special among animals is not our external bodily system, but our nervous system. The computer, insofar as it is an artificial nervous system that processes information, comes closest among our machines to embodying what makes us unique and distinctively human. There is a strong sense of connection and resonance with this machine. As Michael Dertouzos notes the computer is the first type of technology directly related to learning, knowledge, and communication.[2] Since it is our nervous system that supports the highly enhanced and flexible power of the human species, a mechanism that simulates this biological system and its associated capacities would be immensely more powerful than any other machine humans have created.

The history of computers can be traced back to the early 19th Century and Charles Babbage and Ada Lovelace and their idea of the **Analytical Engine**. Based on the science and technology of his time, Babbage never completed the construction of the Analytical Engine, but it anticipated many of the modern elements of computers, including the key feature of software programming. It is with the work of Alan Turing though that the modern computer comes into reality in full force.[3] In the 1930's Turing wrote several key papers on computers, introducing the **Turing machine**, a theoretical model of computers. Along with Alonzo Church he developed the **Church-Turing thesis**, arguing that all definable problems humans could solve could be reduced to a set of algorithms, which, in principle, could be programmed into a computer. During World War II, Turing constructed the first operational computer, designed to break secret German codes. After the war he continued to write additional classic theoretical papers on computers and artificial intelligence and, according to Ray Kurzweil, defined the future agenda of computer development.[4]

During the 1950's and 1960's, based on initial optimistic hopes that computers could simulate human intelligence, various programs and systems were developed that could generate mathematical proofs and solve computational problems. The field of **artificial intelligence** was born.[5] Yet as Hans Moravec notes, although calculation was easy for these machines, reasoning, perception, and common sense would turn out to be much more formidable challenges.[6] Computer scientists could design "**expert systems**" that could perform exceedingly well within a very limited context, storing vast amounts of information, processing that information very quickly, and answering questions within that area. Yet, these systems were blind to anything beyond their limited area of expertise.[7] Still a great deal of progress was made in computer systems, beginning in the 1960's as the United States Government, through ARPA (Advanced Research Project Agency), and various academic institutions such as MIT, Stanford, and Carnegie Mellon developed research departments and produced many innovations. Various commercial businesses such as Intel, Xerox, and IBM were also significantly involved in the early development of computers.[8]

In 1965, Gordon Moore, the president of Intel and inventor of the integrated circuit, observed that the surface area of transistors was decreasing in size at a relatively constant rate over time. From this initial observation and further study, he formulated what has become known as **Moore's Law** on Integrated Circuits. Moore's Law predicts that approximately every 2 years computers will double in integrated circuits and processing speed per unit area, while maintaining the same unit cost.[9] According to Kurzweil though, Moore's

Law is actually a special case of a more general law, the "**Exponential Law of Computing**". From the beginning of the 20th Century, long before the invention of transistors and integrated circuits, computing systems have been increasing in power at an exponential rate. Early in the 20th Century, the first electrical computing systems were doubling in power around every three years. By the end of the 20th Century, computers were doubling in power every year. Kurzweil believes this exponential growth will continue indefinitely into the future. Assuming certain technological breakthroughs discussed below, he sees no absolute limit to computational density for computer hardware. Rather, he foresees the computational density across the earth growing trillions upon trillions of times in just the next century.[10]

Kurzweil believes that the exponential evolution of computation, defined as the capacity to remember and solve problems, is inevitable. Clearly animals, if not life in general, have demonstrated increasing computational abilities throughout evolution. This increasing computational capacity, first within biological life and now extending further through computers, is for Kurzweil a manifestation of the Law of Accelerative Returns, the exponential growth of order in the evolution of nature. To recall from the last chapter, for Kurzweil the increasing complexity or order within technology is also a natural outgrowth of the Law of Accelerative Returns.[11] According to Kurzweil, the growth of computational power in computers is a consequence and expression of the evolution of order, and the evolution of order is exponential.

Whatever set of factors is responsible for the growth of computers, over the last few decades information technology has very quickly developed in terms of its functional capabilities, computing power, and influence upon most dimensions of human life. As noted in the previous chapter, information technology has permeated into most other areas of science and technology, facilitating and supporting advances in biotechnology, biological science, complexity and chaos theory, and cosmology, to name just a few examples.[12] Information technology has quickly become integral to finance, entertainment, business, transportation, communication, the military, and all forms of statistical research, demographics, and monitoring systems around the world. Aside from the public sphere, the computer has also quickly worked itself into our personal lives. Our cars, appliances, and electronic gadgets are all becoming computerized. Of special note is the PC. The **personal computer revolution** was a completely unpredicted phenomenon.[13] Yet, the PC has become, in a few short decades, almost as common a household possession as a TV or a telephone.[14] In the last decade the Internet and the World Wide Web have also exploded on the scene, linking business, homes, schools, social organizations, government centers, and research installations around the world.[15]

Based upon the phenomenal growth rate of computers and their integration into human life, various predictions have been made about their future evolution. Here I will identify some of them. First, let us begin with basic computing power. Molitor reports that the fastest computer today performs 12 trillion calculations a second (12 teraflops). This speed is three times faster than in 2000 – a clear reflection of Moore's Law. He states that it is projected that computers will reach 16 trillion calculations per second (16 teraflops) by 2004 and 200 teraflops in the near future.[16] Kaku notes, though, that although silicon computers will thus become increasingly denser, till around 2020, at that point we will reach the limits of miniaturization in silicon technology. We will need to find a new medium for computation, if computational speed and density are going to continue to increase. In particular, Kaku and many other computer scientists and futurists see great promise in optical, DNA, and quantum computers, which would vastly exceed the power of standard silicon circuit computers.[17] The George Washington forecasting group predicts the first commercial optical computers by around 2015.[18]

Pearson foresees computers catching up with human intelligence by 2020.[19] Zey projects computers exceeding humans in processing power between 2030 and 2050.[20] Both Moravec and Kurzweil, as well, project similar, if not more optimistic, dates for these achievements.[21] In making their claims, they provide excellent graphic representations of how computer growth compares to the computational capacities of various animals on the evolutionary scale, including humans. Moravec, using MIPS (million instructions per second) as a measure of processing speed, estimates that the human brain stores about 100 million megabytes of memory and performs at a rate of 100 million MIPS. According to Moravec, **Deep Blue**, the computer that defeated the world champion chess master Gary Kasparov, performs at about 3% of this level.[22] Based on Moravec's assessment of increasing computer power over this century, he predicts computers will reach human intelligence by around 2020. Kurzweil provides an estimate of 20 million billion calculations per second for a human brain, which is equivalent to 20,000 teraflops. Although, according to Kurzweil, this is about 2,000 times faster than our biggest computer, following Moore's exponential law, super-computers should reach 20,000 teraflops by around 2010 and personal computers should achieve this speed by 2020.[23] Note that these dates roughly correspond to Vinge's estimate of the "technological singularity".[24]

According to Moravec and Kurzweil, once computers catch up with humans in computational speed and memory storage, they will quickly pass us by. Since Kurzweil believes that the exponential growth of computer power is a consequence of the evolution of order, he believes that new types of computers, such as optical, quantum, and nanotechnological, will emerge in the near future to maintain the rate of evolution throughout the coming century. In fact, he states that computer circuitry itself was how evolution found a way to exceed the computational limits of neurons in the brain and keep the evolution of order moving along. Following the Exponential Law of Computing, Kurzweil believes that by around 2030 an individual computer will possess the power of 1000 human brains and by 2050 a personal computer will exceed the total brainpower of all humans presently existing on earth.[25]

Since, according to these various predictions, computers will be achieving, at the very least, equivalent information processing power to humans in the coming decades, what technological developments will further facilitate our interaction with them? The George Washington forecasting group predicts highly effective voice recognition and translation systems in computers by around 2010 and flexible learning programs and software agents by 2010 – 2015.[26] Kurzweil also sees language user interface coming into popularity by around 2010 and the emergence of interactive "**agents**" with human personality qualities by around 2019.[27] In a similar vein, Pearson estimates that we will be conversing with computers by 2020 and developing a working partnership with them, in matters as diverse as finance, management, travel, and business. Between 2005 and 2025, computers will develop external sensors, begin to show higher-level human functions and qualities, and be able to self-repair. Kurzweil predicts that by 2029, most human communication will be with machines.[28] According to Pearson, by 2100 there will be human-machine convergence,[29] a view Kaku holds as well.[30]

According to numerous forecasters, the world will become increasingly computerized – the environment will become intelligent, sensing our presence, understanding our communications, and responding to our requests.[31] Kaku sees the PC disappearing into the environment by around 2020; there will no longer be stand alone computers, but rather computer chips and circuits embedded into objects and surfaces all around us.[32] Kurzweil takes this idea further suggesting that computers becoming invisible and integrated into our clothing by around 2020. According to Kurzweil, we will use portable direct display headsets with virtual reality overlays, and there will be few if any keyboards remaining.[33]

Given all these predictions that computers will exceed human levels of information processing and storage, and other predictions concerning how computers will become more like humans in the future, the question arises whether computers will eventually possess conscious intelligent minds. Will they, in fact, eventually possess minds superior to humans? Over the last few decades, scientists, technologists, and philosophers have been actively debating the cognitive and psychological capacities and potentials of computers. Are computers thinking when they engage in computational processes? Is thinking more complicated and subtle than simply computation?[34] Could a computer someday be able to think, using abstract reasoning, creativity, and basic common sense in a manner similar to humans? In the future, will a computer possess consciousness, emotion, or self-awareness?[35] In short, are computers the next evolutionary step on earth? Or are computers somehow inherently limited in their potential to transcend humans?[36]

Fifty years ago, Alan Turing considered the basic objections regarding the possibility of creating artificial intelligence.[37] In particular, Turing was concerned with arguments against the idea that computers could think. Turing's list of arguments is a good place to begin the discussion on the artificial intelligence debate, as summarized by Moravec:

- The Theological Argument – Machines have no souls and souls are needed for thinking.
- Head in the Sand Argument – It is too dreadful a possibility that computers could think. They would surpass us and we fear that possibility.
- Mathematical Objection – Mechanical reasoning has its limitations. Thinking goes beyond simple computation.

- Argument from Consciousness – Machines have no inner experience. They can't give meaning to their "thoughts".
- Argument from Disabilities – There is an ever-shrinking list of what computers can't do.
- Lovelace Objection – Computers can only do what they are programmed to do. They show no creativity or self-initiative.
- Informality Argument – We can't specify a rule (hence program or algorithm) of thinking for every possible circumstance.

In order to be as precise as possible regarding the meaning of thinking and as a way to ascertain if a computer was demonstrating thinking, Turing proposed what came to be referred to as the famous **Turing Test**. Imagine a person in an enclosed room with two keyboards and two display screens. One keyboard and screen is connected to a computer outside of the room; the other keyboard is connected to a keyboard outside the room being operated by a human. The person in the room cannot tell which keyboard is connected to a computer and which a human is operating. The person can carry on conversations and ask any question through each of the two keyboards and read the responses on the two screens. The problem for the person is to figure out, based upon the answers and comments that come back on the two screens, which set of responses is coming from a computer and which responses are coming from the human. If the person cannot reliably discriminate the human from the computer, then the computer has passed the Turing Test. For Turing, thinking is as thinking does, and if the computer can simulate what a thinking person would say within a dialogue with another person, then the computer is operationally thinking.

The Turing Test, as a real measure of thinking, has been criticized on numerous grounds. In particular, the counter-argument has been presented that simulating the responses of a thinking person does not demonstrate that any conscious or intelligent thinking is actually going on inside of the computer.[38] This counter-argument basically states that passing the Turing Test does not demonstrate consciousness. Yet, what if the two keyboards and screens were replaced with two figures that looked like humans, that we could converse with face-to-face and eye-to-eye, and with whom we could bring to bear all our human skills of empathy, intuition, and personal sensitivity? And what if we could discuss with these apparent humans their own sense of inner experience and consciousness? What if with all this additional more intimate contact, we could not tell which apparent human was flesh and blood, and which was made of silicon and metal? What if the sense of a conscious presence was just as vivid and real with the computer as with the "real" human? Would we still feel justified in saying that the computer had not demonstrated real thinking and real consciousness?

Tipler projects that computers will reach a human level of intelligence by around 2025, a figure similar to those dates proposed by Kurzweil, Moravec, Vinge, and others. Tipler thinks that the arguments against artificial intelligence are basically invalid, being based upon our mind-matter dualist philosophy and he believes that a computer will be able to pass the Turing Test in the next few decades.[39] Tipler asks why we think that a metallic or inorganic system could never feel or never achieve consciousness? What makes the physical substrate of the brain so special that consciousness and emotion can arise within it? He believes that the attributes of mind, consciousness, and emotionality should not necessarily be tied to some particular material foundation; these attributes could be embodied in different kinds of physical systems, as long as the system possessed sufficient complexity.[40]

In support of Tipler, how can we say that the computer can not show real thinking or intelligence when we have a difficult time defining intelligence and thinking in humans?[41] How can we argue that a silicon-based machine (the computer) could not generate consciousness when we are still in the process of understanding how a carbon-based mechanism (the brain) generates consciousness?[42] In fact, the very nature of **consciousness** is a controversial and evolving topic.[43] What is consciousness, such that we can say that computers could not possibly possess it? Both Penrose and Zey argue that consciousness involves non-computable processes, and hence computers will never become conscious, in so far as they are nothing but complex computing mechanisms.[44] Yet, the problem with this argument is that if one could describe what kind of a system the organic brain and body is such that it involves non-computational features, what is to prevent us from creating this type of physical system?

Kurzweil proposes that over the next fifty years computers will progressively convince us that they are conscious.[45] As they increasingly demonstrate more human like qualities, and even become familiar with the philosophical arguments against computers possessing consciousness, they will both intentionally in their dialogues with us, and more unintentionally in their interactions with us, eventually persuade us that they do have inner experiences and are aware both of themselves and the world around them. Greg Bear, in *Queen of Angels*, describes an interesting variation on this scenario, where an advanced AI is challenged to figure out if it is conscious. The AI must convince itself, knowing what all the philosophical and skeptical arguments are concerning machines possessing consciousness.[46] Consciousness, though, seems to be such an obvious fact of our existence that it does not seem to make sense to ask ourselves or puzzle over whether we are conscious or not. Any being that could meaningfully ask this question, it would seem, must necessarily possess consciousness.

Further, consciousness may not be a simple either-or phenomenon. To what degree does a chimpanzee possess consciousness? To what degree does a rabbit, a reptile, a fish, or a spider possess consciousness? At what point on the evolutionary scale do we draw the line between conscious life and unconscious life? It seems as if consciousness probably comes in degrees. Kaku suggests that as computers become more complex and intelligent, consciousness will develop in degrees within them. In a gradual progression to higher forms of consciousness, Kaku foresees the possibility of **self-aware robots** sometime between 2050 and 2100.[47] Moravec also describes a progressive evolution of mentality and self-awareness through successive generations of computerized robots over the next century. He predicts that the impression of consciousness will come in degrees as robots demonstrate the capacity to function across more expansive and complex environmental conditions. By 2030 robots will possess a “concrete mind”, dealing well with perceptual and motor tasks though yet not functioning at an abstract level. They will be exhibiting the beginnings of self-awareness by being able to respond to questions about their own states and capacities.[48]

Critics and skeptics have repeatedly pointed out ways in which computers do not seem to demonstrate the rich array of intelligent capacities demonstrated by humans, and each time programmers find some way for the computer to exhibit the ability.[49] Progress in some areas has been much slower than anticipated. In particular, they are superb at calculating tasks but poor at common sense, but the list of things that humans can do that computers can’t do gets increasingly smaller. In essence, this is the old "It can't be done" argument, applied in this case to computers (Turing’s Disabilities Argument), which is invariably followed by somebody figuring out how to do it.

Although it is often said that computers simply do what they are told (Lovelace’s Objection), programmers have repeatedly pointed out that they cannot totally explain or anticipate what their own designed software will produce.[50] Fractals are an excellent example of the unanticipated creative abilities of computers - no one foresaw the beauty and intricacy of these patterns that would emerge out of the computer. The computer surprised everyone. Of special relevance to the issue of creativity in computers are the new types of computer systems involving "**neural nets**" and "**massive parallel processing mechanisms**" which seem to more closely resemble the functioning of human brains than serial processing computers.[51] Danny Hillis, who created the first massive parallel processing computer systems, has been pursuing the goal of generating complexity in computer processing out of the interaction of many simple processes.[52] Hillis, following the logic of self-organizational complexity theory, believes that creative and unanticipated higher order patterns emerge in the brain through the interaction of a multitudinous and simultaneous array of simpler neural processes. He is attempting to model this creative process in computers.

Marvin Minsky, in fact, proposed in his highly discussed book *The Society of Mind*, that the high level of flexible intelligence we observe in the human mind is actually due to a collection or “society” of simple mechanisms operating simultaneously in the brain.[53] Hillis identifies Minsky as a main source of inspiration in his thinking on parallel processing and self-organizational systems. Artificial life simulations, discussed in Chapter Three, are also based on the idea of multiple simple processes interacting with each other and consequent higher order patterns emerging in this interactive process.[54]

Computer intelligence and behavior are often characterized as mechanistic, rigid and impersonal - old Newtonian stereotypes of the machine (the Mathematical Objection). Yet Nicholas Negroponte notes that the immediate future will see the development of many “human-like” qualities in computer interfaces. Computer software agents will increasingly look and act like humans, with personalities, emotional qualities, and sensitivities to the personalities of humans. Agents will be friends and partners in life.[55] Kurzweil agrees with these predictions regarding agents, identifying 2020 as a date when such human-like agents will become technologically possible and available.[56] In a more general vein, as with consciousness, we should see a gradual evolution of human qualities in both computers and robots in this century.[57] Challenging both the Mathematical Objection and the Lovelace Objection to computers thinking, many computer scientists, such as Hillis, Kurzweil, and Moravec believe that the key to creating computer systems that are both creative and flexible lies in increasing the computational speed and designing for interaction among computational processes.

Still, it could be argued that computers lack self-autonomy because humans build and program them, even if we grant that once this programming is allowed to run, it will show creative and emergent qualities. Yet if we are assuming that it is humans and not computers who make and design computers, this idea is, at best, a half-truth. As noted in the last chapter, we use our present technology to create more advanced technologies. Computers are clearly used in the design and development of more advanced computers and computer software. Our newest computers could not be built without the use of present computers. Further, we do not deny the autonomy and independent intelligence of our biological children just because we make them (biologically) and educate them (psychologically and socially). Through an extensive process of socialization, we clearly program ourselves. Further, as scientists such as Hans Moravec predict, in the future, robots and computers will increasingly take over control in designing and creating themselves.[58]

A critical issue throughout much of this discussion is the exact nature of intelligence. This is a point of debate among psychologists, philosophers, and scientists. Taking a position similar to Tipler, Kurzweil argues that intelligence, and mind as well, is pattern or form rather than substance. (Both Tipler and Kurzweil reject mind-body dualism. They follow Aristotle who defined the “psyche” as the form of the body. Descartes had defined consciousness and mind as a second substance distinct from physical substance.) Kurzweil defines intelligence as the ability to use resources to achieve goals and as the ability to see order where none was seen before. Kurzweil believes that these capacities involve the use of a set of formulae for solving problems. Further, he agrees with Turing that intelligence involves simple methods and heavy computation, an idea also found in Minsky. Kurzweil identifies three basic types of methods or formula that intelligent systems use in computation: **Recursive**, **neural net**, and **evolutionary algorithms**. Recursive methods are used in serial processing computers, where the same operations are performed over and over again. Neural net methods, used in parallel processing systems, involve the interaction of many simple programs. Evolutionary algorithms are programs that learn and evolve through a process analogous to natural selection in computer-generated problem solving situations. Both neural net methods and evolutionary algorithms are self-organizing processes that generate unpredictable and creative results.

Kurzweil contends if we combine these formula or methods with mass computation and add in sufficient knowledge (factual information about the world, for example) we have the makings of an intelligent machine.[59]

Kurzweil argues that in the 21st Century we will be able to design and build "new brains" that demonstrate all the various associated skills of human intelligence, and that will eventually surpass us in all these skills. He points out that there are presently dozen of research projects around the world attempting to map and describe brain circuitry and create computer circuitry that models these biological networks. Kurzweil believes that by 2030 we will have deciphered the brain and its workings. He also notes the ongoing effort to create software that models various human cognitive processes. In his mind, creating such software will be a significant challenge in the coming decades. In particular, as many computer scientists point out, computers do not possess what humans refer to as "common sense".[60] Yet as Kaku notes, researchers are busy creating a vast "**Encyclopedia of Common Sense**" for computers.[61] Assuming we can understand and model the basic psychological processes and how they are supported in brain circuitry and information storage, if we add in the vastly increased computational speed and information storage of future computers, we will create an intelligence greater than our own. Kurzweil sees nothing paradoxical in this idea, since evolution shows an ongoing history of order and complexity building upon itself, of lower forms of intelligence leading to higher forms of intelligence.

The process of creation is different - biological versus technological - but in the long run this may be an evolutionary advance on the process of biological evolution itself. In fact, directing the construction of our mental descendents introduces a higher level of intelligence into the evolutionary process. Previously, the evolution of intelligence was determined by natural selection, as well as natural self-organizational principles.[62] Even if we grant, as Sahtouris argues, a type of intelligence in this evolutionary process, what is being introduced now is evolution guided by conscious, scientifically informed decision-making and research. As we will see, the promise of guided design may soon become a fact in the construction of our biological children. Although it may sound odd to say this, computers (and computerized robots) can be seen as the evolutionary children of humanity, intentionally designed by us, but eventually going beyond the capabilities of their parents.[63]

The issue of artificial intelligence is not simply a technological or scientific question. It is an emotional issue and an issue concerning the ego and pride of humans (The Head in the Sand Argument). Heim points out that in discussions of AI, the computer is often seen as an opponent, and criticisms of AI invariably attempt to identify what a computer cannot do that humans can do.[64] This attitude puts humans and their machines in competition with each other - the classic human versus machine approach that permeates science fiction. Are we concerned that these machines will dehumanize us? Are we afraid, as Clute notes, that computers will surpass us?[65] Is this a threat to our egos? Is this a threat to our survival, as Vinge and Joy among others suggest? Yet, depending on how you want to look at it, the transcendence of humans by computers or robots could be seen as something either positive or negative.[66] Taking the first position, Heim thinks that we should see computers as collaborative with humans. Much of contemporary AI research, according to Heim, has turned to **human-computer symbiosis**. For Heim, we should see the computer as an extension, rather than an attempted simulation or replacement of humans. And yet, following the ideas of Negroponte, the type of collaborative system or partner we would feel most comfortable with would be an intelligence that acted and thought like a human.[67] The question comes down to one: Are we more concerned that computers will surpass us, or are we more concerned that they will be indistinguishable from us?

If computers achieve consciousness and some type of advanced evolutionary level on their own, humans could end up using the computer as a vehicle or medium for human perpetuation and development. If they develop a nervous system that is functionally similar to the human brain, humans may be able to input (download) into the computer their memories, thoughts, feelings, and sense of personal identity. In essence, this would amount to a **mind transplant.** [68] Human brains age. A computer brain would provide a physical system that could maintain itself indefinitely. Following Moore's Law, a computer brain as compact and powerful as a human brain is technologically possible within the next 30 or 40 years. Tipler, in fact, sees this process of transferring human intelligence and mentality into computer systems as both necessary and inevitable.[69] Again, computers are not the enemy; they are the next stage in our own evolution – in this case the vehicle of our perpetuation into the future.

The reciprocal scenario is to implant computer circuitry into the human brain. As we progressively understand the circuitry of the brain and model computer circuitry on the brain, we will be increasingly able to interface computer circuitry with the brain, either rectifying neurological disabilities or amplifying present psychological capacities. We are already well on the road to accomplishing this brain-computer interface with artificial sense organs. Kurzweil sees the process of **Intelligence Amplification** (IA) as inevitable. As the world around us becomes increasingly populated by ever more intelligent artificial intelligences and the world becomes correspondingly more complex, under the coordination of these AI's, humans will need to amplify their intellectual abilities to understand what is going on and meaningfully contribute to the workings of the world.[70] IA will become necessary by around 2050, if not sooner. Yet, further, the inevitable movement of human minds into computer networks will come to pass within another fifty years. Moving into the computer will afford even greater Intelligence Amplification and open up even further the whole arena of virtual reality to humans. Our intelligence and personhood will become "software" or form in the computer system, which will provide, as noted above, a much more stable physical substrate for our consciousness. The symbiosis of computer and human mind will be even more complete.

