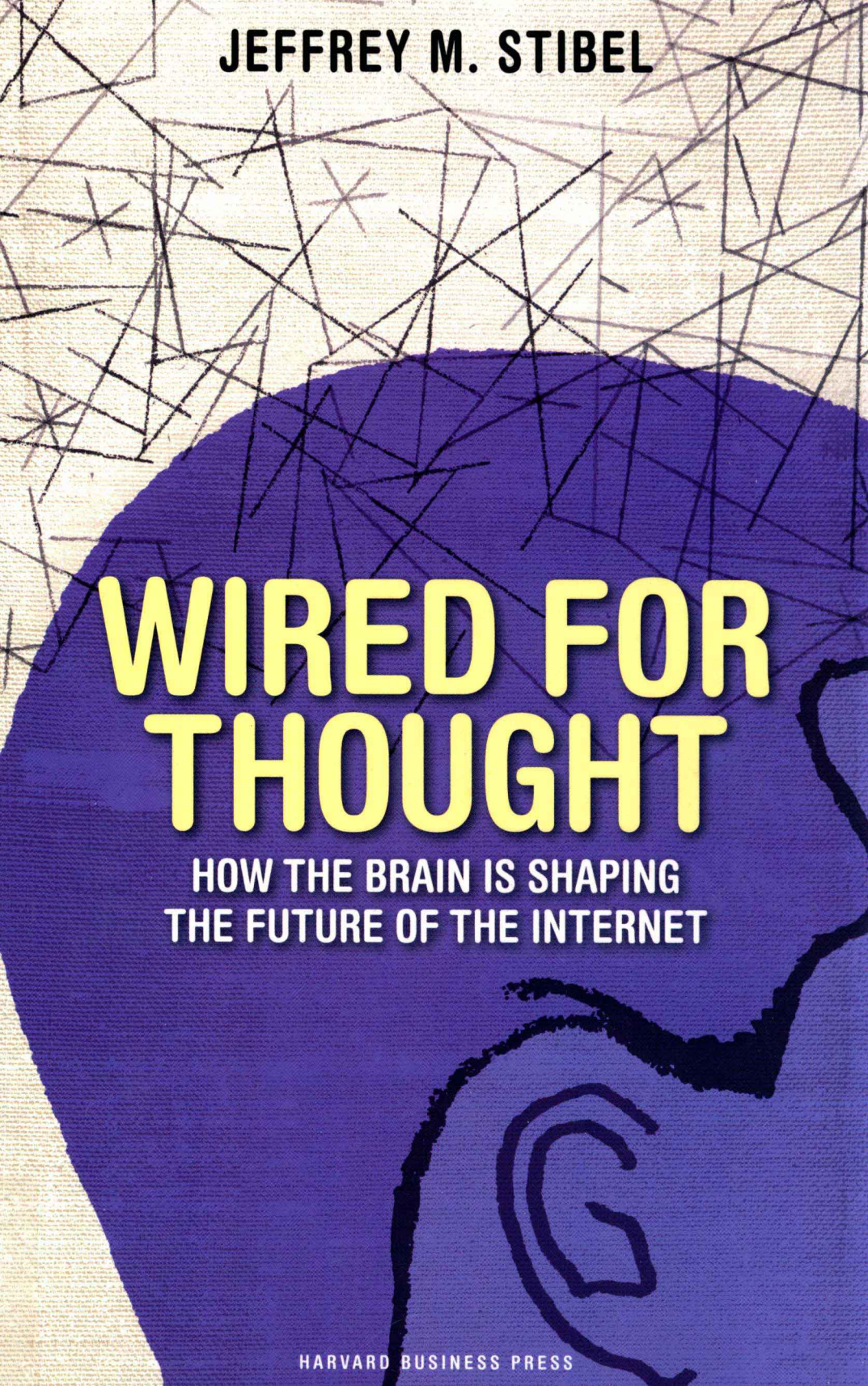
JEFFREY M. STIBEL



WIRED FOR THOUGHT

HOW THE BRAIN IS SHAPING THE FUTURE OF THE INTERNET

HARVARD BUSINESS PRESS

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How the Brain Is Shaping the Future of the Internet

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"I was mesmerized by this book—I could not put it down. The concepts relating the brain to the development of the Internet were a combination of vision and science fiction. The anecdotes and examples are so compelling that you cannot stop reading until the last page."

