

**WHAT
TECHNOLOGY
WANTS**

KEVIN KELLY

VIKING

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and the Economic World*

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My Question

For most of my life I owned very little. I dropped out of college and for almost a decade wandered remote parts of Asia in cheap sneakers and worn jeans, with lots of time and no money. The cities I knew best were steeped in medieval richness; the lands I passed through were governed by ancient agricultural traditions. When I reached for a physical object, it was almost surely made of wood, fiber, or stone. I ate with my hands, trekked on foot through mountain valleys, and slept wherever. I carried very little stuff. My personal possessions totaled a sleeping bag, a change of clothes, a penknife, and some cameras. Living close to the land, I experienced the immediacy that opens up when the buffer of technology is removed. I got colder often, hotter more frequently, soaking wet a lot, bitten by insects faster, and synchronized quicker to the rhythm of the day and seasons. Time seemed abundant.

After eight years in Asia, I returned to the United States. I sold what little I had and bought an inexpensive bicycle, which I rode on a 5,000-mile meander across the American continent, west to east. The highlight was gliding through the tidy farmland of the Amish in eastern Pennsylvania. Amish communities were the closest thing I could find on this continent to the state of minimal technology I had experienced in Asia. I admired the Amish for their selective possessions. Their unadorned homes were square bundles of contentment. I felt my own life, unencumbered by fancy technology, was in parallel to theirs, and I intended to keep technology in my life to a minimum. I arrived on the East Coast owning nothing but my bicycle.

Growing up in suburban New Jersey in the 1950s and 1960s, I was surrounded by technology. But until I was 10, my family had no television, and when it did arrive in our household, I had no appetite for it. I saw how it worked on my friends. The technology of TV had a remarkable ability to beckon people at specific times and then hold them enthralled for hours. Its

creative commercials told them to acquire more technologies. They obeyed. I noticed that other bossy technologies, such as the car, also seemed to be able to get people to serve them, and to prod them to acquire and use still more technologies (freeways, drive-in theaters, fast food). I decided to keep technology to a minimum in my own life. As a teenager, I was having trouble hearing my own voice, and it seemed to me my friends' true voices were being drowned out by the loud conversations technology was having with itself. The less I participated in the circular logic of technology, the straighter my own trajectory could become.

When my cross-country bike ride ended, I was 27. I retreated to an out-of-the-way plot of cheap land in upstate New York with plenty of woods and no building codes. With a friend, I cut down oak trees to mill into lumber, and with these homemade beams we erected a house. We nailed each cedar shake onto the roof one by one. I have vivid memories of hauling hundreds of heavy rocks to build a retaining wall, which the overflowing creek tore down more than once. With my own hands I moved those stones many times. With yet more stones we assembled a huge living-room fireplace. Despite the hard work, those stones and oak beams filled me with Amish contentment.

But I was not Amish. If you were going to cut down a huge tree, I decided, it was a good idea to use a chain saw. Any forest tribesman who could get his hands on one would agree. Once you gain your voice around technology and become more sure of what you want, it becomes obvious that some technologies are simply superior to others. If my travels in the old world had taught me anything, it was that aspirin, cotton clothing, metal pots, and telephones are fantastic inventions. They are *good*. People everywhere in the world, with very few exceptions, grab them when they can. Anyone who has ever held a perfectly designed hand tool knows that it can lift your soul. Airplanes had stretched my horizons; books had opened my mind; antibiotics had saved my life; photography had ignited my muse. Even the chain saw, which can cleanly slice through knotty burls too tough for a hand ax, had instilled in me a reverence for the beauty and strength of wood no other agent in the world could.

I became fascinated by the challenge of picking the few tools that might elevate my spirit. In 1980 I freelanced for a publication (the *Whole Earth Catalog*) that used its own readers to select and recommend appropriate tools

picked out of the ocean of self-serving manufactured stuff. In the 1970s and '80s, the *Whole Earth Catalog* was, in essence, a user-generated website before the web, before computers, employing only cheap newsprint. The audience were the authors. I was thrilled by the changes that simple, well-selected tools could provoke in people's lives.