In Dan Simmons' *Hyperion* series, future human society is under the coordination of a collective of advanced AI's that monitor the technological workings of the vast human galactic civilization. They converse and debate among themselves the future development of civilization, and attempt to manipulate and guide the total technological and social system.[71] There are even human personas, in particular the 19th Century poet, John Keats, who exist as software programs within the AI network and can be manifested or created in physical form within the world, an idea that Kurzweil discusses at length in *The Age of Spiritual Machines*.[72] Both Kurzweil and Moravec foresee a growing population of AI's within our world in the coming century. For Moravec, the AI population will form into a networked ecology of systems that will surpass the earth's biosphere in diversity and complexity.[73] As noted above, Kurzweil, who also predicts a networked system of computers and AI's emerging in the next hundred years, believes that human minds will inevitably upload themselves into this networked system. Because Kurzweil thinks that humans will need to augment their abilities through computer systems, the distinction between human minds and AI's will blur within such a networked system of intelligence. In fact, as a general point, since all these human and artificial intelligences will be networked into various complex forms of integration, our present view of minds as distinct and separate realities will no longer apply.[74] There will be a "**society of minds**", but this society and ecology will involve ongoing re-arrangements, re-combinations, and re-configurations of minds into different personas and modules of consciousness. In Vernor Vinge's *A Fire Upon the Deep*, for example, a human and an advanced AI go through a variety of integrations, separations, and re-combinations as the story unfolds.[75] In fact, almost a decade earlier, William Gibson in his classic cyberpunk novel, *Neuromancer*, had experimented with the idea of human minds and AI's blending and combining into different forms and manifestations.[76]

Although it may be difficult to imagine how consciousness and personhood could exist within a stationary box that is plugged into an electrical outlet, a mobile, perceptive, and expressive mechanism would probably be a much more compelling demonstration of sentience and intelligence. We evolved from creatures that had to interact with a dynamic environment. Our ancestors developed sensory and motor capacities long before they learned to calculate and reason. Perhaps there is some deep significance regarding the emergence of consciousness and self-identity in the fact that living forms exist in a survival game in a sea of turbulence. While scientists and technologists have been working on enhancing the hardware, software, and networking of computers over the last few decades, a second parallel development in technology has been evolving that involves the creation and engineering of machines that can move about, sense, and manipulate their environment. This is the field of robotics.

The human population worldwide is growing at a rate of 2% a year; the robot population worldwide is growing at a rate of 30% a year.[77] Pearson predicts that the robot population will be higher than humans in developed countries by 2025.[78] The development of robots illustrates and synthesizes the futuristic themes of computerized technology and an intelligent, animated environment. One can imagine that over the next century, intelligent robots will spread throughout the human world. Moravec foresees an "**Age of Robots**" in the coming century.[79] We will have robots for servants and they will "work" within business and industry, steadily performing various functions better than humans.

Increasingly they will take over manufacturing and construction, eventually being able to construct themselves. Perhaps we will have robots for friends and even lovers.[80]

Hans Moravec, one of the leading figures in robotics in the world, traces the history of robots in his book *Robot: Mere Machine to Transcendent Mind*.[81] As with artificial intelligence, the initial hope and promise of robots did not materialize as quickly as anticipated by scientists and technologists. The challenges involved in constructing a mobile machine that could detect the layout of an environment and maintain a clear path of direction through it without falling off of edges or colliding with objects, turned out to be much more formidable than anticipated. It takes considerable information processing power to model an environmental layout on a continuous, ongoing basis and successfully move through it. If surprises, detours, and obstacles were introduced on a path, the earliest robots totally floundered in assigned tasks. These early robots, equipped with sensors and locomotion mechanisms, were connected to computers that did the ongoing calculations and decision making, and as Moravec notes, it became clear that although computers were very good at mathematical calculations they were very poor initially at coordinating fundamental processes, such as perception and action.

According to Moravec, the best robots today produce insect level behavior. They can navigate fairly well both indoors and outdoors, and Moravec projects that robots that can learn new routes and perform well even under adverse conditions will be here soon. To say that a robot shows the perceptual-motor intelligence of an insect is not a minor or trivial achievement. An insect nervous system is a highly complex network, and although the human brain is thousands of times more powerful than an insect brain, this difference is minimized when we recall Moore's Law predicting an exponential increase in processing power in the future development of computers. The difference between an insect level robot and a human level robot is not as great a leap as it may intuitively seem. As Moravec notes, real breakthroughs in robotic behavior are coming at an accelerative rate since the computing power necessary for real life interactions is finally becoming available to robotic systems. Moravec predicts that the next fifty years of robotic evolution will show considerably more progress than the last fifty years.[82]

Both Kaku and Moravec distinguish two basic approaches in the design and construction of robots. These two approaches correspond to classic models of how a nervous system operates. First there is the **top-down** or **central processing** approach. Representations or models of eternal reality are stored in a central area or brain. This central command station receives input from external sensors and sends out commands to motor mechanisms. Early robots tended to be top-down systems, where a central computer was programmed with instructions, received input, and directed the movements of a robot. Moravec's early robots were top-down systems. The second approach, referred to as a **bottom-up** or **peripheral-network** system, moves the coordination and intelligence of the robot out of a central command station into the sensors and peripheral motor units. Centralized or top-down systems operated using serial processing computers, performing one calculation at a time; peripheral or bottom-up systems use massive parallel processing systems, performing many calculations simultaneously.[83]

The relatively recent development of peripheral robot systems, especially through the work of Rodney Brooks, is both innovative and highly successful in dealing with the challenges of basic perceptual and motor skills.[84] Rodney Brooks, in his well-known article "Fast, Cheap, and Out of Control: A Robot Invasion of the Solar System",[85] argues that early versions of robots tended to be top-heavy, expensive, and clumsy. Big computers, which could not be moved around, controlled the robots via connecting wires. Brooks nicknamed these kinds of robots "**Staybots**"; they had big brains and big bodies and had trouble moving across the floor. According to Brooks, early concepts of robots were human-like mechanisms.

What Brooks has been developing are much smaller, more specialized machines. Many of these smaller systems are completely mobile and detached, due to more streamlined computer circuitry housed within their body. Brooks calls these newer robots "**Mobots**." Interestingly, one significant breakthrough in their design was to do away with a big centralized "brain"; in fact, Brooks' mobots don't have brains at all. They operate on a peripheral nervous system of distributed electrical circuits, individually controlling their legs, wheels, and arms. They are all spinal cord and nerves. Further, they are parallel processing systems. These mobile mechanisms literally learn how to coordinate their motor appendages, through an interactive process involving simultaneous feedback from all the individual motor units. Brooks' life-like mechanical insects scurry about, zigzagging back and forth, in a trial and error process, as they find their way to their destination. Similar to the fast growing population of special purpose robots in industry, e.g., mechanical arms, hands, precision tools, and conveyors, Brooks' idea for mobots is to start from simple functions, bottom-up, and design and build up from there. Such an approach would mirror the evolutionary process.

Brooks envisions a world of the future filled with these small mobile machines, moving about to pick up trash, to clean and service our homes, buildings, and physical structures, and, in general, to tend to the maintenance of our world. He is also developing "**Fleabots**", even smaller machines, which would eat dust, mow (chew up) the lawn, or landscape a plot of land. Brooks has proposed that we explore the planets and moons of our solar system using armies of these mobots and fleabots. The image of the rigid mechanical man is being replaced by tiny metal ants and centipedes, which, if we lose a few thousand on a space expedition, will cost less than one complex and expensive piece of equipment.[86]

Of special note, Brooks is creating robots that can survive on their own by interacting with the environment. He is working on different types of systems that demonstrate flexibility and can learn, using neural net systems. These robots modify their internal states and external behavior as a function of environmental input. Brooks' mobots and fleabots achieve a level of self-governance or self-regulation. Utilizing the principles of feedback (input on the consequences of actions) and circular causality, the machines exhibit self-guidance in moving about an environment. (Intelligent missiles that track down their targets operate on the same principles.)

More recently, Brooks has been developing a human-like mechanism called "Cog". Cog is also a neural net, massive parallel processing system that learns. Physically, Cog possesses a torso from the waist up with arms and hands and a neck and head. Cog has moving visual sensors (eyes) and can monitor its joint and appendage positions. Further, Cog is interactive with humans. It looks at humans and responds to different actions of humans. One main goal with Cog is the development of manual manipulation and other interactive capabilities, without the need for heavy programming and hardware characteristic of early top-down serial processing robots.[87] Another project Brooks is working on is called Kismet, which involves a robotic head and neck with a face that demonstrates a variety of facial and emotional expressions in response to human actions and facial expressions.[88] Brooks' efforts with Cog and Kismet incorporate many research and theoretical concepts from scientific psychology. Through the construction of human shaped body configurations, he is attempting to address how the basic physical form of the human influences or determines the nature of human intelligence.

Both Moravec and Kaku review the work of Brooks and compare his approach to top-down robotic systems that develop internal models of the environment and possess something analogous to a central brain. The general consensus of opinion is that the robots of the future will utilize parallel processing systems, but both Moravec and Kaku think that Brooks' bottom-up approach needs to be integrated with top-down approaches.[89]

Moravec though proposes a future chronicle of robot evolution that follows a series of developmental steps that moves from more peripheral functions, such as perception and locomotion and specialized tasks, to higher, more centralized cognitive and emotional capacities and more creative, abstract abilities. This series of steps would basically mirror the evolution of intelligence in animal life, much like what Brooks was trying to accomplish in his early work with mobots and fleabots.

Moravec predicts that first-generation universal robots for general commercial and personal use will appear around 2010. These robots will demonstrate basic perceptual, mobility, and manipulative skills. They will possess computers capable of 3000 MIPS, but they won't be able to learn or adapt. They will have specific programmed functions. Second-generation robots will emerge around 10 years later. They will be capable of learning, though they will have to be trained or taught. They will be capable of 100,000 MIPS, and the construction and varied uses of them will become the world's largest industry. Third-generation robots will appear around 2030 and they will be capable of 3 million MIPS. These robots will be able to construct ongoing internal models of the world and run simulations of future events involving both their own behavior and environmental consequences. In essence, they will be able to anticipate and predict. Further, based on interactions with the environment, they will be able to create their own programs. As a general pattern throughout these stages of robot evolution, whatever was designed into a robot by computers in the previous generation becomes a feature that the next generation of robots can design and redesign themselves. What was programmed into the robot becomes in the next generation, something the robot can program itself. Intelligence builds on itself. Fourth-generation robots will appear around 2040 and these robots, operating at 100 million MIPS, will be capable of human like reasoning. They will be able to "think" about their environment and their actions. Although we presently have computers that can perform various logical and mathematical processes at a high level of competence and speed, these computers do not operate within a dynamic and multi-faceted world and do not apply their reasoning capacities to perception and behavior in such a world. Deep Blue can beat the best human chess players, but it cannot avoid danger, search for food, or even physically move the chess pieces in a game it is playing. Fourth-generation robots will be reasoning, anticipating, and planning within a dynamic environment and coordinating their behavior toward goals under the guidance of these higher cognitive processes. Further, fourth-generation robots will have evolved emotional capacities. They will exhibit emotional responses and respond appropriately to the emotional expressions of humans. (Brooks' Kismet is a step in this direction.) Yet, most importantly, fourth-generation robots will take over the direction of creating their own successors. They will be self-repairing and self-reproducing.

As Dyson has noted, one of the key new technologies in the future will be self-reproducing or constructor technologies.[90] John von Neumann, one of the central theoreticians in the development of the modern serial processing computer, described in detail in the 1960's the theory of universal constructors. A **universal constructor** is a machine that given the appropriate materials could build any type of machine.[91] Inspired by the ideas of von Neumann numerous scientists and technologists have been working on the problem of designing self-reproducing machines. Recall that the capacity for self-reproduction is critical to the development of nanotechnology.[92] Moravec envisions that robots will eventually develop the capacity for self-reproduction, and in fact, given the progressive evolution of intelligence and complexity in robots and computers, advanced robots will become absolutely necessary in the construction of their successors. Assuming that humans are not augmented by artificial intelligence, they will no longer be able to understand and design the robots of the distant future. This shift from human to robotic construction of robots is yet another example of the predicted technological singularity coming sometime in the middle of the 21st Century.

The idea of self-reproducing robots is not such a farfetched or distant possibility. An interesting article on robots, that highlights both robotic self-reproduction as well as potential environmental benefits is Thomas Bass' "Robot, build thyself".[93] Bass writes that according to the dream of Klaus Lackner and Christopher Wendt, we can design "**auxons**" (from the Greek "auxien" - to grow) that could reproduce themselves from the raw materials of the earth. Lackner and Wendt have developed a design proposal where these auxons would need just dirt, water, air, and solar energy to make more copies of themselves. Once the initial auxons were constructed they would be able reproduce exponentially. Lackner and Wendt propose an environmental project involving auxons setting up camp in the desert and creating solar panels on a grand scale the size of White Sands Missile Range in New Mexico. Such a robot-made system would be able to supply all of the energy needs of the USA. A colony of auxons 10 percent the size of the Sahara could supply the world's energy needs three times over. The price tag for this project would be 1 billion to 100 billion dollars, which is small in comparison to the annual military budget of the USA.

The arguments and predictions regarding the capacities of artificial intelligence bring into question the distinction between human minds and computer systems. Moravec believes that the emergence of self-reproducing robots will bring into question the distinction between life and non-life. Auxons, theoretically, could make baby auxons without human intervention and Moravec foresees much more dramatic developments in robotic self-reproduction within fifty years. Further, if human minds and AI's integrate in the next hundred years, as Kurzweil projects, and robotic systems and biological systems integrate as well (a technological possibility discussed in depth in Chapter Three), the general distinction between humans and machines will clearly blur and fade in the coming century.

Aside from robots reproducing themselves, Moravec foresees robots progressively becoming the manufacturing and construction workforce of the future. Robots will create products "on the spot" (as they evolve into von Neumann universal constructors) and they will take the lead in the innovation of new products as their intelligence and perceptual-motor capabilities grow beyond the abilities of non-augmented humans.[94]

The discussion so far on robotic evolution through successive generations has taken us to the point where robots will have achieved human level intelligence and integrated perceptual-motor skills, but Moravec envisions that the design and physical form of robots will move way beyond such levels. Robot designs will proliferate throughout the 20th Century and beyond, and with the opening up of space in the coming century, our solar system will team with robots, AI's, and ex-humans (augmented or transformed humans) of all manner and size, dwarfing the biodiversity of the earth. Robots, like AI's, will form into dynamic configurations that can combine, separate, and in numerous ways redesign themselves into a myriad of possible arrangements. Yet further down the line, Moravec imagines the eventual emergence of "**bush robots**", the ideal robotic configuration, shaped like fractal branching trees, with "arms" and "legs" and billions if not trillions of microscopic sensors and fingers that can manipulate matter at the atomic level. In basic form the "bush robot" looks like a naked yet mobile and dexterous nervous system with the brain housed in the trunk of the tree. These advanced robots will possess mental and computational powers a million times that of a human, yet due to the progressive miniaturization of computer circuitry, measure on the average around a meter in length. Their individual fingers, which will be strings of individual atoms, will be able to move at speeds of up to a million motions per second, all the trillions of them being coordinated by a hierarchical system of command centers running back into the main trunk of the body.[95]

As can be seen from this review, robots promise to provide for numerous services in the relatively near future. The robots are coming and, probably long before they invade and explore the solar system, as Brooks and Moravec would propose, they are going to invade and populate the earth. Aside from industrial and manufacturing possibilities, robots will engage in various types of social interactions with humans. As noted earlier, software agents, as disembodied personas, also are being developed that would socially interact with humans, and in the future, agent software will probably be integrated into robots. Robots could serve as teachers, friends, and companions, and provide for home entertainment and the care of the elderly. They may serve as athletic coaches, gurus, and bodyguards.[96] In particular, there is the fast developing area of robotic sex – the creation of "**sex bots**". Snell predicts that sex bots will be common in the near future. They will be used for sexual experimentation where people will try out sexual behaviors and fantasies with robots that they would be hesitant or unable to try out with humans. Snell also thinks that sex with robots may turn out to be better than with other humans. Kurzweil sees these sexual robots becoming very popular by 2020 to 2030.[97]

Robots are also developing into a new art form, and a new vehicle for the creation of art. Aside from performing practical functions to serve human needs, people are experimenting with the creation of dynamic robotic displays, interactions, and demonstrations. Robot combat is a new spectator sports craze. Robots are appearing in more and more entertainment venues. Mark Pauline has created various mobile machines, which are literally set loose on each other while spectators sit back and watch what happens. Further, the robot as a mechanical projection or metaphor on humans is becoming a medium for artistic expression.[98] Kurzweil reviews artificial intelligence efforts in creating art, music, and poetry, and it is only a matter of time before such artistic programs are uploaded into robots.[99]

Our growing dependency on computers (and perhaps in the very near future, robots) raises the general issue of our future relationship to information technology. Humans have been dependent upon various types of technology since the beginning of recorded history and before. Yet, is our dependency becoming too great on these machines? If these machines become as powerful and intelligent as people like Kurzweil and Moravec predict, will we be absorbed, transcended, or eliminated? What is going to happen to us in an increasingly computerized and robotized world?

There are different answers to these questions. A few decades ago, the developing computer systems were seen as a potential threat to our individuality and our freedom (the classic fear of machines). Yet, as both Naisbitt and Toffler note, computers have had the opposite effect.[100] Individuals can now do a host of new things, personally and professionally, that they could never do before. Individuals can access and communicate with a global array of information resources and organizations. The working and living space of the individual is exploding. The richness, variety, and scope of the environment of the individual have grown tremendously. The technology of the Information Age seems to have empowered us.

As with the computer and other intelligent machines of the future, we will undoubtedly continue to strive to make our machines more compatible and supportive with our abilities, and more efficient at serving our needs. As Michael Dertouzos argues the computer-human interface should move increasingly toward compatibility with human behavior, concepts, thinking, and modes of communication. For Dertouzos the computer should be tailored to meet the needs of humans.[101] Both software agents and robots are being designed to be sensitive and attentive to human behavior and human needs and interests. Also, as noted earlier, scientists and technologists are working on intelligence and sensory augmentation systems that could be implanted into the human body and nervous system to support and enhance human abilities and behavior.[102] Following this line of thinking, we will control computer systems and robots and use them to enhance our powers and the quality of our life.[103]

But equally, as apprentices of old, we will be educated, molded, and selected to work and use our machines efficiently. As we will see later in this chapter, the jobs, professions, and fundamental economies of nations are being transformed by information technology. Postman and Naisbitt, in a cautious and critical vein, have argued that modern information technology is undermining our humanistic culture and values.[104] Zey sees the growing influence and significance of computers in a more positive light, arguing that they will teach us and challenge us to new heights, but he is also concerned that humans could become too dependent upon them.[105]

Technology and humanity are open systems and each is supporting and driving the evolution of the other. Even at the basic level of internal design principles, computer circuitry is being modeled after brain circuitry and our brain circuitry, with the introduction of neural implants, will be modified to accommodate to computer circuits. Zey describes the process of "**cybergenesis**" as bringing human nature and the human intellect into the machine, but he adds that we are also working on bringing the machine into the human.[106] Pearson predicts that by 2030 we will have full 2-Way brain links with computers, being able to send and receive messages in neurological interface with a computer.[107] (On a related note, Kurzweil predicts that around the same time humans will be able to communicate directly brain-to-brain with computer supported neural implants.[108]) Whether we are discussing human skills, dispositions, and behaviors and their interface with external computer design and layout, or the internal circuitry and workings of the human nervous system and computers, following the terminology of Toffler, the "technosphere" and "psychosphere" are interactive and steadily integrating in their mutual evolution.[109]

Because technology empowers humans, and because humans and technology are interactive open systems, mind-matter dualism is untenable as a way to understand the relationship of humanity and machines. Walter Anderson describes our relationship with advanced technologies, such as biotechnology and information technology, as symbiotic.[110] Machines are not an alien reality. Who created them? What are their functions? In particular, computer systems model and empower fundamental neurological and psychological human capacities such as memory, learning, thinking, and communication, and robotic systems add in basic perceptual, motor, and social interactive behaviors. Futurists such as Pearson and Zey describe our relationship with computers and robots as a growing partnership.[111] Information technology is the most human like of all technologies. In spite of how strange it may sound (given a Newtonian dualist view of matter) to say that machines can possess mental or human qualities, it is clear that they are progressively being designed with more and more features of intelligence, personality, and human psychology. We should describe our relationship with computers and robots as an intimate resonance and evolving reciprocity.

Two interesting perspectives on the future relationship between humanity and technology that further reinforce and enrich many of the points made above are Gregory Stock's *Metaman* and Kevin Kelly's *Out of Control*. Both Kelly and Stock's views undercut the dualist separation of humanity and machines.[112]

Kelly proposes that the distinction between the biological and living, and the technological and inorganic, will increasingly blur in the future. As he puts it, the "**born**" and the "**made**" are getting closer together. Both Anderson and Moravec have made similar points. As will be discussed at length in Chapter Three, more and more parts of living bodies can be replaced with technological creations. We have been able to construct a variety of artificial organs, tissues, and structures, and progress in this direction is accelerating. The idea of a mind transplant, totally replacing the physical body and brain of a human with a technological system is an extreme example of this biotechnological trend, but at the very least, we may be able to implant various types of electronic memory and thinking chips in the near future that would enhance normal cognitive abilities. Complimentarily, Kelly notes that machines are becoming more lifelike and intelligent. Machines are being constructed that more closely approximate living creatures. According to Kelly, our sense of a qualitative difference between our machines and ourselves will lessen in the future.

Stock's view is that humans and technology are quickly evolving toward a collaborative and symbiotic relationship. This integrative relationship is emerging at a global level of organization. Each end of the equation is benefiting the other and the fears of competition or overthrow of humanity by machines, according to Stock, are unfounded. Stock refers to this integrated human-technology global system as "**Metaman**". He points out that the Metaman system shows all of the characteristics we would associate with life, and it is evolving in ways that are more advanced and more efficient than biological systems alone. In essence, technology is speeding up the rate of change in human life.

A particular point worth mentioning about Stock's view of technology is that a process similar to natural selection is going on among our machines, with human preference and compatibility providing the selection criteria. Different versions or brands of the same technological unit compete against each other with human likes and dislikes providing the selection process determining which versions will get used the most. The types that get purchased and used the most are then manufactured in higher numbers, and the brands or types not purchased as much get phased out or discontinued. The process is like survival of the fittest. This technological competition drives the evolution of technology and guides the technology toward increasing compatibility with humans.

As technology moves toward increasingly intelligent machines and complex systems, the jobs of the future will require higher education and enhanced intellectual skills. The move from a smokestack and steam shovel technology in the Industrial Era to an informational technology is transforming the economic and professional worlds. As more and more of the simpler or mechanical jobs are handled by automated technology and computer systems, job opportunities will increasingly shift toward different skills and abilities. These new skills will involve knowledge of the new information technologies, as well as a constructive and positive attitude toward these machines.[113] Presently we are in the middle of a great extinction of what once were viable jobs that are no longer needed. Information machines are subsuming and taking the place of industrial and mechanical machines. In the final analysis, our attitude toward computers, robots and other types of information technologies will have to be positive and collaborative, rather than antagonistic or competitive, if we are to survive and thrive economically and professionally in the future. If Kurzweil is correct, within a hundred years, if not sooner, we will need to amplify our abilities with computer circuitry if not merge with our computers if we are to have any contributing value at all in the economy and business of the world.

Still there are many worries and concerns over our growing dependency on computers and the viability and survival of humans in the future. Kaku describes many of the present fears with robots and computers, including the pervasive monitoring of human affairs through ubiquitous computing in all aspects of human life, computers gaining control of fundamental social and technological systems such that humans will no longer be able to understand or direct the world around them, or robots gone mad or wild, without their being any means to stop them or shut them off.[114] Yet, perhaps in the long run even partnership and symbiosis will not be enough. At what point does technological augmentation and integration become so pervasive that what was human becomes insignificant? The computer may not conquer and destroy us, as in *Terminator*, by trying to kill us, but by progressively infusing into us, transforming us beyond recognition, and taking over civilization from the inside out. Some writers such as the transhumanists and Moravec see the transformation and transcendence of humanity as evolutionary and ultimately positive, creating more advanced forms of intelligence and mind.[115] Moravec foresees all kinds of possibilities, including uploading human minds into computer systems, as well as technological augmentation and biotechnological transformations of the human bodies, creating a diverse population of **Exes** (ex-humans), that at best carry with them humanity as a memory into the future.

