Giant Brains Controlling Scientific Knowledge: A History (In Progress) of Human/Computer Relationships

Bernadette Longo

Professor of English, Clemson University

A lecture presented by the Center for Interdisciplinary Studies of Writing and the Composition, Literacy, and Rhetorical Studies Minor

Speaker Series
No. 17 ♦ 2000

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Preface

Bernadette Longo, Assistant Professor at Clemson University in South Carolina, delivered a keynote lecture at the University of Minnesota in May 2000. Her talk was part of an ongoing book project with the tentative title, *Giant Brains Controlling Scientific Knowledge: A History (In Progress) of Human/Computer Relationships*. Her goal is to trace the human relationship with computers and how, through the evolution of this relationship, we have begun to treat computers more like people than objects.

Longo 's scholarly focus is on technical writing and editing. Her new book, *Spurious Coin: Science, Management and a History of Technical Writing* is available through SUNY Press (2000). We are pleased to present Dr. Longo's lecture as part of the ongoing discussions about the history of literacy and its relationship to new technologies.

The Center's Annual Colloquium and its Speaker Series contribute to its primary mission, which is to improve undergraduate writing at the University of Minnesota. These activities, along with faculty development workshops, conferences, publications and other outreach activities, are designed to foster active engagement with issues and topics related to writing among all of the members of the university community. In addition, the Center annually funds research projects by University of Minnesota faculty who study any of the following topics:

- curricular reform through writing across the curriculum,
- characteristics of writing across the curriculum,
- connections between writing and learning in all fields,
- characteristics for writing beyond the academy,
- the effect of ethnicity, class, and gender on writing, and
- the status of writing ability during the college years.

We encourage readers to enter into a dialogue with us by contacting the Center for more information about Center activities and publications relating to theories of writing and the improvement of undergraduate writing throughout the academy.

Lillian Bridwell-Bowles, Series Editor
Erika R.L. Rivers, Editor
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"It may also be asked, in doubt rather than criticism, whether I am speaking of natural philosophy only, or whether I mean that the other sciences—logic, ethics, politics—should also be carried on by my method. I would answer that I certainly do think my words have a universal application…For I am compiling a history and tables of discovery about anger, fear, shame and the like, and also about political matters, and no less about the mental actions of memory, composition and division, judgment and the rest; about all these, just as much as about hot and cold, or light, or vegetation or the like."

Francis Bacon, *Novum Organum*, 1620

Human/computer relationships are part of our lives every time we open email, boot our computer, can't understand how our cars work, program our VCR, set our digital clock—on and on. These relationships between ourselves and our computers have almost become second nature to us; they are becoming common sense in our digital culture. They are becoming invisible, attesting to their power.

Computers speak to us with a language that is transparent and technical, even though we often speak to these devices with a language that is audible and mundane. Computers speak to us with a language educated into technology, which nonetheless emulates common speech, e.g., "If Windows will not boot, create a Start-up disk and check the control panel." We speak to them in common terms, e.g., "Why won't you start up," or "How is that supposed to work?" Even though we may not speak exactly the same language, we tend to think of computers as having animus—electronic beings who can help us. Our relationship with them is based on their utility for us.

Our relations with the utility of electronic computers began with ENIAC, whose first public demonstration took place on Valentine's Day in 1946. A War Department press release for broadcast the next day clearly stated the following utilitarian rationale for the new electronic device: "The important fact to be remembered in connection with the ENIAC is that it does not replace creative thinking. Rather, it encourages further original thought by freeing the scientist from the time-consuming burden of routine calculation" (2). This focus on utility was reiterated in remarks at the dedication of the new computing device:

> "[T]he ENIAC will provide the means of extending the frontiers of knowledge with all that implies for the betterment of mankind" (Gen. Barnes, qtd. in Goldstine, 229).
> "It is to be emphasized…that progress in science consists of revising and improving our existing theories, and that this progress is definitely hampered when we do not have the proper computational facilities" (Captain H. H. Goldstine, p. 2).
>
> "The new field of electronics is an era of speed—speed far greater than has ever been known before. The ENIAC, being a thousand times faster, does problems more quickly, but, more importantly, it opens an unexplored expanse of problems that, due to their vast number of arithmetic operations and their extensiveness, made the computation of such problems previously impossible" (J. P. Eckert, p. 3).
>
> "As long as mathematics is costly, manufacturers will continue to market devices which are ill-designed and to use processes which are inefficient. In high-speed computing and more wide-spread use of numerical mathematics for industrial design lie possibilities which affect us all—better transportation, better clothing, better food processing, better television, radio, and other communications, better housing, better weather forecasting" (J. W. Mauchly, p. 3).
>
> "The War Department tonight unveiled the world's fastest calculating machine and said the robot possibly opened the mathematical way to better living for every man" (Associated Press, qtd. in McCartney 107).

According to the developers of the first electronic computer, the utility of this device resided in its ability to do routine work for mathematicians, which would result in an improved quality of life for the general population through manufactured goods.

Our perceptions of the utility of these "electronic brains" quickly broadened from the realms of mathematics and science to management systems in government and business. In 1951, the U. S. Census Bureau introduced into their operations a Remington Rand computer designed by Eckert and Mauchly. The Air Force, Army, and Atomic Energy Commission quickly followed suit. In 1954, General Electric introduced the first general application business computer into their operations.

Concerns with utility and utopia echoed within the nascent digital culture. The editors of the 1954 *Harvard Business Review* hailed GE's application of the UNIVAC as the coming of the next age of industry:

> The management planning behind the acquisition of the first UNIVAC to be used in business may eventually be recorded by historians as the foundation of the second industrial revolution; just as Jacquard's automatic loom in 1801 or Taylor's studies of the principles of scientific management" (preface to Osborn, 99).

Sociologist Theodore Caplow, examining effects of the division of labor, also foresaw post-ENIAC culture leading toward a "utopia of automatic production":

> Projected into the indefinite future, these trends shape themselves into a kind of science-fiction utopia, in which hydroponic farms and cybernetic factories grind out a stream of scientifically tailored products with automatic zeal and in any quantity desired, while human labor is mostly engaged in creative services. Like many dreams based on the assumption of technical progress, this one is inherently reasonable" (288).

These promises of automated utopia also held the threat of technological unemployment. As Edmund Berkeley cautioned:

> At the moment when we combine automatic producing machinery and automatic controlling machinery, we get a vast saving in labor and a great increase in technological unemployment….The robot machine raises the two questions that hang like swords over a great many of us these days…What shall I do when a robot machine renders worthless all the skill I have spent years in developing?…How shall I sell what I make if half the people to whom I sell lose their jobs to robot machines? (202).

If computers were to usher in a new age of industry and prosperity through "better management controls" (Higgins and Glickauf, 99), managers and clerical workers alike would see wisdom in the utility of these electronic brains—even if it meant risking their jobs.

The urge for utility in our digital culture has long roots extending back to arguments for the utility of experiential science over scholastic speculation championed by Francis Bacon in the 17th century and by Georgius Agricola in the 16th century. It was this earlier conflict between legitimate science through speculation and illegitimate magic from experimentation that established a fundamental rationale for the domination of scientific knowledge in our digital culture: it is useful. Today, this argument is so ingrained in our common sense that it does not need to be stated. It is a part of our natural landscape. Yet our forebears fought for the supremacy of this concept and won a cultural war for the dominance of rationalized, experimental science.

The Utility of Experiential Knowledge

For the scholastics who followed Aristotle's teachings, science was concerned with explaining the reasons for ordinary, natural events. It was not concerned with the extraordinary, which was deemed to be the province of magic and the Hermetic books of secrets. Experimental—or experiential—knowledge was the province of magic and was fit for the illiterate. In practice, scholars regularly carried out both textual and experimental work. But their textual science circulated in formal academic settings as legitimate knowledge while their experimental magic was reserved for private uses as non-legitimate knowledge.