At the age of 28, I started selling mail-order budget travel guides that published low-cost information on how to enter the technologically simple realms most of the planet lived in. My only two significant possessions at the time were a bike and sleeping bag, so I borrowed a friend's computer (an early Apple II) to automate my fledgling moonlight business, and I got a cheap telephone modem to transmit my text to the printer. A fellow editor at the *Whole Earth Catalog* with an interest in computers slipped me a guest account that allowed me to remotely join an experimental teleconferencing system being run by a college professor at the New Jersey Institute of Technology. I soon found myself immersed in something altogether bigger and wilder: the frontier of an online community. It was a new continent more alien to me than Asia, and I began to report on it as if it were an exotic travel destination. To my immense surprise, I found that these high-tech computer networks were not deadening the souls of early users like me; they were filling our souls. There was something unexpectedly organic about these ecosystems of people and wires. Out of complete nothingness, we were barn-raising a virtual commonwealth. When the internet finally came along a few years later, it seemed almost Amish to me.

As computers moved to the center of our lives, I discovered something I had not noticed about technology before. In addition to technology's ability to satisfy (and create) desires, and to occasionally save labor, it did something else. It brought new opportunities. Right before my eyes I saw online networks connect people with ideas, options, and other people they could not possibly have met otherwise. Online networks unleashed passions, compounded creativity, amplified generosity. At the very cultural moment when pundits declared that writing was dead, millions began writing online more than they ever had written before. Exactly when the experts declared people would only bowl alone, millions began to gather together in large numbers. Online they collaborated, cooperated, shared, and created in myriad unexpected ways. This was new to me. Cold silicon chips, long metal wires, and complicated high-

voltage gear were nurturing our best efforts as humans. Once I noticed how online computers stirred the muses and multiplied possibilities, I realized that other technologies, such as automobiles, chain saws, biochemistry, and yes, even television, did the same in slightly different ways. For me, this gave a very different face to technology.

I was very active on early teleconference systems, and in 1984, based on my virtual online presence, I was hired by the *Whole Earth Catalog* to help edit the first consumer publication that reviewed personal computer software. (I believe I might have been the first person in the world hired online.) A few years later, I got involved in launching the first public gateway to the emerging internet, an online portal called the Well. In 1992, I helped found *Wired* magazine—the official bullhorn of digital culture—and curated its content for its first seven years. Ever since, I've hung out on the cusp of technological adoption. My friends now are the folks inventing supercomputers, genetic pharmaceuticals, search engines, nanotechnology, fiber-optic communications—everything that is new. I see the transforming power of technology everywhere I look.

Yet I don't have a PDA, a smartphone, or Bluetooth anything. I don't twitter. My three kids grew up without TV, and we still don't have broadcast or cable in our home. I don't have a laptop or travel with a computer, and I am often the last in my circle to get the latest must-have gadget. I ride my bike more often than I drive these days. I see my friends leashed to their vibrating handhelds, but I continue to keep the cornucopia of technology at arm's length so that I can more easily remember who I am. At the same time, I run a popular daily website called *Cool Tools*, which is a continuation of my long-ago *Whole Earth* job evaluating select technology for the empowerment of individuals. A river of artifacts flows through my studio sent by vendors hoping for an endorsement; a fair number of those artifacts never leave. I am surrounded by stuff. Despite my wariness, I have chosen to deliberately position myself to keep the maximum number of technological options within my reach.

I acknowledge that my relationship with technology is full of contradictions. And I suspect they are your contradictions, too. Our lives today are strung with a profound and constant tension between the virtues of more technology and the personal necessity of less: Should I get my kid this gadget? Do I have time to master this labor-saving device? And more deeply: What is this technology taking over my life, anyway? What is this global force that elicits both our love

and repulsion? How should we approach it? Can we resist it, or is each and every new technology inevitable? Does the relentless avalanche of new things deserve my support or my skepticism—and will my choice even matter?

I needed some answers to guide me through my technological dilemma. And the first question I faced was the most basic. I realized I had no idea what technology really *was*. What was its essence? If I didn't understand the basic nature of technology, then as each new piece of it came along, I would have no frame of reference to decide how weakly or strongly to embrace it.

My uncertainty about the nature of technology and my own conflicted relationship with it sent me on a seven-year quest that eventually became this book. My investigations took me back to the beginning of time and ahead to the distant future. I delved deep into technology's history, and I listened to futurists in Silicon Valley, where I live, spin out imaginative scenarios for what will come next. I interviewed some of technology's fiercest critics and its most ardent fans. I returned to rural Pennsylvania to spend more time with the Amish. I traveled to mountain villages in Laos, Bhutan, and western China to listen to the poor who lack material goods, and I visited the labs of rich entrepreneurs trying to invent things that everyone will consider essential in a few years.

