

movies, musicians and music, but the way by which they are distributed has changed, thereby requiring massive restructuring of their corresponding industries. Electronic games, another radical innovation, are combining with film and video on the one hand, and books on the other, to form new types of interactive engagement. The collapsing of industries is still taking place, and what will replace them is not yet clear.

Radical innovation is what many people seek, for it is the big, spectacular form of change. But most radical ideas fail, and even those that succeed can take decades and, as this chapter has already illustrated, they may take centuries to succeed. Incremental product innovation is difficult, but these difficulties pale to insignificance compared to the challenges faced by radical innovation. Incremental innovations occur by the millions each year; radical innovation is far less frequent.

What industries are ready for radical innovation? Try education, transportation, medicine, and housing, all of which are overdue for major transformation.

The Design of Everyday Things: 1988–2038

Technology changes rapidly, people and culture change slowly.
Or as the French put it:

Plus ça change, plus c'est la même chose.

The more things change, the more they are the same.

Evolutionary change to people is always taking place, but the pace of human evolutionary change is measured in thousands of years. Human cultures change somewhat more rapidly over periods measured in decades or centuries. Microcultures, such as the way by which teenagers differ from adults, can change in a generation. What this means is that although technology is continually introducing new means of doing things, people are resistant to changes in the way they do things.

Consider three simple examples: social interaction, communication, and music. These represent three different human activities, but each is so fundamental to human life that all three have persisted throughout recorded history and will persist, despite major changes in the technologies that support these activities. They are akin to eating: new technologies will change the types of food we eat and the way it is prepared, but will never eliminate the need to eat. People often ask me to predict “the next great change.” My answer is to tell them to examine some fundamentals, such as social interaction, communication, sports and play, music and entertainment. The changes will take place within spheres of activity such as these. Are these the only fundamentals? Of course not: add education (and learning), business (and commerce), transportation, self-expression, the arts, and of course, sex. And don’t forget important sustaining activities, such as the need for good health, food and drink, clothing, and housing. Fundamental needs will also stay the same, even if they get satisfied in radically different ways.

The Design of Everyday Things was first published in 1988 (when it was called *The Psychology of Everyday Things*). Since the original publication, technology has changed so much that even though the principles remained constant, many of the examples from 1988 are no longer relevant. The technology of interaction has changed. Oh yes, doors and switches, faucets and taps still provide the same difficulties they did back then, but now we have new sources of difficulties and confusion. The same principles that worked before still apply, but this time they must also be applied to intelligent machines, to the continuous interaction with large data sources, to social networks and to communication systems and products that enable lifelong interaction with friends and acquaintances across the world.

We gesture and dance to interact with our devices, and in turn they interact with us via sound and touch, and through multiple displays of all sizes—some that we wear; some on the floor, walls, or ceilings; and some projected directly into our eyes. We speak to our devices and they speak back. And as they get more and more intelligent, they take over many of the activities we thought that

only people could do. Artificial intelligence pervades our lives and devices, from our thermostats to our automobiles. Technologies are always undergoing change.

AS TECHNOLOGIES CHANGE WILL PEOPLE STAY THE SAME?

As we develop new forms of interaction and communication, what new principles are required? What happens when we wear augmented reality glasses or embed more and more technology within our bodies? Gestures and body movements are fun, but not very precise.

For many millennia, even though technology has undergone radical change, people have remained the same. Will this hold true in the future? What happens as we add more and more enhancements inside the human body? People with prosthetic limbs will be faster, stronger, and better runners or sports players than normal players. Implanted hearing devices and artificial lenses and corneas are already in use. Implanted memory and communication devices will mean that some people will have permanently enhanced reality, never lacking for information. Implanted computational devices could enhance thinking, problem-solving, and decision-making. People might become cyborgs: part biology, part artificial technology. In turn, machines will become more like people, with neural-like computational abilities and humanlike behavior. Moreover, new developments in biology might add to the list of artificial supplements, with genetic modification of people and biological processors and devices for machines.

All of these changes raise considerable ethical issues. The long-held view that even as technology changes, people remain the same may no longer hold. Moreover, a new species is arising, artificial devices that have many of the capabilities of animals and people, sometimes superior abilities. (That machines might be better than people at some things has long been true: they are clearly stronger and faster. Even the simple desk calculator can do arithmetic better than we can, which is why we use them. Many computer programs can do advanced mathematics better than we can, which

makes them valuable assistants.) People are changing; machines are changing. This also means that cultures are changing.

