Imaging God: Cyborgs, Brain-Machine Interfaces, and a More Human Future

By Gregory R. Peterson

Abstract: Recent developments in the neurosciences have made possible the advent of brain-machine interfaces, potentially altering our understanding of our relationship with technology and even the very meaning of what it is to be human. This article briefly examines some of the recent developments in neuroengineering and considers the ethical implications. Working from Jesus' miracles as well as from a dynamic understanding of the image of God, I argue that the categories of healing and transformation should be employed in thinking through the implications of brain-machine interfaces specifically and neuroengineering generally. Although the vocabulary of the cyborg may represent the newfound freedom that this technology can bring, the category of the face may serve as a reminder of the boundedness of human nature.

Key Terms: brain-machine interface, neuroengineering, image of God, neuroethics, cyborg.

In 1982, Clint Eastwood starred in a movie by the name of *Firefox*. Based on a novel by the same name by Craig Thomas, the film tells the story of a super secret Soviet fighter jet that works on thought commands alone. Eastwood, at what was probably one of the lower points of his career, played an American pilot sent to the Soviet Union to steal the plane and return it to the United States. Only sixteen at the time, I still remember viewing the cold war drama, enjoying the cheesy special effects and pondering whether such a thing could be possible. Could one control an airplane's motion or, more dangerously, fire a missile just by thinking about it? How would that even work? It seemed too incredible to believe.

The idea that devices could simply be controlled by thoughts and that human beings will eventually use neural implants to enhance cognition or to "jack in" to a computer network has long been a staple of science fiction. Recently, however, science fiction has been moving slowly towards science fact. As one dramatic example of this, John Donoghue and colleagues working with Cyberkinetics Neurotechnology Systems, Inc. are working on a brain-machine interface that they hope will eventually allow paralyzed individuals to walk again. Donoghue has successfully connected a device to the motor cortex of the brain of a quadriplegic human volunteer, who is able to successfully move a computer cursor about on a television screen to check his email, change the volume, or to doodle.[1] Donoghue's device, the BrainGate Neural Interface System, connects directly to the part of the brain responsible for controlling the motion of one's own limbs. Over time, subjects learn that willing the operation of a particular limb also activates the computer cursor on the screen, and soon they are able to give commands to the cursor without moving or saying anything at all. The idea that a computer cursor or, indeed, any device can be connected directly to neurons in the brain, bypassing the normal mediating effects of the body, is nothing short of remarkable. Perhaps thought-controlled aircraft are not so incredible after all.

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One sign of a science's maturation is the move from theory to technology. Modern neuroscience is at the beginning of this move, transitioning from simply trying to understand the brain (about which there is still much to discover) to developing applications to either recover what once was lost or to enhance what is already there. What does this transition portend?

For many critics, the development of machine-brain interfaces is but one more sign that we are unwittingly entering into a new era of technological dystopia. Together with ongoing developments in genetic engineering, biotechnology, and nanotechnology, brain-machine interfaces cross an ethical line that should be inviolate. Human dignity is threatened as it never has been before, and this threat is coupled with a societal transformation that will be equally damaging. Rather than ushering in the rosy future imagined by *Star Trek*, we should envision the future conjured by Ridley Scott's movie, *Bladerunner*, or William Gibson's novel, *Neuromancer*, a world ruined by technology and full of despair.

Alongside of these ethical evaluations, another theme is prominent. The development of machine-brain interfaces, it is claimed, stand to change our concept of human nature or even what it is to be human. Indeed, the word human may need to be jettisoned altogether in order to comprehend this new way of thinking. We are not human, but cyborg, or posthuman, or techno-sapiens. Are we?

Answering this question requires a linkage of the ethical and the ontological. Who we are in part determines how we should act. While terms such as *cyborg*, *posthuman*, and *techno-sapiens* have their use, they also can mislead. Indeed, the word *human* is itself full of ambiguity that must be teased out. Are we human now, or is humanity something that we become?

