Imaginative, Applied, and Virtual Technologies 1

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Abstract

In 1957, Herbert Simon, one of the founding fathers of artificial intelligence (AI) was quoted as saying that we now live in a world where machines can think. Today, almost fifty years later, many of his critics remain unconvinced that this is the case. No one, however, appears to dispute that computer technologies have changed our experience of the world and re-framed many long-standing questions about how machines, mind, and intelligence are related. This paper uses historical and contemporary examples to examine these questions and this transformation. The discussion will focus on four areas: First, I will illustrate that imaginative and applied technologies evolve. Second, I will show that human concerns and technologies inform how we 'do' science. Third, I will demonstrate that technology influences our capacity to think and feel and, finally, I will explore how technologies affect our humanness.

Introduction

In 1957, Herbert Simon, one of the founding fathers of artificial intelligence (AI) was quoted as saying that we now live in a world where machines can think. Today, almost fifty years later, many of his critics remain unconvinced that this is the case. No one, however, appears to dispute that computer technologies have changed our experience of the world and re-framed many long-standing questions about how machines, mind, and intelligence are related. This paper uses historical and contemporary examples to examine these questions and this transformation. The discussion will focus on four areas: First, I will illustrate that imaginative and applied technologies evolve. Second, I will show that human concerns and technologies inform how we 'do' science. Third, I will demonstrate that technology influences our capacity to think and feel and, finally, I will explore how technologies affect our humanness.

The evolution of imaginative and applied technologies

The historical story offers a good starting point for examining these areas, for history illustrates that the organic-mechanical relationship has been multi-faceted and evolutionary. History also shows that technology impacts human values and human communication. For example, if we turn to the seventeenth century, we find people were becoming more familiar with the kinds of mechanical devices produced by engineers, clockmakers, and the makers of automata. These technological advances translated into the community in both imaginative and practical ways. For example, Gottfied Wilhelm Leibniz (1646-1716) explored the possibility of building a machine (a calculus ratiocinator) that could completely formalize all thought if he assigned a number to every concept and Blaise Pascal (1623-1662), developed what has often been called the first adding machine. Much to his dismay he found it was termed a 'mechanical brain'. (Brazier, 1984)

It was also in the seventeenth century that the French mathematician, philosopher, and physiologist, RenŽ Descartes (1596-1650) stated that the animal and human body are automoton. Let me note that what is often overlooked in presenting Descartes mechanical orientation -- commonly called the mind/body problem 2 -- is that this description of the body as an automaton was a key factor in positioning science so that it could study the physical body - - now a 'soulless machine' 3 -- without interference from the Church. The larger point here is that Descartes' work provides an historical touchstone showing that cultures bring mechanistic analogy, philosophic method, and scientific investigation together as they evolve, a point I will return say more about as this paper progresses.
Technologies inform how we 'do' science

Before addressing this point directly, however, I want to demonstrate that technology -- like science -- is involved with the physical and material, but it is also different in quality from science per se and thus plays a different role within our ideation process. For example, if we think in terms of the computer, it is well-documented that the work of Charles Babbage (1791- 1871) has played a key part in computer development and was foundational to the computer revolution of the twentieth century. Babbage, who worked as an inventor, reformer, mathematician, philosopher, scientist, critic, and political economist was also a prolific writer. Probably Babbage is best known for his work on the Analytical Engine, 4 which is a machine that has features very similar to those of a modern general purpose computer.

What is perhaps less well known is that Babbage's interest in this kind of project was spurred on by the error prone reproduction of tables at the time he lived. Some say Babbage wanted to build the Difference and Analytical Engines to address the significant loss of life and commerce resulting from ships going aground due to trusting in the printed numbers (Swade, 1991). Others suggest the navigational dilemma was a political move manufactured by Babbage to get funding for the projects. (Campbell-Kelly & Aspray, 1996). All, however, agree that Babbage wanted to build a mechanistic device that could produce error-free calculations and thus replace the need for the human mind in table complilation, since the mind is so prone to lapses of concentration when engaged with tedious copying and calculation.

Two points are significant here. First, as is well known, Babbage's work is often considered a turning point in the development of computer technology. Second, his focus was on mechanizing a specific kind of problem-solving -- one where a machine would calculate a series of numerical values and then automatically print the results. I want to emphasize that Babbage envisioned a machine with the capacity to do something that went beyond doing the kind of simple arithmetic operations of earlier machines, such as those created by Pascal and Leibniz. Yet, and this is a key point, computers today are more than problem-solving technologies.