The more closely I looked at the conflicting tendencies of technology, the bigger the questions became. Our confusion over technology usually starts with a very specific concern: Should we allow human cloning? Is constant texting making our kids dumb? Do we want automobiles to park themselves? But as my quest evolved, I realized that if we want to find satisfying answers to those questions, we first need to consider technology as a whole. Only by listening to technology's story, divining its tendencies and biases, and tracing its current direction can we hope to solve our personal puzzles.

Despite its power, technology has been invisible, hidden, and nameless. One example: Since George Washington delivered the first State of the Union address in 1790, every American president has presented to Congress an annual summary of the nation's condition and prospects and the most important forces at work in the world. Until 1939, the colloquial use of the term *technology* was

absent. It did not occur twice in a State of the Union address until 1952. Surely my grandparents and parents were surrounded by technology! Yet for most of its adult life, our collective invention did not have a name.

The word *technelogos* is nominally Greek. When the ancient Greeks used the word *techne*, it meant something like art, skill, craft, or even craftiness. *Ingenuity* may be the closest translation. *Techne* was used to indicate the ability to outwit circumstances, and as such it was a trait greatly treasured by poets like Homer. King Odysseus was a master of *techne*. Plato, though, like most scholarly gentlemen of that era, thought that *techne*, which he used to mean manual craftwork, was base, impure, and degraded. Because of his contempt for practical knowledge, Plato omitted any references to craft in his elaborate classification of all knowledge. In fact, there's not a single treatise in the Greek corpus that even mentions *technelogos*—with one exception. To the best of our knowledge, it was in Aristotle's treatise *Rhetoric* that the word *techne* was first joined to *logos* (meaning word or speech or literacy) to yield the single term *technelogos*. Four times in this essay, Aristotle refers to *technelogos*, but in all four instances, his exact meaning is unclear. Is he concerned with the "skill of words" or the "speech about art" or maybe a literacy of craft? After this fleeting, cryptic appearance, the term *technology* essentially disappeared.

But of course, technology did not. The Greeks invented iron welding, the bellows, the lathe, and the key. Their students the Romans invented the vault, the aqueduct, blown glass, cement, sewers, and water mills. Yet in their own time and for many centuries thereafter, the totality of all that was manufactured was virtually invisible—never discussed as a distinct subject, apparently never even contemplated. Technology could be found everywhere in the ancient world except in the minds of humans.

In the centuries following, scholars continued to call the making of things *craft* and the expression of inventiveness *art*. As tools, machines, and contraptions spread, the work performed with them was termed the "useful arts." Each useful art—mining, weaving, metalworking, needlework—had its own secret knowledge that was passed on through a master/apprentice relationship. But it was still an *art*, a singular extension of its maker, and the term retained the original Greek sense of craft and cleverness.

For the next thousand years, art and technique were perceived as distinctly personal realms. Each product of these arts, whether an iron-work fence or an

herbal formula, was considered a unique expression derived from the particular cleverness of a particular person. Anything made was a work of solitary genius. As the historian Carl Mitcham explains, “Mass production was unthinkable to the classical mind, and not just for technical reasons.”

By the European Middle Ages, craftiness manifested itself most significantly in a new use of energy. An efficient horse collar had disseminated throughout society, drastically increasing farm acreage, while water mills and windmills were improved, increasing the flow of lumber and flour and improving drainage. And all this plentitude came without slavery. As Lynn White, historian of technology, wrote, “The chief glory of the later Middle Ages was not its cathedrals or its epics or its scholasticism: it was the building for the first time in history of a complex civilization which rested not on the backs of sweating slaves or coolies but primarily on non-human power.” Machines were becoming our coolies.

