Digital Nervous Systems: Making Sense of Shared Information

Business @ The Speed of Thought: Using a Digital Nervous System. *By Bill Gates (with Collins Hemingway), Warner Books, New York, 1999, xxii + 470 pages, $30.*

BOOK REVIEW

By James Case

The phrase "digital nervous system" occurred to Bill Gates during preparations for Microsoft's first annual CEO summit, a carefully orchestrated extravaganza held at the firm's Redmond, Washington, campus in the spring of 1997. He was to deliver the keynote speech and wanted to make the most of his opportunity. He had been searching for a one-line description of a concept then under development at Microsoft—as much for in-house use as for eventual sale to the (corporate) public—and this one seemed to suit his need. Gates predicts that every sizeable corporation will soon have such a system, and that—like snowflakes—no two will be identical. Designing, installing, and updating digital nervous systems will consume decades, creating endless opportunities for software firms and professionals. The book under review is his attempt to expand the message contained in his original speech, and disseminate it to a wider audience.

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The nature of a digital nervous system is well illustrated by the system Merrill Lynch recently brought on line. By 1997, the firm had more than a trillion dollars worth of client assets under management. It had prospered, for more than a century, by amassing vast amounts of financial data, analyzing them, and creating long-range financial plans. To that end, it had been among the Wall Street pioneers in computer use. Yet in 1997, Merrill Lynch was still using computers in an ad hoc manner, analyzing one sort of data in one way, on one department's machines, and other sorts in other ways on other equipment. All forms of decision making were still based on written reports, which typically required input from a host of departments and working groups, and took days if not weeks to generate.

The firm's information technology (IT) staff felt that top-to-bottom reform was long overdue. Management was concerned mainly with the need to make more efficient use of the company's most valuable asset, its team of financial consultants (FCs). These (generously compensated) individuals were spending entirely too much of their time tracking down data from diverse sources, on stock prices, interest rates, market research, customer accounts, proprietary products, and the like, and entirely too little of it acting as financial advisers to paying customers. Practices that were once state-of-the-art seemed an inadequate response to the new Internet providers. Merrill Lynch set out to construct an "FC-centric" system rich in data content and replete with analytic capabilities.

The IT team asked the board of directors for authority to spend up to a billion dollars in their effort to maintain the firm's leadership in the financial services industry. After expressing its distaste for cost overruns, the board gave its approval and lapsed into a waiting mode. At length—in October 1998—the Trusted Global Adviser (TGA) system was rolled out, on time and under budget. About 30% of the total was spent on software. The rest went for hardware, including replacements for PCs.

Realizing that it would take forever to rewrite "legacy applications" operating on old systems, and to integrate all the company's "core business systems," the IT team created a "universal PC shell"—a common user interface permitting each FC to access, from his or her own Windows Desktop, data stored on any of the firm's existing or proposed computers. This "superbrowser" enables staff members to work with any number of local, client-server, legacy, and Web browser applications, at the same time and in a single consistent format. Regardless of origin, related data are organized into pages of information, which in turn are arranged in sections, chapters, and books.

In the upper right-hand corner of the TGA screen is a Customizable Information Center (CIC), in which each individual FC can have automatically displayed whatever real-time data—such as market indices and individual stock prices—he or she feels called upon to monitor on a regular basis. The user pastes new selections into the Stock Exchange folder, and real-time feeds for the selected exchanges start up. For a mere $250 million over four years—about $3500 per financial consultant per year—Merrill Lynch completely overhauled the information system on which the 14,700 FCs in its 700 U.S. offices (along with some 2000 foreign FCs) depend.

Financial consultants used to spend a lot of time tracking portfolio performance against client objectives. Evaluating progress for 300 clients, many of whom might have more than one portfolio, was a distinct challenge. TGA makes several views of the relevant data available automatically, so that an FC can tell at a glance whether a portfolio is meeting expectations, and can vary key decision variables to isolate (graphically, no less) their individual effects on overall performance. In time, clients will be able to run such "what if" scenarios on their own PCs.

To take care of the administrative aspects of their work—filling out expense reports, calling clients, sending e-mail—FCs click on suggestively named tabs that automatically invoke the appropriate applications, such as a word processor, a spreadsheet, or a

contact manager. The FC involved doesn't need to know what these applications are called, or where they are running, or how they operate. He or she need only key in the data requested at the displayed prompts, until the e-inquisitor seems satisfied with the answers given.

