CHAPTER 1

Enquire Within upon Everything

When I first began tinkering with a software program that eventually gave rise to the idea of the World Wide Web, I named it Enquire, short for *Enquire Within upon Everything*, a musty old book of Victorian advice I noticed as a child in my parents' house outside London. With its title suggestive of magic, the book served as a portal to a world of information, everything from how to remove clothing stains to tips on investing money. Not a perfect analogy for the Web, but a primitive starting point.

What that first bit of Enquire code led me to was something much larger, a vision encompassing the decentralized, organic growth of ideas, technology, and society. The vision I have for the Web is about anything being potentially connected with anything. It is a vision that provides us with new freedom, and allows us to grow faster than we ever could when we were fettered by the

hierarchical classification systems into which we bound ourselves. It leaves the entirety of our previous ways of working as just one tool among many. It leaves our previous fears for the future as one set among many. And it brings the workings of society closer to the workings of our minds.

Unlike *Enquire Within upon Everything,* the Web that I have tried to foster is not merely a vein of information to be mined, nor is it just a reference or research tool. Despite the fact that the ubiquitous *www* and *.com* now fuel electronic commerce and stock markets all over the world, this is a large, but just one, part of the Web. Buying books from Amazon.com and stocks from E-trade is not all there is to the Web. Neither is the Web some idealized space where we must remove our shoes, eat only fallen fruit, and eschew commercialization.

The irony is that in all its various guises—commerce, research, and surfing—the Web is already so much a part of our lives that familiarity has clouded our perception of the Web itself. To understand the Web in the broadest and deepest sense, to fully partake of the vision that I and my colleagues share, one must understand how the Web came to be.

The story of how the Web was created has been told in various books and magazines. Many accounts I've read have been distorted or just plain wrong. The Web resulted from many influences on my mind, half-formed thoughts, disparate conversations, and seemingly disconnected experiments. I pieced it together as I pursued my regular work and personal life. I articulated the vision, wrote the first Web programs, and came up with the now pervasive acronyms URL (then UDI), HTTP, HTML, and, of course, World Wide Web. But many other people, most of them unknown, contributed essential ingredients, in much the same almost random fashion. A group of individuals holding a common dream and working together at a distance brought about a great change.

My telling of the real story will show how the Web's evolution and its essence are inextricably linked. Only by understanding the Web at this deeper level will people ever truly grasp what its full potential can be.

Journalists have always asked me what the crucial idea was, or what the singular event was, that allowed the Web to exist one day when it hadn't the day before. They are frustrated when I tell them there was no "Eureka!" moment. It was not like the legendary apple falling on Newton's head to demonstrate the concept of gravity. Inventing the World Wide Web involved my growing realization that there was a power in arranging ideas in an unconstrained, weblike way. And that awareness came to me through precisely that kind of process. The Web arose as the answer to an open challenge, through the swirling together of influences, ideas, and realizations from many sides, until, by the wondrous offices of the human mind, a new concept jelled. It was a process of accretion, not the linear solving of one well-defined problem after another.

I am the son of mathematicians. My mother and father were part of the team that programmed the world's first commercial, stored-program computer, the Manchester University "Mark I," which was sold by Ferranti Ltd. in the early 1950s. They were full of excitement over the idea that, in principle, a person could program a computer to do most anything. They also knew, however, that computers were good at logical organizing and processing, but not random associations. A computer typically keeps information in rigid hierarchies and matrices, whereas the human mind has the special ability to link random bits of data. When I smell coffee, strong and stale, I may find myself again in a small room over a corner coffeehouse in Oxford. My brain makes a link, and instantly transports me there.

One day when I came home from high school, I found my father working on a speech for Basil de Ferranti. He was reading books on the brain, looking for clues about how to make a computer intuitive, able to complete connections as the brain did. We discussed the point; then my father went on to his speech and I

went on to my homework. But the idea stayed with me that computers could become much more powerful if they could be programmed to link otherwise unconnected information.

This challenge stayed on my mind throughout my studies at Queen's College at Oxford University, where I graduated in 1976 with a degree in physics. It remained in the background when I built my own computer with an early microprocessor, an old television, and a soldering iron, as well as during the few years I spent as a software engineer with Plessey Telecommunications and with D.G. Nash Ltd.