In the 18th century, the Industrial Revolution was one of several revolutions that overturned society. Mechanical creatures intruded into farms and homes, but still this invasion had no name. Finally, in 1802, Johann Beckmann, an economics professor at Gottingen University in Germany, gave this ascending force its name. Beckmann argued that the rapid spread and increasing importance of the useful arts demanded that we teach them in a “systemic order.” He addressed the *techne* of architecture, the *techne* of chemistry, metalwork, masonry, and manufacturing, and for the first time he claimed these spheres of knowledge were interconnected. He synthesized them into a unified curriculum and wrote a textbook titled *Guide to Technology* (or *Technologie* in German), resurrecting that forgotten Greek word. He hoped his outline would become the first course in the subject. It did that and more. It also gave a name to what we do. Once named, we could now see it. Having seen it, we wondered how anyone could not have seen it.

Beckmann’s achievement was more than simply christening the unseen. He was among the first to recognize that our creations were not just a collection of random inventions and good ideas. The whole of technology had remained imperceptible to us for so long because we were distracted by its masquerade of rarefied personal genius. Once Beckmann lowered the mask, our art and artifacts could be seen as interdependent components woven into a coherent impersonal unity.

Each new invention requires the viability of previous inventions to keep going. There is no communication between machines without extruded copper nerves of electricity. There is no electricity without mining veins of coal or uranium, or damming rivers, or even mining precious metals to make solar panels. There is no metabolism of factories without the circulation of vehicles. No hammers without saws to cut the handles; no handles without hammers to pound the saw blades. This global-scale, circular, interconnected network of systems, subsystems, machines, pipes, roads, wires, conveyor belts, automobiles, servers and routers, codes, calculators, sensors, archives, activators, collective memory, and power generators—this whole grand contraption of interrelated and interdependent pieces forms a single system.

When scientists began to investigate how this system functioned, they soon noticed something unusual: Large systems of technology often behave like a very primitive organism. Networks, especially electronic networks, exhibit near-biological behavior. Early in my online experience I learned that when I sent out an e-mail message, the network would cut it up into pieces and then send those bits along more than one pathway to the message's final destination. The multiple routes were not predetermined but "emerged" depending on the traffic of the whole network at the instant. In fact, two parts of the e-mail might take radically different pathways and then reassemble at the end. If a bit got lost along the way, it was simply re-sent along different routes until it arrived. That struck me as marvelously organic—very much like the way messages in an anthill are sent.

In 1994, I published a book called *Out of Control* that explored at length the ways in which technological systems were beginning to mimic natural systems. I cited computer programs that could duplicate themselves and synthetic chemicals that could catalyze themselves—even primitive robots that could self-assemble, just as cells do. Many large, complex systems, such as the electrical grid, had been designed to repair themselves, not too differently from the way our bodies do. Computer scientists were using the principles of evolution to breed computer software that was too difficult for humans to write; instead of designing thousands of lines of code, the researchers unleashed a system of evolution to select the best lines of code and keep mutating them, then killing off the duds until the evolved code performed perfectly.

At the same time, biologists were learning that living systems can be imbued

with the abstracted essence of a mechanical process like computation. For instance, researchers discovered that DNA—the actual DNA found in the ubiquitous bacteria *E. coli* in our own intestines—could be used to compute the answers to difficult mathematical problems, just like a computer. If DNA could be made into a working computer, and a working computer could be made to evolve like DNA, then there might be, or must be, a certain equivalency between the made and the born. Technology and life must share some fundamental essence.

During the years I was puzzling over these questions, something strange happened to technology: The best of it was becoming incredibly disembodied. Fantastic stuff was getting smaller, using less material but doing more. Some of the best technology, such as software, didn't have a material body at all. This development wasn't new; any list of great inventions in history contains plenty that are rather wispy: the calendar, the alphabet, the compass, penicillin, double-entry accounting, the U.S. Constitution, the contraceptive pill, domestication of animals, zero, germ theory, lasers, electricity, the silicon chip, and so on. Most of these inventions wouldn't hurt you if you dropped them on your toes. But now the process of disembodiment was speeding up.

Scientists had come to a startling realization: However you define life, its essence does not reside in material forms like DNA, tissue, or flesh, but in the intangible organization of the energy and information contained in those material forms. And as technology was unveiled from its shroud of atoms, we could see that at its core, it, too, is about ideas and information. Both life and technology seem to be based on immaterial flows of information.