The Intelligent Environment and Virtual Reality

"Many people are comforted by the fact that we still have our hand on the 'plug' that we can turn our computers off if they get too uppity. In actuality, it's the computers that have their figurative hands on our plug."

Ray Kurzweil

"Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts
...A graphical representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the non-space of the mind, clusters and constellations of data. Like city lights, receding..."

William Gibson

Aside from the possibilities of technological infusion and augmentation in humans, it is also predicted by numerous futurists that information technology will increasingly permeate into all aspects of the environment. As noted earlier, computer systems are being incorporated into all other present technologies. More and more of the products we buy have computers, of various degrees of complexity, within them. As I reviewed in the last chapters, our vehicles and transportation systems are becoming computerized.[116] Our homes and offices will soon have computer systems which monitor and control all operational and human support functions, e.g., lighting, heating, safety, cleaning, cooking, supplies, etc.[117] In general, the total human environment is being "**wired**".

The computer though is not just transforming the environment around us; it is instrumental in the creation and evolution of a new type of reality, the universe of cyberspace and virtual reality. Various futurists and technological prophets foresee that virtual reality will steadily become a more significant feature of human life, to the point where we may spend most if not all of our time in virtual reality.[118]

In this section I examine how computers and information technology are transforming our environment, our world, and the nature of reality itself. In discussing the computerization of our present environment I use Nicholas Negroponte's ideas, contained in his well-known book *being digital*, as a starting and anchor point.[119] For Negroponte, computing is not simply about computers; it will affect all aspects of our life and our world. In examining the idea of virtual reality I begin my discussion with Michael Heim's *The Metaphysics of Virtual Reality*.[120] For Heim, the computer is taking us into a different kind of reality, a new metaphysical realm.

Negroponte believes that a true revolution going on around us that is changing human life. According to Negroponte, "The change from atoms to bits is irrevocable and unstoppable."[121] Currently most of our information is still recorded in atoms (in solid physical matter), but eventually most information will be stored as patterns of bits within the electronic and optical media of energy. **Bits** are form rather than substance.[122] Negroponte states that industries are going to quickly change from atom-based to bit-based, some sooner, some later. The media is also going to change. Education will follow. For Negroponte, there are many advantages of bits over atoms: Bits can be mixed together, and we can have bits about bits. Bits are more fluid and create more complex organizations. Bits are a more dynamic and complex reality than atoms. From Negroponte's perspective, the digital age is moving human reality from the realm of matter to the realm of form and energy. What Negroponte especially brings out is how information (bits) is much more open and flexible than physical matter in creating complex forms and organizations. It is a new medium and architecture for sculpting our world.[123] Hence, we see right away from this central thesis of Negroponte that our computerized environment is not simply a re-arrangement and wiring of matter, but a fundamental change in the embodiment and nature of form.

Negroponte argues that in the future **digital age** intelligence will exist in both the transmitter and the receiver of media systems. Presently, in a TV the intelligence is all in the sender - the transmitter. TV stations basically control the content of the message. Most TVs today simply let you adjust for simple parameters like brightness and color. Negroponte states that the home cable box is the wrong place for the selection of channels; the TV should be selecting from some more distant point in the information network. The receiver should control what is transmitted from the sender.[124]

Soon, however, according to Negroponte, the TV and the computer will merge. Frederick Pohl also predicts this merger in the near future.[125] The computer is literally going to envelop the TV and, according to Negroponte, by the year 2005, people will spend more time on the Internet than watching TV. Today the growth of computers is much faster than the growth of TVs and the video capabilities of computers are increasing very quickly. The computer/TV of the future will let you adjust for content - a random access medium - not limited by time or space. Digital life will have little real time broadcasting. It will all be on demand. A new culture will develop out of this change.[126] In essence, the mode of communication in the media will no longer be passive reception. As Pearson predicts, the TV of the future will be interactive.[127]

Negroponte contends that the medium is no longer the message; information or bits transcend any particular medium. A medium is an embodiment of the message and there can be many different embodiments. Bits should be sent regardless of the type of receiver. In essence, there will be a blurring, if not eradication, of the differences between a TV network, a newspaper, and other information and entertainment businesses.[128] As Kurzweil states it there will be a convergence of all media in the future.[129] The determination of how the bits will be viewed will occur at the receiver end. As the Internet integrates the different media, we will develop a single worldwide media machine. We could though argue that bits have become the new medium - a more abstract and flexible medium that can be embodied or translated into a variety of more limiting medium.

Information and entertainment providers are all moving into **multi-media**, according to Negroponte, a new key concept of the digital age. For Negroponte, it is critical to think of multi-media as interactive where we can move from one medium to another and engage the simulated reality. Most multi-media now is on disk, for example, CD-ROM, but Negroponte thinks the CD-ROM is the Beta of our present era. In the future, multi-media will come through outside sources significantly more diversified in content and much vaster in memory, e.g., *Britannica.com* and *Discover Magazine*.[130]

The organization of information is also drastically changing in the digital age. For Negroponte, **hypertext** and **hypermedia** will transcend the spatial and atom-fixed limitations of books and other atom-based sources of information. Basically, hypertext is where any given text through electronic links connects to other related texts. Negroponte also notes that the breadth/depth problem in books will be transcended; a hypertext could have a broad and simplified initial level and references/links that extend outward in depth on all its topics. In the digital world we can go beyond three dimensions of storage and a fixed medium of display. We can go beyond a linear or fixed arrangement of material.[131] Again we see how the complexity and fluidity of information and bits clearly transcends the limits of traditional storage and display.

Negroponte introduces the concept of the "**Bit Police**". How is information going to be monitored and regulated? Should there be a system of control located in some set of centralized governmental and corporate organizations? Negroponte thinks that the selection and control processes should occur at the receiver end. But we could ask, what about censorship and ownership rights to information? Negroponte believes that the copyright concept and laws are outdated for the electronic universe and will break down. An incredible amount of material is already being pirated and the next decade will see various information crimes - invasion of privacy, vandalism, and thievery. The digital age information and communication system is evolving as a network, rather than a hierarchy, without any centralized system of control and monitoring. This shift in organization from an Industrial-Newtonian system to a network without a central command center is transforming the laws, individual rights, and possibilities of crime in our society.[132]

Negroponte extensively addresses the issue of the machine-human interface, a topic introduced in the previous section. Early in the computer's evolution it was much more mysterious and technical. Not many people knew how to use one. There have since been many advances in **Graphical User Interface** (GUI), e.g., menu bars, windows, icons, and cursors. Yet thus far, advances in making machines more human friendly have been almost exclusively in physical design and sensory displays. In the future, Negroponte believes that we must move toward creating computers that learn about the user, recognize the user, have active intelligence, and can understand language and speech. Many other computer scientists, including Dertouzos and Kurzweil, share this point of view. For Negroponte, GUI is not a problem of trying to design a display panel, but rather of trying to design a human. He states that we do not want to make a dumb machine easier to use for smart humans, but rather we should try to make the machine smart at the interface and more like a human. We should ask what would make it easier for a computer to deal with humans, and not just vice versa. Computers should be able to see and hear and interact with us.[133] In a similar vein, Dertouzos has argued that the machine-human interface must become like a human-human interface.[134]

Miniaturization, according to Negroponte, will lead to speech production and recognition becoming the primary mode of interaction with computers. Speech recognition in the computer, though, will not be speaker independent. The computer will learn the nuances of the individual's speech.[135] Kurzweil's work in speech recognition programs is a good example of this effort toward adaptive speaker sensitive systems. Also, Negroponte believes that we should be able to interface at a distance with the computer. We need to be able to walk around a room or through our house and office and continue to talk with our computer. Negroponte states that in the future we will talk as much or more to machines than to humans. As noted earlier, Kurzweil shares this belief.

Negroponte discusses *Windows* and other display formats where information is organized and presented as images and icons on a screen. In interfacing with such a display, basically we look at a screen and click on keys, icons, and commands. Yet how dynamic could such displays become in the future? Will we be able to move through them? How colorful, multi-sensory, kinesthetic, tactual, hierarchical and network-like could they become? We could have many kinds of maps, doorways, avenues, and displays within displays. We could go on journeys through the windows and displays.

Hence, in considering the future of computer displays and interfaces, we are lead into the topic of **virtual reality**. Within the context of the present discussion, I should note that virtual reality, as a technological simulated reality, will actually become more real than real. We will be able to systematically vary the simulation, repeating it, slowing it down or speeding it up, penetrating to different depths of detail, or changing perspective. Further, we will move increasingly into the display, or reciprocally, the display will increasingly engulf us. When we move into a display - a better word might be an "array" - we will meet other humans, as well as other forms of intelligence.[136]

The virtual array will be part of our future **intelligent environment** - an environment that actively and thoughtfully interacts with us. In fact, all the above discussions on virtual reality, computer displays, media convergence and multi-media, speech recognition, GUI's, and the new medium of bits, are all connected to the general theme of an evolving intelligent environment. In the last section I examined how computers would become more human like and more compatible and integrative with humans. In this section, we are beginning to see that human compatibility and interactivity are central features of the type of intelligence being designed into the computerized environment. Computerization brings with it new forms of complexity and organization that at times will challenge humans, open up new perspectives, and even disrupt our present ways of life and thinking, but much of what is going on in the design of information systems is geared toward serving human needs and communicating more effectively with us. We are trying to build human-centered intelligence into our environment.

Kaku describes a future "**electronic ecology**" of ubiquitous computing. The environment will sense humans and respond to them. We will have "smart objects" and "smart paper" that is connected to the Internet.[137] There will be "smart rooms" and "smart cars".[138] Many of our products already have microchips embedded in them,[139] but the trend in the future will be for almost all our products to have computer chips in them.[140] According to Negroponte, our new machines will have active labels and interactive intelligence. Appliances will become instructors for their own operation and maintenance and instruction manuals will disappear. Machines will explain themselves. (In a sense, this is self-consciousness emerging in the machine.) Intelligent products will be "smart ready" to personalize to one's particular needs and patterns of behavior.[141] Aside from intelligent houses and smart appliances, Salzman and Matathia also foresee intelligent clothes and smart nametags, and many other smart product developments moving into all aspects of everyday life.[142] Dertouzos describes present efforts to develop a "body net" that would be worn and integrate a phone, radio, computer, diary, and TV.[143] Centron and Davies, highlighting a popular and related theme, argue that computers will shrink and disappear into the environment, becoming an invisible technology that will be everywhere, animating and coordinating everything.[144] Pohl, integrating several of the above ideas, predicts computers and connected communication technologies miniaturizing and disappearing into our clothes.[145] We will truly be "wired", being able to talk to our clothes and through our clothes. Pearson and Halal predict that an intelligent and ubiquitous computerized environment will emerge in full force between the years 2010 and 2020.[146]

We should note and re-emphasize as a general theme that this process of computerizing the environment is human centered. The intelligence built into our appliances, products, houses, clothes, and numerous other environmental structures is geared toward compatibility and sensitivity to human life-styles, needs, goals, behaviors, and even mindsets. Further, as I describe in later chapters, this computerization of the environment, creating human connected and human centered intelligence, is quickly extending outward into the "natural environment" as well.[147] Through the computer, which is an extension of ourselves, we are engaging in what Zey refers to as "vitalization" – the bringing of "humanness" into all aspects of our world.[148] But I would propose that the evolving intelligent environment is part of a bigger picture. It is another clear example of the principle of reciprocity at work in the future. The world of physical matter around us is being integrated into human life. Yet through this process of transforming our environment humans will be changed and transformed as well.

The human centered intelligent environment will reach to the level of individuals. Recall that one significant future trend highlighted in the previous chapter was the increasing customization of technologies.[149] Emphasizing a similar idea, Negroponte proposes the expression "**Post-Information Age**" to refer to the time when machines and information technology become individualized and personalized. Machines will understand people and interact with us with perhaps more sensitivity than most people. We will no longer be treated as part of a group. Through programs that learn about their human users, information technology will treat each person as a unique human being. According to Negroponte, there will be true individualization within the technology of the "Post-Information Age".[150]

One exceedingly interesting and influential theme in Negroponte's book is the idea of **software agents**. The topic of agents, already introduced, is a paradigm example of the evolving intelligent environment, and clearly illustrates the role of reciprocity in the future evolution of humans, machines, and the environment. According to Negroponte, agent based interfaces will emerge as the dominant form of human-machine interaction. Negroponte predicts that within twenty years we will interact with a set of holographic agents through speech at a distance. We will talk to our agents. We will see them. Basically, agents are personalized programs that learn, have a number of human-like features, and interact with humans. An agent is a form of artificial intelligence, but an agent will do things that humans cannot do. It will navigate through and interact with other information systems. We will have "**digital butlers**", personalized filters that know an individual's interests, and scan, read, summarize, and report from vast data banks back to the individual. Agents will monitor and coordinate the operations of the household, through communicating with the various intelligent appliances in the home. In fact, our "smart houses" and "smart cars" of the future, to whatever degree they acquire personas will be specialized agents. We will not necessarily go out surfing on the Net, as we do today. Our agents will do it for us. Agents will help solve the information management issue for individuals in the future. They will sort through, manage, and organize for us a wealth of information.[151] Although rather primitive "virtual assistants" already exist, to recall, various futurists and computer scientists predict that between 2015 and 2020 much more sophisticated and intelligent agents will be available.[152] Kaku foresees agents evolving through generations, as Moravec foresees robots evolving through generations, becoming more and more compatible with humans and more human like in the process.[153]

Agents will be a decentralized system where each agent is good at a particular task, but they will also communicate with each other. They will all be tied to the individual, learning about the individual and helping the person in different ways to coordinate his or her life.[154] These intelligent modules will be interactive and go out into the environment to do things for the person, like an extension of his or her body. Hence, it is highly probable that the development of personalized agents will make our normal distinctions between the self, others, and the environment blur and break down. Agents will learn about us, become close associates and even friends with whom we are constantly in touch and this level of intimacy will make them become a part of us. Agents will create a different kind of human self, a distributed multiplicity of personalities and intellects. Talking to our agents will be like talking to facets of us. We will live our lives with a set of familiar technological persona. This intelligent ambiance and support through agents leads to the interesting conclusion that the technological enhancement of human mentality (Intelligence Amplification) may emerge on the outside of our skins. An individual's intelligence will be the sum total of his or her mind and the "minds" of his or her agents.

The focus of the next section is the Internet and global information technology, but in order to present a coherent and complete picture of Negroponte's ideas on computers and their impact on future human life, as well as the basic features of an intelligent environment, it is necessary to discuss his views on electronic communication here. His general theoretical framework used in describing the salient features of the digital age, in fact, highlights the significance of the Internet. Negroponte identifies four powerful qualities basic to the digital age: **Decentralizing** - **Globalizing** - **Harmonizing** - and **Empowering**. All these qualities of the digital age connect to the growing importance of the Internet. According to him, because of these four qualities the digital revolution is unstoppable. As he puts it, regarding the rate of change in information technology and human life, "There is no speed limit on the electronic highway".[155]

Negroponte also uses the expression "**Being Asynchronous**" to describe our future way of life in the digital age. Answering machines (more precisely an agent) will always answer the phone and give the receiver the chance to see if he or she wants to respond. But further, email will become more popular than the telephone because it is non-intrusive. Email is fast increasing in popularity also because it is both asynchronous and computer readable. Email, in fact, according to Negroponte, will become the primary mode of communication between humans. It will change our lifestyle, where work and home and recreation will no longer be separate. Addresses and places of employment will become virtual and electronic. A seamless workplace will develop as the global society and Internet grow. Email will benefit children and education because kids will both read and write on the Internet. The Internet will become a web of wisdom and knowledge as more and more people come on line. Negroponte states that although there has been little change in education over the last hundred years, this will soon change. Highlighting the theme of personalization again, information technology will offer different educational conditions for different learning styles. Email and the Internet will empower the individual.[156]

Negroponte predicts that Internet use will continue to grow quickly in the years ahead. The fastest growing areas will be the Third World and less technologically advanced countries.[157] The Internet network, though, is not like the TV network; the latter is a centralized hierarchy, whereas the former is a distributed array of senders and receivers, each web site doing both. The Internet is not a one-way street. Yet on the Internet, individual people and special groups can become like TV stations, each sending out information, news, and entertainment. Negroponte believes that the Internet will be a model of things to come. It has developed without any overall designer (it is decentralized) and it is creating a network of people and organizations from around the globe (it is globalizing). The true value of the Internet is that it is creating a new social order and life; it is more about community than information. It is creating **MUDs** (Multi-

User Dungeons) - discussion groups on any topic imaginable, any time of the day or night.[158]

Negroponte's ideas on the personalization of future information technology imply that the global computer network will increasingly possess a high degree of individualized sensitivity. Agents will interface with the Internet and communicate the personal interests and needs of their users into the world system. The world information system, in turn, will acquire a personalized understanding of how best to serve and support the different individuals of the world population. It will assist people around the world in communicating their unique talents, needs, and goals. This personalization of the global system will contribute to the sense of unity, communion, and interpersonal connectedness among the people of the world.[159]

Although the emerging intelligent environment will possess a high degree of individualized sensitivity, it will reciprocally possess a high degree of interconnectivity and integration. Heim notes that our machines already show some level of interconnectivity and are no longer a set of discrete appliances.[160] Negroponte argues that machines need to be able to talk with each other to better serve people. We should not see them as isolated entities and functions. For Negroponte, intelligent machines will develop as networks. Further, houses, neighborhoods, public structures, facilities and cities will be networked. Various pieces of this growing intelligent network are being created and wired together every day.[161] Negroponte's concept of the agent fits into this development as well, since our house and our appliances may possess persona or virtual faces that will talk with us, inform us of any present operational problems and suggest possible improvements, based on searching the Internet for the latest developments in environmental intelligence.[162]

Aside from the computerization of our present physical environment, computers are creating a whole new arena of virtual and electronic environments. All of the various video and computer games create electronic environments and virtual realities. Cyberspace environments are a fast growing area of entertainment and recreation. Yet on a more practical side, industry, manufacturing, and businesses increasingly use **Computer Aided Design** (CAD). Products, systems, and structures are first created electronically and virtually, and initially explored and tested on the computer. As Kaku notes, cyberscience is a new research methodology emerging in many different scientific disciplines. Education is fast developing learning environments on computers. All of these electronic virtual environments are becoming increasingly intelligent, flexible, realistic, and compelling. Perhaps even more so than with computerized physical environments, electronic environments promise enhanced human sensitivity and interactivity.

The emergence of virtual reality indicates that computer technology is diversifying and expanding the potential environments of human life. It is creating not only simulations, but also fantasy worlds and alternate realities. We could ask, as many futurists have, if this multiplication of realities is psychologically healthy. Will we lose touch with the "real" reality?[163] But humans are special, in part, because we are creatures of imagination and fantasy, and everything in our present environment has been altered, manipulated, and influenced by our creative presence. Cyberspace and virtual reality reflect and support our creativity and intelligence. Further, it is not altogether clear, philosophically or scientifically, why virtual reality is less "real" than what we refer to as normal reality.[164]

Michael Heim is one person who has written extensively on virtual reality and cyberspace. He presents seven different concepts of virtual reality:[165]

1) A simulation of reality intended to produce a sense of realism
2) A system supporting interaction, again for the purpose of producing a sense of realism
3) Anything artificial
4) Sensory immersion in a virtual environment, consisting of sight, sound, and tactual information
5) Telepresence - combined together with robotics - to be somewhere else virtually
6) Full-Body Immersion
7) Networked Communications with computers or other humans

Further he sees at least two different attitudes toward virtual reality:

1. The imaginative - creating a new form of reality - an alternative/non-drug induced state of consciousness - the West coast version.
2. The practical - to be used as a tool for projects.

Heim's views on virtual reality are connected with his general assessment of computers and information technology, including the Internet and World Wide Web. According to Heim, information technology can be applied to every human activity and can mediate every human transaction. Heim states that computer enthusiasts do not see the computer as simply a tool, but rather much more. For enthusiasts, the computer will enhance and augment human thought. (Recall the previous discussion of Intelligence Amplification.) Heim argues though that the computer also creates a new environment, virtual reality, which is a metaphysical laboratory for examining our sense of reality. As we explore this new realm, we will be changed in the process. What we have made, in turn, will remake us, a reciprocity of the creator and the created, of humanity and technology.[166] In a similar vein, Sherry Turkle has argued that **cyberspace** offers a "psychological laboratory" for exploring our sense of self.[167] (The term "cyberspace" will be used to denote the total reality and information space encountered through computers, including web sites, the Internet, and the array of documents and files contained in individual computers. Virtual reality, a computer generated sensory environment, is part of cyberspace.)

Heim is not totally positive in his assessment of computers and information technology; he sees problems with this new reality. In the beginning, computers promised to provide a way to deal with the knowledge explosion in their capacities to systematically store huge amounts of information and quickly search for new information in the vast data banks of other computer systems. Yet Heim notes that we have become obsessed with getting huge amounts of information quickly and he thinks that the law of diminishing returns applies to this information frenzy; the more information we gather, the less significance it has. He also notes that in spite of the promise of computers to organize our tasks and make them easier, the computer has created the pathological aspects of mindless productivity and increased stress. Further, search engines, using some type of rigid logical process of scanning the Internet, have cut off the peripheral musing and the openness of mind that occurs when one browses through a library. A search engine focuses a search. Libraries are becoming information centers rather than places to browse. Yet, according to Heim we need the elements of exploration and play in learning.

Yet again, there is the other side of the coin, embodied in “surfing the Net” which is definitely a form of browsing and meandering through the **World Wide Web**. Surfing the net is possible because of hypertext. Heim is particularly fascinated with the new reality of hypertext and his assessment is mixed and guarded regarding this new way to organize and display information. Recall that hypertext is the linking of key words and concepts in a computer document to other related computer documents or web sites. Hence, while reading a document, a person can jump to other documents by simply clicking on bolded words. In this fashion of moving from one document to another, a person can explore a maze of interconnected sources of information and never come to an end point in the process. According to Heim, hypertext produces a feeling of omniscience - a hypertext heaven. Yet Heim notes that although hypertext does produce a feeling of exhilaration, it also creates a sense of being in an endless maze. (The ideas of a cyberspace maze, as well as a hypertext heaven, clearly connect back to themes found in William Gibson’s *Neuromancer*.[168]) Since hypertext is steadily linking together all of the documents that are on the World Wide Web, it is becoming the text of all texts, but it is not linear or hierarchical. There is no single way to represent its organization; there are an infinite number of paths through the system. Movement through the hypertext is intuitive and associative; it is a zigzagging series of jumps, rather than a logical sequence. The reader though is referred to “An Atlas of Cyberspace” for a variety of efforts to map the logical and functional geography of cyberspace.[169]

As Heim reports, Ted Nelson first developed the notion of hypertext in the 1960’s in an attempt to develop a systematic philosophy using the computer as a means to organize his thoughts. Yet it was books, with their self-contained boundaries, that helped to produce the idea of unified philosophical systems. How can a unified system of thought be captured in a system that goes on forever and can be explored in an infinite number of ways? The reality of hypertext challenges the presumed goal of contemporary search engines to create an integrated system of knowledge. Although people do explore the Web through search engines, the documents in the Web are organized via hypertext. Each site contains links to other sites, ad infinitum. From the bottom up, the Web is not being organized like some great encyclopedia. Rather, its individual creators are organizing it as a maze of interconnections running in every direction; it is a network, not a hierarchy.

The emerging hypertext organization of the Internet and the World Wide Web has great relevance to the nature of the Information Age and our future world. If our system of information and knowledge is being structured according to a network pattern that allows for an infinite number of paths of access, then how will this reality affect our concepts of order and integration in our world? The architecture of the network contains no center and it lacks a stable, overarching point of view. Can we have any sense of unity and identity if our knowledge base is a maze? Social order within the past was frequently modeled on the concept of a hierarchy, a top-down chain of command. Cyberspace is a maze, an "Alice in Wonderland" structure to reality.