To be sure, the practical success of mechanizing human tasks is evident in the computers on our desktops today. The philosophical ramifications of the evolving mind/machine convergence are harder to separate from human concerns as a whole. For example, in the nineteenth and early twentieth centuries we can contrast the mechanical system developed by Herman Hollerith (1859-1929) with the mind/machine view of Alfred Smee (1818-1877). Smee, who was among the first to attempt to close the gap between neurology and the mind, said we could perhaps build intelligent machines - but Smee was emphatic in stating he did not favor any attempts to do so - for religious reasons. 5 On the other hand, Hollerith's focus was concrete and eventually led to the machinery that dramatically cut US census processing time in 1890.

We can also contrast Sigmund Freud's (1856-1939) model of the mind with that of Sir Charles Sherrington. (1857-1952). In this case, the psychiatrist Freud used technology metaphorically, comparing his model of the mind to hydraulic and electromagnetic systems. Sherrington (1857-1952), on the other hand, an English physiologist who won the 1932 Noble Prize for discoveries on the function of neurons, used technology to discuss how the self, the brain, and the community are connected. 6

Probably the most important perspective to consider today, at least when reviewing computers, minds, and machines, is that of Alan Turing (1912-1954). Turing's Imitation Game is premised on the idea that the brain can be reduced to an algorithm and duplicated 'in principle' on a digital computer. Let me emphasize that it is specifically this kind of approach that strikes many technology enthusiasts, who are also AI critics, as being one-dimensional and in the mode of the language/logic Cartesian prototype. In other words, many of these critics see the 'Turing test' as an approach lacking the capacity to model how intelligence is embodied and, by extension, how computers inform our lives and thus change our cognitive abilities as we use them. Some critics suggest the very premises that are the foundation of this approach negate brain plasticity and how each mind changes while interacting with other minds on an ongoing basis. Others say the imitation game infers intelligence can be limited to something that is computational - in a mechanical way. This, according to the critics of AI, simply negates that the vitality of a human mind is a part of a living 'self.' In sum, this mechanical/computational emphasis is seen by critics of AI as one that overlooks how computers have shifted our minds -- by virtue of altering how we relate to machines, human beings, and even the images science produces computationally. This is my next concern.

How technology influences our capacity to think and feel

As I noted earlier, computers have compelled us to re-frame older arguments about the mind and mechanism. More important to this discussion, computers and brain science have shown us that our bodies are not automata and our minds are interactively informed by other people as well as through our environment(s).

One intriguing aspect of this clarifies when we consider scientific imaging. Scientific imaging techniques, such as fMRIs/MRIs, CTs, and PET scans, are only beginning to be developed.

Yet, these images, such as Charles Pelizzari's image, which combines a MRI image of a human head (in white) with a PET scan showing metabolic function, are generated by using computers and quantitative data to map an image of a physical location. A striking feature here is that the information revealed using these technologies can be qualitatively compared to that offered by microscopes and telescopes, innovative technologies of earlier eras. More specifically, like these older technologies, scientific imaging technologies have helped us extend our natural vision. They have fostered our understanding of how the brain and our bodies work. These techniques have also allowed us to visually share concrete information about formerly invisible domains.

One intriguing development spurred by this ability to capture pictures of the working brain is how consciousness theorists have used these images. For example, some, like the Churchlands, have combined scientific imaging techniques with artificial intelligence to erode the logic/language prototype of how the mind works. (Churchland, 1996; Churchland & Sejnowski, 1994). This area of study, like AI itself, has been instrumental in helping us see many of our historical ideas and long-standing preconceptions about the mind were simply wrong. AI has also clearly shown how difficult it is to replicate the complexity of the mind and its functions. Moreover, incongruent results have inferred that many different kinds of models may be 'correct' to some degree (for example neural networks and symbolic systems) and, thus, the real challenge might be in seeing how approaches that now appear to diverge are in fact related. 7

In other words, despite the visual connectedness we find in a graphic like this one, bringing various perspectives together is not a straightforward problem -- for we are invariably find we are dealing with different types of systems, as this graphic also shows! For example, while initially it had been thought that computers would help solve memory-type problems, this assumption failed to account for the complexity of what we unknowingly do with our minds. Computers have also illustrated that there IS a difference between human and computer pattern recognition and association, for these kinds of skills continue to baffle computers and are, nonetheless, activities that are key to human thought and human living. What I want to emphasize is that while computers are improving their 'skills,' humans continue to take the kind of parallel thinking process these kinds of ideas include for granted. We analyze and act so quickly that we are not even aware of how fast are minds are functioning.

