Ten paradoxes of Technology

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Abstract
Though we may be competent at using many technologies, most of what we think we know about technology in general is false. Our error stems from the everyday conception of things as separate from each other and from us. In reality technologies belong to an interconnected network the nodes of which cannot exist independently *qua* technologies. What is more we tend to see technologies as quasi-natural objects, but they are just as much social as natural, just as much determined by the meanings we give them as by the causal laws that rule over their powers. The errors of common sense have political consequences in domains such as, development, medicine and environmental policy. In this paper I summarize many of the conclusions philosophy of technology has reached reflecting on the reality of our technological world. These conclusions appear as paradoxes judged from our everyday perspective.

This paper presents a philosophy of technology. It draws on what we have learnt in the last 30 years as we abandoned old Heideggerian and positivist notions and faced the real world of technology. It turns out that most of our common sense ideas about technology are wrong. This is why I have put my ten propositions in the form of paradoxes, although I use the word loosely here to refer to the counter-intuitive nature of much of what we know about technology.

1. *The paradox of the parts and the whole.*

Martin Heidegger, once asked whether birds fly because they have wings or have wings because they fly. The question seems silly but it offers an original point of entry for reflection on technology and development.

Birds appear to be equipped with wings and it is this that explains their ability to fly. This is the obvious common sense answer to Heidegger's question. But this answer has implications that are less than obvious. Although our intuitions tell us birds belong in the air, our language seems to say that they are separate from the environment on which they act and even separate from the "equipment" they use to cope with that environment. Birds *use* wings to fly in something like the way in which we humans use airplanes.

Pursuing the analogy we could say that if birds did not have wings they would be just as earthbound as were humans before the Wright brothers—or was it Santos Dumont? —invented the airplane. But this makes no sense. Although there are a few species of flightless birds, most birds could not survive without flying. Flying is not just something birds do; it is their very being.

A better analogy to birds' flight would be human speech. Although speechless humans do exist, they lack an essential aspect of what it is to be human. Speech is not properly understood as a tool humans use to communicate because without it they are not fully human. Speech, like flight for

birds, is essential in a way tools are not. One can pick up and put down a tool, but humans can no more abandon speech than birds can abandon flight.

Pushed to the extreme the common sense answer to Heidegger's puzzling question breaks down. Of course we usually do not fall into such absurdities when talking about animals, but the misleading implications of ordinary language do reflect our inadequate common sense understanding of technology. This has consequences I will discuss in the rest of this paper.

Heidegger's second option, that birds have wings because they fly, challenges us in a different way. It seems absurd on the face of it. How can birds fly unless they have wings? So flying cannot be the cause of wings unless an effect can precede a cause.

If we are going to make any sense of Heidegger's point we need to reformulate it in less paradoxical language. Here is what he really means. Birds belong to a specific niche in the environment. That niche consists of treetops in which to dwell, insects to eat, and so on. It is only available to a specific type of animal with a specific type of body. Flying, as a necessary property of an organism that occupies this particular niche, requires wings rather than the other way around as common sense would have it.

This is a holistic conception of the relation of the animal to its environment. We are not to think of birds, insects and trees as fully separate things but rather as forming a system in which each relates essentially to the other. But this is not an organic whole the parts of which are so intimately connected they can only be separated by destroying the organism. In the case of an animal and its niche, separation is possible at least temporarily, although it threatens the survival of the animal and perhaps of other elements of the environment dependent on it.

These relationships are bit like those of a part of a machine to the whole machine. The part can be separated from the whole but it then loses its function. A tire that has been removed from a car continues to be a tire but it cannot do the things tires are meant to do. Following Heidegger's thought, it is easy to see that the form and even the existence of tires such as we know them depends on the whole car they are destined to serve. And the reciprocal also holds: care and tire are mutually interdependent. The car is not just assembled from pre-existing parts since the nature of the parts is derived from the design of the car and vice versa. The car does not ride on the road because it has tires. Rather, the tires belong to the car because the car rides on the road.