In the mid-16th century, Georgius Agricola published *De Re Metallica,* a compilation of knowledge about mining and metallurgy. In his approach to compiling the knowledge in *De Re Metallica*, Agricola was typical of other encyclopedists in the Greek and Roman tradition. Yet in other ways, Agricola was like the popularizers of secret lore (or magical knowledge) in 16th-century Europe. He presented recipes for manipulating nature, just as previous authors of books of secrets had done. He included information about alchemy and elves in the mines, which was the province of magic. But Agricola extended the encyclopedic and Hermetic traditions, synthesizing them with experimental knowledge.

Unlike traditional scholastic texts, Agricola included Hermetic texts as sources for his speculative reasoning and he treated what scholastics would consider occult topics, such as magnetism, whose workings could not be seen. For example, in Book II of his work, Agricola presented lengthy information about using a divining twig to locate veins of ore. But in addition to simply telling how to use the divining rod, he explained the reasoning behind the twig's movement by discussing magnetism and idiosyncratic human properties:

> …when one of the miners or some other person holds the twig in his hands, and it is not turned by the force of a vein, this is due to some peculiarity of the individual, which hinders and impedes the power of the vein, for since the power of the vein in turning and twisting the twig may be not unlike that of a magnet attracting and drawing iron toward itself, this hidden quality of a man weakens and breaks the force, just the same as garlic weakens and overcomes the strength of a magnet (39).

Here Agricola presented a recipe for using a divining rod based on occult magnetic principles, e.g., a "hidden quality of a man" can weaken or break the magnetic force; garlic weakens or breaks the magnetic force; a magnet draws iron toward itself; a person can use the magnetic force to find a vein of metal through the use of a divining rod. Agricola's work resembled the books of secrets in that his advice was in the form of a decontextualized recipe. Unlike books of secrets, however, Agricola related his recipe to Hermetic knowledge by discussing the place of occult knowledge in his 16th-century culture:

> Since this matter remains in dispute and causes much dissention amongst miners, I consider it ought to be examined on its own merits. The wizards…seek for veins with a diving rod shaped like a fork…it is not the form of the twig that matters, but the wizard's incantations which it would not become me to repeat, neither do I wish to do so. The Ancients…were also able to alter the forms of things by [the divining rod]; as when the magicians changed the rods of the Egyptians into serpents, as the writings

> of the Hebrews relate; and as in Homer, Minerva with a divining rod turned the aged Ulysses suddenly into a youth, and then restored him back again to old age; Circe also changed Ulysses' companions into beasts, but afterward gave them back again their human form; moreover by his rod, which was called 'Caduceus,' Mercury gave sleep to watchmen and awoke slumberers. Therefore it seems that the divining rod passed to the mines from its impure origin with the magicians. Then when good men shrank with horror from the incantations and rejected them, the twig was retained by the unsophisticated common miners, and in searching for new veins some traces of these ancient usages remain (40-41).

In this passage Agricola examined both the magical and practical uses of the divining rod, seeking to separate the magical history of the rod from its practical uses in mining. This separation was crucial to retaining the rod as an acceptable, respectable instrument of mining, since its magical history was caught up in theological and social contests. In the 16th century, magic included all practices based on experiential knowledge that sought to manipulate nature. According to this formulation, Hermetic knowledge contained in books of secrets certainly was magical and knowledge about the physical world gained from practical experience—like that of mining and metallurgy—could also be considered magical. Thus, Agricola's entire subject matter in *De Re Metallica* verged on the magical. He definitely crossed over the line into magic, however, when he discussed occult subjects, such as magnetism and divining rods.