There is no question that human culture has been vastly impacted by the advent of technology. Our lives, our family size and living arrangements, and the role played by business and education in our lives are all governed by the technologies of the era. Modern communication technology changes the nature of joint work. As some people get advanced cognitive skills due to implants, while some machines gain enhanced human-qualities through advanced technologies, artificial intelligence, and perhaps bionic technologies, we can expect even more changes. Technology, people, and cultures: all will change.

THINGS THAT MAKE US SMART

Couple the use of full-body motion and gestures with high-quality auditory and visual displays that can be superimposed over the sounds and sights of the world to amplify them, to explain and annotate them, and we give to people power that exceeds anything ever known before. What do the limits of human memory mean when a machine can remind us of all that has happened before, at precisely the exact time the information is needed? One argument is that technology makes us smart: we remember far more than ever before and our cognitive abilities are much enhanced.

Another argument is that technology makes us stupid. Sure, we look smart with the technology, but take it away and we are worse off than before it existed. We have become dependent upon our technologies to navigate the world, to hold intelligent conversation, to write intelligently, and to remember.

Once technology can do our arithmetic, can remember for us, and can tell us how to behave, then we have no need to learn these things. But the instant the technology goes away, we are left helpless, unable to do any basic functions. We are now so dependent upon technology that when we are deprived, we suffer. We are unable to make our own clothes from plants and animal skins, unable to grow and harvest crops or catch animals. Without technology, we would starve or freeze to death. Without

cognitive technologies, will we fall into an equivalent state of ignorance?

These fears have long been with us. In ancient Greece, Plato tells us that Socrates complained about the impact of books, arguing that reliance on written material would diminish not only memory but the very need to think, to debate, to learn through discussion. After all, said Socrates, when a person tells you something, you can question the statement, discuss and debate it, thereby enhancing the material and the understanding. With a book, well, what can you do? You can't argue back.

But over the years, the human brain has remained much the same. Human intelligence has certainly not diminished. True, we no longer learn how to memorize vast amounts of material. We no longer need to be completely proficient at arithmetic, for calculators—present as dedicated devices or on almost every computer or phone—take care of that task for us. But does that make us stupid? Does the fact that I can no longer remember my own phone number indicate my growing feebleness? No, on the contrary, it unleashes the mind from the petty tyranny of tending to the trivial and allows it to concentrate on the important and the critical.

Reliance on technology is a benefit to humanity. With technology, the brain gets neither better nor worse. Instead, it is the task that changes. Human plus machine is more powerful than either human or machine alone.

The best chess-playing machine can beat the best human chess player. But guess what, the combination of human plus machine can beat the best human and the best machine. Moreover, this winning combination need not have the best human or machine. As MIT professor Erik Brynjolfsson explained at a meeting of the National Academy of Engineering:

The best chess player in the world today is not a computer or a human but a team of humans and computers working together. In freestyle chess competitions, where teams of humans and computers compete,

the winners tend not to be the teams with the most powerful computers or the best chess players. The winning teams are able to leverage the unique skills of humans and computers to work together. That is a metaphor for what we can do going forward: have people and technology work together in new ways to create value. (Brynjolfsson, 2012.)

Why is this? Brynjolfsson and Andrew McAfee quote the world-champion human chess player Gary Kasparov, explaining why “the overall winner in a recent freestyle tournament had neither the best human players nor the most powerful computers.” Kasparov described a team consisting of:

a pair of amateur American chess players using three computers at the same time. Their skill at manipulating and “coaching” their computers to look very deeply into positions effectively counteracted the superior chess understanding of their grandmaster opponents and the greater computational power of other participants. Weak human + machine + better process was superior to a strong computer alone and, more remarkably, superior to a strong human + machine + inferior process. (Brynjolfsson & McAfee, 2011.)

Moreover, Brynjolfsson and McAfee argue that the same pattern is found in many activities, including both business and science: “The key to winning the race is not to compete against machines but to compete with machines. Fortunately, humans are strongest exactly where computers are weak, creating a potentially beautiful partnership.”