Future Fast Forward

Over the past two decades, research in neuroscience has proceeded at an astonishing pace. When William James published his *Principles of Psychology* in 1890, neuroscience was still in its infancy and the word "neuron" had not yet even been coined. Little more than a century later, we not only have detailed models of how neurons work, but are also able to peer inside the working brain by means of fMRI and other advanced scanning technologies. In 1990, then president George H.W. Bush declared the coming decade as the decade of the brain, and rightly so. Given these advances, it seems little wonder that we are now able to take advantage of them, and there are multiple ways that we can do so. Knowledge of basic brain anatomy and neuron function helps doctors to analyze injuries, diagnose diseases, and provide interventions. Growing knowledge of the role neurotransmitter chemicals such as dopamine and serotonin play has been important in developing theories for a wide range of diseases and conditions, from Parkinson's Disease to depression and drug addiction. This research, in turn, has been suggestive for the development of new pharmaceuticals intended to combat these problems.

In recent years, these approaches have been complemented by the development of brain-machine interfaces that take on a variety of forms, some of which connect more directly to the brain than others. Electroencephalographs might be considered a very early example of such a device, and in the 1960s and 1970s became associated with a variety of biofeedback movements that claimed to cure physical or psychological ills by having subjects learn how to manipulate their brainwaves. Electroencephalographs, however, do not connect directly to the brain, but read brain waves from electrodes placed on the scalp. Similarly, several of the current devices that might be considered brain-machine interfaces act in a similarly indirect fashion, not by being connected directly to the brain but being connected to the nervous system, which in turn is connected to the brain. The most dramatic of these involve the most basic of abilities: to see and to hear.

Cochlear implants have long been in use as a partial cure for deafness. Implanted behind the ear, standard cochlear implants interpret speech patterns in the environment and transform them into electrical impulses that stimulate the auditory nerve which connects in turn to the brain. Under development is an implant that would connect directly to the brain. These new implants would function essentially as an artificial ear, a direct but machine-based connection to the environment. Similar developments are in the works for vision as researchers endeavor to create a bionic eye for those who suffer from loss of sight. Bionic eyes typically involve use of a small video camera or computer chip that can receive and then interpret light signals. These devices can then be connected to the optic nerve or even to the visual cortex in the brain. One such device, developed by William Dobelle and known as the "Dobelle eye," mounts a small video camera on a pair of eyeglasses. The camera connects to a computer "fanny pack" mounted on the person's backside, which then interprets the visual information and converts it into signals that are transmitted to electrodes connected directly to the visual cortex of the individual's brain. The image created is a black and white dot matrix, crude but useful enough to read large letters and navigate about in the real world. Presumably, continued refinements will only increase the sophistication of such devices.[2]

As impressive as these developments are, even more dramatic interfaces are in the works. Neuroengineers at a number of labs are working to develop interfaces that not only allow the brain to receive information from the world, but also to act directly on it independently of the physical body. Donoghue's research (mentioned at the beginning of the article) that allows patients to manipulate a computer cursor by thought alone is a prominent example of this.

The next step is to move to manipulating physical objects. Miguel Nicolelis and colleagues at Duke University have already succeeded in doing this with monkeys. As with Donoghue's approach, electrodes are connected to the motor cortex of the brain, which is responsible for movement. The electrodes are then connected to a computer, which interprets the electrical impulses produced by the nerves responsible for controlling the monkey's limbs. Once interpreted, these impulses can then be used to control a robotic arm. In the first stage of research, whenever the monkey moved its own arm, the robotic arm would make a parallel motion. In the next stage, however, the monkeys learn to manipulate the robot arm and, when they do so, stop moving their own arm. In essence, the robotic arm becomes an extension of a monkey's body, even though it is not physically attached. In a dramatic exemplification of this extension of the body, one experiment had a monkey's brain connected to a remote robotic arm at another lab six hundred miles away.[3] When the monkey moved its arm, the robotic arm 600 miles away moved in precisely the same fashion. Because the motor cortex of a monkey is relevantly similar to that of a human being, it will be only a matter of time before this sort of technology is available for human subjects.

From Therapy to Enhancement

The primary aim of this research is therapeutic, to provide normal functioning to those who have lost it or have never had it. Bionic eyes and ears will allow some deaf and blind people to hear and see again. A main goal of research groups such as those of Donoghue and Nicolelis is to provide a cure for paralysis. Understanding how signals of the motor cortex correspond to movement commands in a robotic arm is a first step towards developing a synthetic relay that can connect these brain signals back to the human body, either directly or by radio transmitter, enabling victims of paralysis to once again directly control their own bodies. Alternatively, if an individual has lost a limb, it would be conceivable to connect the relevant motor area of the brain to the artificial limb, allowing it operate like a normal part of the body. While early applications will be crude, there is good reason to suppose that technological progress will improve their performance and extend their application.

