WORLD WIDE MIND

THE COMING INTEGRATION
of
HUMANS *and* MACHINES

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PROLOGUE

A Dead BlackBerry

> [H]uman nature was originally one and we were a whole, and the desire and pursuit of the whole is called love.
>
> —Plato, *The Symposium*

When my BlackBerry died I took it to a cell phone store in San Francisco's Mission district. I handed it over to the clerk the way I would give my cat Elvis to the vet.

"JVM 523," I said mournfully. When I'd woken up the screen was blank but for that cryptic error message.

The clerk called tech support while I wandered around the store, peering at cell phone covers and batteries. He beckoned me over ten minutes later.

"It's dead," he said.

"You can't just reload the operating system?"

"They say not."

"How can a software bug kill a BlackBerry?" I said. "It's just code."

He shrugged. He hadn't been hired for his ability to answer philosophical questions. But, he told me, for fifty bucks they could send me a new one overnight.

"All right," I said, and walked out, minus BlackBerry.

The stores were full of avocados and plantains, $15 knapsacks hanging from awnings, and rows of watches in grimy windows. Crinkly-faced

women pushed kids in strollers and grabbed their hands to keep them from pulling no-brand socks out of cardboard boxes. The world, whole and complete.

Except for my email, and the Internet. Just me and my lone self-contained body. I missed my BlackBerry's email, of course, but what I missed just as much was having the planet's information trove at my fingertips. I couldn't summon Google on the street and ask it questions. How high is this hill I'm climbing? What do the critics say about this movie? Where can I find camping equipment on Market Street? When is the next bus coming?

Most of all, I couldn't ask it, "Who is this person?"

I had asked it that question a few months earlier while visiting Gallaudet University, a school for the deaf in Washington, D.C. I wanted to see how American Sign Language dealt with fractions and cosines. So I was taken to visit a math class.

The professor was blond and flamingo-slender, with a snub nose. She spoke with the distinctive lisp of a high-frequency hearing loss. It was a warm spring day, with breezes tumbling in through an open window. I soon saw how fractions were done. She signed the numerator using a one-handed code for the numbers 1 through 9, dropped her hand an inch, then signed the denominator. As she discussed slopes, she gestured them in midair in a lovely hand jive of math and motion.

The class handout gave me her name: *Regina Nuzzo*. I unholstered my BlackBerry, held it under the desk at an angle, called up Google, and stealthily typed her name into it. I scrolled down the results with the thumbwheel. Ph.D. in statistics from Stanford. Postdoc at McGill, on analyzing fMRI data. Progressive hearing loss. And she was a science writer, too. She had just done a story on hybrid cochlear implants.

When I looked up she was sweeping her left hand in an arc, taking in all the students, tapping her thumb and index finger together. It was the ASL "do" sign, meaning, in combination with her tilted head and quizzical expression, "What shall we do now? What's next?"

Now I knew her background, her history, her interests. It gave her depth, dimension, a local habitation, and a name. I looked at her, thinking: *Wow, a deaf science writer. Just like me.*

Nosy? Invasive? Perhaps just a little. But I was a visitor from the other side of the country. Knowing something about her would help me smooth my way into a conversation. Anyway, I figured the day was coming when it would be considered rude *not* to Google someone upon meeting them. One could discover mutual interests so much more quickly that way.

I went up to her after class to ask her about the complexities of teaching math in American Sign Language. It was easy to steer the conversation to our mutual interest in writing. Our conversation began that day, both by email and in person, and it has never stopped.

But when I was standing in the Mission District amidst the ruckus of faded awnings and shouting children, all that was in the past. I missed my BlackBerry. I kept reaching for the holster, expecting to feel the device's rounded plastic edges and their slight warmth from my body. *Forget your Blackberry,* I told myself. *Look about you. Pay attention to the sights and smells of the world.*

I walked about, nosed into stores, and ate lunch at my favorite taqueria. But it troubled me how separate the two worlds of my experience were. My BlackBerry offered me an infinite supply of information and messages. The material world offered me infinite sensation and variety, and the faces and voices of my friends. It seemed altogether wrong that each world could be experienced only by excluding the other. Surely, I thought, there must be a way to bring them together.