What is more important to perceive, especially if we are to surmount some of the limitations within the Cartesian model -- is that AI research has had some measure of difficulty defining changes that come about interactively. This is a problem that cannot be philosophically skirted, for interaction is a critical component of our lives. It has been a factor in the emergence of the computer, and it is an area that shows how amorphous the issues really are.

The tangibility of this amorphous quality can easily be represented by looking at images such as chaotic attractors and fractals. Images like fractals are similar to those produced by the scientific imaging techniques described above in that they use the computer to model quantitative data. The fractal-like image, however, differs from the one of the brain discussed earlier by virtue of being an image that is strictly a simulation of information rather than a picture of physical reality. This suggests that to simply speak of things that are natural as compared to some kind of artificial reality is not a comprehensive approach. In our lives today, it seems more useful to speak about the mind and machines in terms of some kind of ongoing exploration -- an exploration that includes our physicality.

This kind of contextual orientation leads me to propose that we carefully analyze computer technology in terms of science -- as well as in terms of the culture as a whole. For example, we must account for how we interact with virtual reality and computers in general.

Elizabeth Goldring is a Fellow at MIT's Center for Advanced Visual Studies. Her work offers an excellent example of how computers are being used interactively. Goldring is attempting to build video environments for people with little or no eyesight. She uses a device called a Scanning Laser Ophtalmoscope (SLO), which was invented by her collaborator Robert Webb, a Senior Scientist at the Schepens Eye Research Institute, Harvard University. 8

Goldring, who was first introduced to the SLO as a patient, found that the machine allowed her to see an identifiable image for the first time in two years. After this experience she experimented with finding ways that will allow people who are visually challenged to see images. The eye here is one of her images. What I want to stress is that Goldring is able to do this kind of work because advances in brain science and imaging techniques have made synthetic seeing a near-reality. (Goldring, 1997). More important, the visually challenged can gain much from efforts that allow them to see, since our visual sense atrophies from disuse.

Since 1991, I have been experimenting with 'retinal poetry' for people who are visually challenged, with a device called a Scanning Laser Optalmoscope (SLO). With this device I am on the brink of being able to create interactive environments for people with little of no eyesight. Eventually this work could lead to visual communication over the Internet for people normally isolated from visual communication. . . . Advances in brain science and seeing technology make synthetic seeing a near-reality. . . . most people who are now blind or almost blind could theoretically see something, when using these laboratory technologies. The problem is how to make synthetic seeing an accessible, useful and enjoyable option for millions of visually challenged people worldwide. (Goldring, 1997)

Char Davies, the Director of Visual Research at Softimage in Montreal, Canada offers another good example of computer interactions. She has created an award-winning program called Osmose. According to SoftImage documentation, Osmose is a fully-immersive and interactive virtual environment which uses stereoscopic computer graphics, a head-mounted display, real-time motion capture, and live video projection. Its setting is a series of virtual worlds in which the user explores and becomes a part of: a fog, a forest, a clearing, a pond, a leaf, or can journey inside the ground, into an abyss, and finally into a world of digital figures and lines of code. 9

Many immersant reactions speak about this kind of experience as a profound one. In fact, while watching a fifteen-minute video on Osmose, complete with immersant testimonials, I was astounded at the degree to which people spoke of being transformed. Because of this exhilarating effect visits are limited to fifteen minutes. 10 I have included OSMOSE in this discussion to stress that interactive computer programs have the capacity to influence and manipulate our minds

How technology impacts our humanness

This ability to manipulate our minds brings me to ask how technology impacts our humanness, my final point. As I have shown, computer technologies have entered all areas of our lives and have generated a wide range of responses. These responses, like historical mind/machine convergences, have informed science, our metaphysical ideas, art, and religious traditions. Given this, it seems accurate to say that imaginative, applied, and virtual technologies are connected today.