The cognitive scientist (and anthropologist) Edwin Hutchins of the University of California, San Diego, has championed the power of distributed cognition, whereby some components are done by people (who may be distributed across time and space); other components, by our technologies. It was he who taught me how powerful this combination makes us. This provides the answer to the question: Does the new technology make us stupid? No, on the contrary, it changes the tasks we do. Just as the best chess player is a combination of human and technology, we, in combination

with technology, are smarter than ever before. As I put it in my book *Things That Make Us Smart*, the power of the unaided mind is highly overrated. It is things that make us smart.

*The power of the unaided mind is highly overrated. Without external aids, deep, sustained reasoning is difficult. Unaided memory, thought, and reasoning are all limited in power. Human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits. The real powers come from devising external aids that enhance cognitive abilities. How have we increased memory, thought and reasoning? By the invention of external aids: it is things that make us smart. Some assistance comes through cooperative, social behavior: some arises through exploitation of the information present in the environment; and some comes through the development of tools of thought—cognitive artifacts—that complement abilities and strengthen mental powers. (The opening paragraph of Chapter 3, *Things That Make Us Smart*, 1993.)*

The Future of Books

It is one thing to have tools that aid in writing conventional books, but quite another when we have tools that dramatically transform the book.

Why should a book comprise words and some illustrations meant to be read linearly from front to back? Why shouldn't it be composed of small sections, readable in whatever order is desired? Why shouldn't it be dynamic, with video and audio segments, perhaps changing according to who is reading it, including notes made by other readers or viewers, or incorporating the author's latest thoughts, perhaps changing even as it is being read, where the word *text* could mean anything: voice, video, images, diagrams, and words?

Some authors, especially of fiction, might still prefer the linear telling of tales, for authors are storytellers, and in stories, the order in which characters and events are introduced is important to build the suspense, keep the reader enthralled, and manage the emotional highs and lows that characterize great storytelling. But

for nonfiction, for books like this one, order is not as important. This book does not attempt to manipulate your emotions, to keep you in suspense, or to have dramatic peaks. You should be able to experience it in the order you prefer, reading items out of sequence and skipping whatever is not relevant to your needs.

Suppose this book were interactive? If you have trouble understanding something, suppose you could click on the page and I would pop up and explain something. I tried that many years ago with three of my books, all combined into one interactive electronic book. But the attempt fell prey to the demons of product design: good ideas that appear too early will fail.

It took a lot of effort to produce that book. I worked with a large team of people from Voyager Books, flying to Santa Monica, California, for roughly a year of visits to film the excerpts and record my part. Robert Stein, the head of Voyager, assembled a talented team of editors, producers, videographers, interactive designers, and illustrators. Alas, the result was produced in a computer system called HyperCard, a clever tool developed by Apple but never really given full support. Eventually, Apple stopped supporting it and today, even though I still have copies of the original disks, they will not run on any existing machine. (And even if they could, the video resolution is very poor by today's standards.)

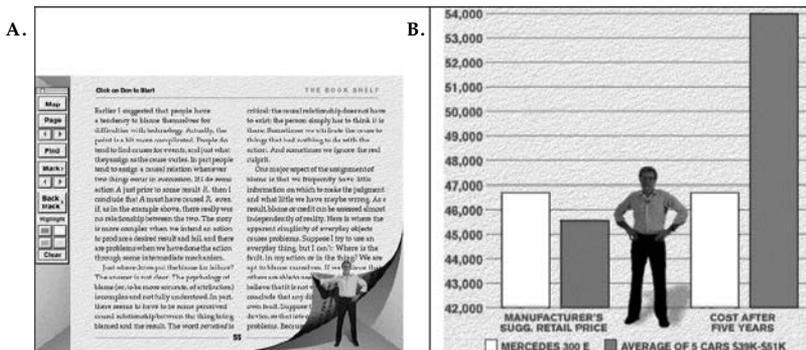


FIGURE 7.5. The Voyager Interactive Electronic Book. Figure A, on the left, is me stepping on to a page of *The Design of Everyday Things*. Figure B, on the right, shows me explaining a point about graph design in my book *Things That Make Us Smart*.