In Agricola's time, engineers and practitioners of the mechanical arts had access to books of secrets containing magical recipes. Since the purpose of the magical knowledge—the manipulation of nature for practical ends—coincided with the purpose of engineering and mechanical arts, engineers and craftsmen found these books useful. According to William Eamon:

> Medieval engineers enthusiastically appropriated magic as a theoretical framework for technology. Indeed they regarded magic as technology's sister art. Not only did learned magic give technology a theoretical matrix, it served an important ideological

> function by promoting the image of the professional engineer as a magus who, with his inventions, manipulates nature's occult forces and gains mastery over the physical world.…[For some engineers,] the usefulness of the occult sciences in this world overcame any consternation about the dangers it may have held for the soul in the next (69-71).

Some engineers may not have been concerned with their souls, but evidently Agricola was. By separating the divining rod's magical history from its practical utility, Agricola first conceded that the divining rod had an "impure origin with the magicians" who consorted with demons and threatened the religious and social order. But when he "examined [the use of the rod] on its own merits," Agricola argued that miners who were "unsophisticated" in the ways of magic could still make use of the rod for locating veins of ore. In other words, the rod could be used to locate ore even though miners did not rely on magic to make it work. In accomplishing this separation of an occult natural phenomenon, such as the use of the divining rod, from the realm of magic, Agricola prepared the way for considering magnetism and other natural phenomena as legitimate objects of utilitarian scientific study.

Agricola's introduction to *De Re Metallica* also worked to differentiate his text from books of secrets. Instead of recounting how the information contained in the book was revealed to him in a personal encounter with a god—a generic literary device for giving books of secrets their authority—Agricola built the authority for his text on his own experience and that of people to whom he had talked and whose texts he had read. In this respect, Agricola's authority was built in the encyclopedic tradition, and although he included alchemical information from Hermetic texts, he also discussed the questionable nature of this information:

> Whether they can do these things or not I cannot decide; but, seeing that so many writers assure us with all earnestness that they have reached that goal for which they aimed, it would seem that faith might be placed in them, yet also seeing that we do not read of any of them ever having become rich by this art, nor do we now see them growing rich, although so many nations everywhere have produced, and are producing, alchemists, and all of them are straining every nerve night and day to the end that they may heap a great quantity of gold and silver, I should say the matter is dubious (xxviii).

Agricola thus destabilized the information from books of secrets by undermining the authority of the books he cited. *De Re Metallica* resembled a book of secrets by addressing occult subject matter, but not by endorsing alchemy and magic. Agricola's final criterion for including occult knowledge was that he found it useful. In applying this experimental criterion and privileging first-hand information, while destabilizing the traditional repository for experimental knowledge (books of secrets), Agricola began to reconstruct the place of experimental knowledge based on its utility. In *De Re Metallica*, Agricola argued for valuing previously occult knowledge as genuine currency in a knowledge economy. By the 20th century, long after Bacon's interpretation of Agricola's work, this economy was so dependent on scientific and technical knowledge that arguments for valuing knowledge on the basis of utility were common sense.

Technical Language as the Lingua Franca of a Scientific Culture

In *Spurious Coin: Science, Management and a History of Technical Writing*, I argue that technical language fulfills a valuation function within our culture dominated by science and rational thought:

> Because scientific knowledge dominates in 20th century United States, technical language is the coin of the realm, circulating in an economy of scientific knowledge. And because technical writing's roots are most deeply planted in the field of mining engineering, with its emphasis on economics, value, and social stability, technical language conveys estimates of the value of ideas—estimates that originate from science as the supreme authority (21).

Far from being a neutral conduit for factual information, technical language stabilizes a knowledge/power system based on scientific knowledge and rationalized theories of the world. To carry out this stabilizing function, technical language estimates values of ideas, placing them in relationship to each other within a cultural structure. Some ideas are deemed to be “pure” science, which tends to elevate them out of the realm of social responsibility. Other ideas are deemed to be “applied” science—or technology—which implies that they are subject to social scrutiny and accountability.