TGA has a user interface tuned for common scenarios. An FC who has the News page up to see real-time news stories from the wire services can drag a company's symbol (say EK for Eastman Kodak) from the live stock ticker in the CIC over to the News page to see a list of stories about that company. A click on Stock History provides links to Microsoft Investor, from which the movements of the company's stock price over the last thirty days, or the last year, can be obtained. If the market data vendor is having transmission difficulties, causing the stock feed to die, TGA notices and places a question mark beside the "current price" field to indicate that the number on display may not be up to date.

Every time an FC clicks on a particular stock, a wealth of information concerning it—and similar information concerning its principal competitors—appears automatically within about two seconds. In an effort to document best practices, Merrill Lynch is carefully monitoring the use made of the system by its most experienced and/or productive FCs. The plan is to create electronic models of their work habits (much as Mi-crosoft is helping catalogue vendors to create electronic models of customer buying habits), thereby enhancing the TGA system for all users.

In addition to seeing the same information as the FCs, senior executives use a version of TGA that enables them to monitor company performance figures and other operational data. Access to different sets of "loose-leaf notebooks" is available to branch managers, middle marketers, insurance professionals, home office staff, and support staff. Insurance professionals have access to information that administrative staff would be unable to use, and vice-versa. Thus, everyone is made to feel that the system is tuned to his or her needs.

In a rollout that lasted a little more than a year, Merrill Lynch upgraded ten of its offices a week. Two weeks before each conversion, a team would arrive to deliver mandatory training, followed (on the Friday afternoon before the change-over) by a hardware team. The latter would install Pentium Pro-based workstations for each employee, new cabling, and a pair of multiprocessor PC servers. On Monday morning, the office would go live, under the watchful eye of the trainers, who would remain for a week to ensure that the entire office was up to speed.

For a time, there were lengthy philosophical discussions within Merrill Lynch as to how much of this newly accessible information should be shared with customers. It was concluded that information is not wisdom, and that customers are best served when experienced FCs are helping them to make sense of shared information. Accordingly, the IT group created Merrill Lynch OnLine, a system that would give customers access to research, account information, basic bill payment, and other fundamentals. Hoping to sign up perhaps 200,000 customers within the first year, the company hit that target within seven months. Perhaps surprisingly, the older and wealthier customers were quicker to sign on than the younger and (presumably) more computer-literate ones.

The initial success of Merrill Lynch OnLine has prompted the firm to add more market data, more account information, and more bill-paying options. Today, customers can e-mail their FCs, get delayed stock and mutual fund quotes, view research reports, pay bills, perform fund transfers, and, with the most recent addition, enter trading orders. The long-term goal is to provide "total synchronicity" between FC and client, so that both are looking at the same thing, on the same screen, at the same time. When that happens, IT likes to say, "the real magic" starts.

Gates's "take home" message is exceedingly simple: The same unsatisfactory conditions that existed at Merrill Lynch in 1997 exist almost everywhere and can be corrected in similar ways, at similarly endurable expense. Vast quantities of information exist in the bowels of almost every commercial establishment, already in electronic form but scattered about in different locations and formats, for use on different machines by different groups of people for different purposes. The data typically reside in corporate sales records, purchasing records, production records, maintenance records, personnel records, financial re-cords, legal records, advertising and promotion records, and so on. Only recently have a few progressive firms begun—often with Microsoft assistance—to construct digital nervous systems capable of accessing virtually all such data from a single desktop, and extracting from it what corporate decision makers need in the way of "actionable" information.

Such systems can now be built, as was the one at Merrill Lynch, from standard, off-the-shelf components: ordinary PCs and garden-variety Internet technology. The data are already there, in electronic form. The challenge is to make all (or almost all—Gates does address need-to-know issues) the data available to—and usable by—every employee, from the CEO on down. Such systems can and probably should be built incrementally, as was the one at Merrill Lynch. That system is still a long way from achieving its goal of total synchronicity, and will be adding capabilities for years to come. So will the other pioneers of the digital nervous system concept, among them Boeing, Coca-Cola, Dell, Compaq, Marriott, Texaco, Xerox, Microsoft itself, and the U.S. Air Force—all of whose transition experiences are related in the book.

Individual case studies occupy a large part of the book, which is addressed mainly to CEOs and others in top management. It is entirely nontechnical. A companion Web site has been set up, for those interested in further detail, at www.Speed-of-Thought.com. The questions the book is intended to answer are largely the two nearest and dearest to a CEO's heart: What will such a system cost, and how will it affect my bottom line? The responses vary according to the nature of the corporation, and would be hard to present in any other than the case-by-case format Gates has in fact adopted.