The interactive nature of this is why I am want to suggest we ask how computers define relationships. Stepen Manes, in a review of a Microsoft CD-ROM that simulates a Barney robot, detailed his experience with this newly developed toy designed to be a playmate for children watching Barney on television by saying this robot "generally behaves like an uninhibited 3-year old" and the simulation is so life-like that "at the end of the tape . . . my polite purple pal says, 'Thank you for watching TV with me.' As Manes notes, and I would agree, "Having our own private Barney comment on the antics of the public Barney on the screen takes television to a new level of self-referentiality." 11 (Manes, 1997).

This innovation is not unprecedented or unforeseen, as the ELIZA program developed at MIT by Joseph Weizenbaum in the 1960s and Richard Powers novel Galenta 2.2 show. The ELIZA program, named after Eliza Doolittle of Pygmalion fame, was meant to pattern a therapist encouraging patients to talk about their problems. Yet, while the program 'worked', it clearly had little understanding of the problems 'discussed.' The uncanny aspect of this was that ELIZA could induce an illusion of deep perceptiveness even among people who knew it was merely a program.

Weizenbaum's own secretary, who had watched him work on ELIZA for several months, nevertheless asked him to leave the room on her first 'therapy' session with the program. A well-known Soviet computer scientist tried out a version of ELIZA in the presence of his American hosts in Stanford, and embarrassed them by entering into a deep private discussion with a computer. (Crevier, 1992, p. 137)

The novel Galenta 2.2, on the other hand, offers a picture of two men attempting to train a neural net to pass an MA candidacy exam in literature at a University. Fictionalizing this process allowed the author, Powers, to comment on many human questions about what machine intelligence is. What is most striking here is that the richness of the story compels the reader to ask what thinking and feeling are and how both relate to intelligence. The plot actually leads the reader through this. The reader is encouraged to first reflect on how one of the trainers becomes attached to the computer. Then the reader is challenged to ask why the computer eventually wants to know its name, sex, race, and other pertinent and 'personal' information. Overall the fictionalization poignantly illustrates how difficult it is to divide our intellectual grasp of reality from our actual experience. By being fiction, moreover, it gives each of us a chance to grasp both sides of the equation from a human, rather than a scientific vantage point.

Conclusion

In sum, I have attempted to show that the human mind interfaces with imaginative, applied and virtual technologies on many levels. More specifically, the mind has developed computer technologies and we are now using these new technologies to gain perspective on our minds. These computers -- we have created -- have expanded our reality, re-framed our perspective on historical mind/machine analogies, and have shown that they have the capacity to describe information. Computers have also shown us they can interact with our cognitive, emotive, and conceptual abilities. In addition, computers have shown they can model what appears to be unrelated or inaccessible information relationally. There is a measure of beauty within this, for this exercise of articulating alternative relationships actuality allows us to use information to reach beyond information. Yet, I must emphasize, that how or whether we do this in ways that better our lives depends on us!

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Endnotes:

1 Presented at the Society For The History Of Technology (Shot), 1997 Annual Meeting, Pasadena, California. 16-19 October 1997

2 While the philosophical distinction between mind and body in western thought can be traced to the Greeks, it is in Descartes work where we find the first systematic account of the mind/body relationship. More specifically, "And although I may, or rather, as I will shortly say, although I certainly do possess a body with which I am very closely conjoined; nevertheless, because on the one hand, I have a clear and distinct idea of myself, in as far as I am only a thinking and unextended thing, and as, on the other hand, I possess a distinct idea of body, in as far as it is only an extended and unthinking thing, it is certain that I [that is, my mind by which I am what I am] is entirely and truly distinct from my body, and may exist without it." (Descartes, 1974, p. 165) Social issues may have inclined him toward this view. He was well aware of Galileo's experience. Moreover, his friend Giordano Bruno had been burned at the stake for rejecting many Church tenets. Many say that this climate led Descartes to establish the mind/body relationship in a way that was personal - and in a way that would solidly establishing initial scientific premises from which to study the physical world. Whether or not this was a conscious or non-conscious decision on Descartes' part, the separation of the mind and matter acknowledged the 'realness' of the world in a way that did not take anything away from the Church's spiritual supremacy. By separating the mind (the spirit) from matter scientists were able to freely pursue science and their studies of the material world. The Church, of course, kept the spirit in their domain.