I will call this *the paradox of the parts and the whole. The apparent origin of complex wholes lies in their parts but, paradoxical though it seems, in reality the parts find their origin in the whole to which they belong*. I want to illustrate this paradox with two images, each of which exemplifies the two answers to Heidegger's question in graphic terms.
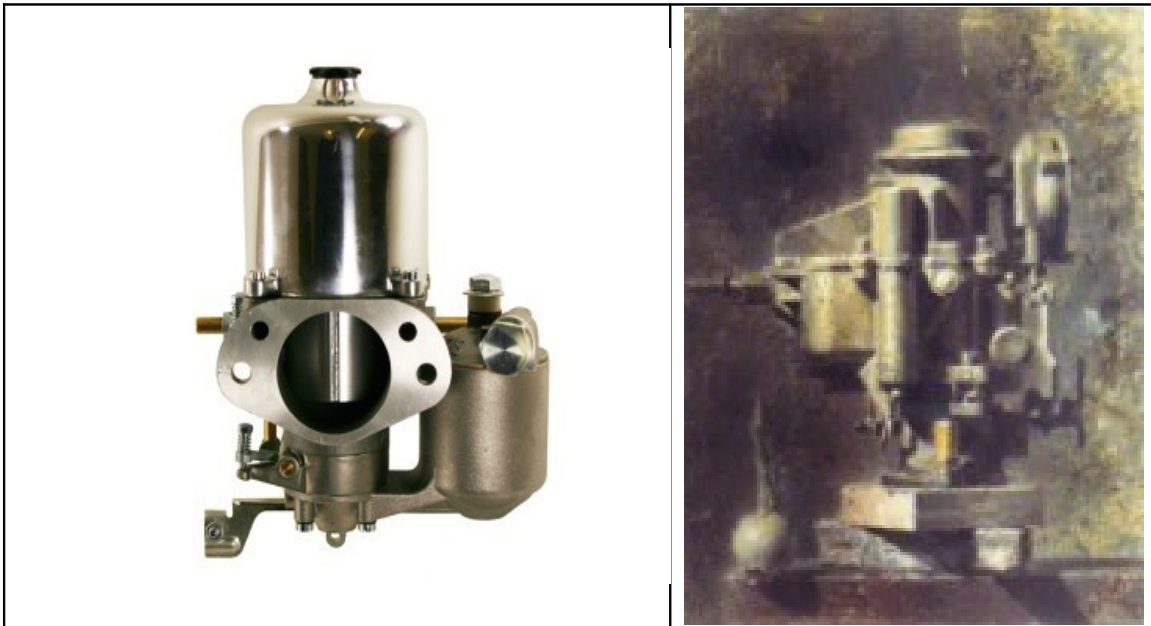
The first of these images shows a carburetor in a manufacturer's catalog. As you can see it is a wonder of sharp edged surfaces and smooth curves in cold, shiny steel. It is completely separate from its environment and fulfills the dream of reason, the dream of pure order. Now look at this second image by the painter Walter Murch. We are once again in the presence of a carburetor, but this time it is portrayed as a warm and fuzzy object that blurs into the air around it. It is compared subtly with a sprouting onion over to the left which establishes a scale that contradicts its strangely monumental aspect. This is a romantic rather than a rationalistic image. It hints at the history and the connectedness of the thing rather than emphasizing its engineering perfection.

Which image is truer to life? I prefer Murch's which I used as cover art for a book called *Questioning Technology* (1999). Murch sets us thinking about technology's complexity, the environment in which it functions, the history out of which it arises, rather than answering the question in advance with a nod to its supposedly pure rationality.

Examples that confirm the point are easy to find. A technology imported or imitated from a developed country is implanted in a new environment in a less developed country. It is expected that it will perform in the same way everywhere, that it is not a local phenomenon bound to a particular history and environment. In this respect technologies differ from such rooted phenomena as customs or language. Difficult though it be to transfer Western industrial technology to a poor country, it is far easier than importing such things as a different cuisine or different relations between men and women or a different language. So we say that technology is universal in contrast to these particular and local features.

And this is usually correct to a considerable extent. Of course it makes no sense to send tractors to farmers who have no access to gasoline. Such gross mistakes are occasionally made but for the most part the problems are more subtle and are often overlooked for a long time. For example, industrial pollutants that were evacuated safely by a good sewage system in a rich country may poison wells in a new, much poorer, locale. Differences in culture too pose problems. The keyboards of the typewriters and computers Japan imported from the West could not represent its written language. Before a technical adaptation was found some Japanese concluded that

modernization would require the adoption of English!