Heim's analysis of computers and information technology also has a definite romantic and metaphysical flavor. For Heim, cyberspace is a new reality, charged with meaning, emotion, and spirit. In talking about the concept of the interface, where two or more information sources come face to face and become interactive, Heim likens the idea to the interface of the Father and the Son in Christian theology. A third reality is created in the union of the two, like the Holy Spirit or the Tao uniting the Yin and the Yang. The interface is the window or door into cyberspace. As we habituate ourselves to the interface, we merge with the other side. Heim notes, however, that William Gibson, in *Neuromancer,* refers to cyberspace as an "**infinite cage**".[170] The more we become immersed within this realm, the more danger there is that we will lose touch with ourselves. Within the reality of cyberspace and the stream of information that flows past us and through us, we must find a way to keep an anchor on ourselves.

Heim contends that our fascination and love affair with computers is erotic and sensual. One of his chapter titles is "The Erotic Ontology of Cyberspace." He thinks that humans, in their obsession with computers, are searching for a home for the human heart and human mind. As Heim notes, Gibson in his science fiction novels explores the allure of computers. In *Neuromancer,* cyberspace is a place of rapture, erotic intensity, desire, and self-submission.[171] Further, Heim points out that historically the experience of divine ecstasy is often associated with sexual ecstasy, an expression of the force of Eros, of attraction and extension of the self into another. Within cyberspace, Eros moves into the realm of Logos (data, information, knowledge), and Heim sees this process as becoming enraptured with the beauty of Platonic forms. I should note though that cyberspace is not simply abstract forms. We will meet "virtual bodies", colors, sensations, and the expressions of feelings of others within this realm.[172]

Heim's views on the divine and erotic aspects of computers and cyberspace challenge the ideas that computers dehumanize, that they create too cognitive a reality, and that technology in general is divorced from the spiritual. Can we move into a higher or more sublime realm through cyberspace? Will the heart as well move into this new reality and be even more fulfilled? The Internet promises enhanced communion and interpersonal connectivity, and anticipating a theme in the next section, perhaps cyberspace is a significant aspect of our journey to cosmic consciousness.

Heim uses the theory of monads developed by the German philosopher Leibniz to describe the organization of cyber-reality. Leibniz believed that each individual mind or monad was connected to the universal mind or monad of God. For Heim, each of us is a monad having terminals that connect into a central universal monad, the total matrix of the Internet. He says that the body is the basis of our feelings and reality of separateness, and the universal matrix, in eliminating the body when we move into cyberspace, brings us together again.[173] Perhaps as the book tradition separated us, and the oral tradition before had given us a sense of community, the computer may bring back the feelings and reality of togetherness and community.

Not everyone is as convinced of the mesmerizing power of cyberspace and virtual reality as Heim. Michael Dertouzos, for one, does not think that information technology will propel us to live our lives in cyberspace.[174] Yet Dertouzos does foresee great possibilities in the technological evolution of virtual reality. First he notes that present efforts in virtual reality are creating both increased "**immersion**" (the sense of being within a simulated environment) and "**presence**" (the perceptual sense of vivid reality). Second, he notes that virtual reality does not have to be limited to simulations of actual reality; we increasingly possess the power to create alternate realities. Virtual reality allows us to expand our perceptual experiences. Third, virtual reality can be super-imposed upon "normal reality", creating suspended and embedded images within our physical environment. This augmentation of reality can be accomplished through the wearing of computerized translucent headsets that virtually project images or sounds into the world. And finally, Dertouzos is willing to consider the possibility that with all the potential areas of freedom and control involved in living with virtual reality humans may be able to reach "higher mental and psychological states" with this technology. [175]

John Briggs, on the other hand, is unequivocally positive about the promises and powers of virtual reality. He sees virtual reality as one of the most important technologies of the future. Briggs argues that as a medium for expression and communication, virtual reality could permeate all aspects of human life. He provides an impressive list of existing applications of virtual reality that includes architecture and construction (CAD), art (which will lead to dynamic forms of artistic visualization), business (dynamic 3D displays of trends and statistics), disabilities (movement and sensory simulations), education (studying virtual worlds), engineering (design and testing simulations), entertainment (multimedia experiences), medicine (simulated surgery), military (simulated flight and battle training), religion (visual-auditory experiences that are conducive to spiritual experiences), and sex (simulated experiences with real or virtual partners).[176]

The communication function of virtual reality is a theme emphasized in various discussions on this topic.[177] Sterling Lanier refers to virtual reality as the telephone of the future. Humans with computers create virtual reality displays, and our displays and simulations often serve as expressions or representations of our ideas, visions, and insights that we want to communicate to others. With the growing sophistication of software available for creating websites, our web sites are increasingly taking on the quality of dynamic virtual reality experiences, producing some level of "presence", interactivity, and navigation, creating a feeling of "immersion".[178] Virtual scenes can be connected through doorways and portals (hypermedia links), creating a sense of exploring a series of virtual worlds. A maze or labyrinth of interconnected virtual realities, imagined in Gibson and other science fiction writers, and discussed in Heim, is evolving on the World Wide Web.

So far virtual reality displays are primarily visual and auditory in sensory content, but haptic and touch simulation is also being developed, where individuals wear computerized gloves and even body suits to create a real sense of full body immersion in the simulated reality.[179] Vision and sound clearly evoke emotional reactions in humans, but with the addition of touch, and even eventually smell and taste, the emotional effects of virtual reality will become even more powerful. Virtual sex is one area where touch is critical, and there are already technological efforts to create this more intimate sense in virtual sexual experiences. Heim's analysis of virtual reality as an erotic, emotional, and even romantic experience will seem even more appropriate and accurate as virtual reality enriches and extends into all the senses.

Further, it is important to re-emphasize that virtual reality is not limited to simulations of the actual world around us. Virtual reality, as Heim and Briggs note, is a medium for artistic expression and experimentation. We are not limited to what exists, but given human imagination coupled with computer power, we can create "worlds" that diverge in indeterminable ways from our own world. There is vast flexibility, freedom, and intelligence is this growing universe. It is clearly, as Heim notes, a metaphysical laboratory.

Given these considerations, we can ask whether this new type of reality is more than just a virtual or simulated reality. Is it an evolutionary jump to a higher level of reality? Just as the realm of information and bits brings with it increased flexibility, complexity, and change, we could argue that virtual reality does the same. Why should we refer to such a reality as just "virtual"? Following J.T. Fraser's idea that evolution brings with it increasing freedom and complexity at each new level of organization[180], virtual reality seems to bring with it increased freedom and complexity over the reality of ordinary perception and the physical world. A virtual environment of electronic simulations can be controlled and manipulated in ways that would be impossible within our ordinary world. Is the realm of virtual reality less or more real?

Two scientists who have considered such deeper issues regarding virtual reality are Ray Kurzweil and Hans Moravec. Kurzweil, to recall, thinks that by the end of the 21st Century, humans will be able to download their minds (defined as a complex pattern of information and rules for processing that information) into computer hardware. What will such minds "see" and "experience" when they open their "eyes"? According to Kurzweil, the total body experience will be simulated within future computer technology, and our cyber-minds will experience a virtual reality created within the computer. In essence, these minds will live in virtual reality. This virtual reality though will far exceed in richness, variety, and depth the reality that we are accustomed to. Since imagination, intelligence, and computer power will determine the horizons of this virtual existence, our normal world will be exceedingly impoverished and constricting in comparison to what will be created in virtual reality. Further, with the development of a world wide net of computers, possessing processing powers billions and eventually trillions of times the combined capacity of all the humans and computers in the world today, innumerable cyber-minds and AI's will populate this interconnected virtual universe. These minds and intellects, manifesting themselves in forms and configurations unimaginable to us today, will communicate with each other, more deeply and intimately than skin bound humans today. Empowered by the computer network that they exist within, these minds will be able to create all manner of virtual worlds to explore and share with each other. We will truly live in a "maze" of immense dimensions and multifarious configurations. Kurzweil, in fact, explores the idea of a human mind and the human's agent mind becoming romantic and intimate over time, and developing a new integrated sense of identity.[181]

Moravec is even more dramatic and philosophical in his predictions and descriptions of the future evolution of cyberspace, cyber-minds, and virtual reality. To recall, Moravec believes that a great diversity of AI's will emerge in the next couple of centuries. Also, referring back to the previous chapter, he points out that the information storage capacity of matter, space, and time far exceeds any present computer or material systems. He suggests that in the future, the information storage capacities of matter will be engineered and expanded to levels trillions upon trillions of times more than our present brains and computer systems. This informational dense material substrate will allow for the creation of a myriad of virtual universes, populated by minds and intellects vastly exceeding our own limited capacities. Moravec's advanced robotic systems, such as the "bush robots" along with whatever augmented versions of humans exist in this future time, will in essence, all evolve and disappear into this hyper-complex and hyper-dense virtual reality. For Moravec, it seems very likely that the minds of this virtual cosmos will experiment and explore way beyond the constraints and parameters of our present universe in the construction of their reality. Also the minds of this cyber-cosmos will probably move beyond any normal sense of having a body, even a virtual one. Now in following this line of thought, the expression of "virtual reality" becomes totally inaccurate and unsuitable. We should go in the opposite direction and refer to it as a "**hyper-reality**". It literally is going to evolve from the inside of normal matter and space, as it is re-configured to support vastly enhanced informational density and processing speed. This "hyper-reality" will be permeated with consciousness and mind and project to its inhabitants a cosmos of ultimate intelligence, a creation of their own minds.[182]

The Internet, the Communication Web, and the Global Brain

From the previous reviews of the ideas of Kurzweil, Heim, and Negroponte, among others, it is clear that the connectivity of computers is a critical dimension in their present capacities and future possibilities. Computers do more than just compute; they communicate, and as we enter the 21st Century they are communicating worldwide.

The **Internet** is the global network of communication connections linking together the world's computer systems. It is the biggest and most intricate machine that humanity has ever built. The birth of the Internet though was inauspicious, and the scope and significance of what was to come was clearly not anticipated when it was created. The Internet began in the early 1960's when the computer systems between Stanford and UCLA were connected together. In the 1970's the United States government, through the Pentagon's Advanced Research Projects Agency (ARPA), decided to create a de-centralized network among universities and computers in the United States to ensure communications between scientists around the country in case of a nuclear attack from the Soviet Union. Using the communication network begun in Stanford and UCLA, ARPANET was born. ARPANET grew slowly at first, and by the early 1980's only 200 computers around the country were connected together. During the 1980's though the rate of growth began to accelerate, and the computer network that was emerging was formally set free from ARPANET regulation in 1990. A year later, in 1991, Tim Berners-Lee invented the World Wide Web, which allowed for visual graphics, sound, and multi-media to be transmitted across the computer network. The modern Internet was born.[183]

What began as a communication network for scientists sharing research information, and then morphed into a rather secretive national defense system for maintaining connections in a time of war, in the 1990's the Internet transformed once again into a general system for communication among computers and users around the world. In part due to its continuing de-centralized nature – there is no central command point or hub coordinating the flow of information through the system – the Internet rapidly grew throughout the 1990's, extending its reach across the globe, like branching neuronal dendrites, as if it had a life of its own.[184] The Internet is doubling in size every year.[185] Molitor reports that in 1987 there were only 28,000 users on the Internet. By 1991, there were a million users and by 1999 there were 130 million users. Molitor projects that by 2005 there will be a billion users worldwide, and Pearson predicts that by 2020 approximately 75% of the world's population will be using the Internet.[186] Moore and Simon predict that by 2007, everyone in the United States, at least, will be connected to the Internet.[187] Still, most present users of the Internet are still concentrated in the United States and modernized countries in Europe and Asia, accounting for over 90% of total users.[188] There are only minimal connections throughout most of Africa, the Mid-East, and South America, but there are presently significant increases occurring in Russia and

Southeast Asia.[189] Yet, though the number of connections is minimal throughout less technologically countries, Negroponte predicts that the fastest growth of Internet users will occur in these nations in the immediate decades ahead.[190]

The World Wide Web has been critical to the rapid growth and popularity of the Internet. Tim Berners-Lee, after creating the Web, formed a Web consortium that included both universities and business organizations, including MIT, ATT, Microsoft, Sony, Netscape, and Sun, which spurred the development of the Web. As Dertouzos describes the growth of the Web, one of the earliest achievements was the creation of an addressing scheme, which involved a language for assembling information into home pages and conventions for linking and transporting information. Dertouzos states that the popularity of the Web is in large part due to the fact that the Web allowed for the creation of "**Home Pages**", individual web sites advertising and communicating the interests, products, and ideas of any person, group, or organization to all other Internet connected computers and users in the world. Further, the genius of the Web, according to Dertouzos, involved connecting the ideas of computer networking and hypertext.[191] Any home page could be connected to any other home page in the Web, or any item within a web site could be linked to any other item in the site through hypertext, and it was through this web-like connectivity from any point to any other point in the network that what Heim describes as the labyrinth of cyberspace emerged on the Internet.[192]

The development of an adequate technological infrastructure to support the quickly growing computer network is though, according to Dertouzos, is far from complete. There are numerous government and international efforts to create this technological system, including the NII project in the United States, the Global Information Society project in Europe, and the ISDN in Japan. Dertouzos argues, based on the past achievements of the Web and Internet that the global infrastructure must be available to everyone and easy to use. Dertouzos also discusses the ongoing business competition to control the "Net". He describes the "**War of the Spiders**" as media, computer, and cable companies attempt to control the flow of information content. He also examines the "**Battle of the Pipes**" in the creation of the communication lines connecting computers and other information technologies together. He notes that the telephone system already has in place a massive connective web, but presently has low bandwidth transmission throughout much of it. Fiber optic lines and TV cable companies promise much higher bandwidth and speed of transmission of information, but satellite systems could provide access to everyone around the world without having to create cable or telephone lines. Dertouzos thinks that there should not be one dominant technology in the creation of the global infrastructure and that everyone using the system should collectively control the content and flow of information through it.[193]

The emergence of the Internet and World Wide Web, and the growing communication infrastructure supporting it, is actually part of a more fundamental global process that has been occurring throughout the world since the beginning of recorded history. The Internet and World Wide Web are part of the ongoing efforts of humanity to weave a web of communication lines around the world.[194]

Stretching back to written messages and documents carried on foot or horseback or by ships sailing across the seas, and continuing through the modern development of the printing press, newspapers and magazines, telegraph, telephone, radio, and modern media, including the TV, satellite systems, and wireless phones, humanity has ever increasingly created a global network of communication systems. In order to understand the significance of the Internet and the World Wide Web, it is important to place these computer technologies in the context of the evolution of communication technology.

Over the last few decades, it has frequently been stated that we are in the midst of a "**communication revolution**". Through advances in communication technologies, we are all being connected together, with access to printed, acoustic, visual, and multi-media sources that bring the latest news and entertainment on demand at ever increasing speeds. Marshall McLuhan, in his highly influential book *Understanding Media*, ushered in the communication revolution and brought it to a new level of self-consciousness.[195] McLuhan introduced the expression "**The Global Village**" to refer to the fact that via the media and global communication systems more and more of us are watching and listening to the same events, movies, music, and news. Increasingly we are all watching each other and talking to each other. Communication technologies have extended our senses, our bodies and our minds; we can "reach out and touch someone" across the seas.

Many technological trends support the emergence of the Global Village. As Moore and Simon note the speed of communication transmission has steadily decreased throughout the last century, and the cost of long distance telephone communication has also plummeted. One hundred fiber optic cables have been laid across the Atlantic Ocean in the last twenty years, connecting the continents and hemispheres of the earth.[196] Early in the 20th Century, the telephone and then the radio and TV quickly spread into most homes in the United States, and though three-quarters of all the telephones in the world are still concentrated in just eight countries, the accelerative spread of telephony has now reached into India and China, with telephones doubling in India alone in the last five years. Global telephonic communication will further accelerate with the introduction in the next couple of decades of language translating telephones.[197] The number of multi-channel TV's has also doubled throughout many countries in Europe and South America in the last five years.[198] With the continued growth of low orbit communication satellites, telephone and TV will become accessible to everyone.[199] Zey reports that there are presently around 800 communication satellites in orbit and within the next decade the number will increase to 2000.[200] Enhancing the availability of global communication access and making the whole communication system more dynamic, has in just one hundred years since its invention, rendered the corded telephone obsolete and seen it replaced by the mobile cellular phone. Cordless phone sales have shot past regular corded phone sales in the United States, and China, which has only recently embraced technological modernization, has also shown a sizeable increase in cellular phone sales.[201] Based on the predicted integration of media and communication technologies, including the telephone and the Internet, within the coming decades more and more people around the world will be able to access the total multi-media interactive global communication system from anywhere on the planet.

Related to this, **wireless mobile communication** is, according to Molitor, one of the five key technological forces transforming telecommunications.[202] He reports that in 1998 there were already 300 million subscribers worldwide and he predicted one billion subscribers by 2002. He sees wireless communication as part of the general trend toward universal communication. The other four key forces, according to Molitor, are: optical transmission, which in lab demonstrations relayed 10 trillion bits of information in one second, satellite communications, broadband digital technologies, and the Internet. These advances are creating a technologically integrated world, and humanity is clearly and inexorably being "assimilated" into it.

We see then that the growth of the Internet and the modern communication technology web is part of the general process of integrating and infusing more intelligence into the world and the environment. I previously described how networking among machines, including computers, automobiles, and appliances within the home, is a significant dimension of the growing intelligent environment. In the present case, networking and intelligence involves the creation of a global communication web that connects innumerable people, organizations, and technologies. It provides a vast system of information gathering and transmission with both senders and receivers in this web empowered by computers. Data and information are collected and compiled across the globe, using innumerable types of technological sensors and monitoring devices, and are then broadcast and directed to individuals and groups for purposes of decision-making, entertainment, and coordination of activities.

The Internet, as part of the global communication network, is transforming the social organization of the world. It is accelerating the development of a global society. Before the Internet, McLuhan had already described the emergence of a "Global Village" supported by the communication technologies of his time. The emergence of a global social system in McLuhan's time though was the result of an historical process of evolving communication technologies stretching back for centuries, if not thousands of years. The Internet has simply further accelerated the evolution of global communication and global human interaction. With the birth of the Internet powered by the modern computer, the amount of information that is being transmitted across nations has skyrocketed. Also, the speed of information transmission across the Internet is almost instantaneous, further enhanced with the introduction of fiber optic cables, satellites, and broadband technologies. The speed at which information can be processed, integrated, summarized, and re-transmitted has also exponentially grown with the steadily increasing power of computers. Supported and empowered by these technological developments, nations are increasingly linking together through the Internet on activities involving trade, business, the environment, world health, diplomacy, and intelligence, to name just a few areas.[203] International corporations are able to coordinate their activities much more effectively than ever before. Dertouzos, in fact, argues that the open access to the world afforded by the Internet, where there is no simple method for controlling boundaries and electronic pathways, will force nations to work together. There is no easy way to remain separate and isolated within an Internet connected world.[204]

The growth of the Internet is also fostering the development of social networks, of "**virtual neighborhoods**" and special interest groups that are geographically spread around the world.[205] Recall Negroponte's discussion of MUDs.[206] These smaller networks within the global network are actually supporting a trend toward increased individuality and individual empowerment, as we contact and interact with other people worldwide who share and reinforce our unique interests, talents, and life issues. The separation of physical space is being transcended. We can become friends or working associates with people in Australia, Japan, or Russia. It is interesting that this evolution of social networks is, to use a term from Alvin Toffler, "de-massifying" human society.[207] By linking together with other people around the world who share our unique interests, we are forming into thousands of different special interest groups, each possessing the power to create a distinctive social and cultural reality.

As Dertouzos notes though, the increasing "electronic proximity" of millions of people, brings together both friends and enemies, and has both positive and negative effects. Inter-connectivity is a double-edged sword. If it is difficult to be isolated, it becomes easier to be spied upon, and easier for both our friends and enemies to invade our computer systems and our lives. Electronic proximity puts our machines more in contact with each other, and fosters in many people more interaction with machines than other people. Nonetheless Dertouzos believes that the vast new access and opportunities for collaboration among people around the world is overall a very positive development created by the Internet.[208]

Still, enhanced communication can produce information and decision overload, too many facts to consider, too many issues to address.[209] As Dertouzos observes, with so many computers in the "Net", there are huge quantities of "Info Junk" being transmitted.[210] At what point do we feel that we are too interconnected with others around us? Cellular phones are always carried with us and with computer terminals in our homes we are always connected to email, work, and the Internet. At what point will we feel too immersed and embedded in this ubiquitous global system of networking and information exchange? If this web of communication keeps growing, how will individual space be preserved in the future? Even if the Internet is enhancing personal empowerment, do humans necessarily require some degree of isolation and separateness? Does too much communication backfire on itself and destroy individuality?

The overall global trend though is clearly toward ongoing (24/7) communicative interaction and integration. Each of us is becoming both a convergent point and a divergent point in the vast global communication system, both sending and receiving data on a continual basis. On the World Wide Web, we are creating our own individualized web sites that can be visited by anyone anywhere in the world. As Negroponte notes, in the future we will create our own personal TV stations.[211] On the receiving end, the TV is always on; the line is always busy; the music is always in our ears. People feel increasingly isolated without their cell phones and pagers activated, or their TVs broadcasting in the background. In the digital age, we feel isolated and out of touch without email. We are becoming nodes in Heim's God-like matrix. We are all increasingly "wired in", to each other and to our machines. It is understandable why futurists like Gregory Stock see this global process of human – machine integration and communication leading to the emergence of a new type of living form, a "global cyborg" that never sleeps.[212] It is equally understandable why critics of modern technology, such as Postman and Naisbitt, see modern humans as "technologically intoxicated" and overly dependent on their machines.

The pervasiveness and intrusiveness of communication and information technologies has generated real concerns over privacy rights and issues of personal surveillance. Pearson predicts that by 2013 there will be biometric records of 75% of the world's population.[213] More generally, he foresees a comprehensive, multi-linked surveillance system developing across the world. Innumerable types of personal statistics, as well as organizational and business statistics, are being collected, processed, and distributed throughout the information web. Further, often based on such data collection processes, we are increasingly barraged with advertisements, inquiries, and solicitations. Not only is this information web gathering increasing amounts of data about all of us, but this information is also being disseminated and integrated throughout the system, harkening back to the "Big Brother" image of *1984* where all citizens were watched and controlled. As I noted above, people may require a certain amount of isolation and separateness for their own psychological health. Does increased monitoring threaten our individuality and our freedom? Shouldn't people and organizations have certain privacy rights? The ever-increasing reach of monitoring and data collection associated with the Internet and other webs of communication and information technology, compromises our privacy rights, our freedom, and our need for isolation.

Dertouzos discusses in depth the challenges and issues associated with privacy and surveillance. Throughout the 20th Century, intelligence gathering and counter-intelligence, empowered with the introduction of computers, developed ever more sophisticated ways of collecting data and preventing the collection of data, in a reciprocal predator and prey evolutionary process. To recall, the first operational computer system was developed by Turing to break the Nazi communication secret codes. Modern cryptography, as science and art, is intimately connected with computer technology. In what amounts to "**information wars**", software programs are continually being created and perfected which promise either fool-proof protective codes to prevent access and surveillance, or programs designed to break through or decode any such fool-proof system. One can imagine numerous situations where it would be justifiable to monitor others, e.g., criminal and terrorists activities. One can just as easily imagine numerous situations where personal or organizational activities should be protected against surveillance. To what degree do people, businesses, and governments have the right to know what is going on in the world? To what degree do individuals and groups have the right to protect themselves against monitoring and surveillance? As Dertouzos states, some balance needs to be achieved, and repeatedly re-negotiated regarding access to information and the right to protect information.[214]

Aside from the Internet entering into our lives and transforming both the environment and the social organization of our world, the Internet is also creating what Carter Henderson calls a "parallel universe".[215] As I described earlier, computers are creating a whole new world of virtual reality. Broadening our perspective to include the Internet and the World Wide Web, the global network of computers is creating the vast labyrinthine universe of "cyberspace". With cyberspace comes a new language "**cyberspeak**".