Looking ahead fifteen to twenty years, it would not be presumptuous to speculate that neuroengineered devices might play a role in alleviating such conditions as depression, obesity, and chronic pain. Implantible electronic devices are already available for relieving chronic back pain, and forms of electronic stimulation of regions of the brain have already met with some success for relieving forms of depression. One might imagine as well a neural implant designed to interfere with brain signals that register hunger, providing a tool for combating obesity. Although there might well be preferable alternatives to implanting electronic devices in the brain, an inherently risky proposition, these are at least possibilities.

While treatment of obesity can be considered a purely therapeutic intervention, it should be noted that it can also be considered a cosmetic intervention—that is, an enhancement—since obesity carries a social stigma in American society. There is a blurry line between therapy and enhancement, and it is quite possible to think of using neurotechnology to enhance performance, not just to restore normal functioning. Once a bionic eye is developed, for instance, it is not beyond imagination to develop artificial eyes with enhanced visual capability. A hunter might want an eye with long-range, telescopic vision, while a police officer might prefer a bionic eye capable of seeing in the infrared spectrum, allowing night vision.

Even pain relief can be seen as a kind of enhancement for certain professions, especially for sports. Some are already pushing the idea of enhancement and would have us believe that this new era is already underway. In 2002, cybernetics professor Kevin Warwick implanted a computer chip into his arm, allowing the nerve signals transmitted from the arm to the brain and the brain to the arm to be recorded wirelessly to a computer. A professor at the University of Reading and, by his own accounts, the world's first cyborg, Warwick hopes to develop computer-body and mind-machine interfaces for purposes not simply of therapy, but also enhancement.

Scenarios of enhancement envisioned by computer scientists range from the plausible to the extremes of science fiction. It does not take a great deal of imagination to conceive of a day when, for instance, cell phones implanted in the scalp and connected to the ear become fashionable or even a business "must have." MIT's wearable computer project (www.media.mit.edu/wearables/) envisions a future without laptops, where computers are a clothing accessory, with the visual display beamed directly into your eye from a tiny laser mounted on eyeglasses or, perhaps, connected directly to the optic nerve. On the deep end (and one might say quite implausible) end of speculation, inventor Ray Kurzweil imagines a future when our consciousness can be "downloaded" to a computer, allowing us to escape our mortal bodies altogether.[4] On these accounts, the cyborg future is inevitable, as we increasingly embrace and meld with the machines we create.

For Good or Ill?

The issue of therapy and enhancement, and the blur that can occur at the border between the two, is not unique to the area of neuroscience and neuroengineering. Indeed, it occurs in much more familiar form in the arena of genetics and genetic engineering; and has also been raised with psychopharmaceuticals. Psychiatrist Peter Kramer, for instance, has pondered the implications of using psychoactive drugs such as Prozac not to cure illness but to enhance lifestyle options, to change one's personality by use of a pill.[5] Indeed, the difference between using psychoactive pharmaceuticals and brain-machine interfaces may be conceived as quite minimal, for although the means are different, one typically chemical and the other typically employing wire connections, electric signals, and computers, their intent is the same: to alter the activity of the brain by artificial means using the methods and models of contemporary neuroscience. But should we look forward to these developments, or should we fear them?

If applications are limited to therapeutic intervention, it is hard to argue that the research should not be pursued. Curing paralysis would be a great good, restoring some semblance of normality to those who suffer from the condition. To provide sight to the blind recalls the miracles of Jesus and his healing ministry. Because the tragedy is so great in these instances and the numbers affected in terms of total population are so small, employing mind-machine interfaces in these select cases seem not only unproblematic, but even morally required. Neurotechnologies may also be safer than genetic therapies where the two may be used to treat the same condition, as neurotechnologies do not require alterations of basic cells or affect future generations in the way that genetic therapies may be able to.