Good sewage systems and Roman alphabets form a niche essential to the proper functioning of these technologies just like the water in which fish swim. Technologies resemble animals in belonging to a specific niche in a specific society. They do not work well, if at all, outside that context. But the fact that technologies can be detached from their appropriate niche means they can be imported without bringing along all the contextual elements necessary for their proper functioning. Technologies can be plucked from the environment in which they originated and dropped into a new environment without afterthoughts. But this can be a formula for disaster.

Consider the adoption of the private automobile by China as a primary means of transportation. In February 2009 auto sales in China surpassed those in the United States for the first time. China is now the largest market for private cars in the whole world. This is not surprising given the size of China's population. But for that very same reason it was foolish to commit so many resources to the automobile. Automobiles are a very inefficient means of transportation. They consume a great deal of fuel for every passenger mile driven. China is so big that its participation in oil markets will eventually push prices up to the point where the private automobile will become unaffordable to operate. Meanwhile, China will have built its cities around automotive transportation with consequences that will be very expensive to reverse. Mistakes such as this occur because policymakers fail to realize the dependence of the parts on the whole. In this they resemble ordinary people everywhere in modern societies. Our common sense misleads us into imagining that technologies can stand alone.

2. *The paradox of the obvious.*

Why do we think like this? Why does common sense tend to validate the first of the two images I have presented? I find the answer to these questions in another paradox which I will call *the paradox of the obvious*. Here is a general formulation: *what is most obvious is most hidden*. An amusing corollary dramatizes the point: fish do not know that they are wet. Now, I may be wrong about fish but I suspect that the last thing they think about is the medium of their existence, water, the niche to which they are so perfectly adapted. A fish out of water quickly dies but it is difficult to imagine fish enjoying a bath. Water is what fish take for granted just as we human beings take air for granted. We know that we are wet because water is not our natural medium. It exists for us in contrast to air. But like fish who do not know they are wet, we do not think about the air we breath.

We have many other experiences in which the obvious withdraws from view. For example, when we watch a movie we quickly lose sight of the screen as a screen. We forget that all the action takes place in the same spot at a certain distance in front of us on a flat surface. A spectator unable to ignore the obvious would fail to foreground the action of the film and would remain disturbingly conscious of the screen. The medium recedes into the background and what we notice in the foreground are the effects it makes possible. This explains why we see the possession of wings as the adequate explanation of flying and why it looks to us like machines are composed of independent parts.

3. *The paradox of the origin.*

Our forgetfulness also blinds us to the history of technical objects. These objects differ from ordinary things and people in the way they relate to time. This person, that book, the tree behind our house all have a past and that past can be read on his wrinkled and smiling face, the dog-eared

pages of the book, the stump of the branch that broke from the tree in the last storm. In such cases, the presence of the past in the present seems to us unremarkable.

But technologies seem disconnected from their past. We usually have no idea where they came from, how they developed, the conditions under which the decisions were made that determined their features. They seem self-sufficient in their rational functioning. An adequate explanation of any given device appears to consist in tracing the causal connections between its parts.

In reality there is just as much history to an electric toaster or a nuclear power plant as there is to persons, books, and trees. No device emerged full blown from the logic of its functioning. Every process of development is fraught with contingencies, choices, alternative possibilities. The perfecting of the technical object obliterates the traces of the labor of its construction and the social forces that were in play as its design was fixed. It is this process that adjusts the object to its niche and so the occlusion of its history contributes to the forgetfulness of the whole to which it belongs. I call this *the paradox of the origin: behind everything rational there lies a forgotten history*.

Here is an example with which we are all familiar. What could be more rational than lighted exit signs and outward opening doors in theatres? Yet in the United States these simple life saving devices were not mandated by any law or regulation until the famous Iroquois Theatre fire in Chicago in 1903. Some 600 people died trying to find and open the exits. Thereafter cities all over the country introduced strict safety regulations. Today we do not take much notice of exit signs and doors and certainly few theatre goers have an idea of their origin. We think, if we think at all, that they are surely there as useful precautions. But the history shows that this is not the full explanation. A contingent fact, a particular incident, lies behind the logic of theatre design.