—Pamela Goldberg, Program Director, Entrepreneurial Leadership Program, Tufts University

"*Wired for Thought* is an important work for those executives who want both a framework for thinking about the Internet's potential and the context to understand why the great successes and failures of the web so far are just the beginning. Jeff Stibel takes you 'back to the future' with the first real look at how artificial intelligence will drive the way the Internet looks, feels, and functions . . . Web 3.0–6.0, here we come!"

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"In the 1930s, the French Jesuit and paleontologist Teilhard de Chardin wrote that humans would one day be connected by one central nervous system. Now Jeff Stibel has given that system a name—the Internet. By putting the familiar world of search engines and click-throughs into its proper historical and biological context, Stibel's book opens a whole range of fascinating possibilities and predictions about the future. Truly a work of philosophy and science, Stibel's *Wired for Thought* is also a practical business book, explaining how our collective brain will work in the future and how organizations can take advantage of it."

—Dick Morris, Chief Strategist to President Bill Clinton, and bestselling author of *Behind the Oval Office*, *Outrage,* and *Fleeced*

"*Wired for Thought* is fascinating, fun to read, and very accessible. It gave me new insights and strengthened my understanding of both the brain and the Internet."

—Ellen Marram, Board of Directors, the *New York Times*, Eli Lilly, and Ford; former President and CEO, Nabisco

To Dennett and Lincoln

PREFACE

BrainGate

IT IS IRONIC THAT MANY of humanity's achievements are rooted in a history of mistakes. This was true of Einstein's theory of relativity, many of the inventions of Thomas Edison, and numerous pharmaceutical drugs (such as penicillin and Viagra), and so, too, was it true of the most successful public offering in recent history.[1] Only weeks before Google's initial public offering in 2004, the company's founders made a critical error in judgment: they agreed to sit down for a magazine interview, something that typically is prohibited by the Securities and Exchange Commission (for fear that the information could be leaked or used to hype the stock). Beyond that, the interview was with *Playboy*, and that in and of itself was a bit troubling.[2]

But when SEC officials read the article, they dismissed it as harmless banter, clearing the way for one of the most successful IPOs in history.

Why did the SEC consider the article harmless? It was probably because one of Google's founders stated in the article that people would someday have direct access to the Internet through implants in their brains—allowing us to have "the entirety of the world's information as just one of our thoughts." That alone was likely enough for the SEC to assume that the founders of Google were nuts.

But the founders of Google aren't crazy. They understand both the Internet and the brain, and they know that an Internet implant could happen. The statement was forward thinking, certainly, but by no means foolish thinking. And as you read this book, you will quickly see that I share their enthusiasm for the convergence of the Internet and the brain. I even take their enthusiasm a few steps farther.

Imagine this: you are waking up. As your eyes focus, you see a white-haired man in a lab coat congratulating you on a successful surgery. You are still groggy from the anesthesia and can't quite remember what happened. The man enthusiastically explains that he is a scientist and that your surgery has previously been performed only on rats and rhesus monkeys. But with the help of a neurosurgeon, it has now been performed on yet another animal—a guinea pig—and that happens to be you.

Before you can gather your thoughts, the scientist makes an odd request: "Could you please turn off the lights?" As you look around the room, you don't see a light switch. But just as the thought crosses your mind, the lights go off. Smiling, he asks you to turn the lights back on. You think of it momentarily, and they snap

on. He smiles again. "The brain implant has worked!"

If this scenario seems like science fiction, I assure you that it has far more science than fiction. In fact, this technology exists today. The scientist is John Donoghue, chair of the Neuroscience Department at Brown University. He, along with his colleagues, has invented an implantable device called BrainGate that allows people to use their minds to control electronics such as computers.

I was introduced to BrainGate when I began my doctoral program in cognitive science at Brown. As I soon learned, the brain uses electrical and chemical charges to communicate with itself and the rest of the body. The idea behind BrainGate is actually quite simple: by tapping in to the electrical charges of the brain, doctors can position them outward to control other electrical devices, in the same way your TV remote allows you to change the channel without leaving your couch. After numerous animal trials (if you imagine monkeys running down the hallowed halls of Brown turning out the lights using brain waves, you will not be far off), BrainGate was approved by the FDA for clinical trials on humans. The immediate goal was to provide more mobility for those with severe dysfunction, such as quadriplegics and Parkinson's patients.