Widespread use of neurotechnologies, however, may raise a range of ethical fears, some of which are familiar from the debates over genetic engineering, particularly with regard to enhancement. It is not terribly difficult to envision a new kind of rich-poor gap, for instance, between the cyborg haves and have-nots, creating new fault lines. It is also a small step to see the military applications, not least because some of this research already has significant military funding. Advances in military technology are sold to the public of aiding the preservation of soldier's lives in time of war, a principle that has already been exemplified in the past two Gulf Wars. The flip side of such technological advancements, however, is that the new technologies also make it easier to go to war. If, for instance, the American public had anticipated casualties on the level of the Vietnam war (over 60,000 American soldiers dead) rather than the 1991 Gulf War (less than 500 American soldiers dead), it is likely that support for the invasion would never have materialized.

Widespread use of neurotechnologies also conjures in the mind images of a futuristic dystopia, a *Brave New World* type of society where human beings turn bit by bit into machines, where the expressiveness of our frail biological eyes are replaced by the cool gaze of artificial ones, where human beings themselves become commodities, as we compete to keep with the latest technology, the latest version (Jane 5.1) of ourselves. Such a future seems to be one where human dignity is lost, where we become the very machines we created to serve us, where, in the quest for what is better, we end up trading what is precious for that which is less. Indeed, with the explosion of all kinds of personal electronic gadgets, from cell phones to iPods, that age may be already upon us.

The Implications of Being Cyborg

Not everyone, however, sees things in this light. The term *cyborg* is often used to speak of the future blending of body and machine. The term itself comes from an academic paper published by Manfred Clynes and Nathan Kline.[6] In the midst of the space race, Clynes and Kline were concerned with the viability of putting human beings in space for prolonged periods, and suggested that future astronauts may need to be enhanced in order to survive the hardships they would encounter. Since then, the concept has taken on a life of its own, carried on mostly by science-fiction, where cyborgs can conjure both fantasies of power and nightmares of technology run amok, the first exemplified in the campy 1970s television show, the *Six Million Dollar Man*, the latter exemplified by Darth Vader of *Star Wars* fame.

It is only relatively recently that scholars have taken the concept of cyborg seriously. One important source of this literature has been an influential essay by Donna Haraway, who uses the cyborg concept as a symbol for reconfiguring our conceptions of human nature.[7] For Haraway, the concept of cyborg cuts across traditional dualisms and provides a way of reconfiguring our relationships. Cyborgs eliminate clear distinctions between male and female, human and animal, person and machine, while at the same time breaking down totalizing world-views and forcing us towards the ways of knowing that are plural, local, and thoroughly postmodern.

In Haraway's hands, the cyborg concept is as much myth and symbol as it is any concrete reality. Haraway is not concerned with specific body-machine interfaces or the prospects of such technologies becoming widespread, but with the potential for what the concept implies. Other scholars, however, have taken up precisely this task. Andy Clark argues that we already are cyborgs because we are by nature technology-users, and that continuing technological developments will make our embrace of technology more and more intimate.[8] Central to Clark's analysis is a redefinition of the self in a way that breaks down the traditional border between self and environment. For Clark, selfhood is not located in some otherwordly soul, but is the product of ongoing interaction between mind (produced by the activities of the brain), body and environment. Clark argues that memory is a clear exemplification of this, for we remember things not simply by means of our biological endowment (i.e., the areas of the brain that make memory possible), but also by technologies that become, in a sense, part of who we are. We write things down, record phone numbers on our cell phones, and place objects in certain places (the car keys on the telephone desk) to aid in memorization. These things become a part of who we are, and when we lose them, we suffer accordingly.

Conversely, our failing biological memory may be supplemented by aids from the environment. Clark cites a group of Alzheimer's victims who have managed to cope with their disease by rearranging their houses, from prominently displaying pictures of loved ones with name labels attached, to putting utensils in open baskets rather than closed drawers. Clark argues, in essence, that the environment becomes part of their memory system, and so the environment becomes part of who they are.[9]

Technology, in Clark's view, is simply an extension of who we are, not something distinct from us. That is why we are *natural born* cyborgs—technology is so much a part of our being that it cannot be separated from our selves. Mind-machine interfaces are, on Clark's approach, only a difference in degree, not a difference in kind, and so can be embraced without fear.

Although Clark's and Haraway's approaches are very different, they do have at least one thing in common, the rejection of strong limits on human nature and an emphasis on its malleability and constructed character. The reasons for this are somewhat different. Haraway embraces the cyborg precisely because it defies the limits imposed on human natures by intellectual agendas that, on her analysis, have been historically oppressive to women and minorities. Clark cites studies that emphasize the plasticity of the human brain and rejects overly strong limitations on human nature implied by evolutionary psychologists. Clark speaks of our *chameleon* minds, ever ready and ever able to adapt to new situations and new environments.[10] Being cyborg means being embodied, but it also means that our bodies our not limited to the narrowly biological. Being cyborg means that human nature is unshackled in a way that has previously not been conceived, allowing us to explore realities and communities that are yet to be.