4. *The paradox of the frame.*

There is a corollary of the paradox of the origin. I call this fourth paradox, *the paradox of the frame* and formulate it as follows: *efficiency does not explain success, success explains efficiency*. This is counter-intuitive. Our common sense tells us that technologies succeed because they are good at doing their job. Efficiency is the measure of their worth and explains why they are chosen from among the many possible alternatives. But the history of technology tells a different story.

Often at the beginning of a line of development none of the alternatives work very well by the standards of a later time when one of them has enjoyed many generations of innovation and improvement. When we look back from the standpoint of the improved device we are fooled into thinking its obvious superiority explains its success. But that superiority results from the original choice that privileged the successful technology over the alternatives and not vice versa. So what does explain that choice?

Again, the history of technology helps. It shows that many different criteria are applied by the social actors who have the power to make the choice. Sometimes economic criteria prevail, sometimes technical criteria such as the "fit" of the device with other technologies in the environment, sometimes social or political requirements of one sort or another. In other words, there is no general rule under which paths of development can be explained. Explanation by efficiency is a little like explaining the presence of pictures in a museum by the fact that they all have frames. Of course all technologies must be more or less efficient, but that does not explain why they are present in our technical environment. In each case only a study of the contingent circumstances of success and failure tells the true story.

5. *The paradox of action.*

This brings me to my fifth paradox which I call *the paradox of action*. I think of this as a metaphoric corollary of Newton's Third Law of motion. Newton's law states that for every action there is an equal and opposite reaction. This law is verified every time two billiard balls bounce off each other. My corollary applies this model to human behavior. It most obviously applies in interpersonal relations where anger evokes anger, kindness kindness, and so on. Every one of our acts returns to us in some form as feedback from the Other. But this means that *in acting we become the object of action*.

In more formal philosophical language the paradox of action says that human beings can only act on a system to which they themselves belong. Because we belong to the system any change we make in it affects us too. This is the practical significance of our existence as embodied and social beings. Through our body and our social belonging we participate in a world of causal powers and meanings we do not fully control. We are exposed through our body to the laws of nature. And we are born into a cultural world we largely take as given. In short, we are finite beings. Our finitude shows up in the Newtonian reciprocity of action and reaction.

But technical action appears to be non-Newtonian, an exception to the rule of reciprocity. When we act technically on an object there seems to be very little feedback to us, certainly nothing proportionate to our impact on the object. But this is an illusion, the illusion of technique. It blinds us to three reciprocities of technical action. These are causal side effects of technology, changes in the meaning of our world and in our own identity.

It is only when we narrowly define the relevant zone of action that we appear to be independent of the objects on which we act technically. In context, action always conforms to my version of Newton's law and comes back to affect the actor. The illusion of independence arises from the nature of technical action which dissipates or defers causal feedback from the object. Indeed, the whole point of technology is to change the world more than the actor. It is no accident that the gun harms the rabbit but not the hunter, that the hammer transforms the stack of lumber but not the carpenter. Tools are designed to focus power outward, on the world, while protecting the tool user from that equal and opposite reaction Newton proclaimed.

But Newton cannot be defied for long. In one way or another the reaction will manifest itself. In the case of pollution all one need do to identify the reaction is to enlarge the context in space and time and wait for the chickens to come home to roost. Barry Commoner's ecological corollary of Newton's law declares that "Everything goes somewhere." Indeed, all the poisons produced by industry end up in someone's backyard even if it takes years to notice. As technology grows more powerful its negative side effects become more difficult to ignore and finally it is impossible to ignore the dangers they create.

This observation brings us back to our first three paradoxes. The paradox of the parts and the whole states the importance of the niche or context. That niche must include a way of absorbing the impact of the technology, including its waste products. But attention to this aspect of technology is obscured by a narrow conception of technical action. The paradox of the obvious works against recognizing this connection. The feedback that is invisible in the immediate zone of action becomes visible when a wider or longer range view is available. The paradox of the origin wipes the slate clean and obscures the history in which past feedback influenced current designs.

In modern society technologies are perceived as purely instrumental and separate from their past, the environment in which they function, and their operator, like those wings that cause birds to fly. But these apparent separations hide essential aspects of technology as we have seen. I have called ignorance of this principle the illusion of technology.