Notice the phrase “it took a lot of effort to produce that book.” I don’t even remember how many people were involved, but the credits include the following: editor-producer, art director–graphic designer, programmer, interface designers (four people, including me), the production team (twenty-seven people), and then special thanks to seventeen people.

Yes, today anybody can record a voice or video essay. Anyone can shoot a video and do simple editing. But to produce a professional-level multimedia book of roughly three hundred pages or two hours of video (or some combination) that will be read and enjoyed by people across the world requires an immense amount of talent and a variety of skills. Amateurs can do a five- or ten-minute video, but anything beyond that requires superb editing skills. Moreover, there has to be a writer, a cameraperson, a recording person, and a lighting person. There has to be a director to coordinate these activities and to select the best approach to each scene (chapter). A skilled editor is required to piece the segments together. An electronic book on the environment, Al Gore’s interactive media book *Our Choice* (2011), lists a large number of job titles for the people responsible for this one book: publishers (two people), editor, production director, production editor, and production supervisor, software architect, user interface engineer, engineer, interactive graphics, animations, graphics design, photo editor, video editors (two), videographer, music, and cover designer. What is the future of the book? Very expensive.

The advent of new technologies is making books, interactive media, and all sorts of educational and recreational material more effective and pleasurable. Each of the many tools makes creation easier. As a result, we will see a proliferation of materials. Most will be amateurish, incomplete, and somewhat incoherent. But even amateur productions can serve valuable functions in our lives, as the immense proliferation of homemade videos available on the Internet demonstrate, teaching us everything from how to cook Korean *pajeon*, repair a faucet, or understand Maxwell’s equations of electromagnetic waves. But for high-quality professional material that tells a coherent story in a way that is reliable, where the

facts have been checked and the message authoritative, where the material will flow, experts are needed. The mix of technologies and tools makes quick and rough creation easier, but polished and professional level material much more difficult. The society of the future: something to look forward to with pleasure, contemplation, and dread.

The Moral Obligations of Design

That design affects society is hardly news to designers. Many take the implications of their work seriously. But the conscious manipulation of society has severe drawbacks, not the least of which is the fact that not everyone agrees on the appropriate goals. Design, therefore, takes on political significance; indeed, design philosophies vary in important ways across political systems. In Western cultures, design has reflected the capitalistic importance of the marketplace, with an emphasis on exterior features deemed to be attractive to the purchaser. In the consumer economy, taste is not the criterion in the marketing of expensive foods or drinks, usability is not the primary criterion in the marketing of home and office appliances. We are surrounded with objects of desire, not objects of use.

NEEDLESS FEATURES, NEEDLESS MODELS: GOOD FOR BUSINESS, BAD FOR THE ENVIRONMENT

In the world of consumable products, such as food and news, there is always a need for more food and news. When the product is consumed, then the customers are consumers. A never-ending cycle. In the world of services, the same applies. Someone has to cook and serve the food in a restaurant, take care of us when we are sick, do the daily transactions we all need. Services can be self-sustaining because the need is always there.

But a business that makes and sells durable goods faces a problem: As soon as everyone who wants the product has it, then there is no need for more. Sales will cease. The company will go out of business.

In the 1920s, manufacturers deliberately planned ways of making their products become obsolete (although the practice had existed

long before then). Products were built with a limited life span. Automobiles were designed to fall apart. A story tells of Henry Ford's buying scrapped Ford cars and having his engineers disassemble them to see which parts failed and which were still in good shape. Engineers assumed this was done to find the weak parts and make them stronger. Nope. Ford explained that he wanted to find the parts that were still in good shape. The company could save money if they redesigned these parts to fail at the same time as the others.

Making things fail is not the only way to sustain sales. The women's clothing industry is an example: what is fashionable this year is not next year, so women are encouraged to replace their wardrobe every season, every year. The same philosophy was soon extended to the automobile industry, where dramatic style changes on a regular basis made it obvious which people were up to date; which people were laggards, driving old-fashioned vehicles. The same is true for our smart screens, cameras, and TV sets. Even the kitchen and laundry, where appliances used to last for decades, have seen the impact of fashion. Now, out-of-date features, out-of-date styling, and even out-of-date colors entice homeowners to change. There are some gender differences. Men are not as sensitive as women to fashion in clothes, but they more than make up for the difference by their interest in the latest fashions in automobiles and other technologies.