The variety and number of web sites on the Internet is literally amazing. All types of human activities, interests, and commercial products are represented and advertised on the Web. Henderson reviews a number of these web services and types of sites.[216] First, there is **e-commerce** where the number of customers on the Web keeps growing where despite the fact that "dot.com" companies have been failing left and right. One can literally buy just about anything from anywhere on the Internet, and with the opening of the Net to anyone with a computer and modem, free enterprise and auction mania, as witnessed by the success of eBay, has spread through the general population. Anyone and everyone can sell on the Internet. As Henderson points out, there is lots of "free stuff" on the Web as well. E-entertainment has also exploded. Henderson cites the success of Sims games as one salient example among the innumerable games to be played on the Web.

According to Henderson, there are over 40,000 sex sites and matchmaking services for people of all persuasions and types. There are "experts-on-line" for any conceivable topic and on-line education, encyclopedias, and information lists and records galore. Every organization, institution, and business, both reputable and not so reputable, is putting up a web site. Every significant newspaper, magazine, and journal has an electronic version on the Web. As I have discovered, every topic or area of future studies has an incredible variety of web sites, from ecology and biotechnology and space to spirituality and philosophy.

Although Henderson is correct in calling the Internet a "parallel universe", in that many of the businesses and organizations of our world are "mirrored" on the Web, there are many new types of realities and dimensions and features to the Web that do not exist in the non-Web world. It is to a degree an alternate universe, transcending yet subsuming and coordinating the pre-Internet universe.

One significant an evolving dimension to the Internet that actually reflects a more general trend occurring within communication technology is the movement away from text toward visualization and multi-media as the primary modes of communication. The technology of communication, empowered by the growing power of the computer, is revolutionizing the medium, methods, and forms of information exchange. Beginning with photography in the 19th Century, and continuing with the invention of movies and then the TV in the 20th Century, the technology of visualization and multi-media has increasingly taken center stage as our primary mode of information exchange. No longer do we communicate simply through the written or spoken word. The image, whether through TV, the movies, or the computer screen, has become as powerful as the word. We live in an era of visualizations and we are surrounded and engulfed by screens.[217] As the processing power of computers has grown over the last couple of decades, computer simulations and special effects have become a prominent feature of cinematic productions. As Turkle recounts, though the computer originally developed as a system for storing and manipulating text, it has increasingly become a tool of simulation and multi-media entertainment and interaction. Witness the incredible growth of computer games over the last decade.[218] Multi-media forms of communication, education, and entertainment, e.g., the CD-ROM, the videodisk, and the World Wide Web are quickly evolving in competition with each other.

Consider also the role virtual reality could eventually play in telecommunications and in particular on the World Wide Web. Virtual reality is the ultimate multi-media interactive electronic reality. We need no longer simply communicate through the word or the picture; we can immerse our friends and associates in personally created multi-media interactive experiences. Although presently limited by transmission speeds in our communication lines and computer reception capacities, increasingly more dramatic and realistic virtual reality displays and web sites will become available on the Web as the power of computer and communication systems grow. The challenge will be to create powerful enough systems to allow for quick interactive responses involving the information demands of virtual reality across the Internet that equal the speed of reactions in contemporary computer games. When these technological requirements are met, the term “cyberspace” will become an even more accurate and literal description of the universe of the World Wide Web, for we will be able to enter into a multiplicity of electronically simulated virtual spaces, that will probably even be linked together in various ways, by plugging our headsets and bodysuits via our computer into the Web.

The topics of multi-media communication and virtual reality naturally lead into other related possibilities. Future technology could holographically communicate and place your visual and auditory presence wherever you needed to be. A group of individuals, scattered around the globe, could conduct a virtual meeting where everyone appears as visually present to each other. More far-fetched, what if our computer and communication technology could be interfaced with our brains? As noted earlier, Kurzweil and others have predicted that humans will be able to wire their brains to computers in the coming century. Couple this neuro-technological capacity with more powerful Web transmission lines, and we could send each other our thoughts, images, feelings, and sensations across the Web, and invite others into the mental spaces and image scenes of our minds.[219] As noted earlier, Kurzweil believes that by the end of the 21st Century human minds will be able to experientially participate in each other’s personally created virtual realities.[220]

Taylor and Saarinen suggest in their book on media philosophy, *Imagologies* that our electronic and computer system of communication calls for new strategies, practices, and modes of intelligence.[221] This idea parallels the view of Bugliarello and others, to be described momentarily, that the emerging system of global intelligence on the Internet will require new principles of hyper-intelligent organization. According to Taylor and Saarinen, electronic communication is more interactive, visual, nonlinear, terse, and suggestive than traditional text based communication. How we think is being transformed by our new technological systems of expression and discourse. Since communication is a form of social thinking, it would stand to reason that as communication is transformed, so will thinking be transformed.

William Crossman goes so far as to propose that written text will disappear in the future.[222] Crossman notes that before the beginnings of recorded history, the primary mode of social memory was through oral tradition. With the introduction of written text, the amount of information that could be recorded and passed on to succeeding generations significantly increased and the oral tradition faded as our primary form of social memory. Crossman though believes that the oral tradition will return as the dominant form of social memory with the emergence of talking computers. Computers equipped with Voice-in/Voice-out software (VIVO) will provide answers to all our information inquiries through the spoken word, and as we noted previously, the software technology for high quality speech recognition and speech production is fast becoming a reality.[223] Other futurists, such as Edward Cornish, along with Crossman point out that text language skills, such as reading and writing, are showing an overall decline in younger generations, who have grown up with TV and computer games.[224] Echoing the view of Taylor and Saarinen, Crossman contends that our popular culture is already moving away from the written text as the dominant form of communication, and with the vast advantages computer memory storage has over written textual records, we will increasingly come to depend on computer systems that can respond to us orally as our repository of information and knowledge.

With both the enrichment and transformation of knowledge and information occurring within our computer and Internet systems, we are faced with the challenge of how to organize all the data, multi-media, electronic realities, and ideas. As Heim has noted, the incredible intricacy and complexity of cyberspace and the World Wide Web can be both exhilarating and maddening and disorienting. At the time of this writing, there are 31 million domain names, almost 9 million web sites, and over 2 billion pages on the Web. A million new web sites are added every year.[225] Dertouzos estimates that the Internet is growing at a rate of 100% a year.[226] Within this immense and ever growing universe of the Internet and the World Wide Web, there are numerous on-going efforts to organize the maze of information into some type of global knowledge and data system that hopefully will be manageable and useful for humans and human institutions.

One interesting article on the problems and promises of creating a worldwide information and knowledge system is Steve Steinberg's "Seek and Ye Shall Find (Maybe)".[227] According to Steinberg, "The most popular sites on the Web today are trying to bring order out of chaos in a frantic quest for the ultimate index of all human knowledge." Although attempts to create a fundamental classification system of all human knowledge, like the grand encyclopedias of the Enlightenment, are looked upon today by Postmodernists as impossible or arbitrary (everything being relative to multiple contexts and interpretations), there are numerous efforts on the Web that, for commercial reasons, are attempting something like this old ideal of a comprehensive catalogue. Leading the way in this effort to organize human knowledge are the popular search engines of the World Wide Web, programs that can be accessed through a computer that will conduct a search of the Web for sites containing information on whatever topic is requested.[228]

Yahoo, one of the most popular of these search engines, has developed an ontology or taxonomy of presumably everything, covering millions of sites using thousands of categories arranged in a hierarchical system of classification.[229] (Similar classification systems can be found on most other search engines as well.[230]) But any particular site or document on the Web can be classified under different headings, depending on the theme or idea emphasized by the person or program doing the sorting and cataloguing. (Yahoo uses a team of people to do the sorting and categorizing.) Steinberg notes that this ambiguity in sites shows that all classification systems are subjective, depending on the person doing the classifying. There are always choices regarding what themes or topics to highlight in a site. Yet it could just as easily be concluded that the units of reality (web sites and information sources) are complex and any one item has various defining facets or features. No item of information is a member of one unequivocal class. Knowledge or data cannot be neatly compartmentalized into a set of mutually exclusive discrete elements.

As noted above, the number of sites on the Web is into the millions, and the numbers are growing at over a million new sites per year. How can humans and their computer systems keep up with the information explosion within the World Wide Web? There are, in fact, search engines that do not use humans to classify information. Rather, these search engines use computer programs. A good example of such an automated search engine is *Inktomi*, which as Steinberg describes, indexes every word on the Web using hive computing.[231] Hive computing is where many individual computers are connected together (instead of one big computer), and a task is divided among the multiple computers. Inktomi uses spiders (search programs) that go through the Web and download every new page they locate. The *Alta Vista* (a third popular search engine) spider downloads millions of pages a day in an ongoing attempt to keep up with possible site revisions and developments on the Web.[232] Steinberg reports that leaders in the search engine business believe that we will just have to keep building faster and faster spiders to keep up with the growing amount of information being produced.

Yet, as Steinberg points out, a vast index of key words found in different web sites is not equivalent to an index of key ideas or concepts. For Steinberg, a word index solves the problem of subjectivity, but doesn’t give any meaning or context as a catalogue does. As anyone who has used search engines knows, an ongoing problem with them is that they list numerous sites that contain words used in our search inquiries but have nothing to do with the meaning of the question we are asking. As Dertouzos notes, search engines produce excessive lists of possible relevant sites,[233] even if they are listed in terms of probability estimates of relevancy. Steinberg reviews efforts to develop systems that index by concepts rather than words such as *Architext's Excite System*. Excite uses a self-organizing program system that learns.[234] It indexes **Usenet** groups, so a person can find people talking about the specific topics of interest. Also at the cutting edge of search engines, Steinberg discusses *Oracle,* which uses a context system that has knowledge of grammar and a vast hierarchy of concepts. *Oracle* analyzes a document using this combination of semantic and grammatical knowledge and appears to do very well at classification.[235]

Steinberg discusses the various purposes or functions of **search engines**. Clearly, some type of system is needed for organizing and accessing information on the Internet. As Dertouzos states, given the huge amount of information and the chaotic nature of the Web, search engines are a necessary development.[236] Those search engines that use automated programs to sort and classify information at least offer the possibility of continued organization of all the data and ideas being generated and presented on the Web. Yet Steinberg also notes that these search engines are pathways and opportunities of exploration. Since the engines lead people to various computer sites around the world, they also provide a vehicle for communication and interaction with other people.[237]

Search engines though are not the only way that information is organized and accessed on the Web. Because any web site can link through hypertext to any other web site, there are an incredible array of information web sites, of all sizes, on any particular topic imaginable, that list relevant web sites and link to these sites. These central information sites have the form of neurons, with multiple lines or dendrites branching outward to other sites. As the Web has grown, it has acquired the organization of innumerable convergent-divergent points, like ganglia in a nervous system. Further, web sites of similar topics cluster together through mutual linkages and form "**Rings**" of common themes and areas. As numerous writers have commented, the Web has grown like an organic or living system, with nodes extending and interconnecting into other nodes. The Web, in fact, has a fractal quality, with major ganglia and clusters subdividing into smaller clusters. But the Web is also a network for different sites; clusters link across innumerable lines of connection and association, weaving the whole Web into a synthesis of hierarchical and network elements. This process of the interconnecting and integrating of sites into focal areas of interest is a bottom-up, self-organizing phenomenon occurring in tandem with search engine systems that are attempting to organize the whole Web from the top-down.

The evolution of the Internet and the World Wide Web further helps us to understand the relationship of humanity and technology. Although it might appear that within our contemporary digital age, technology is shaping and directing human psychology and society, given the immense growing power of the Internet and Web, the argument could be made that the reverse is happening as well. The evolution of search engines, information clusters, and the World Wide Web as a whole has been motivated by psychological needs to represent, distribute, and access information in a way that is useful, interesting, and stimulating for humans. What interest would we have in finding ways to classify knowledge and information, except to serve our cognitive and practical needs? We link our web sites to other web sites to establish common points of interest and often a sense of shared purpose. In fact, more fundamentally, it has been human needs, goals, and interest that have motivated the development of computer technology. The computer evolved in order to facilitate and support human efforts in government, the military, scientific research, business, education, and personal management. The general argument could be made that all the recent advances in information and communication technology have evolved to satisfy different emerging social and psychological needs. The needs for calculation, decoding, and simulating human intelligence have stimulated the growth of the computer. The emerging global society has required a global system of communication. The need for asynchronous communication has led to e-mail. Multi-media and virtual reality are developing to address entertainment, educational, and engineering needs and desires. The evolving intelligent environment supports innumerable aspects of our contemporary life style. Human reactions to the information explosion on the Web have led to search engines which catalogue, organize, and access information.

Pointing out the psychological and social causes of computers and the Internet serves to put in perspective, once again, the reciprocal connection of humanity and technology. It is clear that the various needs of humans identified above could not have been satisfied or developed as far as they have without the supporting technologies. Technologies facilitate the evolution of our needs and our goals, and if Postman is correct, technology creates new goals and values. Yet humans create technologies as a way to address existing needs, and they further develop technologies to make them more compatible and useful. Need instigates technology, which in turn instigates and stimulates further needs.

The topics of the Internet, the World Wide Web and the organization of human knowledge lead us into one of the most interesting and strange possibilities within the future evolution of human society. One feature of information and communication technology that is worth emphasizing again is that it is a global system, both in its physical organization and in its functions and concerns. H. G. Wells envisioned the future possibilities of a "**World Brain**" and a "**World Encyclopedia**", in which all human knowledge was integrated and stored in some complex physical mechanism and this storehouse could somehow be made available to the total world population.[238] These visions from Wells are, in fact, being realized in the Internet and the World Wide Web. Information technology, through computers and telecommunications, is creating a global electronic network that not only stretches across the surface of the earth but also increasingly envelops the sky above through communication satellites. The information within this global network is becoming increasingly available to both human organizations and individuals, as the Internet spreads throughout the world. We can access the “World Brain” from our home or office. This global electronic storage system of information provides an extremely vast and intelligent environment in which to work and interact.

But a functional “World Brain” (or “**Global Brain**” as it is also called[239]), requires some type of system of global intelligence. Search engines, which categorize and access information, are a step in this direction, along with the host of software programs and systems that coordinate international finance, economics, business, government, and environmental activities. Yet these systems are first approximations to artificial intelligence systems and agents that will really integrate and functionally use the vast information resources of the Internet and the Web. Such artificial intelligence systems will need to understand meaning and content; their “cognitive processes” will need to have immense processing speed to handle the huge amounts of information at their disposal, and this information will have to be readily and appropriately accessible to the problems these systems will be addressing.[240] Kurzweil’s predictions on the evolution of intelligence, processing speed, and memory storage capacity in computer systems would seem to indicate that many of these requirements for a Global Brain are achievable in the century ahead.[241]

George Bugliarello, in his article "Hyperintelligence: The Next Evolutionary Step" provides another contemporary perspective consistent with the above ideas of Wells and de Chardin.[242] Bugliarello believes that a new level and type of intelligence is emerging within the global electronic network. The network not only involves a symbiosis or synthesis of the computer and the telecommunication system, but also a merging of humans and machines at a global level. The evolving global intelligence of this system involves not only local memory banks and expert systems that can be tapped into for various special purposes, but a variety of monitoring and sensing systems around the world for gathering and distributing global data. This global system of humans and machines can solve problems of a different magnitude than was possible before. As the network is evolving, a whole new set of principles and a whole new language are developing for coordinating it. Peter Drucker has argued that the central challenge we face in the immediate future is managing the vast amount of information being collected and disseminated.[243] Bugliarello is suggesting that a system of management for all this information is emerging within the global network and it is a higher form of intelligence than anything that existed on the earth before. Much work still needs to be done on this management or coordinating system, and Bugliarello suggests that we should use various known principles of brain functioning in designing this global brain. Yet, even if there will emerge interesting parallels between the World Brain and the human brain, there will also probably be significant differences. If the World Brain is of a higher level of intelligence than individual brains, then we should expect some emergent and novel properties within the system.

Jerome Glenn thinks that the future emergence of a global intelligence is so significant and fundamental a change in human history that we should refer to this coming time as the “Post-Information Age”.[244] According to Glenn, a global intelligence will emerge as humans increasingly integrate with technology. In the “Post-Information Age”, the distinction between humans and technology will blur. We will become an integrated whole, a conscious technology. The environment will change from dumb matter to an intelligent partner and the primary economic activity will be the linkage of humans to technology and vice versa. Glenn's ideas are very similar and in fact anticipatory to Stock's Metaman hypothesis.[245]

It stands to reason that in the future a vast array of technicians, planners, and professionals will be needed to maintain, coordinate, and further develop this global intelligence system. This hyper-intelligence will, in essence, manage the world.[246] It is also quite conceivable that the majority of us, following Glenn's suggestion, will find our basic source of employment within the Global Brain. We may also find, as Kurzweil suggests, that humans will increasingly spend their lives within the global intelligence system. But in referring back to the previous discussions regarding the evolution of artificial intelligence beyond the present capacities of humans, we may wonder if humans, as we now understand our species, will be able to work and function within such a global intelligence, even symbiotically. At the very least, we will need to augment our nervous systems and "wire our brains" into the global intelligence net.[247] But as a more dramatic possibility, the emergence of a true global intelligence, or what Kaku calls an "intelligent planet", may be the coming technological singularity that Vinge has predicted, a type of technological intelligence so advanced that humans will not be able to understand it.[248] In that case, humanity will need to transcend its present nature, in some very deep sense, as the transhumanists argue for, if we are to communicate at all with this radically more powerful form of intelligence.

Some futurists, such as Michael Zey, believe that a "Global Brain" will not, or at the very least, should not be allowed to materialize in the future.[249] According to Zey, human individuals, as the creative and self-determining leaders of civilization, should maintain control over the workings of the world, not abdicating their position to some type of collective and technological intelligence. If it were possible for a collective of AI's to gain control of the Web and the Internet infrastructure, as depicted in such science fiction novels as *Hyperion, Neuromancer*, and *A Fire Upon the Deep*, then it is not at all clear whether such a form of trans-human intelligence would want to keep us around. At the very least, their purposes and goals may be indifferent to the well being of humanity.

Yet what is very compelling and riveting about the Internet and World Wide Web is that it is growing, in many ways like a living form, without a centralized human source of command, and its communication, coordinating, and monitoring lines are spreading and infusing into both the world of nature and the world of human society. It is integrating into all aspects of human life, and writers like Stock and Glenn are correct in seeing a growing symbiosis between this technological global net and humans. We may or may not see this techno-human global integration as positive, but it is happening. Based on the ongoing reciprocal development of humanity and technology, the integration is moving both sides into increasing compatibility (the Web serves humans and humans serve the Web more and more so). We are growing together, again like dendrites interconnecting within a worldwide nervous system. If such a process of global intelligence evolution is occurring, then the next obvious question to consider is whether this emerging "Global Brain" will one day "wake up" and coalesce into a "Global or World Mind". Having reviewed the debate on whether a computer, given sufficient processing power, could achieve consciousness, it seems perfectly logical to ask whether a global computer system, engaged in unfathomable massive parallel processing activities, integrated together into a network of coordinated communications, would achieve consciousness. In the last section of this chapter, I address the issue of the evolution of a "World Mind".

The Information Age and Information Society

"To a man with a computer,
everything looks like data."

Neil Postman

"…trying to relax or slow down in America
is like trying to take a nap in a video arcade."

John Naisbitt

Having discussed in depth the various dimensions of information and communication technology and their possible evolution in the future, and considered how these different technologies could affect humans, it is time to put the pieces together and consider the overall impact of these technologies on society, now and into the future. One popular theoretical view regarding the contemporary social transformation is that humanity is moving from an industrial society to an information society. This view is a central point in Alvin Toffler's classic futurist work *The Third Wave*, as well as in his later books, *Power Shift: Knowledge, Wealth, and Violence at the Edge of the Twenty-First Century* and *Creating a New Civilization: The Politics of the Third Wave*.[250] Toffler's ideas on the shift from an industrial to an information society are a good place to begin an examination of this theory of the contemporary transition.

Toffler divides human civilization into three eras or waves of development. The first wave was agricultural civilization. The first human cities developed during the Agricultural Era, but the majority of the world population lived in rural settings and people primarily worked the land from a home base. Supported by the ongoing advances taking place in the physical sciences and physical manufacturing, the second wave of civilization was the Industrial Era. Industrialization first spread across Europe and the United States during the 1700's. People began to move from rural areas to cities to work in factories, and the principles of **standardization**, **specialization**, **synchronization** and **centralization** became fundamental rules and principles in both human life and economic production. Vast material wealth was generated through industrialization and the overall standard of living increased dramatically within industrialized nations.[251] The ideals of secular progress, capitalism, and

Newtonian science became essential themes of Western industrialized society. Democratic nations emerged during this period, often via political revolutions,[252] and a division developed between the secular and the spiritual (the separations of science and religion and church and state). According to Toffler, this second wave of development is still occurring within the Third World (undeveloped countries that up to the 20th Century were primarily still first wave agricultural societies).[253]

The third wave of civilization, the Information Age, is presently emerging and spreading outward from the more advanced technological and industrial areas of the United States, Europe, and East Asia into the rest of the world. According to Toffler, the third wave information society brings with it a new set of ideas, values, and principles of life that in many ways conflict with second wave human society. This conflict of ideologies and behaviors is producing an upheaval in human life. Following an open systems perspective on change, a view that Toffler supports, we live during an era of chaos, as our social system reorganizes into a new civilization. We exist at a transition point between one level of order and a new and more evolved level of order.[254]

For Toffler, the Information Age shifts the economic and technological emphasis from industrial manufacturing to information technology. Further, information, rather than physical goods and products, becomes the central commodity and source of wealth.[255] Jobs are shifting from labor intensive and manufacturing positions to information processing and management professions. More and more professional positions and vocations are **information-based jobs**. According to Daniel Bell, the decisions and actions of businesses and other human organizations are increasingly controlled and directed via complex information processing procedures.[256] But the transition from the industrial to the information era goes way beyond these economic and occupational changes.

Alvin and Heidi Toffler, in "Getting Set for the Coming Millennium", present five general questions to help distinguish Industrial Age from Information Age thinking.[257] They see a contemporary clash occurring between industrial organizations and systems of thought that wish to preserve the past, and Information Age organizations and systems of thought that want to move forward into a different type of social reality. The points raised in these five questions extend into general social philosophies that separate the two eras. They ask:

1) Does an organization resemble a factory? If so, it is still an industrial era system. Information era organizations are moving away from mass production to customization.

2) Does the system of thought massify society? Information era thinking favors individuality. The Third Wave wants to figure out how to make diversity work. The Second Wave wants to return to a mass society.

3) How many eggs are in the organization's basket? Information age organizations attempt to distribute power, rather than concentrate it.

4) Is the organization vertical or virtual? Third Wave businesses subcontract.

5) Does the system of thought empower the home? Industrial society took away family functions. Third Wave society re-empowers, but with diverse families.

In the above questions, Alvin and Heidi Toffler introduce a variety of ideas and themes that pertain to future human society, e.g., individuality, families, and human organizations. They believe that the information revolution permeates all aspects of human life.

Aside from the Tofflers' analysis of the transition from the Industrial to the Information Age, there are numerous other views of this transition. According to Russell Ackoff, Newton's idea that the universe is a machine led humans to try to imitate God by making machines. This scientifically inspired effort led to the Industrial Revolution. Following the analytic and mechanistic philosophy of Newton, work was mechanized by breaking each process down into a set of elementary tasks. This **mechanization of work** led to the modern factory and the assembly line, a regimented sequence of workers and discrete tasks. In turn, this form of work and industry led to the dehumanization of work and the treatment of people as machines.[258]

But in the 20th Century this system began to change. As Ackoff states, corporations began to share control and profits to maximize growth. During Word War II, corporations had to increasingly treat workers as people, not machines. There was considerable labor and humanistic protest against the industrial system. Concurrent with this humanistic revolt, new technologies began to develop that observed, measured, and transmitted information, symbols, and signals. These technologies developed into the computer, which, according to Ackoff, is a logical symbol manipulator. For Ackoff, the properties of these newer technologies resembled the properties of the human mind, involving memory, calculation, and communication functions, more than some type of mechanistic clock. Thus in the later part of the 20th Century, the Information Age was born out of a revolt and rejection of the analytic, mechanistic, and impersonal approach of the Industrial Age.[259] And I should add that with this shift from industrial to information technologies there was a corresponding shift in the technological metaphors used to describe human life and human society.