This illusion is less of a problem in traditional societies. There craft knowledge and everyday experience are in constant communication. The lessons learned from using technical devices are absorbed into the craft tradition where they limit and control technical activity. From a modern standpoint this appears to be an obstacle to development, but there may be wisdom in restraint. Certainly our recent experience with technologies such as nuclear weapons and toxic chemicals indicate a need for restraint.

But this is not the way most modern technology has developed. Under capitalism control of technology is no longer in the hands of craftsmen but is transferred to the owners of enterprise and their agents. Capitalist enterprise is unusual among social institutions in having a very narrow goal—profit—and the freedom to pursue that goal without regard for consequences. Once technology has been delivered over to such an institution, the lessons of experience are ignored. Workers, users of technology, victims of its side effects, all are silenced throughout the industrialization process. Technological development can proceed without regard for the more remote aspects of its own context. This makes possible the development of sophisticated technical disciplines and very rapid progress but with unfortunate side effects. In communist countries, this same pattern prevailed under government control where the goal assigned to state enterprises—meeting a quota—was similarly narrow.

Instead of correcting the illusion of technology, modern societies take that illusion for reality. They imagine they can act on the world without consequence for themselves. But only God can act on objects from outside the world, outside the system on which He acts. All human action, including technical action, exposes the actor. The illusion of godlike power is dangerous.

When Robert Oppenheimer witnessed the explosion of the first atom bomb a quotation from Baghavad-Gita flashed through his mind: "I have become death, the shatterer of worlds." But soon he was attempting to negotiate disarmament with Moscow. He realized the shatterer could be shattered. Presumably Shiva, the God of death, does not have to worry about the Russians.

Our actions not only come back to us through causal feedback, they also change the meaning of our world. The most dramatic examples of such transformations of meaning occur around new technologies of transportation and communication. Railroads and later automobiles and airplanes have radically diminished the experience of distance. Regions once remote were suddenly made close by these technologies. The spatial coordinates of our lives, what we mean by "far" and "near," are completely different from what it was for all of human history before these inventions were introduced. Added to these changes, electronic communication has radical consequences as a multicultural world gradually emerges from the monocultures of old. Ordinary people now know more about foreign lands and cultures from movies, encounters with immigrants, and tourism than all but a few adventurers and colonial administrators a century ago. What is more, such familiar distinctions as those between public and private, work and home, are subverted as new technology brings the office into domestic spaces and extrudes creative activities and private fantasies into public arenas.

Even the meaning of nature is subject to technological transformation. Take amniocentesis, for

example. It allows the sex of the fetus to be identified early in pregnancy. Relatively few parents abort fetuses because of their sex, but the fact that this is possible at all transforms an act of God into a human choice. What formerly was a matter of luck can now be planned. Even choosing not to use the information has become a choice in favor of "nature" whereas before no choice was involved. Our society is now capable of technologizing reproduction and has thus changed its meaning for everyone, including those who do not use the technology.

6. *The paradox of the means.*

The paradox of action also holds in the case of identity. The hunter kills a rabbit with his gun and all he feels is a little pressure from the kickback of the weapon. But the rabbit is dead. There is an obvious disproportion between the effect of the action on the actor and his object. But the action does have significant consequences for the hunter. His identity is determined by his acts. That is to say, he is a hunter insofar as he hunts. This reverse action of technology on identity is true of everyone's productive activity in one way or another. In sum, you are what you do.

Consumer society has brought the question of identity to the fore in another way. The technologies we use in daily life, such as automobiles, Ipods, mobile phones, signify us as the kind of people we are. We now "wear" our technologies just as we wear clothes and jewelry, as forms of self-presentation. Today, not only are you what you do, but even more emphatically you are what you use.

These observations suggest *a sixth paradox of the means* which follows directly from the paradox of action: *the means are the end.* There is a weaker version of this paradox with which everyone is familiar. It is obvious that means and ends are not completely independent of each other. Common sense tells us not to expect much good to come of using bad means even if the ends we have in view are benign. But my formulation is more radical. The point is not that means and ends are related, but that they are in fact one and the same over a wide range of technological issues. By this I mean that the changes in meaning and identity discussed above are often the most important effect of technological change, and not its ostensible purpose.