CHAPTER 1

The Push-Pull Dynamic of Evolution

> What's among the top three most desired gifts for single men and women? A quality introduction to a prospective date. In fact, in recent research commissioned by Engage, the chance to meet someone special was more desired than a PlayStation, Xbox, or iPod.
>
> —From a spam ad for an online dating website, sent December 20, 2006.

In 2006 a spam email informed me that among single men and women, "the chance to meet someone special" just barely beat out the PlayStation, the Xbox, and the iPod. It was ridiculous enough to make me laugh out loud. But on reflection I decided that from the way people looked raptly at their screens and caressed their little keyboards, maybe it wasn't quite as ridiculous as it sounded. I loved my BlackBerry. If someone had offered to implant it in me so I could skip the thumb scrolling and typing, I would have said, "Tell me more."

I am already accustomed to implanted computers, because I have two. I am deaf and have a cochlear implant in each ear. Deafness is often caused by the loss of tiny filaments (called *hair cells*) in the inner ear. In a normal ear these filaments vibrate in response to sound and trigger the auditory nerves. I lost many of my hair cells before birth because my mother had had rubella, but I had enough hearing left to be able to use

hearing aids. However, in 2001 my one good ear died completely. It happened in about four hours. No one knows why.

My cochlear implant substitutes for the lost hair cells by directly triggering the auditory nerves with implanted electrodes. A surgeon drilled an inch and a half into my skull, countersunk a ceramic-encased microchip behind my left ear, and threaded sixteen electrodes into my inner ear. Now an external device sitting on my ear picks up sound, digitizes it, and radios a stream of 1s and 0s through my skin to the microchip. The chip receives the radio signal with a tiny antenna and decides how to strobe the electrodes on and off. By choosing which electrodes to fire at any given moment, it makes my auditory nerves transmit sound information to my brain.

Even though I have 280,000 transistors in my skull, more than in the CPU of my computer when I started grad school, they can't reproduce the functioning of a normal ear in all its subtlety and range. In fact, they stimulate the auditory nerves in a way that is quite different than in a normal ear. Because of that, I had to learn how to hear all over again. Voices sounded like gibberish at first. It took me months to learn how to interpret the software's representation of vowels and consonants as English.[1]

But I learned, and now I use radios and telephones easily again. My two implants make me irreversibly computational, a living example of the integration of humans and computers. So for me the thought of implanting something like a BlackBerry in my head is not so strange. It would not be so strange for a lot of people, I think. According to the *New York Times*, in 2009 the average teenage user sent or received 2,272 text messages per month. Assuming a sixteen-hour waking day, that's 76 messages per day, five per hour. And that's just an *average*. The article mentioned a girl who had sent or received 14,528 texts in a month, or 475 messages per day. If one hypothesizes that a relatively active user

1. This journey is described in my book *Rebuilt: How Becoming Part Computer Made Me More Human* (hardcover) and *Rebuilt: My Journey Back to the Hearing World* (softcover). The books are identical despite their differing subtitles.

sends 4,000 texts per month, that's 133 texts per day, or 8 per hour. Numbers like that suggests a seamless, continuous flow of messages woven throughout the day. Teenagers will text on their devices inside knapsacks during class, during restaurant meals, even while driving. That's dangerous and sometimes fatal, but the allure is so strong they cannot resist. And, of course, many adults behave the same way. This intense connectivity reveals a longing for fast, dense communication—one that current bodies and devices can only partly fulfill.

But few people, including me, would actually go to such measures simply to be able to text more efficiently. An implanted device would have to do much more than a BlackBerry. It would have to let people be effortlessly aware of what their friends and colleagues are doing. It would have to let them know what their friends are seeing and feeling, thus enabling much richer forms of communication. And people should be able to walk down the street savoring the richness of the world while also being aware, in the background of their minds, of the ceaseless hum of their friends' ideas and experiences.