Technical language also performs a control function within our culture, which became more efficient with the advent of general purpose business computing. As early as the late-1940s, Edmund Berkeley stated, "Probably the foremost problem which machines that think can solve is automatic control over all sorts of other machines" (188). Berkeley foresaw these electronic brains controlling "automatic missiles for destructive purposes…and for constructive purposes,…delivering mail and fast freight" (189). He asked, "How shall we control these automatic machines, these robots, these Frankensteins?" (189) and worried that ignorance, prejudice, and narrow focus would inhibit people's ability to prevent robots from being used for antisocial purposes.

Focusing on Berkeley's "constructive" arena, Higgins and Glickauf separated social from utilitarian concerns to argue, “Electronic computing equipment opens the door to a degree of production control greater than heretofore possible under manual procedures or past methods of mechanization” (100). But more than controlling production, computers allowed managers to more accurately forecast labor requirements and sales based on the electronic computer’s superior abilities in “statistical manipulation” (100). This “reporting in terms of the future” would lead to more “effective management controls” (101). Because humans could translate our language into the mathematical language of computers and computers could translate their language into ours, the technical communications that controlled management systems could not only become more efficient, they could also become more accurate. This utilitarian electronic brain promised to fulfill dreams of efficient production set in motion within large industrial manufacturing organizations of the previous century.

Engineers of modern management systems in the late-19th century, exemplified by Frederick Taylor, believed that accurate and minute recordings of activities enabled a scientific system of management control. That this system relied on humans was a shortcoming of 19th-century technology. Regardless of this human shortcoming, engineering practice in large manufacturing organizations produced things that would be used to improve the quality of life for large numbers of people—translating scientific knowledge from scientists to non-scientists. To achieve this better life, engineers relied on technical communication to convey scientific knowledge to non-scientists. Technical communication, then, became the lingua franca of science and engineering.

As engineering practice evolved within large, complex organizations during the last half of the 19th century, engineers were called upon to design social as well as mechanical systems to control production and operation. These designs for social control were termed "management systems" and were an important focus of engineering practice in the United States from the 1880s to the start of World War I. As engineers designed management systems to make workers as efficient as the machines with which they worked, they also designed intricate technical communication systems as the mechanism for controlling operations to ensure maximum efficiency. Management systems for control and discipline worked to make an organization's production more efficient by measuring each worker's performance and comparing it to pre-established performance and quality standards. This type of measuring and comparing viewed workers as individual units of production and this individuating process, made possible through technical communication, had an impact on workers that fundamentally changed the nature of organizational life.

The function of measuring and comparing individual performance against standards for production and quality allowed systematized management to operate through constant examination of machines and workers. Constant examination for deviance from standards constituted what Foucault called the "normalizing gaze" (184). Without such constant examination, the management system could not judge whether individual machines and workers deviated from standards. Without such measurement and comparison, deviance could not be identified and corrected. Without such constant examination and correction, operations could not be systematically controlled. Technical writing—recording and reporting observed behaviors and production—was the mechanism for documenting this constant examination and correction and, thereby, controlling the management system through control of individual machines and workers.

The technical writing that conveyed information about individual workers and machines served as the mechanism for what Foucault called a "panoptic" system of surveillance for a "disciplined society." This panopticism—functioning through technical writing—enabled "the penetration of regulation into even the smallest details of everyday life" (198) within the systematically managed operation. No longer were shop workers able to decide how their work was done; written operation standards dictated in detail the most efficient ways to do their work. No longer could managers plan operations based on their idiosyncratic judgments; production and quality data were entered into standardized calculations to determine maximum future operations. Technical writing's panoptic episteme worked within a system of "hierarchy, surveillance, observation, writing" (Foucault, 198). This surveillance system ensured that the minute details of an individual's performance were available for correcting deviant behavior and planning future operations.