Consider the example of the automobile. Automobile ownership involves far more than transportation. It symbolizes the owner's status. In poor countries, it has an even greater symbolic charge than in rich ones, signifying the achievement of modernity and its vision of a rich and fulfilling life. It cannot be said in such cases that the means are separate from the ends. Possession of the means is already an end in itself because identity is at stake in the relation to technology.

7. *The paradox of complexity.*

This brings me to *a seventh paradox of complexity* which can be succinctly stated as: *Simplification complicates*. This corollary of the paradox of action flows from the nature of technology. As we have seen technologies can be removed from their context and transferred to alien locales. But more profoundly considered, technology is in some sense already decontextualized even before it is transferred, even in its normal setting. By this I mean that creating a technology involves abstracting the useful aspects of materials from their natural connections. This constitutes a radical simplification of those materials, so radical in fact that it must be compensated by a recontextualization in a new technological niche where we find them transformed in a finished and working device. But the recontextualization is not always completely successful.

Here is an example. To make the paper on which this lecture is printed, trees were removed from their place in the ecology of the forest as they were reduced to simplified raw materials. They were then transformed to become useful in a new context, the context of contemporary writing practices. That new context brought with it all sorts of constraints such as size, thickness, compatibility with current printers, and so on. We recognize the paper as belonging to this new context.

But the process of decontextualizing and recontextualizing technical objects sometimes results in unexpected problems. In the case in point, paper making employs dangerous chemicals and its poorly regulated pursuit causes air pollution and immense harm to rivers and their inhabitants. In sum, in simplifying, technological projects such as paper making produce new complications.

This is why context matters. Ignorance of context is especially prevalent in developing societies that receive a great deal of transferred technology. Blindness to context and consequence is the rule in such cases. Technologies adapted to one world disrupt another world. These complications become the occasion for popular reactions and protests as they impinge on the health and well being of ordinary people. This proposition is tested over and over in one developing society after another. Where popular reaction leading to correctives is effectively suppressed, as it was in the Soviet Union, the consequences of development can be catastrophic: severe chemical pollution of the air, water and soil, extensive radioactive contamination, and declining fertility and life expectancy.

8. *The paradox of value and fact.*

As it grows more powerful and pervasive, it becomes more and more difficult to insulate technology from feedback from the underlying population. Workers, users, victims, and potential victims all have their say at some point. Their feedback, provoked by maladaptation, negative side effects or unrealized technical potential, leads to interventions that constrain development and orient its path.

Once mobilized to protect themselves, protesters attempt to impose the lessons of experience with technologies on the technical experts who possess the knowledge necessary to build working devices in a modern society. It appears superficially that two separate things, technical knowledge and everyday experience interact in a clash of opposites. Technical experts sometimes decry what they think of as ideological interference with their pure and objective knowledge of nature. They protest that values and desires must not be allowed to muddy the waters of fact and truth. Protesters may make the corresponding error and denounce the experts in general while nevertheless employing their technology constantly in everyday life.

But in fact technical knowledge and experience are complementary rather than opposed. Technical knowledge is incomplete without the input from experience that corrects its oversights and simplifications. Public protests indirectly reveal the complications unintentionally caused by those simplifications, i.e. aspects of nature so far overlooked by the experts.

Protests work by formulating values and priorities. Demand for such things as safety, health, skilled employment, recreational resources, aesthetically pleasing cities testify to the failure of technology to adequately incorporate all the constraints of its environment. Eventually those values will be incorporated into improved technical designs and the conflict between the public and its experts will die down. Indeed, in years to come the technical experts will forget the

politics behind their reformed designs and when new demands appear will defend them as a product of pure and objective knowledge of nature!

Values cannot enter technology without being translated into technological language. Simply wishing away inconvenient technical limitations will not work. The results of such a voluntaristic approach are disastrous as the Chinese discovered in the Cultural Revolution. For something useful to come out of public interventions, experts must figure out how to formulate values as viable technical specifications. When that is accomplished a new version of the contested technologies can be produced that is responsive its context. In the process values are translated into technical facts and the technology fits more smoothly into its niche.