A Theology of Cyborg Grace?

The ministry of Jesus was both a ministry of healing and a ministry of transformation. Jesus restores sight to the blind, lifts the paralyzed off their beds, and even raises the dead. But the ministry of Jesus was not solely a ministry of healing, a restoring of that which had been lost; it was also a ministry of transformation. The miracles of healing are performed not simply for their own sake, but also because they are signs (*semeion*) of the coming kingdom of God. Jesus' Sermon on the Mount transvalues the commandments of the Pentateuch, calls the pharisee Nicodemus to be "born again," and challenges the traditional view that the rich are blessed and the poor are cursed. This call to transformation is ultimately symbolized in the promise of resurrection, a resurrection that is not worked out by our own endeavors, but which is promised by God out of God's grace.

In the context of grace and promise, of healing and transformation, we may ask the most basic of questions, "what does it mean to be human?" Can there be a theology of cyborg grace? Are the new technologies of the mind and brain to be embraced or feared?

In Christian faith, the locus of human nature and meaning is placed in the symbol of the image of God. A turn of phrase found surprisingly sparingly in scripture, it nevertheless has become the central way of thinking of the place and purpose of humanity in the Christian faith. To be in the image of God is to be like God in some relevant way, but also unlike God at the same time, as an image is like and unlike that which it reflects or represents. But how are we like God?

A traditional answer is to specify some trait or traits that we have in common. Historically, these have focused on the cognitive. To be like God is to have an immortal soul, or to be by nature rational, or to have within us the capacity for self-reflection and self-consciousnesss.

While these cognitive traits have some relevance to the discussion, they tend to be static and to become overly-anthropomorphized. I have argued elsewhere that it would be better to think of the image of God in dynamic terms rather than simply static ones, that the image of God is not simply something we are, but also something that we become.[11] This emphasis on becoming is also, at least partially, revealed in other current proposals for thinking of the image of God, in terms of relationality or of the category of co-creator.[12] To take creation as a central category is not to emphasize only an ontological category (the capacity to create), but to emphasis the act of creating itself. Similarly, relationality implies a dynamic interplay within a community bound by love. A relationship that does not grow and change ends up being static and atrophied. To be human, then, is not simply to be something which we were in the past and which we must now recover. We are human now, but we are becoming human as well. We are now in the image of God, but we are becoming God-like as well. We are not fully formed, but incomplete, conforming to the image of Christ, as Paul might say (Romans 8: 29; see also Colossians 3: 10).

Thinking in terms of the language of becoming, of creating, of relationality, is important, for it subtly transforms debates about the use of technologies that stand to alter our very identity. Particularly with respect to genetic technologies, there is often a shrill cry that altering the genome, whether in human beings or other creatures, takes us into the forbidden role of "playing God," implying that there are some spheres of nature that are strictly for God to act in and in which human beings must not interfere. Ted Peters has amply showed the deficiencies of this approach with respect to genetics, arguing that we should not think in terms of playing God, but of playing human.[13] To be human is to be a creator and in being creators we are precisely fulfilling what it means to be in the image of God. But what does it mean to "play human?" What kind of creators should we be?

The stories of Jesus' miracles may serve as one paradigm for thinking through these issues. To play human means, among other things, that we are called to heal the ills that are present before us. In the past, this call to healing has been unproblematic, and the use of technology for healing a great boon. The history of the religious support of hospitals and centers of healing is but one obvious exemplification of this, as well as efforts by charitable organizations and individuals to end suffering across the globe. The interplay of chaplain and doctor, minister and counselor is familiar to us and stands as a paradigm of this call to healing.