But why purchase a new computer when the old one is functioning perfectly well? Why buy a new cooktop or refrigerator, a new phone or camera? Do we really need the ice cube dispenser in the door of the refrigerator, the display screen on the oven door, the navigation system that uses three-dimensional images? What is the cost to the environment for all the materials and energy used to manufacture the new products, to say nothing of the problems of disposing safely of the old?

Another model for sustainability is the subscription model. Do you have an electronic reading device, or music or video player? Subscribe to the service that provides articles and news, music and entertainment, video and movies. These are all consumables, so

even though the smart screen is a fixed, durable good, the subscription guarantees a steady stream of money in return for services. Of course this only works if the manufacturer of the durable good is also the provider of services. If not, what alternatives are there?

Ah, the model year: each year a new model can be introduced, just as good as the previous year's model, only claiming to be better. It always increases in power and features. Look at all the new features. How did you ever exist without them? Meanwhile, scientists, engineers, and inventors are busy developing yet newer technologies. Do you like your television? What if it were in three dimensions? With multiple channels of surround sound? With virtual goggles so you are surrounded by the images, 360 degrees' worth? Turn your head or body and see what is happening behind you. When you watch sports, you can be inside the team, experiencing the game the way the team does. Cars not only will drive themselves to make you safer, but provide lots of entertainment along the way. Video games will keep adding layers and chapters, new story lines and characters, and of course, 3-D virtual environments. Household appliances will talk to one another, telling remote households the secrets of our usage patterns.

The design of everyday things is in great danger of becoming the design of superfluous, overloaded, unnecessary things.

Design Thinking and Thinking About Design

Design is successful only if the final product is successful—if people buy it, use it, and enjoy it, thus spreading the word. A design that people do not purchase is a failed design, no matter how great the design team might consider it.

Designers need to make things that satisfy people's needs, in terms of function, in terms of being understandable and usable, and in terms of their ability to deliver emotional satisfaction, pride, and delight. In other words, the design must be thought of as a total experience.

But successful products need more than a great design. They have to be able to be produced reliably, efficiently, and on schedule. If the design complicates the engineering requirements so much that they cannot be realized within the cost and scheduling constraints, then the design is flawed. Similarly, if manufacturing cannot produce the product, then the design is flawed.

Marketing considerations are important. Designers want to satisfy people's needs. Marketing wants to ensure that people actually buy and use the product. These are two different sets of requirements: design must satisfy both. It doesn't matter how great the design is if people don't buy it. And it doesn't matter how many people buy something if they are going to dislike it when they start using it. Designers will be more effective as they learn more about sales and marketing, and the financial parts of the business.

Finally, products have a complex life cycle. Many people will need assistance in using a device, either because the design or the manual is not clear, or because they are doing something novel that was not considered in the product development, or for numerous other reasons. If the service provided to these people is inadequate, the product will suffer. Similarly if the device must be maintained, repaired, or upgraded, how this is managed affects people's appreciation of the product.

In today's environmentally sensitive world, the full life cycle of the product must be taken into consideration. What are the environmental costs of the materials, of the manufacturing process, of distribution, servicing, and repairs? When it is time to replace the unit, what is the environmental impact of recycling or otherwise reusing the old?

The product development process is complex and difficult. But to me, that is why it can be so rewarding. Great products pass through a gauntlet of challenges. To satisfy the myriad needs requires skill as well as patience. It requires a combination of high technical skills, great business skills, and a large amount of personal social skills for interacting with the many other groups that

are involved, all of whom have their own agendas, all of which believe their requirements to be critical.

Design consists of a series of wonderful, exciting challenges, with each challenge being an opportunity. Like all great drama, it has its emotional highs and lows, peaks and valleys. The great products overcome the lows and end up high.

Now you are on your own. If you are a designer, help fight the battle for usability. If you are a user, then join your voice with those who cry for usable products. Write to manufacturers. Boycott unusable designs. Support good designs by purchasing them, even if it means going out of your way, even if it means spending a bit more. And voice your concerns to the stores that carry the products; manufacturers listen to their customers.

When you visit museums of science and technology, ask questions if you have trouble understanding. Provide feedback about the exhibits and whether they work well or poorly. Encourage museums to move toward better usability and understandability.