The structure of this process is a consequences of a technology cut off to a considerable extent from the experience of those who live with it and use it. But the experience of users and victims of technology eventually influences the technical codes that preside over design. Early examples emerge in the labor movement around health and safety at work. Later, such issues as food safety and environmental pollution signal the widening circle of affected publics. Today, as we have seen, such interactions are becoming routine and new groups emerge frequently as "worlds" change in response to technological change. This overall dynamic of technological change closes the circle described in the paradox of action: what goes around comes around. And because we have experience and are capable of reflecting on it, we can change our technologies to safeguard ourselves and to support the new activities they make possible.

Sometimes the problem is not the harm technology does but the good it might do if only it were reconfigured to meet unmet demands. This case is exemplified by the Internet. It was created by the US military to test a new type of networked computer time sharing. But a graduate student came up with the idea of networking not only the computers but also their users and introduced email. Since then one generation of users after another has developed and explored new ideas for social interaction on the Internet. Home pages were followed by web forums and web forums by social sites dedicated to music sharing and photography. These sites were integrated into blogs and now social sites such as Myspace and Facebook have emerged, pulling together many social resources. At each stage programmers have worked to accommodate the new demands of users with the corresponding technical solutions. This is a process repeated endlessly as technologies develop.

This leads my to my eighth paradox, which I will call *the paradox of value and fact: values are the facts of the future*. Values are not the opposite of facts, subjective desires with no basis in reality. Values express aspects of reality that have not yet been incorporated into the taken for granted technical environment. That environment was shaped by the values that presided over its creation. Technologies are the crystallized expression of those values. New values open up established designs for revision.

9. *The democratic paradox.*

Social groups form around the technologies that mediate their relations, make possible their common identity and shape their experience. We all belong to many such groups. Some are defined social categories and the salience of technology to their experience is obvious. A worker in a factory, a nurse in a hospital, a truck driver in his truck, are all members of communities that exist through the technologies they employ. Consumers and victims of the side effects of technology form latent groups that surface when their members become aware of the shared reasons for their problems. The politics of technology grows out of these technical mediations

that underlie the many social groups that make up society. Such encounters between the individuals and the technologies that connect them proliferate with consequences of all sorts. Social identities and worlds emerge together and form the backbone of a modern society.

In the technology studies literature, this is called the "co-construction" of technology and society. The examples cited here show this "co-construction" resulting in ever tighter feedback loops, like the "Drawing Hands" in M. C. Escher's famous print of that name. I want to use this image to discuss the underlying structure of the technology-society relationship.

Escher's self-drawing hands are emblematic of the concept of the "strange loop" or "entangled hierarchy" introduced by Douglas Hofstadter in his book *Gödel, Escher, Bach*. The strange loop arises when moving up or down a logical hierarchy leads paradoxically back to the starting point. A logical hierarchy in this sense can include a relationship between actors and their objects, such as seeing and being seen or talking and listening. The active side stands at the top and the passive side at the bottom of these hierarchies.

The famous liar's paradox is an example of a strange loop in which top and bottom trade places. Like all statements, the statement "This sentence is false" refers to an object. The statement itself is the actor at the top of the hierarchy. But the object to which it refers is also itself and in describing itself as false it reverses the direction of action. When one claims that something is false that claim is the actor and what it describes as false is the object. But that object is itself. Now the sentence is only true if it is false and false if it is true. A strange loop indeed!

In the Escher print, the paradox is illustrated in a visible form. The hierarchy of "drawing subject" and "drawn object" is "entangled" by the fact that each hand plays both functions with respect to the other. If we say the hand on the right is at the top of the hierarchy, drawing the hand on the left, we come up against the fact that the hand on the left draws the hand on the right and so is also located at the top level. Thus neither hand is at the top or both are, which is contradictory.

On Hofstadter's terms, the relation between technology and society is an entangled hierarchy. Insofar as social groups are constituted by the technical links that associate their members, their status is that of the "drawn" object in Escher's scheme. But they react back on those links in terms of their experience, "drawing" that which draws them. Once formed and conscious of their identity, technologically mediated groups influence technical design through their choices and protests. This feedback from society to technology constitutes *the democratic paradox*: *the public is constituted by the technologies that bind it together but in turn it transforms the technologies that constitute it.* Neither society nor technology can be understood in isolation from each other

because neither has a stable identity or form.