It was at this point that I realized I needed even greater clarity on what kind of force flowed through technology. Was it really mere ghostly information? Or did technology need physical stuff? Was it a natural force or an unnatural one? It was clear (at least to me) that technology was an extension of natural life, but in what ways was it *different* from nature? (Computers and DNA share something essential, but a Mac-Book is not the same as a sunflower.) It is also clear that technology springs from human minds, but in what categorical way are the products of our minds (even cognitive products like artificial intelligences) different from our minds themselves? Is technology human or nonhuman?

We tend to think of technology as shiny tools and gadgets. Even if we acknowledge that technology can exist in disembodied form, such as software,

we tend not to include in this category paintings, literature, music, dance, poetry, and the arts in general. But we should. If a thousand lines of letters in UNIX qualifies as a technology (the computer code for a web page), then a thousand lines of letters in English (*Hamlet*) must qualify as well. They both can change our behavior, alter the course of events, or enable future inventions. A Shakespeare sonnet and a Bach fugue, then, are in the same category as Google's search engine and the iPod: They are something useful produced by a mind. We can't separate out the multiple overlapping technologies responsible for a *Lord of the Rings* movie. The literary rendering of the original novel is as much an invention as the digital rendering of its fantastical creatures. Both are useful works of the human imagination. Both influence audiences powerfully. Both are technological.

Why not just call this vast accumulation of invention and creation *culture*? In fact, some people do. In this usage, culture would include all the technology we have invented so far, plus the products of those inventions, plus anything else our collective minds have produced. And if by "culture" one means not just local ethnic cultures but the aggregate culture of the human species, then this term very nearly represents this vast sphere of technology that I have been talking about.

But the term *culture* falls short in one critical way. It is too small. What Beckmann recognized in 1802 when he baptized technology was that the things we were inventing were spawning other inventions in a type of self-generation. Technical arts enabled new tools, which launched new arts, which birthed new tools, ad infinitum. Artifacts were becoming so complex in their operation and so interconnected in their origins that they formed a new whole: *technology*.

The term *culture* fails to convey this essential self-propelling momentum pushing technology. But to be honest, the term *technology* does not quite get it right, either. It, too, is too small, because *technology* can also mean specific methods and gear, as in "biotechnology," or "digital technology," or the technology of the Stone Age.

I dislike inventing words that no one else uses, but in this case all known alternatives fail to convey the required scope. So I've somewhat reluctantly coined a word to designate the greater, global, massively interconnected system of technology vibrating around us. I call it the *technium*. The technium extends beyond shiny hardware to include culture, art, social institutions, and

intellectual creations of all types. It includes intangibles like software, law, and philosophical concepts. And most important, it includes the generative impulses of our inventions to encourage more tool making, more technology invention, and more self-enhancing connections. For the rest of this book I will use the term *technium* where others might use *technology* as a plural, and to mean a whole system (as in “technology accelerates”). I reserve the term *technology* to mean a specific technology, such as radar or plastic polymers. For example, I would say: “The technium accelerates the invention of technologies.” In other words, *technologies* can be patented, while the *technium* includes the patent system itself.

As a word, *technium* is akin to the German word *technik*, which similarly encapsulates the grand totality of machines, methods, and engineering processes. *Technium* is also related to the French noun *technique*, used by French philosophers to mean the society and culture of tools. But neither term captures what I consider to be the essential quality of the technium: this idea of a self-reinforcing system of creation. At some point in its evolution, our system of tools and machines and ideas became so dense in feedback loops and complex interactions that it spawned a bit of independence. It began to exercise some autonomy.

At first, this notion of technological independence is very hard to grasp. We are taught to think of technology first as a pile of hardware and secondly as inert stuff that is wholly dependent on us humans. In this view, technology is only what we make. Without us, it ceases to be. It does only what we want. And that’s what I believed, too, when I set out on this quest. But the more I looked at the whole system of technological invention, the more powerful and self-generating I realized it was.

There are many fans, as well as many foes, of technology, who strongly disagree with the idea that the technium is in any way autonomous. They adhere to the creed that technology does only what we permit it to do. In this view, notions of technological autonomy are simply wishful thinking on our part. But I now embrace a contrary view: that after 10,000 years of slow evolution and 200 years of incredible intricate exfoliation, the technium is maturing into its own thing. Its sustaining network of self-reinforcing processes and parts have given it a noticeable measure of autonomy. It may have once been as simple as an old computer program, merely parroting what we told it, but now it is more

like a very complex organism that often follows its own urges.