Gates is well aware that top management harbors a wide range of computer skills, and will long continue to do so. Many executives are still getting along just fine without such skills, and have no plans to discontinue the practice. Yet he suspects that the half-life of the latter population will be relatively short and encourages his more ambitious readers to delay no longer their first ventures onto the Internet. He advises beginners to use the Internet to "buy a few books and schedule a little travel," and predicts
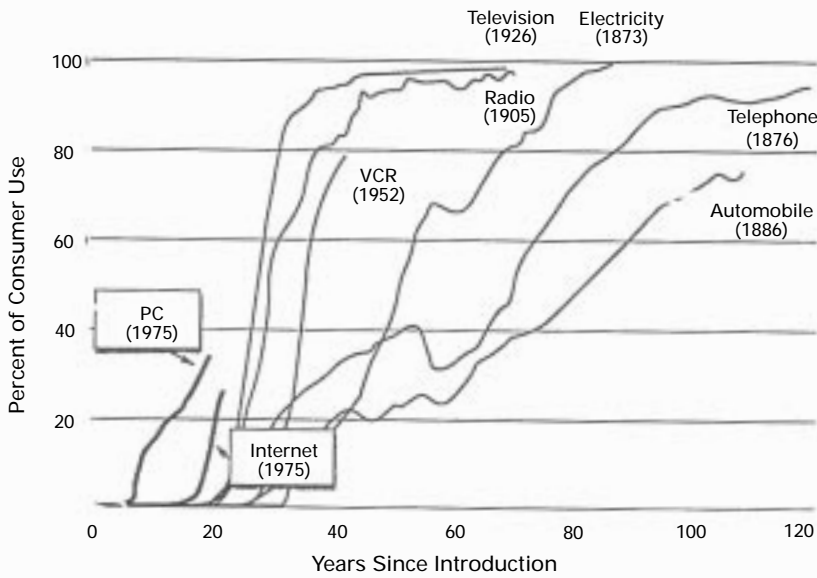
Figure 1. *Rates at which various technologies have been assimilated.*

that virtually all corporations will eventually embrace what he calls "the Web workstyle."

Readers of *SIAM News* may be amused at Gates's occasional mathematical malapropisms. For instance he—and apparently other captains of industry—use the term "metric" to describe any and all measures of performance, be they positive, negative, or of variable sign. Also, as they use the term, the graph of x^3 has not one but two "inflection points," located not at the origin—where curvature vanishes—but at the points to the right and left of it, where curvature is most extreme. Thus, in graphs recording the historic assimilation rates of various technologies (see Figure 1), the dramatic upturns that mark the beginning of mass acceptance are described in the board room as inflection points. Such upturns are much discussed in the book, as elsewhere in the business and financial literature, and *SIAM News* readers may find it disconcerting to see them referred to in this convoluted manner. Yet there seems to be no standard technical term describing points (or arguments) of maximum curvature; even if there were one, moreover, it seems too late to reunite managerial terminology with its geometric antecedents.

The process by which digital nervous systems extract "actionable information" from the masses of e-data now being accumulated by corporate America—indeed by corporate Earth—is of particular interest. For account must be taken of the fact that different managers require different levels of detail: While a CEO may look only at total sales, or sales by region, a district manager may need to "dig down" all the way to original invoices and purchase orders. He or she will be obliged, of course, to make do with electronic facsimiles, which (save for legal purposes) typically do suffice. In addition, the data will have to be combined in different ways for different purposes, with different variables being transformed in different ways before being plotted against one another, and so on. All these things—and many more—can and will be done (indeed automated) once all the data possessed by a given firm are made accessible from a single desktop.

The process of extracting commercially useful insights from—and identifying exploitable patterns and relationships within—databases and other repositories of electronic information has come to be known as "data mining." Its practitioners make use of a variety of mathematical and statistical techniques, especially optimization techniques (see related article on page 1 of *SIAM News*, December 1999). With that in mind, Microsoft, in association with the Department of Computer Science at the University of Wisconsin, has established the Data Mining Institute, under the directorship of Wisconsin computer scientists Olvi Mangasarian and Raghu Ramakrishnan. As Karla Hoffinan observed this spring in a talk at SIAM's Atlanta meeting, a number of small (if not sleepy) consulting firms have recently been acquired—for actual coin of the realm—by vastly larger corporations. And virtually all the acquired firms have been engaged in optimization as it applies to data mining. One suspects that more will be heard on this front.

Once again, Bill Gates has produced an interesting, well-written volume describing his own evolving vision of the future. One need not read the book from cover-to-cover in order get the message. Once the first few chapters have been digested, the rest can be read—with profit—in almost any order.

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