And enjoy yourself. Walk around the world examining the details of design. Learn how to observe. Take pride in the little things that help: think kindly of the person who so thoughtfully put them in. Realize that even details matter, that the designer may have had to fight to include something helpful. If you have difficulties, remember, it's not your fault: it's bad design. Give prizes to those who practice good design: send flowers. Jeer those who don't: send weeds.

Technology continually changes. Much is for the good. Much is not. All technology can be used in ways never intended by the inventors. One exciting development is what I call "the rise of the small."

THE RISE OF THE SMALL

I dream of the power of individuals, whether alone or in small groups, to unleash their creative spirits, their imagination, and their talents to develop a wide range of innovation. New technologies promise to make this possible. Now, for the first time

in history, individuals can share their ideas, their thoughts and dreams. They can produce their own products, their own services, and make these available to anyone in the world. All can be their own master, exercising whatever special talents and interests they may have.

What drives this dream? The rise of small, efficient tools that empower individuals. The list is large and growing continuously. Consider the rise of musical explorations through conventional, electronic, and virtual instruments. Consider the rise of self-publishing, bypassing conventional publishers, printers and distributors, and replacing these with inexpensive electronic editions available to anyone in the world to download to e-book readers.

Witness the rise of billions of small videos, available to all. Some are simply self-serving, some are incredibly educational, and some are humorous, some serious. They cover everything from how to make spätzle to how to understand mathematics, or simply how to dance or play a musical instrument. Some films are purely for entertainment. Universities are getting into the act, sharing whole curricula, including videos of lectures. College students post their class assignments as videos and text, allowing the whole world to benefit from their efforts. Consider the same phenomenon in writing, reporting events, and the creation of music and art.

Add to these capabilities the ready availability of inexpensive motors, sensors, computation, and communication. Now consider the potential when 3-D printers increase in performance while decreasing in price, allowing individuals to manufacture custom items whenever they are required. Designers all over the world will publish their ideas and plans, enabling entire new industries of custom mass production. Small quantities can be made as inexpensively as large, and individuals might design their own items or rely on an ever-increasing number of freelance designers who will publish plans that can then be customized and printed at local 3-D print shops or within their own homes.

Consider the rise of specialists to help plan meals and cook them, to modify designs to fit needs and circumstances, to tutor on a

wide variety of topics. Experts share their knowledge on blogs and on Wikipedia, all out of altruism, being rewarded by the thanks of their readers.

I dream of a renaissance of talent, where people are empowered to create, to use their skills and talents. Some may wish for the safety and security of working for organizations. Some may wish to start new enterprises. Some may do this as hobbies. Some may band together into small groups and cooperatives, the better to assemble the variety of skills required by modern technology, to help share their knowledge, to teach one another, and to assemble the critical mass that will always be needed, even for small projects. Some may hire themselves out to provide the necessary skills required of large projects, while still keeping their own freedom and authority.

In the past, innovation happened in the industrialized nations and with time, each innovation became more powerful, more complex, often bloated with features. Older technology was given to the developing nations. The cost to the environment was seldom considered. But with the rise of the small, with new, flexible, inexpensive technologies, the power is shifting. Today, anyone in the world can create, design, and manufacture. The newly developed nations are taking advantage, designing and building by themselves, for themselves. Moreover, out of necessity they develop advanced devices that require less power, that are simpler to make, maintain, and use. They develop medical procedures that don't require refrigeration or continual access to electric power. Instead of using handed-down technology, their results add value for all of us—call it handed-up technology.

With the rise of global interconnection, global communication, powerful design, and manufacturing methods that can be used by all, the world is rapidly changing. Design is a powerful equalizing tool: all that is needed is observation, creativity, and hard work—anyone can do it. With open-source software, inexpensive open-source 3-D printers, and even open-source education, we can transform the world.

**AS THE WORLD CHANGES,
WHAT STAYS THE SAME?**

With massive change, a number of fundamental principles stay the same. Human beings have always been social beings. Social interaction and the ability to keep in touch with people across the world, across time, will stay with us. The design principles of this book will not change, for the principles of discoverability, of feedback, and of the power of affordances and signifiers, mapping, and conceptual models will always hold. Even fully autonomous, automatic machines will follow these principles for their interactions. Our technologies may change, but the fundamental principles of interaction are permanent.