Okay, that's very poetic, but is there any *evidence* for the technium's autonomy? I think there is, but it rests on how we define autonomy. The qualities we hold dearest in the universe are all extremely slippery at the edges. *Life, mind, consciousness, order, complexity, free will, and autonomy* are all terms that have multiple, paradoxical, and inadequate definitions. No one can agree on exactly where life or mind or consciousness or autonomy begins and where it ends. The best we can agree on is that these states are not binary. They exist on a continuum. So: humans have minds, and so do dogs, and mice. Fish have tiny brains, so they must have tiny minds. Does that mean ants, who have smaller brains yet, also have minds? How many neurons do you need to have a mind?

Autonomy has a similar sliding scale. A newborn wildebeest will run on its own the day after it is born. But we can't say a human infant is an autonomous being if it will die without its mother for its first years. Even we adults are not 100 percent autonomous, since we depend upon other living species in our gut (such as *E. coli*) to aid in the digestion of our food or the breakdown of toxins. If humans are not fully autonomous, what is? An organism or system does not need to be wholly independent to exhibit some degree of autonomy. Like an infant of any species, it can acquire increasing degrees of independence, starting from a speck of autonomy.

So how do you detect autonomy? Well, we might say that an entity is autonomous if it displays any of these traits: self-repair, self-defense, self-maintenance (securing energy, disposing of waste), self-control of goals, self-improvement. The common element in all these characteristics is of course the emergence, at some level, of a self. In the technium we don't have any examples of a system that displays *all* these traits—but we have plenty of examples that display some of them. Autonomous airplane drones can self-steer and stay aloft for hours. But they don't repair themselves. Communication networks can repair themselves. But they don't reproduce themselves. We have self-reproducing computer viruses, but they don't improve themselves.

Woven deep into the vast communication networks wrapping the globe, we also find evidence of embryonic technological autonomy. The technium contains 170 quadrillion computer chips wired up into one mega-scale computing platform. The total number of transistors in this global network is

now approximately the same as the number of neurons in your brain. And the number of links among files in this network (think of all the links among all the web pages of the world) is about equal to the number of synapse links in your brain. Thus, this growing planetary electronic membrane is already comparable to the complexity of a human brain. It has three billion artificial eyes (phone and webcams) plugged in, it processes keyword searches at the humming rate of 14 kilohertz (a barely audible high-pitched whine), and it is so large a contraption that it now consumes 5 percent of the world's electricity. When computer scientists dissect the massive rivers of traffic flowing through it, they cannot account for the source of all the bits. Every now and then a bit is transmitted incorrectly, and while most of those mutations can be attributed to identifiable causes such as hacking, machine error, or line damage, the researchers are left with a few percent that somehow changed themselves. In other words, a small fraction of what the technium communicates originates not from any of its known human-made nodes but from the system at large. The technium is whispering to itself.

Further deep analysis of the information flowing through the technium's network reveals that it has slowly been shifting its methods of organization. In the telephone system a century ago, messages dispersed across the network in a pattern that mathematicians associate with randomness. But in the last decade, the flow of bits has become statistically more similar to the patterns found in self-organized systems. For one thing, the global network exhibits self-similarity, also known as a fractal pattern. We see this kind of fractal pattern in the way the jagged outline of tree branches look similar no matter whether we look at them up close or far away. Today messages disperse through the global telecommunications system in the fractal pattern of self-organization. This observation doesn't prove autonomy. But autonomy is often self-evident long before it can be proved.

We created the technium, so we tend to assign ourselves exclusive influence over it. But we have been slow to learn that systems—all systems—generate their own momentum. Because the technium is an outgrowth of the human mind, it is also an outgrowth of life, and by extension it is also an outgrowth of the physical and chemical self-organization that first led to life. The technium shares a deep common root not only with the human mind, but with ancient life and other self-organized systems as well. And just as a mind must obey not

only the principles governing cognition but also the laws governing life and self-organization, so the technium must obey the laws of mind, life, and self-organization—as well as our human minds. Thus out of all the spheres of influence upon the technium, the human mind is only one. And this influence may even be the weakest one.

The technium wants what we design it to want and what we try to direct it to do. But in addition to those drives, the technium has its own wants. It wants to sort itself out, to self-assemble into hierarchical levels, just as most large, deeply interconnected systems do. The technium also wants what every living system wants: to perpetuate itself, to keep itself going. And as it grows, those inherent wants are gaining in complexity and force.