Then, in 1980, I took a brief software consulting job with CERN,[1] the famous European Particle Physics Laboratory in Geneva. That's where I wrote Enquire, my first weblike program. I wrote it in my spare time and for my personal use, and for no loftier reason than to help me remember the connections among the various people, computers, and projects at the lab. Still, the larger vision had taken firm root in my consciousness.

Suppose all the information stored on computers everywhere were linked I thought. *Suppose I could program my computer to create a space in which anything could be linked to anything.* All the bits of information in every computer at CERN, and on the planet, would be available to me and to anyone else. There would be a single, global information space.

Once a bit of information in that space was labeled with an address, I could tell my computer to get it. By being able to reference anything with equal ease, a computer could represent associations between things that might seem unrelated but somehow did, in fact, share a relationship. A web of information would form.

1 The name CERN derives from the name of the international council (Conseil Européen pour la Recherche Nucléaire), which originally started the lab. The council no longer exists, and "Nuclear" no longer describes the physics done there, so while the name CERN has stuck, it is not regarded as an acronym.

Computers might not find the solutions to our problems, but they would be able to do the bulk of the legwork required, assisting our human minds in intuitively finding ways through the maze. The added excitement was that computers also could follow and analyze the tentative connective relationships that defined much of our society's workings, unveiling entirely new ways to see our world. A system able to do that would be a fantastic thing for managers, for social scientists, and, ultimately, for everyone.

Unbeknownst to me at that early stage in my thinking, several people had hit upon similar concepts, which were never implemented. Vannevar Bush, onetime dean of engineering at MIT, became head of the U.S. Office of Scientific Research and Development during World War II and oversaw development of the first atomic bomb. In a 1945 article in the *Atlantic Monthly* titled "As We May Think," he wrote about a photo-electro-mechanical machine called the Memex, which could, by a process of binary coding, photocells, and instant photography, make and follow cross-references among microfilm documents.

Ted Nelson, a professional visionary, wrote in 1965 of "Literary Machines," computers that would enable people to write and publish in a new, nonlinear format, which he called *hypertext*. Hypertext was "nonsequential" text, in which a reader was not constrained to read in any particular order, but could follow links and delve into the original document from a short quotation. Ted described a futuristic project, Xanadu, in which all the world's information could be published in hypertext. For example, if you were reading this book in hypertext, you would be able to follow a link from my reference to Xanadu to further details of that project. In Ted's vision, every quotation would have been a link back to its source, allowing original authors to be compensated by a very small amount each time the quotation was read. He had the dream of a utopian society in which all information could be shared among people who communicated as equals. He struggled for years to find funding for his project, but success eluded him.

Doug Engelbart, a researcher at Stanford University, demonstrated a collaborative workspace called NLS (oN Line System) in the 1960s. Doug's vision was for people to use hypertext as a tool for group work. In order to help himself steer his computer's cursor across the screen and select hypertext links with ease, Doug invented a wooden block with sensors and a ball underneath, and called it a *mouse*. In a now-famous video, which I didn't see until 1994, Doug demonstrated using electronic mail and hypertext links with great agility with his homemade mouse in his right hand and a five-key piano-chord keyboard in his left hand. The idea was that a person could interface with the machine in a very close, natural way. Unfortunately, just like Bush and Nelson, Doug was too far ahead of his time. The personal computer revolution, which would make Engelbart's "mouse" as familiar as the pencil, would not come along for another fifteen years. With that revolution, the idea of hypertext would percolate into software design.

Of course, the next great development in the quest for global connectivity was the Internet, a general communications infrastructure that links computers together, on top of which the Web rides. The advances by Donald Davis, by Paul Barran, and by Vint Cerf, Bob Kahn, and colleagues had already happened in the 1970s, but were only just becoming pervasive.

I happened to come along with time, and the right interest and inclination, after hypertext and the Internet had come of age. The task left to me was to marry them together.

CHAPTER 2

Tangles, Links, and Webs

The research center for particle physics known as CERN straddles the French-Swiss border near the city of Geneva. Nestled under the limestone escarpments of the Jura mountains, ten minutes from the ski slopes, with Lac Leman below and Mont Blanc above, it offered unique research opportunities, and the area offered a very pleasant place to live.

Engineers and scientists arrived at CERN from all over the world to investigate the most fundamental properties of matter. Using enormous machines, they would accelerate tiny nuclear particles through a series of tubes that, though only a few inches wide, ran for several kilometers within a mammoth circular underground tunnel. Researchers would rev up the particles to extremely high energies, then allow them to collide. For an unimaginably brief instant, new particles might be made, then