A concern with genetic and neural therapies is that they stand, at least potentially, to alter how we think of ourselves. In these cases, the process of healing not only restores what we once lost, but also changes us in the process. A genetic therapy alters our very DNA, while a machine-brain interface extends and alters what counts as "me" to include not only my biological body but also the electrodes, wires, and (perhaps) robotic limbs that restore the functioning that I had lost. As the above considerations about the image of God suggest, however, just because a means of healing also alters our sense of self does not, in and of itself, make that means inherently bad. Some modern leg prostheses include in them a computer chip that helps the artificial limb to respond appropriately to the different forms of human locomotion (e.g., walking as opposed to running). Individuals with such prostheses may be considered cyborgs, but the development of such prostheses do not result in alienation, but rather the opposite sense of liberation, enabling the once impossible: people without legs competing in races.

There is little reason to suppose that quadriplegics will not experience a similar sense of liberation if brain-machine interfaces restore functionality to their limbs. Indeed, Clark is keen to observe how, in the use of at least some of these technologies, how seamlessly the technology becomes experienced as a part of the person rather than something foreign to him or her. Looking ahead, the question may not be so much whether the paralyzed will walk again, but how. While brain-interfaces provide one promise, research in stem cells and in genetic therapies might provide alternative solutions. It might be argued that that the fusing of human and machine implies a loss of dignity, but in the context of healing, rather the opposite seems to be true. The real indignity is being paralyzed, unable to move one's body or even to adequately control one's excretions. As strange as it might initially sound, the fusing of mind and machine in these contexts serves to restore dignity, not erase it.

But Jesus' miracles are miracles not only of healing but also of transformation, signs of the coming kingdom. Can and should technology transform? Philip Hefner makes the bold claim that "Everything we think about religion, everything we think is spiritual is rearranged by technology."[14] Is this rearrangement a good thing?

While one way of testing the merits of a technology is to inquire into its ability to heal, we may also evaluate a technology, provocatively, in terms of its capacity for transformation. Just as the miracles of Jesus were a transforming sign of the coming kingdom of God, our creative activities, reflective of our imaging of God, may aid in the process of transformation. In this transformative role, we are not usurping God's role, but fulfilling our role in imaging God, in co-creating. The idea that technology may play a transformative role, especially a spiritually transformative role, strikes against strongly held conceptions about the nature and meaning of technology. Technology is profoundly material, and as such would seem incapable of the role of transformation. If anything, technology, especially modern technology, is more typically the source of alienation, not transformation. If anything, technology is the problem, not the solution.

At the core of these claims is a world denying intuition that harks back to a Platonist, even dualist framework that separates world and spirit, mind and body, in a way that makes the material, the physical the source of all evil and suffering in a way that is importantly foreign to the biblical tradition. *Genesis* 1 and the *Psalms* resound with the beauty and goodness of creation. Technology, in being material, is not an intrinsic source of evil; it is part of who and what we are. Human beings are tool-makers as far back as the archeological record goes, and it is through our tool-making that we have become what we are today.

In saying that technology can be transforming is to suggest not only how technology alters our individual lives, but also how it shapes entire societies. The automobile, with its links to transportation systems, the demand for oil, global warming, the growth of suburbs and the decay of inner cities, the family vacation, the definition of adulthood in terms of a driver's license, and icons of status is perhaps most emblematic of this shaping. The internet presents a newer example as well, one that shows the dramatically mixed impacts of new technologies, enabling the rise of global child pornography and sophisticated global terrorist networks, but also countering the grip of totalitarian regimes and providing means of opposing centralized power structures.

In asking the question of transformation with regard to new neurotechnologies, we are asking basic questions of spirit. Would such technologies make us more machine, or would they make us more human? Would such technologies foster the growth of loving communities, or fracture them? These are the questions that need to be asked, and it will not always be clear what the answer will be. The difficulty is that the effects of technology are not always obvious beforehand. E-commerce was not envisioned at the time that the internet was created, nor was the importance of cell phones for organizing political protests. The effects creep upon us, and have a life of their own. And because the effects of technology are multivalent, the same technology easily produces both good and ill, empowering some while disenfranchising others. If neurotechnologies do indeed become widespread, we should expect similar complexity and novelty.

Face to Face

It may be argued that there is little that we can do in any case, that the inevitable march of technology will triumph whether we oppose it or not. Once the automobile was invented, highways inevitably followed and those individuals who might have opposed them were powerless to stop the development. Such views of technological inevitability are misguided, for they miss the role that cultural context and communal will plays. This is true even with the automobile, as a comparison of European and American transportation systems and values clearly illustrate. Technological progress is not linear nor is it inevitable.