Such a human-machine integration is far beyond current technology, of course. But technology advances *by* integrating. That is, when one system improves, it spurs improvement in other systems so they can keep up. When those systems improve, they in turn spur the first system to improve. The systems become increasingly dependent on each other. Their futures become mutually bound.

Take, for example, desktop computers and the software that runs them. Better computers let software engineers write bigger programs. Bigger programs create a demand for better computers. The computer manufacturers are happy to oblige, and the cycle starts all over again. A push is matched by a pull, which evokes a new push. That push-pull dynamic has rammed innovation into overdrive. For example, it took between 1900 and 1990 to develop computers that could perform one million instructions per second (MIPS) per thousand dollars. In 2005, computer manufacturers added an additional MIPS per thousand dollars to their computers *every five hours*.

A push-pull dynamic is hobbled, though, when one system can't improve as fast as the other. The Internet is improving very fast. The human body improves very slowly. Our hands evolved to grip spears and plows, and so can type only so many emails in a day. Our senses evolved to monitor a largely unchanging savannah for friends and predators, and so can pay attention to only a handful of events at a time. To be sure, some human attributes like IQ appear to have risen in the twentieth century, but the rate of increase is much slower than technology's. There is no Moore's Law for human beings.

This mismatch between humans and the Internet imposes inherent limits on how much either can improve. This is unfortunate, because they are a natural match for a push-pull dynamic driving each other upward. Their strengths are complementary. The Internet is fast, while humans are slow; capacious, while humans are forgetful. Conversely, humans are self-aware while the Internet isn't, and humans can interact with the physical world while the Internet can't. But they also have aligned strengths: they are both intensely networked, intensely communicative entities.

One way to overcome the separateness of humans and the Internet is to increase the speed and density of their information exchange. Nature has already solved an engineering challenge like this, in fact, in your own head. Your brain has two hemispheres, each of which controls the opposite side of your body. Your left hemisphere controls your right hand and the right side of your face, for instance. In a normal brain the two halves work together smoothly and efficiently because they are connected via the *corpus callosum,* a bundle of 200 to 250 million nerve fibers. Their separateness is overcome by what scientists call "massively parallel connectedness."

But if a surgeon severs the corpus callosum, as has sometimes been done in last-ditch attempts to control epilepsy, it soon becomes clear that the two hemispheres have very different desires and intentions. One hand buttons a shirt while the other simultaneously unbuttons it. One hand pulls down one's trousers, while the other pulls them back up. In

his book *The Bisected Brain* Michael Gazzaniga wrote that splitting the hemispheres "produces two separate, but equal, cognitive systems each with its own abilities to learn, emote, think, and act." In an intact brain the corpus callosum lets the hemispheres exchange so much data so quickly that functionally they behave as a unified brain. The rapidity and density of the connection effectively erases their differences.

But imagine that the two hemispheres were only weakly connected—by email, say. Then they could only send messages like this back and forth:

> From: Left motor cortex
> To: Right motor cortex
> Subject: Help me open this jar
> Importance: High
>
> Dear Right motor cortex,
> At 14:32:47.2 I gripped the peanut butter jar. Could you please grip the top and twist it to the right by 14.32:47.3? Please let me know how hard you start twisting, and I will email you back with how much I am tightening the grip. If the lid does not move, let's talk to the forebrain for additional strategic planning. I look forward to working with you on this.
>
> Thanks,
> Left motor cortex

Without a corpus callosum, the right and left halves of the brain would feel like, and *be,* separate entities. For any kind of unified consciousness to emerge from disparate parts, it needs fast and massively parallel communication. This is exactly what humans and the Internet lack. We are Paleolithics poking away at Pentiums.

But what if we built an electronic corpus callosum to bind us together? What if we eliminated the interface problem—the slow keyboards, the

sore fingers, the tiny screens, the clumsiness of point-and-click—by directly linking the Internet to the human brain? It would become seamlessly part of us, as natural and simple to use as our own hands.