By the turn of the century, this panoptic discipline facilitated by technical writing was fundamental to the success of management systems based on private property and profits. But some workers objected to the dehumanizing effects of the system's discipline and control. In order to neutralize worker's objections, engineer/managers described the system and its goal of efficiency as "natural," implying that workers were objecting to an inevitable relationship between humans and nature. One influential engineer and writer on the subject of efficiency and management, Harrington Emerson, began his book *Efficiency as a Basis for Operation and Wages* with this assertion: "Nature's operations are characterized by marvelous efficiency and by lavish prodigality. Man is a child of Nature as to prodigality, but not as to efficiency" (3). With this assertion, Emerson constructed management systems as engineer-designed replicas of nature's manufacturing operations. Here nature has become an abundant production plant, giving her children examples of both efficiency and waste. By couching his argument in these terms, Emerson's assertion that management systems are "natural" serves to remove the systems from their historical contexts, claiming instead that the systems are universal.

For the engineer/managers in the at the turn of the 20th century, human nature was exemplified by the large, complex organizations through which workers made products to improve general living conditions and owners made profits by virtue of their ownership of property, machines and workers' labor. Workers could participate in the general improvement of living conditions by purchasing the products that they helped to make, thereby ensuring a market for these products, profits for factory owners, and survival of the management system. By calling this production system—and the management control upon which it relied—"natural," engineers short-circuited questions about the inevitability of the control systems and the surveillance through technical writing which made the production system efficient and profitable.

By the turn of the 20th century, management control systems and the technical writing that made them work seemed like part of the natural landscape of an industrialized United States economy. By the middle of that century, computers were introduced into that landscape to improve management control, "effect savings by replacing clerical workers or preventing the hiring of additional clerical help" (Osborn, 102), and allow managers to "spend more time on decision-making and policy-forming matters" (Osborn 106). When Eckert and Mauchly formed the Electronic Control Company in 1946 (Ceruzzi 25), scientific management had come of age.

New Communication Technologies Support Systematized Management

Since management systems depended on technical writing as a control mechanism, system efficiency was directly influenced by the efficiency of technical writing. JoAnne Yates has argued that systematic management was able to spread from shop floors to business offices because of the communication technologies that developed concurrently with those systems (64). Just as machines and workers became specialized and standardized to gain maximum efficiency from them, communication also became specialized and standardized through the implementation of office appliances and reporting forms.

By the 1890s, calculating machines were used in business settings, as well as in engineering and scientific practices. These machines enabled improved efficiency in accounting departments, since they could manipulate numbers much faster than even "lightning calculators," "people who could add long, wide columns of numbers rapidly and even entertained with this skill" (Cortada 27). With faster and more efficient calculating, clerks and accountants could manipulate increased volumes of information stemming from the need for more records to control the management system. As Hamilton Church described in "The Meaning of Commercial Organisation"(1900), management system control required that all aspects of the organization be quantified, which in turn resulted in more data for analysis:

> With the growth of competition the necessity for co-ordination and of an accurate and swift presentation of results is more and more imperative.… Everything should be the subject of forecast as to financial results, and of prearrangements as to the actual carrying out. And when it is completed, the records of what did actually take place should be capable of comparison with what was intended to take place. Control then becomes a living reality (397).

Typewriters also contributed to increased efficiency and standardization in record-keeping and communication. The trend toward specialization combined with this new technology led to a new category of clerk whose functions were limited along the lines of Taylor's functional management model. Ellen Lupton described this new category of clerk:

> Whereas the traditional clerk often had been responsible for mentally *composing* as well as physically *writing* a text, workers in the mechanized office were assigned limited functions as stenographers (who captured an executive's spoken words in shorthand) and typists (who mechanically transcribed such words). …The new system…saved the high-cost time and effort of the managers, while a lower-paid crew of clerical workers generated a huge volume of legible, uniform documents (Lupton's italics, 44).

The legible and uniform documents that typists generated were gradually accepted by businesses and their customers. By the 1920s, people had become accustomed to less personal documents and the efficient production of these impersonal documents spurred further efficiencies. These standard, uniform documents were well suited for recording and conveying the detailed information upon which systematized management relied.