Once I became familiar with these ideas, I urged one of Donoghue's students to start a company. That company was quickly funded by a venture capitalist.[3] It started human trials and quietly made its debut on the NASDAQ exchange a few years later.[4] The first clinical trial in 2004 involved a paralyzed man who is now able to control a computer cursor with his mind. The lead surgeon, another professor at Brown, described the results as "almost unbelievable."[5] I suspect he added the word "almost" out of deference to Donoghue. Four other patients have since been implanted, all with remarkable

success. The results were published in the venerable journal *Nature* in 2006 (*Nature* had published the animal trials in 2002).[6]

Why does this story sound outrageous?[7] It is mainly because—as the doctor who performed the surgery has said—the idea is too hard to believe. We think of the brain as something beyond our comprehension, so we dismiss the notion that it obeys the laws of science. Here is the way CBS's *60 Minutes* put it when it featured BrainGate in 2008: "Once in a while, we run across a science story that is hard to believe until you see it. That's how we felt about this story when we first saw human beings operating computers, writing e-mails, and driving wheelchairs with nothing but their thoughts."[8]

The brain, however, is understandable. It is nothing more than a biological machine.

And that brings us back to the idea that the Google founders had. If we can implant a chip into our brains to turn on lights, can't we also implant a chip that allows us to remotely connect our brains to the Internet? That would give us access to virtually all of the world's information.

How would such a device affect what you think about memory? Would you still value rote memorization or be impressed by people who had photographic memories? Wouldn't you essentially have a perfect memory, limited only by your ability to retrieve information?

If you were able to connect to the Internet, you would also have access to millions of people, possibly through "mental" e-mail, Facebook, or instant messaging. If you couldn't find the information, you could ask someone, as if you were using a lifeline on *Who Wants to Be a Millionaire*. Would that change your notion of what intelligence is? Why value IQ when relationships are more powerful? After all, who is smarter when you have mental access to information—the person who knows all there is to know about quantum mechanics but nothing about nonlinear geometry, or the

person who has close friends in both fields and just enough knowledge to ask the right questions? How would this kind of intelligence affect your personal life, your professional life, your business?

All this raises another, more important question: could the Internet itself be made to perform more like the brain? Could it perform the functions of a brain—just as a mechanical hearing aid performs the function of the inner ear, or a contact lens performs the function of the cornea, or an artificial heart performs the function of that biological muscle?

My conviction that the Internet is evolving into a brain has been the foundation of my business career. It has given me a way to anticipate what will happen next; it has given me vision. In many ways, because I understand the brain, I feel as if I'm seeing a movie for the second time when it comes to the Internet.

Why is this perspective important? It's because you could spend your entire life trying to understand each of the thousands of Internet companies that have sprouted. You could analyze the permutations of each of them. But if instead you understand the brain—how thinking works—you will understand what is happening on the Internet: not only what is happening now but also what will happen in the future.

You may ask what you will gain by reading this book. My answer is this: you can take any phenomenon and study its parts for years, but until you step back far enough to see it in its entirety you will not understand how it works and where it may go. If you do not understand energy on a global scale, you will not understand the business by studying wires and power plants. If you do not understand international agribusiness, you won't get anywhere standing in a field of corn. And this same principle is true of the Internet and the constellation of innovations and business opportunities that surrounds it.

INTRODUCTION

The Internet Is a Brain

IN THE HISTORY OF LIVING THINGS, our species is unique in having invented devices that leverage and extend the powers of our own bodies. We have forged swords to extend the length and power of our arms; telescopes and cameras to extend the power of our eyes; artificial hearts to mimic the organic pumps that beat in our chests. We have come to understand that the human body can be reverse engineered. As Harvard psychologist Steven Pinker has said, "We understand the body as a wonderfully complex machine . . . The stuff of life turns out to be not a quivering, glowing, wondrous gel but a contraption of tiny jigs, springs, hinges, rods, sheets, magnets, zippers and trapdoors, assembled by a data tape (DNA) whose information is copied, downloaded and scanned."[1]

That description may be true of the body in general, but for a long time the brain was thought to be too mysterious to explain. We might create a pump in the image of the human heart, or a camera lens in the image of an eye, or even a hinge in the image of a bone joint. But what analogy could there be to the brain—a sticky, three-pound lump of wrinkled matter lying silently in the skull?