The history of life on Earth shows that when new needs arise, evolution accommodates them by creating new structures. In the primeval Earth, single-celled creatures joined up to become multicelled ones, surrendering independence in exchange for collective power. CO_2-breathing plants cooperated with O_2-breathing animals to create a new biosphere in which each could evolve all the faster. Predators invented better ways to hunt, so prey invented better defenses, which forced predators to innovate yet again. When humans appeared the process picked up speed, with each cycle taking place in centuries rather than millennia. Plows led to better harvests, which gave people leisure time to invent better plows. Telegraphs let newspapers go national, which created a demand for better journalistic tools such as teletypewriters. New computer chips let electrical engineers create even faster chips. Each push triggers a pull, which sets the stage for another push.

This is the way evolution works. Increases in complexity and power are not accidental; they are *automatic*. Systems ratchet each other up in push-pull cycles, driving each other to higher levels of complexity and scope. We see this push-pull dynamic in so many contexts that some scientists argue there must be fundamental laws of nature, akin to those of thermodynamics, driving ecosystems to higher and higher levels of order. Progress via a push-pull dynamic appears to be woven into the very structure of life.[2]

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2. I have drawn the idea of a "push-pull dynamic" from Robert Wright's *Nonzero: The Logic of Human Destiny*. He concisely summarizes civilization's accelerating cycle of development on pages 4–7, and discusses it in detail throughout the book. (I find his phrase "non-zero-sumness" awkward, so I have used "push-pull dynamic" instead.) To be sure, there is considerable debate about whether there really is a "law" of nature driving species to greater complexity. Biologists frequently point out that evolution is a blind force that has no conscious goal; fitter organisms reproduce whether they are more complex or not. There are many examples of species that have remained static for millions of years (such as sharks) or even regressed, depending on one's point of view (whales are descended from land-dwelling four-legged mammals). On the other hand, life overall clearly *has* gotten more complex since it originated on earth. It's beyond my scope to defend the underpinnings of Wright's argument, but I think it is persuasive at

In today's world, the strongest push-pull dynamic in existence is the synergy between human beings and the Internet. The Internet constantly produces new tools—such as email, blogging, texting, YouTube, Twitter, the Kindle, and the iPad. People use them to amplify their powers by socializing and publishing in new ways. Money flows to developers, and even more tools are invented. Overdrive? More like strapping a rocket onto a sled careening downhill.

But as I said, the lack of a fast and efficient interface sets inherent limits on how much humans can do with the Internet. If human minds could work directly with the Internet, two grand unifications would happen at once. First, humans would become more closely connected with each other. As I will explain later in the book, we would have entirely new ways to sense each other's presence, moods, and needs. A person with a suitably wired brain could be aware of other people as if they were part of her own body, the same way she knows where her own fingers are. Second, humanity and its tool, the Internet, would become a single organism with entirely new powers. Not just a mere hybrid, but a new species in its own right.

To be sure, the Internet is a human invention reflecting human choices and values. However, it often looks *as if* it is a separate species with an internal logic of its own. The 1987 stock market crash has been blamed on program trading—computers that started selling frantically because every *other* computer was selling. The ceaseless war between viruses and antivirus programs looks eerily like the workings of a biological ecosystem. However, even if one posits that the Internet is comparable to a biological species, it's obvious that it's not very intelligent. It has primitive ways of "sensing" and "reacting," but it has no self-awareness and no ability to formulate its own goals. Nor, as I argue later, could it ever reach such a state on its own. It could, however, be the backbone of a sophisticated new organism if physically integrated with humanity. The Internet

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least for explaining the development of technological society. Whether or not there is a fundamental law of increasing complexity, there certainly seems to be the equivalent of such a law operating *now*, in human affairs. For a good overview of the arguments over the directionality of evolution, see Paul Davies's book *The Eerie Silence,* pp. 66–72.

would become a new nervous system for humanity, and humanity would become a new body and executive brain for the Internet.