This paradox is endemic to democracy in general. Self-rule is an entangled hierarchy. As the French revolutionary Saint-Just put it, "the people is a submissive monarch and a free subject." Over the centuries since the democratic paradox was first enacted, its reach has extended from basic political issues of civil order and defense to embrace social issues such as marriage, education, and health care.

The process of extending democracy to technology began with the labor movement. It called attention to the contradiction between democratic ideology and the tyranny of the factory. This was the first expression of a politics of technology at a time when technical mediation was still confined to a single sector of society. The dream of control of the economy by those who build it with their brains and hands has never been fully realized. But today, around the many issues raised by technology, something very much like that dream is revived in new forms. Those who demand environmentally compatible production, a medical system more responsive to patient needs, a free and public Internet, and many other democratic reforms of technology, follow in the footsteps of the socialist movement whether they know it or not. They are broadening democratic claims to cover the whole social terrain incorporated into the technological system.

10. *The paradox of conquest.*

Hofstadter's scheme has a limitation that does not apply in the case of technology. The strange loop is never more than a partial subsystem in a consistent, objectively conceived universe. Hofstadter evades ultimate paradox by positing an "inviolate level" of strictly hierarchical relations above the strange loop that makes it possible. He calls this level "inviolate" because it is not logically entangled with the entangled hierarchy it creates. The person who says "This sentence is false" is not entangled in the paradox she announces. In the case of the Escher drawing, the paradox only exists because of the unparadoxical activity of the actual printmaker Escher who drew it in the ordinary way without himself being drawn by anyone.

The notion of an inviolate level has its place in logic but not in life in a technological society. In fact the illusion of technique is precisely defined by this notion. This illusion gives rise to the popular belief that through technology we "conquer" nature. But human beings are natural beings and so the project of conquest is inherently paradoxical. This *tenth paradox of conquest* was succinctly formulated in another context by F. Scott Fitzgerald: *the victor belongs to the spoils.* The conqueror of nature is despoiled by its own violent assault. This paradox has two implications. On the one hand, when "humanity" conquers nature, it merely arms some humans with more effective means to exploit and oppress other humans who, as natural beings, are among the conquered subjects. On the other hand, as we have seen, actions that harm the natural environment come back to haunt the perpetrators in the form of pollution or other negative feedback from the system to which both conqueror and conquered belong. In sum, the things we as a society do to nature are also things we do to ourselves.

In reality there is no inviolate level, no equivalent of "Escher" in the real world of co-construction, no godlike agent creating technology and society from the outside. All the creative activity takes place in a world that is itself created by that activity. Only in our fantasies do we transcend the strange loops of technology and experience. In the real world there is no escape from the logic of finitude.

Conclusion

The ten paradoxes form a philosophy of technology that is remote from current views but corresponds more nearly to experiences we have with increasing frequency. In rich countries the Internet and the environment are the two domains in which the paradoxes are most obviously at work. The many disorders of development illustrate their relevance in the rest of the world. Everywhere technology reveals its true nature as it emerges from the cultural ghetto in which it was confined until recently. Today technological issues routinely appear on the front pages of the newspapers. Fewer and fewer people imagine they can be left to the experts to decide. This is the occasion for the radical change in our understanding of technology. The institutionalized abstractions of the corporations and the technical professions are no longer the only standpoint from which to understand technology. Now it is more and more in the foreground of our everyday activities and provokes renewed philosophical reflection.

Here in conclusion is the list of the ten paradoxes. Let us hope they soon cease to feel paradoxical and become the new common sense.
1. The paradox of the parts and the whole: The apparent origin of complex wholes lies in their parts but in reality the parts find their origin in the whole to which they belong.
2. The paradox of the obvious: What is most obvious is most hidden.
3. The paradox of the origin: behind everything rational there lies a forgotten history.
4. The paradox of the frame: Efficiency does not explain success, success explains efficiency.
5. The paradox of action: In acting we become the object of action.
6. The paradox of the means: The means are the end.
7. The paradox of complexity: Simplification complicates.
8. The paradox of value and fact: Values are the facts of the future.
9. The democratic paradox: The public is constituted by the technologies that bind it together but in turn it transforms the technologies that constitute it.
10. The paradox of conquest: The victor belongs to the spoils.