With computers, we have tried to find that analogy. We say that semiconductors switch on and off like neurons and that fibers of glass can transmit messages as do synapses and axons. Beyond that, however, we've come to a dead end. The computers we have built are not really as analogous to the human brain as, say, an artificial heart is to a real heart. A computer itself is not like a brain.

But then there is the Internet. With the Internet we have created something unlike anything humankind has built before. Steam locomotives, television sets, automobiles—they are all inert. Even chessboards and baseball stadiums, which flicker to life momentarily, go dark when the game is finished. But the Internet is not like that. It is unbounded, self-perpetuating, and capable of collective consciousness. It is more like the crowd in the baseball stadium than the ball game, more like the gambits of chess than the chessboard and the rules.

To be sure, every significant innovation is miraculous—a discovery that is more than the sum of its parts. Alexander Graham Bell attached two small drums to two solenoids, for instance, and out of those bits created something beyond the sum of the parts: transmission of the human voice. But the telephone did not go on to replicate and improve itself, by itself; the Internet can and does. And beyond that, the Internet learns. It processes information, shapes it, transmits it. It remembers some things, forgets others, and constantly loops whatever it has, spinning it in as many ways and as many directions as one could imagine.

For these reasons (and many more, as you will read in this book), I offer you this simple analogy: as the artificial pump is to the heart, as the camera is to the eye, and as the hinge is to the joint, I believe that the Internet is to the brain. In fact, I'll go one better than that. I believe that the Internet *is* a brain.

At first blush, that assertion may seem preposterous. The Internet is a brain? When I say the Internet is a brain, I don't mean that the Internet is that three-pound glob, all wrinkled like your toes when you climb out of a hot bath. I mean that the Internet is gradually gaining the ability to think. Now before you decide I'm writing the screenplay for a B-grade science fiction thriller, let me do some explaining. To understand why I believe that the Internet is a brain, you must first understand how I define the brain itself.

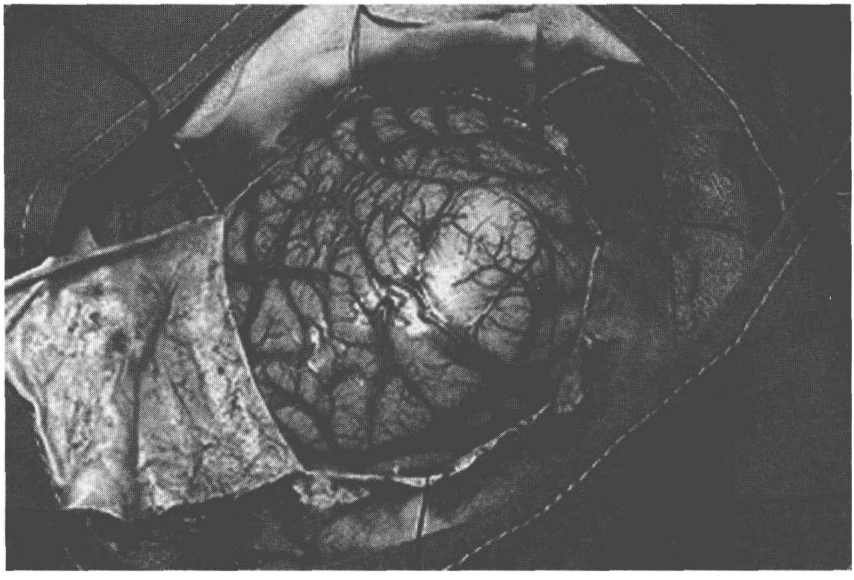
A Paper Model of the Brain

Most of my friends get their weekly dose of medical science from *Grey's Anatomy* and *ER*, so it is no surprise that they think of the brain as a sticky hunk of gray matter that looks like a chewed-up football. In reality the brain is nearly 60 percent white matter, with only the remainder being the gray stuff we typically think of. Except for the brain's deep ridges and two hemispheres, most people wouldn't recognize a brain if they were sitting next to one in an airport terminal. The brain is actually very soft, almost jellylike, ivory in color with deep red veins—more Bordeaux than Burgundy. The firm, gray brains we think of don't take on that form until they are actually dead, bloodless, preserved, and of little use to us (see figure I-1).