I know this claim sounds strange. It seems to anthropomorphize stuff that is clearly not human. How can a toaster want? Aren't I assigning way too much consciousness to inanimate objects, and by doing so giving them more power over us than they have, or should have?

It's a fair question. But "want" is not just for humans. Your dog wants to play Frisbee. Your cat wants to be scratched. Birds want mates. Worms want moisture. Bacteria want food. The wants of a microscopic, single-celled organism are less complex, less demanding, and fewer in number than the wants of you or me, but all organisms share a few fundamental desires: to survive, to grow. All are driven by these "wants." The wants of a protozoan are unconscious, unarticulated—more like an urge or a tendency. A bacterium tends to drift toward nutrients with no awareness of its needs. In a dim way it chooses to satisfy its wants by heading one way and not another.

With the technium, *want* does not mean thoughtful decisions. I don't believe the technium is conscious (at this point). Its mechanical wants are not carefully considered deliberations but rather tendencies. Leanings. Urges. Trajectories. The wants of technology are closer to needs, a compulsion toward something. Just like the unconscious drift of a sea cucumber as it seeks a mate. The millions of amplifying relationships and countless circuits of influence among parts push the whole technium in certain unconscious directions.

Technology's wants can often seem abstract or mysterious, but occasionally, these days, you can see them right in front of you. Recently I visited a start-up called Willow Garage in a leafy suburban tract not far from Stanford University. The company creates state-of-the-art research robots. Willow's latest version of a

personal robot, called PR2, stands about chest high, runs on four wheels, and has five eyes and two massive arms. When you take hold of one of its arms, it is neither rigid at the joints nor limp. It responds in a supple manner, with a gentle give, as if the limb were alive. It's an uncanny sensation. Yet the robot's grip is as deliberate as yours. In the spring of 2009, PR2 completed a full 26.2-mile marathon circuit in the building without crashing into obstacles. In robotdom, this is a huge accomplishment. But PR2's most notable achievement is its ability to find a power outlet and plug itself in. It's been programmed to look for its own power, but the specific path it takes emerges as it overcomes obstacles. So when it gets hungry, it searches for one of a dozen available power sockets in the building to recharge its batteries. It grabs its cord with one of its hands, uses its laser and optical eyes to line up a socket, and after gently probing the outlet in a small spiral pattern to find the exact slots, pushes its plug in to get fueled. It then sucks up power there for a couple of hours. Before the software was perfected, a few unexpected "wants" emerged. One robot craved plugging in even when its batteries were full, and once a PR2 took off without properly unplugging, dragging its cord behind it, like a forgetful motorist pulling out of the gas station with the pump hose still in the tank. As its behavior becomes more complex, so will its desires. If you stand in front of a PR2 while it is hungry, it won't hurt you. It will back-track and go around the building any way it can to find a plug. It's not conscious, but standing between it and its power outlet, you can clearly feel its want.

There is a nest of ants somewhere beneath my family's house. The ants, if we let them—and we won't—would carry off most of the food in our pantry. We humans are obliged to obey nature, except that sometimes we are forced to thwart it. While we bow to nature's beauty, we also frequently take out a machete and temporarily hack it back. We weave clothes to keep the natural world away from us, and we concoct vaccines to inoculate us against its mortal diseases. We rush to the wilderness to be rejuvenated, but we bring our tents.

The technium is now as great a force in our world as nature, and our response to the technium should be similar to our response to nature. We can't demand that technology obey us any more than we can demand that life obey us.

Sometimes we should surrender to its lead and bask in its abundance, and sometimes we should try to bend its natural course to meet our own. We don't have to do everything that the technium demands, but we can learn to work with this force rather than against it.

And to do that successfully, we first need to understand technology's behavior. In order to decide how to respond to technology, we have to figure out what technology wants.

After a long journey, that is where I have ended up. By listening to what technology wants, I feel that I have been able to find a framework to guide me through this rising web of hatching technologies. Seeing our world through technology's eyes has, for me, illuminated its larger purpose. And recognizing what it wants has reduced much of my own conflict in deciding where to place myself in its embrace. This book is my report on what technology wants. My hope is that it will help others find their own way to optimize technology's blessings and minimize its costs.