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# Introduction

In January 1983, *Time* magazine selected the PC as its Man of the Year, and public fascination with the computer has continued to grow ever since. That year was not, however, the beginning of the computer age. Nor was it even the first time that *Time* had featured a computer on its cover. Thirty-three years earlier, in January 1950, the cover had sported an anthropomorphized image of a computer wearing a navy captain's hat to draw readers' attention to the feature story, about a calculator built at Harvard University for the navy. Sixty years before that, in August 1890, another popular American magazine, *Scientific American*, devoted its cover to a montage of the equipment constituting the new punched-card tabulating system for processing the U.S. census. As these magazine covers indicate, the computer has a long and rich history, and we aim to tell it in this book.

In the 1970s, when scholars began to investigate the history of computing, they were attracted to the large, one-of-a-kind computers built a quarter-century earlier—sometimes now referred to as the “dinosaurs.” These were the first machines to resemble in any way what we now recognize as computers: They were the first calculating systems to be readily programmed and the first to work with the lightning speed of electronics. Most of them were devoted to scientific and military applications, which meant that they were bred for their sheer number-crunching power. Searching for the prehistory of these machines, historians mapped out a line of desk calculating machines originating in models built by the philosophers Blaise Pascal and Gottfried Leibniz in the seventeenth century and culminating in the formation of a desk calculating industry in the late nineteenth century. According to these histories, the desk calculators were followed in the period between the world wars by analog computers and electromechanical calculators for special scientific and engineering applications; the drive to improve the speed of calculating machines during World War II led directly to the modern computer.

While mostly correct, this account is not complete. Today, research scientists and atomic weapons designers still use computers extensively, but the vast majority of computers are employed for other purposes, such as word processing and keeping business records. How did this come to pass? To answer this question, we must take a broader view of the history of the computer as the history of the information machine.

This history begins in the early nineteenth century. Because of the increasing population and urbanization in the West resulting from the Industrial Revolution, the scale of business and government grew—and with it grew the scale of information collection, processing, and communication needs. Governments began to have trouble enumerating their populations, telegraph companies could not keep pace with their message traffic, and insurance agencies had trouble processing policies for the masses of workers.

Novel and effective systems were developed for coping with this increase in information. For example, the Prudential Company of England developed a highly effective system for processing insurance policies on an industrial scale using special-purpose buildings, rationalization of process, and division of labor. But by the last quarter of the century, large organizations turned increasingly to technology as the solution to their information-processing needs. On the heels of the first large American corporations came a business machine industry to supply them with typewriters, filing systems, and duplication and accounting equipment.

The desk calculator industry was part of this business machine movement. For the previous two hundred years, desk calculators had merely been hand-made curiosities for the wealthy. But by the end of the nineteenth century, these machines were being mass-produced and installed as standard office equipment, first in large corporations and later in progressively smaller offices and retail establishments. Similarly, the punched-card tabulating system developed to enable the U.S. government to cope with its 1890 census data gained wide commercial use in the first half of the twentieth century, and was in fact the origin of IBM.

Also beginning in the nineteenth century and reaching maturity in the 1920s and 1930s was a separate tradition of analog computing. Engineers built simplified physical models of their problems and measured the values they needed to calculate. Analog computers were used extensively and effectively in the design of electric power networks, dams, and aircraft.

Although the calculating technologies available through the 1930s served business and scientific users well, during World War II they were not up to the demands of the military, which wanted to break codes, prepare firing tables for new guns, and design atomic weapons. The old technologies had three shortcomings: They were too slow in doing their calculations, they required human intervention in the course of a computation, and many of the most advanced calculating systems were special-purpose rather than general-purpose devices.

Because of the exigencies of the war, the military was willing to spend whatever it would take to develop the kinds of calculating machines it needed. Millions of dollars were spent, resulting in the production of the first electronic, stored program computers—although, ironically, none of these machines was completed in time for war work. The military and scientific research value of these computers was nevertheless appreciated, and by the time of the Korean War a small number had been built and placed in operation in military facilities, atomic energy laboratories, aerospace manufacturers, and research universities.

Although the computer had been developed for number crunching, several groups recognized its potential as a data-processing and accounting machine. The developers of the most important wartime computer, the ENIAC, left their university posts to start a business building computers for the scientific and business markets. Other electrical manufacturers and business machine companies, including IBM, also turned to this enterprise. The computer makers found a ready market in government agencies, insurance companies, and large manufacturers.