Daniel Bell's views[260] should also be described, since before Toffler and most other prophets of the Information Age, he correctly anticipated many of the new features of the era. Bell lays out a threefold historical schema of pre-industrial, industrial, and post-industrial society. He identifies five significant dimensions within a society:

1) Economic
2) Occupational
3) Axial principle
4) Future orientation
5) Decision making

For Bell, across the three historical periods, the economic sector has moved from extractive, including farming, mining, and fishing, to the manufacture of goods, and then on to transport, trade, finance, real estate, health, education, research, government and recreation. The occupational sector has moved from farmer, miner and fisherman to semiskilled worker and engineer and finally to professionals and technical scientists. Technology has moved from raw materials to energy to information. The axial principle has moved from traditionalism and land/resource limitation to economic growth and state and private control of investments and now to the centrality and codification of theoretical knowledge as the source of innovation and policy. The time perspective has moved from the past to adaptiveness and projections, and now to the future and forecasting. Decision making and methodology have moved from common sense to empiricism and experimentation, and presently to abstract theory, models, simulations, systems analysis, and the creation of a new intellectual technology.

Bell provides a very thorough and systematic analysis of the historical transitions from the agricultural to the industrial and the information eras. His analysis reinforces and enriches Toffler's views of the developments through the three periods. We can see from Bell's description that the Information Age involves significant transformations throughout all major dimensions of society.

David Snyder, in "The Revolution in the Workplace: What's Happening to Our Jobs?",[261] focuses on the industrial and information revolutions and points out some interesting similarities between the two social transitions. Snyder agrees that we are in the midst of a fundamental social change. He points out, though, that this transition is causing significant problems in the short run. He states that there is an increasing world surplus of workers; there has been a decline in the average US wages since 1973; more young adults are returning home, unable to support themselves on their own; there is continued downsizing occurring in businesses; the two income family is becoming the norm; there is a devolution of labor intensive jobs, and there is a widening disparity of the rich and the poor. Snyder sees all of these changes as the result of a technological and economic revolution, and notes that the same types of events occurred during the Industrial Revolution. Snyder, following an open systems model of change, expects things to go backwards during this significant period of change, involving a necessary element of chaos, before moving forward again. We should keep this point in mind because it would explain some of the confusion and turmoil of our present times, and it helps us to maintain a proper balance in our view of the Information Age. For Snyder, it is not going to be an easy transition, filled with wonders and benefits for everyone, at least not right away. We are in the middle of a revolution.

Peter Drucker, in his book *Post-Capitalist Society*, argues that the main growth industries today are concerned with the production and distribution of knowledge and information.[262] The super-rich of the Industrial Age were steel barons; the super-rich of today are owners of computer hardware and software, communications and high-tech businesses, and consulting firm companies. This shift, in Drucker's mind, constitutes a fundamental change in human society. Drucker prefers the expression "**knowledge society**" to "information society"; for

Drucker, information needs to be organized, interpreted, and applied to create economic growth. Hence, it is knowledge that is generating economic growth. People possess knowledge and people market their knowledge and use knowledge to increase productivity. Knowledge moves information. In the coming era, it is knowledge more than simple information that will matter economically and professionally.

As Drucker notes, and even Kelly presents a similar view, the largest single investment of companies today is in the production and dissemination of knowledge. Most of the cost of any product is in the "thinking it out" phase, e.g., research and marketing. For Drucker, managers have become people who make knowledge productive; in fact, they apply knowledge to make more knowledge. The essence of Drucker's Post-Capitalist society is the maximization of the productivity of knowledge. This is where the money and time are put. And at this point we should recall Bell’s observation that, in the Post-Industrial era, a whole new set of techniques and methodologies have developed around knowledge organization and utilization. Something new is occurring.

There are some writers, however, who question the presumed clear dividing line between the Industrial Age and Information Age. Both Gregory Stock and Kevin Kelly contend that the transition from an industrial to an information society has been going on for the last one to two hundred years. Stock notes that a vast increase in information storage, information coordination, and communication across the world has been occurring in business, commerce, industry, and the economic market since the first half of the 19th Century. To reinforce this point, Robert Wright points out that a global net of communication and information exchange has been evolving across the world for centuries, and the Internet is just the latest technological expression of this trend.[263] Kelly contends that the Information Age began with the development of self-regulating machines that use feedback information to control their output. The governing system of the steam engine ushered in the Information Age. Both Kelly and Stock believe that the transition from industry to information technology is not as abrupt and sudden as Toffler describes it, and has been actually occurring more slowly over the last two centuries.[264]

Michael Zey believes that the theory of the industrial - information transformation is highly misleading. Zey argues that industry and manufacturing have not slowed down; rather they continue to accelerate.[265] At best, we could say that our machines and our industries are becoming more intelligent and requiring greater amounts of information input, storage, and coordination to operate them. In fact, following Kelly's idea of self-regulating machines, our machines increasingly operate themselves through the utilization of information input, feedback, and coordination; they are becoming more robotic and self-governing. The need to physically move and direct the actions of our machines has decreased significantly; they are more automated. In an important sense, machines increasingly move themselves. Following these ideas, the Information Age is not replacing the Industrial Age; rather, a highly intricate and intelligent system of information processing is being embedded into our machines.

The above criticisms of Toffler raise the question of whether the contemporary transformation is cumulative, or whether the changes around us are revolutionary, where the old is being thrown out and replaced by the new. In this case, the truth seems to lie somewhere in between the two views. Evolution involves continuity and discontinuity, aggregation and transformation. Evolution does show significant jumps at times (the **theory of punctuated equilibria**),[266] and knowledge systems, such as in science, also go through holistic and rather sudden transformations as Kuhn has pointed out. Yet, biological evolution also builds upon itself, where simpler life forms aggregate into more complex forms as described by Lynn Margulis in her theory of the origin of nucleated and multi-cellular life,[267] and Robert Wright notes similarly that though old civilizations may pass away, to be replaced by newer ones, many of the elements of the older civilizations are assimilated into the newer ones.[268]

There is unquestionably much that is new to our information society, and many things of the last century have disappeared. There is becoming and passing away. Manual labor and manual devices have been replaced by automated and self-regulating technologies. Computers and robots are increasingly moving into industry and manufacturing. Yet factories, albeit transformed, still exist, and the screwdriver, hammer, and wrench are still necessary tools, at least for the time being. (These common manual tools though are continually being improved through advancing technology and science.) A similar point could be made regarding the agricultural - industrial transition. Industry did not replace agriculture; rather, industry empowered agriculture with machines that made the process much more efficient. Many manual agricultural jobs disappeared and new jobs opened up in industry. Food production is obviously still with us, and, yet now, it is moving to an even higher level of sophistication, as information technology gains control of agricultural machines and operations that evolved during the Industrial Age.[269]

Even if the focus of the Information Age is more on knowledge and information, and even if this new focus brings with it new methodologies, and perhaps even new higher levels of intelligence (AI's and the Global Brain), we should not lose sight of the significance of the material realm within our new age. Recall some of the technological advances discussed in the previous chapter regarding energy, transportation, and super-projects. The material realm (obviously) has not disappeared; in fact, as Zey notes, it has advanced even further.

Consider the ancient dualistic separation of matter and spirit, and its more modern version, the dualism of matter and mind. The Industrial Age could be described as a **materialistic society**. Following Bell's analysis, economics and ways of life focused on the creation, manipulation, and acquisition of physical mechanisms, goods, and artifacts. The Information Age has shifted the emphasis to the creation, manipulation, and acquisition of data and ideas. This shift though has been supported and fostered through the development of a whole new set of physical technologies that facilitate the manipulation and transmission of information. People spend more of their time at work in the realm of ideas, but using information and communication technologies, which direct more efficiently the realm of matter. We gather information and apply our knowledge to the creation, production, and marketing of our products, and we instill in our products more information, automation, intelligence, and complexity. The contrasting futuristic theories of material versus psychological advance miss the point that matter and mind are not distinct realities and are actually reciprocal realities. Mental evolution fuels physical evolution and vice versa. In the contemporary information era, mind is increasingly empowering matter, in part because our advancing material technologies increasingly empower the mind.

The concept of the reciprocal evolution of mind and matter can be applied to Toffler's views on social change. Toffler applies open systems theory to his analysis of the structure and fundamental parts of human society.[270] He distinguishes between a **techno-sphere**, an **info-sphere**, a **psycho-sphere** and a **socio-sphere** in dividing human society into a set of component systems. The techno-sphere is the organized system of technology within society; the info-sphere is the integrated totality of data, ideas, and information across civilization; the psycho-sphere is the highly complex and diverse psychological make-up of people; and the socio-sphere is the integrated set of norms, group behaviors, and other social phenomena existing in our world. All four spheres are highly interactive and they are all continually growing and changing. The spheres are in reciprocal evolution.

All human civilizations have a physical base, the utilized resources and materials and the physical instruments, machines, and technologies powered by the energy derived from the physical base. Long before the beginnings of recorded history, humankind had developed tools and primitive machines and begun to exploit and develop the physical resources of the earth. There is clearly a significant level of technological achievement by the time of the Agricultural Revolution. Industrial civilization though vastly enriched the physical base and techno-sphere of human civilization. Industrial science and technology extended the resource base of the earth, bringing oil and electricity into the picture as useable resources, and technology itself was stimulated and guided in its own accelerative growth by the advances of the Scientific Revolution. During both the Agricultural and Industrial Revolutions, there were also a variety of significant information and psychosocial changes, in part brought about by the technological and physical advances. Settlements emerged, cities and nations formed, organized religion appeared, philosophy, literature, and later science flourished, and the Enlightenment, associated with the Industrial Revolution, brought numerous political, social, and ethical changes.

Presently, however, the info-sphere has been rapidly growing in richness, complexity, and organization. The amount of information, in particular, is increasing at an accelerative rate. This is often referred to as the "**information explosion**". It is literally an explosion for its effects are spreading outward through all the other spheres or systems of human life. This effect is both upward into the psychosocial realms and downward into technology, industry, and our interactions with the physical world. It affects human life and it affects the growth of technology. Yet it is also true that the information explosion is being supported and facilitated reciprocally by a revolution in the techno-sphere, in particular, a revolution in communication and information technologies.

Michael Dertouzos also believes that modern human society is in the midst of a fundamental transformation, an information revolution, and that this revolution is going to impact all aspects of human life.[271] Although there are numerous critics of the philosophy and the human and environmental effects of the Industrial Revolution,[272] as Dertouzos notes the Industrial Age brought with it numerous economic and human benefits. Dertouzos raises the question of whether the information revolution will be as successful as the Industrial Revolution. Will our lives and our personal relationships, as well as government and entertainment improve as promised? Will industrial and economic production improve as predicted? Although futurists such as Toffler see great benefits associated with the Information Age, not all futurists are so optimistic. I have already described some of the general criticisms of technology's impact on society, including those of Postman, Dyson, and Naisbitt, but there are further more focused critiques specific to information technology and its effects. Also, to recall, there are clearly some potential extreme dangers regarding the evolution of computer and robotic intelligence and the future viability of humans. Having discussed some of the theories of the transformation from the Industrial Age to the Information Age, I am now going to focus more closely on the Information Age, and consider both its possible benefits and possible negative effects.

First, let us begin with the concept of **information** and how it has become so closely associated or connected with our present age and the significant changes occurring in our world. We have already noted that over the last fifty years or so, a whole new distinctive set of technologies has emerged, technologies that operate on information rather than physical matter or energy per se. (It should though be kept in mind that these technologies clearly require a physical and energy infrastructure and resource base to support their information processing activities.) What, though, is information, the basic reality that our new technologies store, process, and transmit? At a biological and psychological level, information is something that is received through our senses, processed in our nervous systems, and generated and sent through our muscles. Information tells us something; information re-presents. Information distinguishes among different alternatives or possibilities. Often information is used to mean something new or different, as in "informative" rather than redundant. In fact, in perceptual theory, information is defined as differences or patterns of differences relative to a base rate or norm. Information is form rather than substance, order rather than randomness, and can be embodied in various medium or media. Finally, information can be quantified, and this last insight is the opening key to understanding the connection of information with information technology.

Dertouzos describes **Five Pillars of the Information Age,** connecting the concept and reality of information with the technologies of our age.[273] The Five Pillars are:

1. Numbers can represent information.
2. All numbers can be represented with sequences of 1's and 0's.

3. Computers, which represent information in the form of numbers, transform information (process it) by doing arithmetic on numbers.
4. Communication systems move information by moving numbers.
5. Computers and communication systems combine to form computer networks.

Further, Dertouzos notes that information is both a noun and a verb. Information as a noun is data representations, such as in stored information or transmitted information, but information is also a verb, as in "**information work**", where information is used to operate on information. Doing arithmetic, bookkeeping, writing, and scientific reasoning are examples of information work.[274] Information work though creates more information (the noun), which of course, gives us more information for information work. Because we have developed technologies that can both store and transmit information as a noun, and do information work at levels far exceeding human capacities in many ways (though not in other ways yet), our jobs, our lives, and our world are being enveloped and permeated by a rapidly growing infosphere. There is more information (the noun) and more information work (the verb), and each type of information keeps causing the other type to grow.

Walter Anderson, in considering the Information Age and its effects and implications, presents a variety of valuable additional points regarding the nature of information. He states that information is always incomplete (no matter how much data we collect); information widens choices by identifying more possibilities and opportunities; information is subject to multiple interpretations (no matter how clear and definitive the data); information comes in many forms; people speak different information languages; information leaks and it is almost impossible to destroy it.[275] These qualities of information highlight the dynamic, ever-shifting, and complex nature of information. As Anderson states, in the Information Age, to be informed means to know how to keep learning and to be open-minded, rather than believing in fixed complete answers.

If we combine the ideas of Dertouzos and Anderson, what emerges is a technologically amplified, self-reinforcing and open-ended system or infosphere. Scientific and technological discoveries, ideas, and inventions are emerging at a phenomenally accelerated rate. Computers facilitate this evolutionary process, since they allow for the storage, manipulation, and organization of information. Additionally, computers are allowing for the enhanced monitoring and collection of data, events, and facts from all corners of the world regarding business, demographics, finance, and the environment, among other things. Further, the continued development of telecommunications is generating a global network of information exchange, where all this data and all these ideas are being relayed and transmitted among the different nodes in the information system. But as these nodes become more informed through the exchange of information, there are more ideas and interpretations regarding how to organize and utilize the information. There are more questions to ask, and more data to collect. Information not only reduces ambiguity but also generates new issues. In essence, the explosion of ideas and the sharing of ideas keep generating more and more information. The two processes, of computerization and communication, in fact, are interconnected, for as information increases there is more data to exchange; and as ideas and information are shared and combined, new ideas keep emerging. The information revolution is thus supporting, as well as being fed by, the communication revolution. And following Kurzweil's hypothesized "Law of Accelerating Returns", the infosphere does not achieve closure or completion in this process but actually keeps generating more information at an exponential rate.

Diversity and transience are key features of the Information Age[276], and to a great degree are connected with the information explosion. Within the information society, we exist in a Heraclitian flux. There is an escalating variety of different options and points of view. Additionally, there is a faster rate of turnover of what's "in" and what's passé. The mass media has proliferated into a diversified and individualized array of TV channels, magazines, and information sources. According to Toffler, we live in a "**Blip Culture**" where messages and calls for our attention come fast and furiously from every direction. We keep switching channels and stations and we keep switching careers, lifestyles, and causes. Our philosophy and culture have moved from rigid standards of conformity and hierarchies of command to individualism, increased freedom, and networks of distributed power.

Although industry, commerce, government, and work are increasingly integrated and coordinated via a vast information system, there is also an increasing level of mental chaos being generated by this very same system. The information explosion is blowing us away. We are bombarded and buried by messages, ideas, advertisements, and data. We have to keep relearning and redefining our personal and professional realities, competencies, and responsibilities. We are part of a great network of sharing, sales, and gimmicks. The informational complexity of our lives, defined in terms of more alternatives and more changes, is accelerating. As Gleick notes just about everything is accelerating, as more and more information is compressed into smaller and smaller units of space and time.[277] Everyone is collecting information and distributing it to everyone else. As Dertouzos notes, we are inundated with "**Info-Junk**",[278] filled with data, messages, and ideas that are important, crucial, once in a lifetime deals. "The information highway has no speed limit", to quote Negroponte, but it is a congested maze of infinite possibilities and everybody's personal business. The mail is filled with a thousand ads and offers to improve one's life, and the phones ring indeterminately with calls from telemarketers, who get information on our buying habits and potentials through the innumerable information sources collected on all of us. There is too much information, good and bad and trivial; we are on information overload.

Presumably, all this information and information sharing is good for us, both personally and collectively. Yet how is increasing overload and information density good for us? Perhaps all this information and complexity is the inevitable result of evolution, of Kurzweil's Law of Accelerating Returns. Kurzweil though does note that the evolution of order often leads to integrations and simplifications of disconnected and diverse elements.[279] Further, as Dertouzos points out, people are repelled by too much complexity and prefer a significant degree of simplicity in their lives; one of his main criticisms of present information technology is that it needs to become simpler and more human compatible in its design and operating features. There are, in fact, numerous "voluntary simplicity" movements in our modern world,[280] but even these efforts backfire in ways, for there are many different "simplicity guidelines" for innumerable aspects of life, generating just more lists, and more complexity and choices all over again.[281]

As a general question we may ask, what is the value of all this information? What end does it serve? Dertouzos argues that information has value if it leads to the satisfaction of some human desire or need.[282] We, of course, can simply crave information, as a simple desire to learn or know about some topic, but Dertouzos wishes to emphasize the utilitarian value of information. For him, information is not a final good but a means to an end. One central promise of the Information Age, a promise connected with the value of information and communication technologies, as well as just with information per se, is that information empowers and associated technologies deliver this power. Just as industrial technologies gave us increased power over the world and our lives, making things better for people along many dimensions of life, information technology, and the information and information work it delivers, will presumably help us to improve our lives in many ways. From this perspective, information and information technology, just like industrial technology, is indeed treated as a means to an end. But as I already pointed out, using Dertouzos as one of my sources, technology is not simply a means to an end, but changes and molds the very nature of the human using the technology.[283] The goals and ends of humanity get redefined through technology. The vast quantities of information being delivered to each of us end up changing our very nature and ways of life, and in fact, may become an end in itself. Regardless of whether this deluge of information and corresponding intense frenzy of information work serves any fundamental human need or even helps us feel better about life or ourselves, we dive right into it. The way of life becomes self-reinforcing. In the Information Age, we have become devoted, albeit somewhat mad suppliers and consumers of information.

Referring back to Anderson's comments on the nature of information, there do seem to be certain values associated with it, including expanding choices and keeping the mind flexible and open. An uninformed mind is frozen, impoverished, and closed. Advocates of the value of information technology and the beneficial effects of the emerging Information Age present a variety of arguments regarding why the new technologies and associated changes in human society are on the whole positive. As I have stated and described in some detail already, the effects of information technology and Information Age thinking are permeating through all aspects of human life and human society. I have reviewed the ideas of Negroponte, Toffler, and Bell, among others, who generally support a positive view of the overall effects of the Information Age. One other writer, Michael Dertouzos, whom I have cited already on numerous occasions, is basically optimistic, though also balanced and realistic about the Information Age, and he presents a very comprehensive picture of the present effects and future possibilities, both good and bad, of information technology that should be summarized.

Dertouzos believes that information technology will change our lives along many different dimensions, including entertainment and pleasure, health, learning, business, organizations, and government. Although he acknowledges that currently there are lots of problems and degrees of chaos connected with the emerging technological systems, he also generally believes that there are ways to rectify these difficulties and successfully meet the challenges. To review some critical points already described and add a few new ones, according to Dertouzos, we need better and simpler designs, without feature overload and excessive options, in our systems; we need a better filtering system to control "Info-Junk"; we need systems that do not require excessive learning and constant upgrading; we need software programs and computer systems that are more human compatible and resonant with human thinking and human needs; we need to balance privacy and monitoring-surveillance needs better; and in general we need to address and rectify the de-humanizing effects of our present technologies. Yet, he also thinks that despite de-humanizing effects associated with computer technology, both the personal computer and the World Wide Web have enjoyed such phenomenal growth because people value sharing information and forming communities, and they are quite willing and eager to continue to integrate computer technology into their lives. (Referring back to the previous discussions on the reciprocity of humanity and technology, I should note that this is a psychosocial explanation of technology, emphasizing the directing role of mind over the evolution of physical machines.) Dertouzos also suggests as a general strategy, that future technological development should be guided by certain basic principles. We should ask if a new technological idea is, in fact, technologically feasible, if it is economically feasible, and if the new technology fulfills some human need. Although he believes that the Information Age will transform society as much as previous social-technological revolutions, we need to understand and embrace it (rather than resist and fight it) and intelligently guide it.[284]

Given these general introductory points, Dertouzos predicts the following developments:

- Kitchens will become increasingly automated, including intelligent "cooks" that will prepare meals and even shop for us given our directions, individual tastes, and dietary needs.
- The entire operations of a home will be integrated and coordinated through information technology. All the rooms of the home will become "smart rooms".
- There will be customized publishing for us and tailored news.
- We will have informed automobiles.
- There will be mass individualization, including mass individualized production and reverse advertising.[285]
- There will be increased technologically supported "togetherness" through long distance computer simulations.
- The Web will develop as a network for helping people.

- There will be “home doctors” and health monitoring systems that will go with us everywhere. We will wear miniaturized systems that will also contain health and biological information including our genetic make-up.
- Pleasure and technologically supported sexual activities will be significantly enhanced.

Based on the powers and benefits associated with information technology, Dertouzos foresees the rise of the “**urban villager**”. Presenting a view that is similar in ways to Toffler’s idea of the "electronic cottage",[286] Dertouzos believes that information and communication technology will allow us to move back into rural settings and still stay connected and participatory with the major events and activities of the world. We will live an informed and stimulating urban existence, a benefit associated with the Industrial Age, via our technology, yet also have the peaceful and congenial home environment of rural villagers, a benefit of the Agricultural Age. His hope is that this new type of human existence will tilt more toward the psychological traits of the villager that values community and connectedness, than the traits of the modern urban dweller, who has lost a sense of community and become hardened to the fast paced realities of city life.[287]

Dertouzos believes that there are some things that information technology will not change. There are human constants that we won’t be able to eliminate or get around. As noted above, he thinks that ever-increasing complexity and information overload in our lives won’t work. We need simplicity in our technology and its effects or we will avoid it and not use it. Also, on a related note, he thinks there is a fundamental speed limit to the pace of human life, which people will work toward maintaining. In spite of the predictions of many techno-prophets, he thinks that we will always need human relationships and human contact; we won’t end up communicating primarily with machines or spend all our time in virtual reality. He believes that there are certain primordial “**Forces of the Cave**” – the smells, tastes, feelings, and sensations of human life – that can’t be transmitted across communication lines or simulated in our machines. The need for “**high touch**”, to use an expression of Naisbitt, will continue to be important, especially to balance all the high tech. He also points out that information technology per se does not increase economic productivity; that without the personal skills of quality management, companies do not benefit from more or better technological support. According to Dertouzos, the human element is critical and essential in all aspects of life and technology won’t do away with it.[288]

The “**Information Marketplace**” is perhaps the central theme in Dertouzos’ examination of the Information Age. For Dertouzos the Internet and World Wide Web should be seen as a global marketplace, similar in nature to the open marketplaces of the past, where everybody can buy and sell their products and services and exchange information freely without some central authority. Dertouzos states that science has been exploiting the Information Marketplace of the Internet for years, but others are just getting on the bandwagon in the last decade or so. The Information Marketplace has a variety of advantages, aside from the basic fact that it is global, where the whole world is potentially both the customer for one's products and the supplier of one's specific needs. With the empowerment of advanced technology, one can use visualization, product and market simulation, rapid assembly, and lifetime product monitoring to enhance one's business. (Halal, Kull, and Leffmann predict pervasive computer integrated manufacturing by 2012.[289]) Again, emphasizing the irreducible human dimension in the Information Age, Dertouzos argues that the Information Marketplace must be supported by interpersonal relationships and personal attentiveness.

