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IN OUR OWN IMAGE: CREATING THE COMPUTER

FROM "GIANT BRAIN" TO INFORMATION APPLIANCE

In the years following World War II, the world appeared to be entering a new age, the Atomic Age, portrayed as an era of prosperity fueled by energy "too cheap to meter". Automobiles, trains, planes, homes, industry would all draw their power from nuclear reactors of various sizes and formats, and society would assume new forms around the possibilities of ubiquitous, unlimited energy.¹ Some of those visions became reality, some turned into nightmares. Fifty years later we draw on atomic power, but the phrase "atomic age" is more likely than not to evoke images of a nuclear winter of desolation.

Instead, we speak now of the "Information Age", or the "Computer Age". It too is a product of World War II, but the potential of the electronic digital computer for social transformation was not immediately evident. Costing upward of a million dollars, weighing several tons, drawing a hundred kilowatts of power, it seemed at first destined for limited scientific use. Several subsequent and unforeseen developments had to occur before the possibilities became clear. The "computer age" of which people spoke in the 1960s referred to large mainframes in the scientific laboratory, the government agency, the military command center, or the corporation.² The computer was the agent of automation, the tool of Big Brother. "I am a human being," protesters of the late '60s exclaimed, taking their cue from the then common IBM punch card, "do not fold, spindle, or mutilate" (Figures 1–3).

Few at the time foresaw, or even imagined, computers with many times the capacity of those mainframes sitting on people's desks or indeed on their laps, serving as agents for personal business and as tools of Little Brothers seeking not to exercise control over society but to wreak havoc on it. In the 1950s, the computer was an object of wonder, viewed through plate glass windows and tended by technicians. It was a visible statement of corporate and governmental power. Today, at least in the developed world, it has become a common appliance, an instrument of personal power as much a part of daily life as television and the telephone. Indeed, it is on the verge of combining with television and the telephone to form a single information/communication/entertainment device, in stationary and portable format (Figure 4).

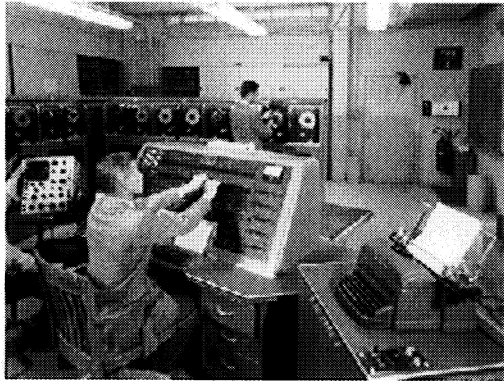


Figure 1. Early mainframe UNIVAC.

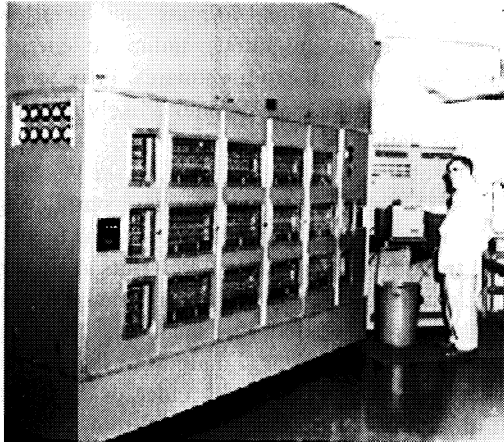


Figure 2. Early mainframe ILLIAC.

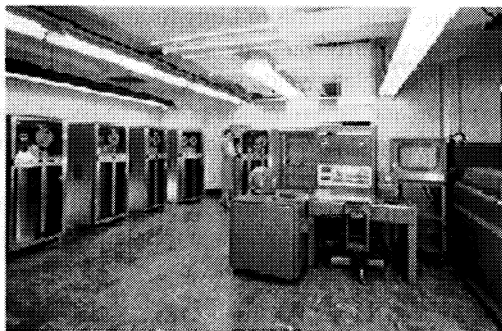


Figure 3. Early mainframe IBM 704.

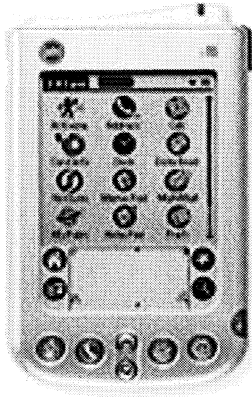


Figure 4. Palm™ i705. Courtesy of Palm Inc.

Our image of the computer is evolving along with it. As it becomes more common, we grow less conscious of its presence. Yet, at the same time, it increasingly shapes our view of the world. We think of the computer as a machine, as a thing. Indeed, we speak of *the* computer, as if it were a single, generic device. But there is no computer, only computers. Or rather, *the* computer is an abstract scheme, first devised by Alan M. Turing in 1936 and then articulated by John von Neumann and others in 1945. In a paper addressed to a recondite problem in mathematical logic, Turing sought to capture what it meant to speak of a number as “computable”. “According to my definition,” he wrote, “a number is computable if its decimal can be written down by a machine”.³ But what kind of machine? Turing imagined a device that shifted among a finite number of predefined states in response to symbols read from and written to a potentially infinite tape. He showed how any logical function could be expressed in terms of the operations of such a device, that is, could be defined as a Turing machine. Moreover, since the states and operations themselves can be denoted by symbols, it was possible to define a Universal Turing Machine that would first read the description of a particular computation and then carry it out. The purpose of the exercise was not to design an actual machine or to do computations, but rather to show that some functions cannot be computed and, more important, that there is no function for deciding whether any given function can be computed or not (Figure 5).

The “First Draft of a Report on the EDVAC”, published in July 1945, bears only John von Neumann’s name, but it was the outcome of his collaboration with John Mauchly and Presper Eckert, the designers of the ENIAC.⁴ Its significance lies in transforming Turing’s abstract scheme into a general design for a physical device. The finite state machine became the control and arithmetic units, the tape became memory. In keeping with Turing’s central insight of a universal machine, von Neumann’s report placed data and instructions in the same memory, thus allowing the device to modify the instructions as it proceeded (Figure 6).

This scheme has remained the basic structure of the vast majority of computers. The processors have become faster and logically more complex, the memory (both primary

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