By the early 20th century, communication technologies had strengthened the control of large, complex organizations through management systems. These systems, modeled on scientific observation and Prussian military line-and-staff organization, were well suited to maximize operational efficiency through the implementation of production standards. They relied on constant examination, recording, and correction of worker and machine performance to maximize operations. These systems relied on the consent of individual workers to internalize standards and perform constant examination through technical communication in return for the promise of personal financial benefits.

From its origins on the shop floors, systematized management spread to the clerical office and even into the management ranks themselves. All workers—manual and brain workers alike—came within the systematic control of the organization through technical communication. All workers—even the engineer/managers who designed management systems—became labor in the tensions between labor and capital. Workers relinquished the power to control their own work and became inscribed in a system controlled by technical communication and, in the late-20th century, computers manipulating technical language.

Divisions of Labor Based on Efficiency

Engineers developed management systems and became managers. Their "brain" work was separated from "manual" work done by laborers on shop floors in order to increase efficiency of operations within the system. Engineers also developed office equipment to make their brain work more efficient. This led to another division of labor, in which a new class of clerical workers was responsible for routine communication functions at the heart of the management system. By developing this new class of clerical worker, managers could use their higher priced time efficiently by concentrating on planning and oversight. Lower paid clerical workers could generate routine communications at a lower cost to the system.

In a similar division of labor after World War II, engineering and technical writing functions were separated to enable engineers to concentrate on researching and developing technology. The communication functions relative to those efforts were increasingly delegated to a new class of technical writers. By the mid-1950s, the new occupation of technical writing was rapidly organizing and expanding. But unlike some successful engineers who became managers, technical writers could not really become scientists.

The development of the computer as a labor-saving device for mathematicians can be interpreted as a division of labor analogous to the division between engineering and technical writing or between managers and clerical staff. In this iteration, though, routine mathematical calculations were carried out by electronic brains developed by engineers -- information-generating computers untainted by humanistic traditions. Knowledge minted by these machines could carry the stamp of science and could circulate as genuine currency in a scientific economy. When computers entered the realms of systematized management, managers could be confident that the computer's knowledge (and human's knowledge of computers) would improve the standard of living for the general public.

The Giant Brain

Because computers are developed by engineers, they can generate genuine scientific knowledge. Yet in our perception of these machines is an urge to see ourselves—to attribute human characteristics to these "mathematical robots" (War Department, "Ordnance" 1):

> "Fabulous wonder brain designed and constructed…" (headline to article by John G. Brainerd).
>
> "These machines are similar to what a brain would be if it were made of hardware and wire instead of flesh and nerves…since their powers are like those of a giant, we may call them *giant brains*" (Edmund Berkeley's italics, 1).
>
> "I have described, in some detail, the nature of modern computing machines…It is now possible to pass on to the other term of the comparison, the human nervous system. I will discuss the points of similarity and dissimilarity between these two kinds of 'automata'" (von Neumann, 39).
>
> "The data-processing center, which acts as UNIVAC's baby sitter or nursemaid, allows management to forget the problems of computer operation" (Osborn, 106).

In our early contacts with electronic computers, we sought to understand them in relation to our standard for understanding the world: the human being. Paul Ceruzzi retells an anecdote that illustrates people's early reactions to being in contact with "giant brains":

> [Grace] Hopper once recounted how she develpoed a version of FLOW-MATIC in which she replaced all the English terms, such as "Input," "Write," and so on, with their French equivalents. When she showed this to a UNIVAC executive, she was summarily thrown out of his office. Later on she realized that the very notion of a computer was threatening to this executive; to have it "speaking" French—a language he did not speak—was too much (93-94).

If a UNIVAC executive was uneasy about losing face to a computer, our digital culture had not developed to the point where computers were part of the natural landscape. Relationships between humans and their electronic brains were still being negotiated. As time went on, however, we began to understand humans in relation to computers, describing human brains as being like computers and human functions, such as communication, as being like computer systems. When did computers become the standard for understanding human functions? And how does this shift reflect changing cultural contexts for humans and computers? In Derrida's terms, when did the supplemental electronic brain supplant the human god-king's brain ("Plato's Pharmacy")?

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