Such a physical integration can now be discussed in a scientifically grounded way. It's like the way Jules Verne, in his 1865 novel *From the Earth to the Moon,* imagined launching a spaceship by firing it out of an enormous cannon. Verne underestimated the future development of rocketry, but he had the physics right. He explained the concept of escape velocity and correctly identified southern Florida as the best spot in the United States for launching a spacecraft. (Florida's nearness to the equator gives any projectile additional velocity as long as it is launched eastward.) He correctly explained that such a spacecraft must slow down as it leaves Earth and speed up as it nears the Moon, and got the duration of the voyage almost right, predicting four days (the Apollo astronauts did it in a little over three.) Because it was grounded in real science, Verne's novel was *conceptually* plausible. In the same way, recent advances in neuroscience and neurotechnology make it possible to write a conceptually plausible account of how brains could be "read" and linked together. This book is grounded in science now going on in labs around the world, and draws on technology that is already in use in human beings.

This book is, in other words, a thought experiment. In terms of technology, here is what it covers.

- It discusses *existing technologies* for detecting brain activity and the algorithms used to interpret the resulting data. I cover them in order of increasing sophistication. But none of these algorithms, I point out, can yet understand the brain's lived experience of the world.

- It presents two emerging *mechanisms* for reading and writing brain activity, specifically, nanowires and optogenetics. Mechanisms are crucial, since without them nothing else is feasible. If you need to be convinced that they now exist before going along with the thought experiment of this book, then I suggest you read Chapter 8 first.

- It outlines a *communications protocol* for sending perceptions and memories from one brain to another. While the neural machinery of mental activity differs from one brain to another, high-level concepts and relationships are brain-independent. We share them through language and common experience. A suitable protocol could transmit those concepts and relationships in code, with implanted computers managing the specifics of each person's neural wiring.

- It presents *examples* of the new kinds of collective communication that the physical interlinking of humans with the Internet would allow. I describe new activities such as telempathy, synthetic perception, synthetic memory, and dream brainstorming.

- It offers an *account* of how a collective mind might emerge out of these collective interactions. Such an entity—some call it a hive mind—would be, by definition, inaccessible to any individual, just as the collective action of an ant colony is beyond the imagination of an individual ant. We might know, however, that something new had come into existence, and I discuss what the clues to that might look like.

Along the way I debunk common assumptions about "mind reading" fed by science fiction. It will never be possible to experience the world exactly the way another brain does. It will never be possible to achieve perfect, unambiguous communication. It will never be possible to do away with language. What I propose are new *kinds* of communication, which like every previous kind will present new possibilities and new risks.

I also aim to imagine how to sustain the life-affirming properties of human contact and community in the face of such powerful and addictive technologies. They will not improve the quality of human life if they only bury people even further into their electronic shells. Practically every week some magazine runs a story about how email, cell phones,

texting, Facebook, Twitter, etc., etc., have diminished the quality of face-to-face communication. In 2009 The *New York Times* profiled a family of six in which every member, including the five-year old, starts the day by grabbing a nearby electronic gadget instead of talking to each other.

There is nothing new about the fear that technology is harming human interaction. People philosophized and worried about telegraphs and telephones in very much the same way that people now philosophize and worry about the Internet. In an 1880 novel titled *Wired Love: A Romance of Dots and Dashes* two telegraph operators carried on a very politely Victorian version of cybersex and pondered whether they had a "real" relationship. Going back even further, Plato fretted about the impact of writing on human interaction 2,400 years ago in the *Phaedrus*. (To see that writing is a technology, consider what it would take for you to create a pen, ink, and paper on your own.) Plato argued that unlike its author, a written text could not engage in conversation; if questioned it would simply give the same answer again. Knowledge only truly exists in human interaction, he said. He concluded that by seducing people into believing that they can obtain knowledge from solitary reading, the written word threatens human ties.

The debate about technology's effects on social interaction has been around for so long that it is essentially technology-independent. I see it as being about the tension between conflicting desires for autonomy and community. On the one hand we want to be autonomous, and seek space and privacy. On the other hand we want to be known and loved, and seek intimacy and community. These desires are in constant conflict. By constantly introducing new ways to be alone and together, technology keeps renewing the conflict. The conflict endures through the millennia; only the specific technologies change.