In pondering this point, it is worthwhile to turn back to the cyborg advocates' emphasis on the malleability of human nature. What makes the cyborg desirable for some is the possibility it represents for extending and transforming human nature not only in ways that were previously not possible, but in any way that we desire. Cyborg as myth and ideology enjoins a radical human freedom, unbound by any constraints. The cyborg may even consider itself a new species, *techno-sapiens*, a posthuman creature so different from what we are now as to be unrecognizable. In a few small steps, the cyborg myth becomes a soteriology as well, a telos to which we direct ourselves.

It may be the case, however, that we are not infinitely malleable, at least not in the way that cyborg advocates might suggest. In thinking this through, we might consider the importance of the face. Cell phones, email, and the internet all provide alternatives to face-to-face communication, so much so that some have fretted over a new kind of disembodied lifestyle, where individuals living in their cramped hovels sit in front of flickering screens, using imaginary identities to carry on imaginary conversations. Despite this, however, we all continue to yearn for face-to-face communication. Email correspondents eventually desire to seek each other out in person, if not to touch, at least to see. Cell phones allow us to talk from anyplace to anyplace, but often enough we use them to arrange places to meet in person. In business, telecommuting and teleconferencing were once prognosticated to replace centralized work forces and business travel; neither have readily disappeared. Even in composing emails, we often enough insert "emoticons" to substitute for the face we cannot see. In communication, faces are primary.

This point is bolstered some by modern psychology and neuroscience. Our minds are programmed, it would seem, to read faces. A specific form of brain damage results in the loss of the ability to recognize faces (a condition known as prosopagnosia) with devastating results. Research by Paul Ekman and others has indicated that there are at least six universally recognized facial expressions that exist across all cultures.[15] The facial expression of disgust is as recognizable in the Amazon as it is in Alabama.

The face is also important for ethical interaction. The complex of voluntary and involuntary muscles lying beneath the surface of the face control our ability to express our emotions honestly. Genuine smiles, it turns out, cannot be faked, because some of the muscles employed are not subject to voluntary control; the result is that a fake smile and a real smile can be visibly distinguished. Faces convey a wealth of information beyond the purely verbal. The facial expression tells us whether a statement is ironic or to be taken at "face value." Facial expressions may reveal the genuineness of expressions of love or whether the exhortation to bravery is heartfully felt. Or the facial expression may tell us nothing at all, or mislead us, as some of us become adept at facial lying, at expressing that which we pretend to feel but genuinely do not.

The eyes are said to be the window of the soul, and by extension we might describe the face as the door. Lose the eyes and lose the face, and it becomes hard to recognize another individual as human. For this reason, face disfigurement can be devastating. Burn victims who suffer severe damage to their faces suffer enormously from their loss and experience, at least in many cases, severe social isolation as a result. A burn victim does not become less human because of the loss of a face, but the reason that radical facial disfigurement is such a profound tragedy is because it creates an impediment for others to recognize and communicate with the humanity present.

In science-fiction, it is precisely this facelessness that depicts the presumed horror of the cyborg, the human-machine with one real eye and one mechanical one. Is it possible to love mechanical eyes, to kiss steely lips? Human nature may be malleable, but it may not be infinitely malleable. But the conclusion should not be that cyborg technologies should never be used. Rather, as is always the case for technology, we must stipulate the criteria for technological use. Does the technology heal? Does it make us more human, not less? If our natures are bounded, then there will be important limits, ways that neuroengineering and brain-machine interfaces will make us less human, not more so. Of these usages, we must beware, but we should not confuse the possibility of ill-effects with the fear of change. Change will come; what matters is how we will shape it.

Endnotes

1. cf. Jack Kelly, "Monkeys, Humans Get Brain-Driven Prostheses." Discover 26:1(January, 2005), 45.

2. cf. Andy Clark, *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence.* (New York: Oxford University Press, 2003) 16–17, 124–5.

3. Clark, 91–2, and Kristina Dell, and Michael D. Lemonick, "Robo-Monkey's Reward." *Time* 162:17 (October 27, 2003), 46.

4. Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence.* (New York: Viking Press, 1999).

5. Peter D. Kramer, *Listening to Prozac* (New York: Penguin Books, 1993). See also Gregory R. Peterson, *Minding God: Theology and the Cognitive Sciences* (Minneapolis: Fortress Press, 2002) chapter 4.

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