3 "And, as a clock, composed of wheels and counter-weights, observes not the less accurately all the laws of nature when it is ill-made, and points out the hours incorrectly, than when it satisfies the desire of the maker in every respect; so likewise if the body of man be considered as a kind of machine, so made up and composed of bones, nerves, muscles, veins, blood and skin, that although there were in it no mind, it would still exhibit the same motions which it at present manifests involuntarily, and therefore without the aid of the mind [and simply by the dispositions of its organs]" (Descartes, Meditationes, vi)

4 The Difference Engine, an earlier invention, was not a general purpose machine. It could only perform operations by adding numbers in a particular sequence. (Swade, 1991)

5 Smee wrote: "There is nothing to prevent man from forming an elaborate engine, which should work by change of matter [i.e. electricity] . . . but . . . he must, with the Psalmist exclaim, 'Such knowledge is too wonderful and excellent for me.'" (Smee, 1849, p. 200, 221; in Dyson, 1997). This view should be compared with that of Alan Turing. In his famous article "Computing Machinery and Intelligence" Turing wrote, "In attempting to construct such machines we should not be irreverently usurping His power of creating souls, any more than we are in the procreation of children: rather we are, in either case, instruments of His will providing mansions for the souls that He creates." (Turing, 1950, p. 443)

6 We find many examples of his use of technological metaphors in Man on his nature. Speaking of the actual cells of the brain he writes, "if we pursue the simile of the telephone system, are not the mere wires but are the actual exchange; they do the retransmitting. . . . . [But if] it is mind we are searching the brain for, then we are supposing the brain to be more than a telephone-exchange. We are supposing it a telephone-exchange along with the subscribers as well." (Sherrington, 1941, pp. 281- 282)

7 This has been termed the central paradox in AI itself in the sense that we have learned that systems simple enough to be understandable are not complicated enough to behave intelligently and systems that behave intelligently are not simple enough to be understood. (Dyson, 1997, p 182).

8 The machine is intended to serve primarily as a medical/research instrument for diagnosing retinal disease through the visualization of the retina (the back of the eye). People suffering from blinding forms of macular degeneration and proliferative retinopathy are sometimes able to see test pictures projected via laser scanning onto a small remaining healthy portion of retina (often in the peripheral area of the visual field).

9 Davies describes OSMOSE as being about, "our relationship with Nature in its most primary sense. Osmosis: a biological process involving passage from one side of a membrane to another. Osmosis as a metaphor: transcendence of difference through mutual absorption, dissolution of boundaries between inner and outer, inter-mingling of self and world, longing for the Other. Osmose as an artwork seeks to heal the rational Cartesian mind/body subject/object split which has shaped so many of our cultural values, especially toward nature." (in Jones, Fall 1995) Her success is perhaps confirmed by Mark J. Jones' description of his experience in his piece "Char Davies: VR through Osmosis" published in Cyberstage."I don my head-mounted display and the assistant wires my chest and back with interface devices. Osmose is activated and I am transported to a 3-D wireframe grid. "practice," they say, "get used to the space and the interface." I look all around me and grid extends

to infinity in all directions. I inhale and gradually begin to rise; if I lean forward I move forward. Lean back and I move backwards. I'm flying, I am an enigma, I have no physical form, yet I am whole. I am immersant. . . . Where is the edge of this immensity? Deeper I look, faster I go, but still get no relief. Finally, I continue on through, suddenly I am back in paradise. Back in that old tree. I am home." (Jones, Fall 1995)

10 During a recent London engagement, time slots for immersant experiences were gone in less than a week after the booking was announced. It should be noted that Davies recognizes that OSMOSE is not the answer to all social problems. She poses the questions: "is it possible for artists to subvert the technological imperative associated with virtual reality or are such attempts destined to be co-opted?" (Davies, 1997, p. 28)

11 Walter Mossberg, writing in The Wall Street Journal, offers what might be a more thought provoking comment on this 16-inch high purple and fuzzy computer. Mossberg writes, "I really wanted to hate this thing. . . . but as it turns out, I like this toy. . . . Microsoft has created the first really smart toy for little kids I've ever seen. . . . And it won't stop with Barney. The company is already planning a new Actimate product based on another well-known character, still undisclosed, for older kids." (Mossberg, 1997, p. B-1)