Rather than try to resolve the conflict, I want to transcend it by introducing a new perspective. For our two hemispheres, the distinction between autonomy and unity is meaningless because fast communication makes them effectively a single entity. In a similar way, the direct connection of brains to each other would transform the very terms of

the debate. We would have to rethink what it means to be an individual and what it means to be part of a community. What would happen if we had the emotional equivalent of Twitter in our heads every waking moment? What if we could communicate nonverbally with people while dreaming? Bizarre-sounding ideas, to be sure, but exchanging 133 or more written messages in one day would have sounded equally bizarre just a few years ago. Teenagers' conceptions of communication and community are already very different from their parents'.

If humans and machines become integrated in ways that let people communicate collectively, it would trigger a vast reconfiguration in how people define personal boundaries. Such a reconfiguration is already under way, in fact, with many people revealing deeply personal information on Facebook and Twitter. As *New York* magazine put it, "More young people are putting more personal information out in public than any older person ever would . . . In essence, every young person in America has become, in the literal sense, a public figure."

Similarly, notions of identity and selfhood are changing. Psychologists worry that nonstop texting makes it harder for teenagers to define themselves as autonomous individuals, since they are constantly engaged with messages at the cost of exploring their own selves. But I argue that what is really happening is a redefinition of selfhood rather than its simple diminution. In the 1950s the philosopher Pierre Teilhard de Chardin suggested that individuality would be enhanced, not weakened, by collective communication. Later in this book I discuss his ideas in detail.

Still, writing dozens if not hundreds of messages per day cannot help but take away time from introspection, conversation, and the intimacy of personal connection. Physical presence and touch are crucial to development and health, and we ignore them at our peril. Even with interlinked brains we would still be mammals with mammalian instincts and needs. I argue that uniting technology with the body would address some of the problems that bedevil us now, such as incessant distraction and near-addiction to a flood of incoming messages. And if done right,

connecting the human body directly to the Internet would make online communication as personal as face-to-face communication. Counterintuitively, it will become possible to *combine* electronic connection with physical presence, making them complement each other. Today, online technologies are "dis-enchanting"; they pull people apart. Tomorrow, they could be "enchanting" in that they pull people together.

Enchantment is a special and rare experience. When one is "enchanted" with someone, one becomes fully aware of his spark, his personhood, his uniqueness, his physicality. One does not experience the dissociation and abstraction so often created by today's electronic technologies. But when enchantment happens in today's world, it is usually only a one-on-one experience. One is spellbound by a lecturer, infatuated with a lover, in harmony with a co-worker. *Collective* enchantment, on the other hand, has become relatively rare. In collective enchantment, one feels in harmony with a group. Not overpowered by it, as in mobs or fascistic rallies, but acutely attuned to it and contributing to it. This is what happens in the dance, the symphony, the team collaboration. It does *not* happen online, because that is precisely where the body disappears. But if the body could be integrated with the Internet, in such a way that one feels what others feel and sees what others see, then the possibility of collective enchantment returns. And enchantment in a richer, deeper way, and on a larger scale, than has ever been possible before.

But that kind of physical and electronic connection is going to require a profound readjustment of the boundaries of privacy. How much of ourselves we are willing to show, and how much of each other are we willing to see? I am going to suggest that in order to make intimate electronic communication work, we will have to teach people how to do it. Deliberately, systematically, mindfully.

I was bereft when my BlackBerry died. It impressed on me how separate the Internet is from the human body, and how much I felt that separation when I lost access to it. So in this book I talk about overcoming that separateness from the world of information. But my BlackBerry's demise also made me think hard about my reduction of face-to-face

connection with other human beings. So I tell a parallel, personal story about intimacy. I rediscovered how to become enchanted with people. I went to communication workshops in northern California, which were resolutely and radically nontechnological. I moved to Gallaudet for a year to learn American Sign Language in an effort to connect with other deaf people in a language purely of the body, and also to get to know Regina better. While this book is about connecting people via technology, it is also a romance about friends, about a woman, and about what humanity can become.