Dertouzos argues that the growing Information Marketplace is a ubiquitous and powerful force in human society and business. For Dertouzos, any company that ignores its significance and potential effect on business, professions, and employment is planning in ignorance. Although physical goods can obviously be sold through the Information Marketplace, the key new commodity associated with the Information Age is of course information. Joseph Pelton, among many others, points out that the world's gross domestic product depends increasingly on information and information services and less on material products.[290] Dertouzos estimates that approximately 60% of the US Gross National Product (GNP) is information or information work – the Gross National Information Product (GNIP). At a worldwide level, Dertouzos states that information work is 50% of the global industrial economy of 9 trillion dollars.[291]

There are though problems and concerns that Dertouzos raises regarding the Information Marketplace. He thinks that initially it will widen the gap between the rich and the poor, because money and a technologically advanced infrastructure are necessary to be able to use the Information Marketplace. He doesn't believe, as others such as Toffler, that Third World undeveloped nations will be able to jump right from an agricultural economy into the Information Age.[292] If evolution involves a cumulative process of building on previous developments, (and of note, information technology emerged in countries that already were industrialized, having a solid technological foundation to begin with) then Dertouzos does have reason for concern that undeveloped countries and poorer people will have some significant challenges ahead of them before they can take advantage of the Information Marketplace. Still, at least in the United States, according to Centron and Davies, the "digital divide" is disappearing and they predict that computer literacy in urban areas will hit 100% by 2005.[293] Again, though still at a national level, Moore and Simon argue that the computer is not creating a further divide between the rich and the poor, but rather is a democratizing force. The biggest growth market they report for computer sales in the United States is in mid and lower income families, and Internet access has exceeded 50% nationwide. They predict that everyone in the United States will be connected to the Internet by 2007.[294]

Perhaps a more significant problem associated with the Information Marketplace and information technology in general is the impact it is having on job security and professions. Recall Snyder's assessment of the pervasive and unsettling effects of the information revolution on employment. Dertouzos notes that the Information Marketplace will push many people out of work, and although there will be new jobs, many other types of jobs will be lost.[295] Kaku predicts that information technology will kill all middleman and repetitious jobs.[296] Further, industrial jobs will continue to decline. Halal in fact predicts that by 2015 factory jobs will fall below 10% of the workforce in the United States.[297] In general, Centron and Davies argue that job opportunities keep shrinking through automation. As computers, and I might add robots, get better at more and more jobs once done by humans, whole professions will disappear. They predict this trend will actually intensify in the future.[298] Kaku sees certain jobs flourishing in the future, notably in entertainment, software design, science and technology, services, crafts, information services, and the medical – biotechnological professions. Yet we face the strong possibility, as Dertouzos notes, that machines and computers will progressively take over more and more of the work and services.

What is the natural result of this progression? Dertouzos believes we could eventually come to a "**work-free society**".[299] Kurzweil and Moravec have predicted similar scenarios. Moravec, to recall, thinks that intelligent robots will take over all manufacturing and production, and do a much better job than humans ever could.[300] Kurzweil notes that although automation is creating more and better jobs for humans right now, moving us more into the position of "knowledge workers"[301], what happens when the job skills of artificial intelligence exceed humans for all types of professions, including information and knowledge intensive positions?[302] Dertouzos and Moravec suggest that maybe we will live off the revenue of the machines that we will own and in essence give up working all together. Kaku thinks that perhaps a new great divide will develop between the "brain lords" and upper service, who own the machines, understand the technology, and benefit from the immense knowledge the machines can provide, and the "cyberserfs" and the lost people who never made it into the Information Age.[303] But this sounds like a cyberpunk novel.

Dertouzos asks though if we would we trust everything to our machines? Would we want to be idle, to presumably bask in the sunshine and plenty of a world entirely automated to serve our fancies and personal needs?[304] There is no escaping that such a scenario hearkens back to Wells' nightmarish vision of the pampered Eloi in *The Time Machine*, who in essence were "devoured" by the underground workings of technology, anthropomorphized as the Morlock.[305] For Kurzweil, there is no choice in how to deal with this eventual situation. If we can't beat them, then we must join them. Turning our economy, production, and the total workings of our world over to intelligent machines will bring us to a point of extreme dependency, as foretold and imagined in numerous science fiction novels and stories, including *Hyperion*, which I discussed earlier, and such a situation would be untenable, dangerous, and unbearable. Once again we hit a version of the technological singularity, where our machines pass us by, and the only solution, short of pulling the plug, which is undoubtedly impossible, as Kurzweil notes, is to plug in even further, and significantly augment our capabilities with our technologies, as Kurzweil suggests.[306] Thus we face the apparent paradox that although we have continued to work toward making our technologies more compatible with human needs and abilities, and in many cases even created these new technologies to serve human goals, these same technologies will end up threatening to push humans, as we now understand ourselves, out of the equation of life.

Continuing on the topic of employment and jobs in the Information Age, another futurist worth mentioning is Edward Cornish. Cornish provides a succinct overview of the effects of information technology on human society in his article "The Cyber Future: 92 Ways Our Lives Will Change by the Year 2025".[307] Although Cornish describes some of the potential benefits of information technology, he also highlights an important negative theme associated with the Information Age. The theme is uncertainty, and the associated dimensions of insecurity, risk, and instability. In general, Cornish believes that information technology is greatly increasing our powers, a belief many other futurists share, but he also contends that we do not know what to do with this power or how to manage it. Further, the social and cultural effects of information technology will be significant and pervasive, but hard to predict. Still, in agreement with the predictions on employment discussed above, Cornish thinks that information technology will probably deprive many people of jobs and leave them stranded, not knowing what to do. He believes that permanent mass unemployment is a strong possibility as information technology takes over more and more jobs. With so many people stranded without permanent jobs and with an increased emphasis on individuality, the new cyber-society will highly value entrepreneurship – in fact, it will necessitate individual risk-taking.

As a consequence of the information explosion, skills and knowledge will become obsolete at an increased rate, thus generating insecurity and instability, but the Internet will allow people to gain access to tremendous amounts of information and become much better informed than any previous generation of humanity. Still, again introducing the element of uncertainty in the equation, information technology will be used to spread lies, as well as truths and accurate information. The danger in this last fact is that, according to Cornish, people will use computers to make more and more of their decisions. Computers will take over more and more of our mental tasks, and as raised in the previous discussion, should we trust our lives to machines? Information technology will also follow us wherever we go as it becomes increasingly portable and miniaturized.[308] We will continually be exposed to efforts to manipulate us, persuade us, and delude us.

Cornish's comments reinforce the unsettled and transforming nature of the psycho-sphere and the socio-sphere in the Information Age. The era of stable social and employment support systems seems to be disappearing, and in its place people will increasingly have to depend more on their own individual entrepreneurship to survive economically and personally. Yet the Internet and the global communication system though will support increased interaction and exchange among people, in meeting both economic and personal needs. But people need a sense of familiarity and intimacy in their interactions with others. Going out on the Web is a great unknown. No longer part of some stable and intimate lifelong group or organization, as citizens of the age of transience, we are now part of the vast and uncertain "Global Village", attempting to sell our abilities, interests, personalities, philosophies, and creations in cyberspace. As citizens of the World Wide Web, we will have to become entrepreneurs of life.

The futurists described so far, even if they acknowledge different problems and dangers, also see various positive effects associated with the Information Age and information technology. There are though writers who present very strong and unequivocal critiques of information technology and its effects on human society. These critiques highlight problems previously identified, but also add a variety of new ones to the list.

Kirkpatrick Sale in “Shattering, Shriveling, and Shredding” argues that information technology is eliminating lifetime jobs, a point made by Cornish above, and expert computer systems, which presumably were to help people who needed quick, efficient services, are replacing professionals and robbing them of job security. Further, in spite of the presumed increased economic opportunities that information technology is supposed to provide, it is actually increasing the separation of the rich and the poor, and here recall Kaku’s suggestion that a great economic divide of owners of information technology systems and the cyber-knowledgeable and everyone else may develop in the future.[309]

According to the futurist Arnold Brown there are numerous problems associated with information technology including such psychological factors as increased noise pollution, stress, and depression for people immersed within it.[310] Brown observes that many people are becoming too bound to media, labeling them “**mediapeds**”, and that with excessive time spent with media and information technology, people live too vicariously. He also states that information technology is cutting into our free time and threatening our privacy. The invasiveness of information technology is a common criticism, already mentioned, and the issue of diminishing free time connects with the compression and acceleration of life associated with the Information Age.[311] As a general point, Brown believes that we should be much more cautious and critical of new technologies and not embrace them without serious consideration of their effects on human life. Sometimes the anti-technologists are right. Brown calls for a serious and effective process of technology assessment before introducing any new technology into human society, an idea I previously described in my discussion of Dyson, Postman, and Naisbitt and their criticisms of the effects of technology on human life.

In my discussion of Cornish’s ideas on the Information Age, I commented on how the lack of stable, intimate personal and professional relationships, a consequence of our transient, highly fluid modern world, was moving us out onto the World Wide Web and into the Global Village in search of many of the necessities of life. The Internet, in spite of it capacity to connect us, is a big, open arena filled with uncertainties and strangers, and as Dertouzos argues, the “Forces of the Cave” and the need for personal, face-to-face contact, at least at this point in time, cannot be transmitted across the Web. Brown notes that information technology leads to stress and depression, and the negative psychological effects of cyberspace have been supported and confirmed in other studies. In what amounts to another paradoxical effect of information technology, given its capacities and promises, Amy Harmon reports that Internet use is significantly correlated with increased depression and loneliness.[312] Although computer technology and the marvels of virtual reality, multi-media, and vast repositories of information on the Web are presumably supposed to stimulate our minds and our senses, we seem to become emotionally depressed in cyberspace, and although we can reach out and touch people around the world, we find ourselves lonelier. Dertouzos' argument that people need non-technologically mediated personal contact, and Naisbitt's related point that high tech motivates us to seek out high touch seem both confirmed and reinforced in studies of Internet use. A world that focuses too much on technology loses sight of the other half of the equation of reality, the human being.

Michael Marien goes so far as to provide a top ten list of reasons why "the information revolution is bad for us".[313]

1. Information Glut – Generates excessive stress, filled with commercials, and does not provide any practical wisdom.
2. Bad for the Future – Produces a serious decline in future thinking.
3. Bad for Law and Order – Creates the opportunity for cybercrime.
4. Bad for National Security – Allows for the waging of information wars and everyone is vulnerable.
5. Bad for Jobs – Creates excessive unemployment.
6. Bad for the Environment – Keeps the focus off of building a sustainable society.
7. Bad for Democracy – Only promises increased participation in government but local communities are left to centralized control.
8. Bad for Privacy – Creates more monitoring and invasiveness.
9. Bad for the Quality of Life – Increases the pace of life.
10. Bad for the Equality of Nations – Increases the separation of the haves and have not's.

Although many of the above criticisms have already been discussed, it is interesting to note that several of them connect with a loss of futurist thinking, a rather paradoxical effect since information technology is frequently associated with a future oriented approach to life. The reason why information technology generates this effect is undoubtedly connected with the fact that it increases the pace of life, causing people to focus more on the immediate here and now, in a frantic effort to compress more activities into life, and also it allows for a more immediate gratification of needs..[314]

Stewart Brand, who presents a more balanced assessment on the effects of information technology, does note though that the problems associated with information technology are accelerating and putting an increasing strain on our present culture. Although he notes increasing accountability, globalization, grass roots participation and self-organization, and enhanced ecological monitoring as positive consequences of the information technology, he also considers the increasing loss of a clear sense of the future associated with the Information Age. For Brand though this diminishing sense of the future is connected with the increasing rate of change caused by information technology. The future is becoming unthinkable, uncertain and beyond our present capacities for prediction and understanding. Brand's analysis consequently leads us back again to the theme of uncertainty associated with the Information Age, and also to Vinge's technological singularity, to a point in time fast approaching when our technologies will accelerate into a new reality that is incomprehensible to us.[315]

Perhaps we are being led down the garden path toward a destination that we do not understand. Deborah Sawyer, in fact, invokes the metaphor of the "Pied Piper" in her critique of information technology arguing that in spite of all the promises and hype, the enticing songs of the techno "Pied Piper", there are numerous problems being created due to the Internet and the World Wide Web.[316] She notes that although there is more access to information there is less sharing. Further, although the quantity of available information has increased, the quality of information has declined (since of course anybody can put anything on the Web). The concentration of reliable information has become limited to fewer organizations. The Internet, instead of opening people to each other, has increased the barriers between people, a phenomenon undoubtedly connected with our increased isolation within our technological cubbyholes, and consequent loneliness. Through search engines and readily accessible web sites, we rely too much on immediately finding information on the Web instead of sustained research and exploration. This change again illustrates our excessive focus on the present need for immediate gratification. More generally, as members of the "Blip Culture" our attention span is suffering and Gleick goes so far as to suggest that as a society we are suffering from a generalized case of attention deficit disorder.[317] Sawyer also notes a decrease in courtesy (consider "flaming"), and social skills, and an increase in dishonesty, producing unreliability and uncertainty regarding information and communications on the Internet. Finally, Sawyer argues that the Internet and World Wide Web are producing an overall decline in cognitive skills. It is easier to plagiarize and use the World Wide Web to provide all the answers; know-how is disappearing.

On a related note, both Hazel Henderson and Robert Theobald are critical of the obsessive emphasis placed on information and information productivity in the Information Age.[318] They point out that we are becoming overly concerned with the sheer volume of data being created. Henderson presents an "**information quality scale**", progressing from bits and data at the bottom of the scale, and moving upward to assumptions and models, worldviews and paradigms, goals and purposes, and finally visions and values at the top. According to Henderson, not all information is created equal and we need to be become more concerned about quality than simply quantity. For Theobald, our obsession with more and more information and knowledge reflects our basic Western need to keep acquiring more and more possessions, and our compulsion for continued growth. Theobald states that we need to cultivate a philosophy of "enoughness". We should remove the clutter and overload around us, deciding what is important, based on values and priorities, and eliminating the compulsive drive to keep moving forward with something more. We should work against the cultivation and expansion of needs. Henderson thinks that the obsession with continued growth and the selling and marketing of information reflect an Industrial Age economic philosophy. Although in some ways the Information Age may be significantly different than the Industrial Age, for Henderson and Theobald, in other ways it is just more of the same thing.

Expanding on these criticisms of Information Age philosophy and practice, both Henderson and Theobald wish to emphasize the need for human emotion and humanistic vision in our thinking about tomorrow. Supporting this point, it seems to me that Information Age thinking is too cognitive and rational in its view of tomorrow. The term "information", in fact, is a cognitive term. But how do emotions and the human heart play into the equation for tomorrow? Theobald calls for an "**Age of Compassion**" and Henderson wishes to make the rallying cry for tomorrow more cosmic, visual, and organic; she prefers the expressions "**The Solar Age**" and "**The Age of Light**" which carry different connotations than the words "data" and "information". An inspiring and psychologically satisfying image of tomorrow must address both the mind (thinking and knowledge) and the heart (emotion and value). The Industrial Age, with its mechanized view of reality and humanity, clearly missed this dimension of human existence, and romantics, humanists, and spiritualists were highly critical of the Industrial world.[319] In following Henderson on this point, one of the failings of the Industrial Age that has lead to its collapse was its dehumanizing philosophy.[320] The question is whether Information Age philosophy is much different.

Are not visions, images, human emotions, and inspirational stories, songs, and symbols just as real and powerful as forms and patterns of information? Our minds play host to both ideas and melodies of the heart. An Information Age theorist could reply that such emotional elements are units of information as well, and there is truth in this response. Emotions inform.[321] Yet, we could reciprocally say that ideas and units of information are not empty of affect and feeling. Does the human ever entertain a thought without an accompanying feeling or a feeling without an accompanying thought? Can the emotional and cognitive be separated? If not, then to emphasize one dimension of human existence to the exclusion of the other is unrealistic, misleading, and ultimately destructive to human society.

Neil Postman, whom I have already discussed regarding his general criticisms of a society ruled by technology, a "technopoly" as he calls it, also provides a rather comprehensive critique of computer technology that can serve as a definitive summarization of the problems connected with the effects of information technology on human life and modern society.[322] Postman expresses many of the above criticisms of the Information Age and adds a few of his own. He contends that America (and increasingly more of the world) embraced the computer in a mindless, hurried fashion, and that in this hurried process, the computer has become a "metaphor gone mad", presumably capturing in its essence everything about life and humanity and invading all human activities. Because the computer appeared to be the universal machine with infinite uses, it has been integrated into everything and is used by everyone. As a general image of reality, computer technology and science has re-defined humans as thinking machines and information processors, and re-defined nature as information to be processed. Information technology has subordinated all other human areas of life, and raised the concept of information to metaphysical status and the means and ends of all human creation. We have increasingly relinquished control and responsibility to computers, and although according to Postman, there is no transcendent purpose to “technopoly”, above and beyond its own continuation and evolution, we have equated human progress with technological innovation.

It would be bad enough to raise the computer to a position of Godhead, but this vision of human existence gone mad brings with it innumerable problems and it does not deliver on its promises. The computer creates information glut and chaos, producing a never-ending stream of meaningless and useless trivia. According to Postman, there is no simple and effective way to control information, notwithstanding the call for better filtering devices and technological barriers to invasions into our personal space and privacy, and Americans consequently have developed what he calls an “Anti-Information Deficiency Syndrome” – we cannot block anything out. Further, he contends that more information neither frees us nor stimulates creativity nor brings peace of mind. In support of these last points, I would point out that information overload paralyzes and confuses the human mind and clearly generates increased stress. If the computer accomplishes anything, Postman proposes that it seems to be raising egocentrism to a virtue. For Postman, the computer age emphasis on speed, efficiency, and data as central social values is not the answer to our problems. It would seem that in his mind, such values are to a great degree the cause of many of our contemporary problems.

Memes, Knowledge, the Global Mind, and Beyond

The information explosion is a competitive reality. In the Information Age, ideas compete with each other for power and our attention. This bombardment of information, data, and advertisements is a significant part of the stressful, overloaded nature of our modernized society. The realm of mind is not all unity and harmony, as Plato believed. Rather, the realm of ideas (the infosphere) is filled with conflict, as Hegel believed. Some scientists, beginning with the biologist Richard Dawkins who first proposed the theory,[323] have suggested that the ideas of a society or culture be described as "**memes**", units of information that spread, multiply, and compete with each other for power and dominance.[324] Memes are the units of the Information Age and we are living in the middle of a "meme war." Because of the power and pervasiveness of the communication media, wars are increasingly fought with ideas rather than guns. As Toffler and Dertouzos note, information wars of all kinds, political, economic, cultural, and even military, are emerging all around us.[325]

One strong advocate of the “meme theory” is the contemporary psychologist Mihaly Csikszentmihalyi.[326] According to Csikszentmihalyi, information systems compete and evolve. These information systems should be described as memes. He defines a meme as “any permanent pattern of matter or information produced by an act of human intentionality”. Artifacts, such as statues, books, clocks, and furniture, as well as ideas and data, are memes. Plato believed in an eternal realm of “forms” or “ideas”. Meme theory suggests that ideas and artifacts, as units of information, are natural and temporal realities. They exist within the world of human minds and human society. They change and evolve just like biological systems, competing with each other for bigger niches in the ecology of human minds. Dawkins, the creator of meme theory, had originally drawn an analogy between genes and memes. Genes self-replicate, carry genetic information, and compete in the biological arena. Memes also self-replicate (through humans copying and reproducing them), carry units of cultural information, and compete in the social and mental arenas.[327] Meme theory can be viewed as a way to represent or describe the ontology of the Information Age, a world populated by data, ideas, and patterns of information. In a sense, meme theory is a form of **philosophical idealism**; the world of the Information Age consists of “mental realities”.

Although memes are created by human minds, once created they will begin to affect the human mind and shape it. This feedback upon the human mind illustrates the reciprocity of minds, and ideas and artifacts. We may believe that we can control our thoughts and artifacts, but, in fact, they control us in return. We are too Newtonian about information, ideas, and technology, thinking that we stand above our inventions and simply use what we create to serve our ends. As Postman, Dertouzos, and others have pointed out, technologies shape the goals, needs, and values of the humans that use the technologies.[328] Although humans create ideas, we ponder and consider the implications of our thoughts and communicate our thoughts to each other, and the effects of these cogitations and communications ripple out through the landscapes of our minds, reshaping our psychological make-up. Our ideas move our minds; our artifacts, as the embodiments of our ideas, shape our behavior and lifestyles.

Memes are dynamic and they evolve. Our ideas grow and change; our artifacts go through evolution. Memes evolve because they get energy for reproduction and development from us. They live and thrive within our society and us. We use them and share them and make new, presumably better versions of them continuously. Since memes are in competition with each other, (which idea is the most convincing, which version of a technology is most economical and easy to use) according to Dawkins they go through a process analogous to natural selection. Persuasive ideas spread across minds and cultures; ineffectual ideas become extinct. New better technologies push earlier technologies out of the market. Gregory Stock has argued, in a similar vein, that the total human-technological global system, what he calls Metaman, is continually evolving due to the internal competition of various product versions for each component dimension (transportation, communication, manufacturing, etc.) of the system.[329]

Yet do more evolved memes necessarily benefit humans? Csikszentmihalyi thinks not. Memes compete for our attention and it is their survival that determines their success. Consider tobacco, TV, and automobiles, all very successful memes. Are they beneficial to humans? Csikszentmihalyi notes that memes can become parasites on us, where they take but give back very little. Such memes, in fact, may become more powerful than humans; consider obsessions, addictions, and compulsions regarding our ideas, artifacts, and creations. On the other hand, there are beneficial memes as well. For Csikszentmihalyi, art, literature, science, religious and spiritual symbols, and technological devices are all memes that are often very beneficial to the growth and enrichment of the human mind. Csikszentmihalyi believes that we need to practice "**eumemics**", the selective control of memes determining which get reproduced, based on their relative cost, destructiveness, and benefit to humans.[330]

Given the previous discussions of the positive and negative effects of information technology and the Information Age, Csikszentmihalyi's idea for a discipline of eumemics dovetails with other proposals that technologies need to be assessed before being introduced into human society. Advocates of new technologies though would probably respond that new technologies are thoughtfully assessed before being mass marketed. Critics, in turn, would probably respond that the technologies are assessed for economic gains, rather than overall benefit to society.[331] Yet from an evolutionary standpoint, how are we to decide, before testing an idea, if it is necessarily good for us or bad for us? Further, to attempt to control the creation and spread of ideas sounds like censorship, if not some kind of thought control. Not that we do not already, in various ways, attempt to manage the ideas and technologies offered and presented into the social arena. Throughout all of history, we have attempted to control our creations and their effects upon us. Information wars are basically attempts to control or defeat one set of ideas using another set of ideas; the free market can be seen as one socially approved arena that allows for competition, and wars, among our memes and artifacts. Some futurists, such as Virginia Postrel, would argue that we should not attempt to control the creative production of new ideas and technologies; we should allow our creations to compete and evolve through trial and error, in a process analogous to what Dawkins would describe as the natural selection of memes.[332] This difference of opinion, of assessment versus experimentation, though is just another information war. How much control or freedom should we support in the evolution of our technologies and ideas?

The theory of memes provides a conceptual framework and philosophical ontology for understanding the infosphere and the technosphere of the Information Age. Information, ideas, and artifacts are not passive realities that are simply molded and shaped by humans. They are dynamic realities that interact and compete with each other and direct the lives and actions of their creators. Memes, like living forms, may conflict and compete or they may mutually support each other. Either way, our world is a churning ecosystem of interactive and transforming memes.

The concepts of meme competition and information wars bring into focus a good example of what may be some of the challenges and problems of the future. It would be naive to suppose that the future will be utopian, filled with harmony and tranquility. Even if we solve the problems of today, in the future new challenges, tensions, and difficulties will emerge. The problems of the future will probably be at a different level of reality than those in the past. Can we imagine a world of vast ideological and informational interactions, evolutions, and conflicts? When we envision the future we usually think of technological changes, yet meme theory brings home the point that the future may show the greatest changes at the level of ideas, knowledge, and philosophies. We may be moving into a more “mental reality”, and this reality will probably be much more scintillating and dynamic than the world of physical matter.