But even that description is misleading. In the way it thinks, the brain is far more similar to a legal-sized piece of paper (so I guess my friends would have been better off getting their science

FIGURE I-1

Picture of exposed meninges and brain during surgery (awake craniotomy)



Source: Reproduced with permission from Dr. Emil A. Popovic, MD (www.popovic.com.au).

from *L.A. Law* or *Law & Order)*. This piece of paper represents the outermost area of the brain, the *cerebral cortex*. It is here that most of the magic of thought takes place. Imagine this piece of paper: thin, rectangular, and blank (mostly) to start.[2] On the paper are bits of information that grow, like Braille embossed on the page, as the brain is formed. Those are the *neurons*, the brain's computing units, and they help to store and process information.

But what's intriguing is how the brain was designed physically to connect information. Suppose you place a number of dots at random on the page; if you imagine two dots at either end, they are far away from each other. Now if you crumple the paper into a ball, the two dots grow closer. If you crumple the page enough times, each point

will be within striking distance of every other point. Now you really understand the brain: it is uniquely powerful, because it enables connections between disparate pieces of information. It allows for quick communication. The brain is not fast in general—at least not compared with computers—but it makes up for its lack of speed by packing information tightly inside our skulls, like the crumpled paper.

From a computing standpoint, the human brain is a sophisticated *parallel processing* machine. This means that unlike *serial* computing—in which one thing happens, then another, and then another—in parallel processing a number of things can be happening at once. Neuroscientists call this *distributed computing*, meaning that because the functions of the brain are distributed all over the place, things happen simultaneously. (I think that *distributed computing* is a better term, because *parallel computing* conjures the idea of two unbending parallel lines—like railroad tracks—whereas *distributed* is a freewheeling image that describes more accurately how the brain actually works.)

A Brief History of the Brain

Six million years ago our brains were the size of chimps' brains. No surprise, these primitive brains gave us a chimp-like level of intelligence. But about 2.5 million years ago we had what has been dubbed "the Great Encephalization."[3] Over the next 150,000 years, our brains grew by 400 percent. This was good: as a result, not only were we hardwired to avoid danger (instinctively jumping out of the way), but also we had acquired a sense of anticipation (so that we could suspect that a four-legged creature with fangs was up to no good).

But something even better was beginning to happen: the human brain began to develop its *cerebral cortex*, a one-eighth-inch

mantle of about 10 billion neurons that, like a shower cap, fit tightly over the primitive brain. The cerebral cortex added another dimension to human intelligence: reasoning, introspection, and even the refined elements of emotion.

Now the human brain has about 100 billion neurons, or, as one researcher noted, the equivalent surface area of roughly four football fields (in comparison, the base of the great Pyramids in Egypt would only cover ten football fields).[4] Neurons consist of the soma, an axon, and dendrites. Think of the *soma* (and its nucleus) as the center of the neuron, or the information clearinghouse. The *axon* acts as a transmitter, sending information from one neuron to another. The *dendrites* receive information from other neurons. Neurons communicate with one another through electrical and chemical transmitters. Tightly packed, neurons work together in a distributed network, forming patterns that allow us to perform tasks such as walking, speaking, remembering someone's name, and even reading this book.

The most amazing fact about the brain, however, is that the brain is not very amazing. Like the rest of our bodies, it's made up of humble carbon molecules. There's no magical goo anywhere—no special place where our thoughts reside, not to mention our desires, ambitions, fears, dreams, aspirations. The brain is only a lump of axons and dendrites and other carbon-based stuff. For all my years in graduate school and all the books I've read on the brain, there ain't much more to it than that.

A Sacred Chalice

The fact that the brain is an ordinary organ—it's got nothing over the pancreas or the liver downtown—is actually a good thing