In general, as various futurists have argued, information is a dynamic and fluid reality. Given the transformation from paper storage to electronic storage, from the atom to the bit, our physical system of records, data, and history is no longer inert, but interactive.[333] To draw an analogy, information stored in a brain is different from information stored on paper. A brain is continuously processing, reinterpreting, and reorganizing its memories. Electronic and computer storage systems, coupled together with a vast, multi-dimensional communications network, are reorganizing and rearranging data and ideas endlessly. As I stated earlier, the communication and information revolutions are fueling each other. More data instigates more communications among the nodes of the Internet, which in turn stimulates more ideas and the need for further communication. Information in the Information Age does not sit still and it is not a set of segregated elements. Following Anderson’s view of the information system, the infosphere can be viewed as perpetually growing and perpetually incomplete.[334]

For Margaret Wheatley, information also self-organizes as it evolves. As she suggests in *Leadership and the New Science*,[335] social and organizational systems feed on information. Information is a resource that is worked with, combined, and created. This unending churning and mixing of ideas and data generate complexity, contradictions, ambiguities, and chaos. Yet out of this dynamical interaction of information come surprises, syntheses, and new ideas. Because information can be moved and manipulated much faster than physical matter, it creates a much more complex and dynamic level of reality. Information technology speeds up this process of self-organization. Things are moving faster because we are living in a more complex and fluid medium of existence.

Kevin Kelly suggests that as we gained control over matter and energy in the last few centuries, so we will gain control over information in the coming century.[336] New systems of control, order, and organization need to emerge or we will be overpowered and buried in a beehive of data and ideas. Dertouzos and Postman, among others, have pointed out the need to filter and intelligently select and monitor all the incoming information. The promises and possibilities of hyper-intelligence and AI’s, and agents coordinating the Internet and the World Wide Web, are proposals for how to achieve this higher level of organization. But further, lest we lose ourselves in trying to control the information explosion through more technology, what should be our values regarding what constitutes knowledge and human wisdom? It is not enough to be efficient and organized in our dealings with information. As Henderson suggests, we need to cultivate our wisdom, knowledge, and values, and to emphasize quality over quantity. Even if we strive to maintain an open arena for creativity and competition, the Information Age requires an overlay of what Postman refers to as higher or transcendent principles. Even if these principles are in competition with each other, this will give all the information some deeper value and significance.

Drucker sees the management of information as the central challenge in the future for our society.[337] With so much data and so many associated social, political and psychological issues, how are we going to organize, integrate, select, and apply information? How are we going to prioritize what is important? This is an individual challenge to each of us, as well as a social challenge to organizations and institutions. We need ways to deal with the shock, speed, and fluidity of it all. How can we maintain a sense of identity and direction amidst the storm of ideas and data? How are we to remain open and flexible without being pulled apart? Drucker, as I mentioned earlier, argues that in the coming years we need to move from an emphasis on information to an emphasis on knowledge, to create a "knowledge society" that transcends and envelops the Information Age.

Kaku argues that although there is an increasing emphasis on "brain power" in our modern world, there is too much of a concern with applying brainpower to short-term gains.[338] Dertouzos argues for the importance and recognition of "**knowledge capital**" within business, though he does not see any difference in principle between knowledge and information. For him, information becomes knowledge when it is useful.[339] Harlan Cleveland states that information, knowledge, and wisdom, in ascending order of significance, are the world's most important resources. For Cleveland, human minds are resources, and ignorance is something that needs to be eliminated around the world.[340] In general, the concept of knowledge introduces an emphasis on human value and principled organization above and beyond simple information.

The information explosion, the ongoing competition of both beneficial and destructive memes, and the fundamental challenges of prioritizing and managing ideas and information lead to the conclusion that perhaps Drucker is correct in seeing the coming age as fundamentally a knowledge society. We need to move the emphasis beyond information to knowledge. Information cannot be an end in itself. Further, as Postman argues, technology cannot be an end in itself. The total arena of human existence must guide technology. Our survival and sanity may depend upon it. We need to move beyond a simple obsession with data, ideas, and information and find ways to meaningfully organize and utilize this mental reality. We need to include the dimensions of heart, of humanistic values, of quality as opposed to simple quantity. Theories and approaches to the future provide general perspectives for making sense out of the evolving world, giving our helter-skelter life some rhyme and reason. (As Kurt Lewin, the Gestalt psychologist once said, "There is nothing as practical as a good theory.") We not only need to manage our world and organize it, we need to give it quality and value. Hopefully the idea of a knowledge society will entail an age of wisdom as well.

Earlier in this chapter, I examined the idea that a Global Brain was beginning to emerge in the communications network of computers in the world. Such a global intelligence is one suggested approach to bringing order and management to the ever-growing storm and labyrinth of information flow. (Although one of the main causes behind the information explosion is, in fact, the global communications network.) Yet, as I also mentioned earlier, the next logical step in this line of reasoning is to consider whether a **Global Mind** or **Consciousness** could arise out of this global technological intelligence. One early 20th Century writer who has inspired this line of thinking is the French priest, philosopher, and paleontologist Teilhard de Chardin. In his highly influential book *The Phenomenon of Man*, he proposed that a global mind, a **noosphere**, was evolving out of the collective minds of the human species.[341] This apparently far-fetched and metaphysical concept, according to some futurists, is being realized through the global electronic network.[342] Wells, possibly inspired by Chardin, had also suggested this possibility of a World Mind emerging out of the operations of a World Brain.[343] What would such a global mental reality be like? And is it possible?

In order to answer the question of possibility, we need an understanding of why consciousness arises in any type of natural system. What are the necessary and sufficient conditions of consciousness?[344] One argument is simply that a sufficient level of complexity of information processing will generate consciousness. A global intelligence presumably would possess such complexity. Another argument is that consciousness requires a sense of self-identity or self-integration within a system. At the very least, the system must be self-organizing. The Internet, to a degree, seems to possess the rudiments of self-referencing. Within it, various information networks and search engines are emerging that list, define, and organize the information content of the Web. As I noted earlier, the sites on the World Wide Web are becoming like ganglia in a nervous system, integrating information and linking sites together along common themes.

It could be argued that the Internet is progressively coordinating its own activities together, as a self-organizing system, as it also increasingly coordinates the activities of humankind and the world system. If the global technological system is like an evolving nervous system or brain within the earth, communication technology can be seen as the sensors and transmitters within this system. The sensors of the system receive input from transmission nodes in the communication network. But to recall, Negroponte believes that intelligence and control will increase in the receiver end of future communication technologies, where the receiver will more actively control and select its input from the rest of the system. As a general point, each node within the Internet and the communication web will become a sender and receiver, possessing intelligence and selectively organizing both input and output. Through these innumerable integrative nodes, the system is self-organizing its information content and information processing.

Aside from questions of consciousness and self-organization, we could ask whether such a system would possess a mind. Numerous definitions and hypotheses regarding the mind have been proposed throughout the history of philosophy, science, and psychology.[345] Discussions of artificial intelligence have added new elements into this age-old inquiry and dialogue. Although the concept of mind is not identical with consciousness or self-awareness, the human mind, at least, seems to possess both these qualities and more. Intelligence, thought, affect, sensation, personality, and memory are other qualities often associated with a mind, and as we saw in our earlier discussion of robots and computers, all these attributes might arise in a sufficiently complex artificial intelligence. The technological and scientific challenge will be to integrate these different psychological attributes or dimensions of the mind into a coherent and functional whole, as they are within a human mind. Further, the human mind seems to require the physical underpinnings of a brain, and perhaps a physical body as well. In that the hypothesized evolving World Mind has a physical brain, the computer-communications network, and even a body, the earth and all connected technologies under its control and monitoring, there does not appear to be any obvious or *a priori* reason why a World Mind couldn't exist.

Following from Chardin's ideas, and the above points on information coordination, self-referencing, and mental attributes, we could argue that an "integrated mind and consciousness", a World Mind, might arise within humanity. Throughout history, many people have hoped for some type of unity and cooperation arising within our species. Yet, it is not altogether obvious that even the AI's that would support this global system would be "all of one mind".[346] Humans notoriously have not been of one mind or one goal. Still through the enhanced global communication network and the possibility of technologically supported telepathy, a much higher level of human intimacy might develop. Kurzweil has discussed this possibility at length.[347] Technologically supported telepathy would involve direct communication among human brains through electronic interfaces that read and send human thoughts, feelings, images, and sensations. As described earlier, we could create and communicate to each other virtual realities that we could collectively immerse ourselves within. Brains, of course, could also be enhanced through both computer and biological improvements to support the interface between individuals and the global intelligence system. Technologically supported telepathy could even develop between humans and other living forms, e.g., electronically wired dolphins, chimps, and whales could become part of the World Mind. Or more dramatically, the lines of communication might connect human minds embodied with the software and hardware of the Global Brain itself. Going even further with this line of thought, although Chardin saw the noosphere as an earth bound reality, mental and conscious communication and integration could occur across space. Moravec has considered this possibility in his proposal that a dense informational network, supporting intelligence and consciousness, might eventually begin to spread out from the earth through the micro-fabric of space and time.[348]

But on the other side of the coin, one could argue that an integrated mentality for all humanity, although offering a sense of unity, security, and cooperation, would suppress human individuality and freedom. Zey, taking this position, is quite critical both of Chardin's image and the newer technological variations on his vision.[349] Zey uses the example of the Borg, from *Star Trek*, to illustrate how a technologically integrated society, where individual biological units are wired into a collective intelligence, would destroy individuality. In Zey's mind, to recall, the individual is a critical and necessary element in the future evolution of humanity, providing for creativity and innovation. A World Mind would be repressive.

Zey's argument brings us to an important question regarding the nature of a World Mind if such a possibility could be realized. Would there be some type of single sense of self and singular consciousness within this mind, and if so, what would become of the multitude of individual conscious human minds that would participate within it? Kurzweil, Moravec, and various science fiction writers have dealt with this question.[350] Increased connectivity might swamp out singular conscious realities, but the vastly increased complexity of such a mind might allow for both distinctiveness and merging within itself. It is difficult to imagine a conscious arena that is populated simultaneously by multiple conscious minds,[351] but this may be a limitation in our imagination and evolved capacities.

At this point I want to consider the connection between the idea of a World Mind and evolving intelligent environment. The ecological psychologist J.J. Gibson believed that the natural environment should be described in terms of the "**affordances**" it provides for life. An affordance is a use, meaning, or function that an environmental feature has for a living form. For example, the ground affords the opportunity for terrestrial locomotion, trees afford a habitat for arboreal animals, fruit affords nutrition for many herbivorous creatures, and caves afford shelter and concealment for many different animals. In Gibson's mind, the environment is filled with meaningful realities for life, and life evidently requires an environment for survival. In the most general sense, the environment supports or affords the opportunity for life. Now we can ask why it is that the environment seems to match the needs of life so well. One simple answer would be evolution. Life evolved within the environment and the various compatibilities that we see are a consequence of life fitting into or adapting to the different conditions of the environment. Yet, life also alters and manipulates the environment. In essence, the make-up of the environment in many ways becomes dependent on the presence of life.[352] Gibson described this **mutuality of life** and the **environment** as a reciprocity of distinct but interdependent realities.[353]

I would propose that the present evolution of a computerized intelligent environment is a continuation of this interdependent development between life and the environment. In fact, all "artificial" constructions in the world are continuations of this general process. Humans as a form of life are intentionally enhancing the ways in which the environment can support human existence. Since changes made in the environment instigate further adaptations in life, the process of evolution is reciprocal or co-evolutionary. We have created the Internet, yet the Internet is, in turn, moving us into new directions of growth.[354] As I noted earlier, one of the most interesting features of the Internet is that it seems to have a life of its own. As an open system in nature it seems to be evolving in ways that depend on human interaction but aren't totally controlled by humans; there seems to be unpredictable growth within it. Yet these almost "autonomous" developments in the Internet motivate humans into further adaptations. This same back and forth reciprocal co-evolution occurs throughout all of technology. There are innumerable "unintended consequences" to technological developments,[355] sometimes apparently good and sometimes apparently not so good, but humans repeatedly and persistently find ways to deal with these changes, modifying either their own behaviors or the design of the technologies.

Gibson, in his theory of affordances, wished to challenge the Newtonian idea that the physical world was inherently meaningless and indifferent to the presence of life.[356] In the traditional Newtonian perspective, which actually derives from Plato, humans give meaning, purpose, and significance to the world through imposing order and direction on physical nature. For Gibson, the environment is inherently meaningful for life, in fact, the environment supports life. But to recall, the environment is intimately connected to life because life modifies the environment to support it own continued existence. The future evolution of agents, artificial intelligence, human compatible information technologies, a global intelligence and communication system, and virtual reality are all continuations of this meaningful connection between life and the environment. New features are being added into the environment, due to the intelligence of life itself, which further facilitate the evolution of humans. The fact that we are adding increased intelligence into the environment, via technology, is just a continuation of the environment evolving as a meaningful reality for the existence of life.

Specifically, bringing intelligence, human compatibility, and even mind and consciousness into the construction and evolution of our environment and our world is far from being an unnatural activity or fantastic idea. For a variety of reasons, integrating the growing intelligence of the environment into a global system seems to makes sense. Along the way there will certainly be innumerable unintended consequences and negative repercussions, but the overall intent and goals should be guided toward the betterment of humanity. Although there are critics such as Zey who argue that such global realities would suppress or even eliminate the existence of individuality, personal innovation and drive, and creativity in humanity, there are counter-arguments that such global systems would help us to better realize our unique abilities and personalities.[357]

Also, we should ask whether the emergence of a World Brain and World Mind would constitute what Vinge refers to as the "technological singularity" and if so, would this hyper-intelligence and evolved consciousness spell the end of humanity? I think, as I stated earlier, that the technological singularity is clearly connected with the evolution of a World Brain and World Mind, but this imminent development is not necessarily a bad thing for humanity. Neither life nor humanity is a constant.[358] Since the evolution of the environment and life are reciprocal processes, it would clearly seem to follow that human life, as we now understand it, would need to evolve in some significant way to function within a World Brain-World Mind system. This much is clear from previous discussions on the technological singularity. Kurzweil clearly anticipates such an evolutionary jump, technologically enhanced, within the next century.

So far I have used the expression "intelligent environment" to refer to the intentional introduction by humans of human-like or brain-like features into the environment, e.g., memory, information processing, communication, flexibility, human sensitivity, perception, coordinated action, and personification. Yet many ancients believed that nature possessed an inherent intelligence, and as we have seen, one popular view of the future is that there is an intelligent design or purpose to reality, the teleological or destiny view. Yet, as some computer scientists believe, Kurzweil being one notable example, intelligence is a general property of an evolving universe, being connected with the information storage and information processing capacities of the physical universe. This evolving intelligence does not require an intelligent designer behind the scenes directing the universe.[359] As Kurzweil notes, with the successive emergence of life and humanity, the evolution of intelligence within nature has been further accelerated.[360] The reciprocal co-evolution of life and the environment generates a self-reinforcing cycle of higher and higher levels of intelligence within the entire ecological system. The hypothesis of a World Mind is a good illustration of how a global system of intelligence could emerge within our world, especially if we take into account the idea that this system is like an advanced, self-organizing nervous system for the earth. Information technology infuses into nature and nature itself increases in intelligence as a consequence of this integration.

From the previous discussions on the significance of knowledge, information quality and overload, and the importance of affective and humanistic values, it is clear that there are a variety of problems and challenges surrounding the Information Age. In the evolution of a global intelligence and a World Mind, the existing limitations and negative effects of information technology will need to be corrected. A more highly evolved form of intelligence that benefits humanity must possess wisdom, compassion, philosophical vision, and sensitivity. This is a tall order, but since there is no way short of disaster to go backwards, if we are to evolve a conscious and sentient mental ambiance in which we will live our lives, we must move in this more enlightened direction. A huge virtual reality arcade, economically motivated, that alienates us and drives us mad is not the kind of world intelligence we need. Hence, although the evolution of intelligence may be a natural phenomenon, and the further evolution of technology may be inevitable, the capabilities, goals, and values embodied in this system are features, at least to some extent, that are under our purposeful guidance.

Given these considerations, the sky literally may be the limit to how far a World Mind could extend. As Zey notes, Chardin's idea of an earthbound noosphere is too constraining.[361] We might see the emergence of a solar mind, a galactic mind, and even a universal mind. As a conscious technological network infuses itself into the entire cosmos, the universe as a whole could achieve an integrated consciousness. The universe could gain conscious control and total coordination of itself. The idea of a **cosmic mind** has as its necessary parallel the emergence of an **intelligent cosmic environment** that both supports and is created by such a mind. The universe would evolve along pathways that reflect the development of intelligent life. Moravec's notion of re-designing the fabric of the universe, and creating a virtual or simulated hyper-reality within the cosmos, would be one possible way of achieving this end.[362] This possibility of a form of mentality that spans the universe and embodies the cosmos with a reciprocal intelligence brings us to the idea of God.

Instead of assuming that God exists outside the universe, coordinating its creation and development from the beginning of time, a cosmic mind could be seen as evolving within the universe. The evolution of God within the cosmos would involve a progressive mental and conscious integration supported through some type of universal communication network connecting both individual minds, as well as multiple computer systems distributed across space. At the cosmic level, the challenge to be faced would be how to communicate effectively across huge distances. Is it conceivable or possible that the universe as a whole could be in communication? The emergence of a cosmic intelligence and cosmic coordination would require some mode of different communication system than what we presently have, perhaps of the type suggested by Moravec. We might also be able to communicate through some type of quantum entanglement system as described in Stephen Baxter's *Vacuum Diagrams*.[363]

It also seems clear that our present notions of individual minds will undergo significant change within the context of an expansive mind-space that could stretch across the cosmos. Both Kurzweil and Moravec have discussed how individuality could be transformed within a global or solar context of hyper-intelligence.[364] I do not think that a holistic mind would necessarily compromise individuality; in fact, I think that such an evolutionary development, following the logic of Stock, would enhance individuality. Our own present level of individuality is far from ideal and to a significant degree clouded, contradictory, and unfocused. The enhanced coordinated intelligence of the universe that we would live within could conceivably allow for more freedom, clarity, and mental power. For example, within Vernor Vinge's science fiction novel *A Fire Upon the Deep*, an alien species of dog-like creatures achieves a higher level of mental clarity and coherence when they unite as packs in neuro-sensory resonance.[365] Each individual member of the pack functions with a greater sense of direction and purpose when united with its pack members.

Though the idea of a World Mind might seem ominous and threatening to human individuality and human control of the earth, this possible development at a global level could be seen as an evolutionary step toward the creation of the universal or cosmic mind, as well as the continued growth of our own unique personalities and minds. The total process might take millions, if not billions of years to occur, but the journey would be an amazing one, involving an increasing sense of connection, mental clarity, and intimacy undreamed of in our present times. The traditional teleological view of the future sees purpose and design as pre-ordained, yet what if purpose and design within the totality of nature is an evolutionary phenomenon? The future of the cosmos could involve the emergence of a cosmic purpose and intelligence.

Although Frank Tipler, in supporting a strong version of the Anthropic Principle,[366] thinks that the cosmos from the beginning had a pre-determined reality to allow for the emergence of intelligent life[367], he does describe in detail how cosmic consciousness could evolve through technological intelligence spreading out across the universe. Similar to Moravec, he envisions the eventual creation of a vastly enriched virtual reality universe supported by this cosmic technological intelligence. Tipler also considers, as does Moravec, how mind and consciousness could embody itself through different physical medium that would support ever increasing processing speed and information storage, eventually able to support itself through the ultra-energetic and super-hot compressing medium of a collapsing universe. Inspired by Chardin, Tipler identifies this evolving cosmic intelligence with God, the **Omega Point** of the universe. Following a philosophical view similar to Kurzweil, for Tipler, mind is form and the particular physical "body" which supports it is not limited to biological systems. In fact, it is clear that the only way to achieve ultra-high levels of intelligence within a physical system is to move beyond the inherent limitations of current biological forms. Hence, although it might be argued that mind and consciousness could not exist within a computer system, it seems clear that the only way to achieve higher levels of intelligence, and mind and consciousness is, in fact, to move into some type of computer-like entity.

Tipler also imbues his cosmic computer intelligence with all those ethical, wise, and compassionate features that our present computer technology seems to lack, and gives it omniscient knowledge of the universe. Yet, it should be noted that humanity, individually and collectively, often lacks these same higher qualities as well. Though we can identify numerous problems apparently connected with the emergence of information technology, many of the faults of the technological system have human causes. As Dyson has noted, technological developments are often motivated by economic gains and the entertainment needs of the rich. The information overload of the Information Age is definitely connected with human efforts to sell their products, as well as the Industrial Age obsession with quantity and growth over quality and balance. In many ways, the faults of our present age are due to our culture as much as our technology. As John Barlow notes, "It's a Poor Workman Who Blames His Tools".[368]

The Minds of Machines and the Machines of Mind

"Technology is humanity's child
As is our quest for human purpose.
To love them is to love ourselves.
There are no differences.
Only labels.

Michael Dertouzos

In thinking back over this chapter on the Information Age and information technology, we see that there are numerous different perspectives and points of emphasis taken on this topic. I have examined the technological developments and promises of computer and robotic systems, from Babbage and Turing to the creative and mind-expanding efforts of Kurzweil, Brooks, and Moravec. Pearson, Centron and Davies, Kaku, and Halal have provided a variety of technological predictions on how information technology could affect human life in the future. I have looked at Toffler, Bell, Dertouzos, Drucker, and others on the social, economic and psychological aspects of the Information Age, and the transformation from the Industrial Age to the Information Age. Many of the futurists I have discussed, including Kurzweil, Heim, and Moravec, particularly highlight how computer technology will transform human nature. Negroponte, while underscoring the psychological, philosophical, and social aspects of the digital age, also provided an extensive analysis of technological developments, and in particular, the promised growth of an intelligent environment. Zey, Ackoff, and Heim have also contributed both technological and philosophical ideas to the review. Henderson, Postman, Marien, Theobald, and others have added an extensive list of cautionary and critical comments on information growth, information overload, and contributed important ideas on culture, values, wisdom, and knowledge in the Information Age. From a review of these writers and their ideas, it is apparent that the effects of the Information Age include most aspects of human reality, from the materialistic, economic, and technical to the aesthetic, philosophical, and psychological. In fact, futurist considerations of information technology, in particular pertaining to the emerging global intelligence system, lead to the most cosmic and perhaps spiritual of topics.

Throughout this chapter, the themes of evolution and reciprocity are central. Kurzweil bases his theoretical approach to computer intelligence on the principle of evolution, and the related ideas of Moore’s Law and the Law of Accelerating Returns. Moravec and Kurzweil connect the phenomenon of intelligence with evolution, and project a variety of technological developments based on ever growing intelligence in our technological systems. The hypotheses of a World Brain and World Mind are founded on evolutionary thinking, and inspired by the explosive evolutionary growth of the Internet and World Wide Web. The transformation from the Industrial Age to the Information Age is clearly an evolutionary phenomenon, to be understood in terms of open systems theory and the necessary accompaniments of chaos and becoming and passing away. The emergence of virtual reality can be seen as a new level of higher reality, enhanced by the vast future intelligence of a holistic network that could stretch across the cosmos. As a general point, continuing a theme introduced in the previous chapter, technology itself has been repeatedly described as a natural consequence of evolution.

Yet, even if technology and increasing intelligence in our world are natural consequences of evolution, it is also clear that there must necessarily be a prescriptive and purposeful dimension to our evolutionary future. Between our present values and culture and obsession with gadgets, data, thrills, and economic gain, there is much in our current way of life that needs to be changed, but this philosophical shift will constitute another evolutionary development, albeit hopefully a thoughtful one, based on increased wisdom, knowledge, and foresight.

Reciprocity is the critical idea in understanding the evolution of information technology. Right from the beginning, computers were designed to serve the goals and purposes of humans. Throughout their evolution, the question of how to make our computer systems compatible with human needs and abilities is repeatedly posed. Dertouzos and Negroponte, in particular, emphasize this central theme in technological design. The growth of an intelligent environment, virtual reality, and the Internet all derive their significance from interconnecting humans with their machines. We, of course, have become interdependent with our machines, and Kurzweil is correct, I believe, in stating that we are as plugged into them as they are plugged into our energy outlets. The whole computer – communication network is feeding back on the activities and lives of humans, and moving us along in our own evolution. We are in a new economic and social age, in great part driven by a global information and communication system. The intimate and growing reciprocity of humans and computers, initially grounded in efforts to create thinking machines that mimicked fundamental cognitive and communicative functions, underscores the basic fact that computers are the machines of mind, more so than any earlier form of technology. And because of our continued efforts to create artificial intelligences that better approximate and eventually exceed the mental capacities of humans, these machines clearly have burgeoning minds. Eventually, we will mesh together even more so, through bodily implants, intelligence amplification, virtual reality, and a global intelligence system. This is the ultimate reciprocity of humans and computers; we are minds with physical bodies creating physical bodies with minds, and in the future, these two realities will merge into one.

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