The basic functional specifications of the computer were set out in a government report written in 1945, and these specifications are still largely followed today. However, forty years of continuous and extraordinarily rapid-paced innovation have followed the original conception. These innovations are of two types. One is the improvement in components, leading to faster processing speed, larger information storage capacity, improved price performance, better reliability, less required maintenance, and the like—today's computers are literally millions of times better than the first computers on almost all measures of this kind. These innovations were made predominantly by the firms that manufactured computers.

The second type of innovation was in the mode of operation, but here the agent for change was most often the academic sector,

backed by government financing. In most cases, these innovations became a standard part of computing only through their refinement and incorporation into standard products by the computer manufacturers. There are five notable examples of this kind of innovation: high-level programming languages, real-time computing, time-sharing, networking, and graphically oriented human-computer interfaces.

While the basic structure of the computer remained unchanged, these new components and modes of operation revolutionized our human experiences with computers. Elements that we take for granted today, such as having a computer on our own desk, equipped with a mouse, monitor, and disk drive, were not even conceivable until the 1970s. Then most computers cost hundreds of thousands, or even millions, of dollars and filled a large room. Users would seldom touch or even see the computer. Instead, they would bring a stack of punched cards representing their program to an authorized computer operator and return hours or days later to pick up a printout of their results. As the mainframe became more refined, the punched cards were replaced by remote terminals and response time from the computer became almost immediate, but still only the privileged few had access to the computer. This has all changed with the development of the personal computer and the growth of the Internet. The mainframe has not died out, as many have predicted, but computing is now available to the masses.

We have organized the book in four sections. The first covers the way computing was handled before the arrival of electronic computers. The next two sections describe the mainframe computer era, roughly from 1945 to 1980, with one section devoted to the computer's creation and the other to its evolution. The final section discusses the origins of the new computing environment of the personal computer and the Internet.

The first section, on the early history of computing, includes three chapters. Chapter 1 discusses manual information processing and early technologies. People often suppose that information processing is a twentieth-century phenomenon; this is not so, and this chapter shows that sophisticated information processing could be done with or without machines—slower in the latter case, but equally well. Chapter 2 describes the origins of office machinery and the business machine industry. To understand the modern computer

industry, it is necessary to realize that its leading firms—including IBM—were established as business machine manufacturers in the last decades of the nineteenth century and were major innovators between the two world wars. Chapter 3 describes Charles Babbage's failed attempt to build a calculating engine in the 1830s and its realization by Harvard University and IBM a century later.

The second section of the book describes the development of the electronic computer, from its invention during World War II up to the establishment of IBM as the dominant mainframe computer manufacturer in the mid-1960s. Chapter 4 covers the development of the ENIAC at the University of Pennsylvania during the war, and its successor, the EDVAC, which was the blueprint for almost all subsequent computers up to the present day. Chapter 5 describes the early development of the computer industry, which transformed the computer from a scientific instrument for mathematical computation into a machine for business data processing. In chapter 6 we examine the development of the mainframe computer industry, focusing on the IBM System/360 range of computers, which created the first stable industry standard and established IBM's dominance.

The third part of the book presents a selective history of some key computer innovations in the quarter-century between the invention of the computer at the end of the war and the development of the first personal computers. Chapter 7 is a study of one of the key technologies of computing, real time. We examine this subject in the context of commonly experienced applications, such as airline reservations and supermarket bar codes. Chapter 8 describes the development of software technology and the emergence of a software industry. Chapter 9 covers the development of some of the key features of the computing environment at the end of the 1960s: time-sharing, minicomputers, and microelectronics. The purpose of the chapter is, in part, to redress the commonly held notion that the computer transformed from the mainframe to the personal computer in one giant leap.

The last section of the book gives a history of the developments of the last twenty years that brought the computer to most people's desktops. Chapter 10 describes the development of the microcomputer from the first hobby computers in the mid-1970s, up to its transformation into the familiar personal computer by the end of the decade. Chapter 11's focus is on the personal-computer environment of the 1980s, when the critical problems in personal com-

puting were no longer hardware but software—especially “user-friendly” software. This decade was characterized by the extraordinary rise of Microsoft and the other personal-computer software companies. The book concludes with a discussion of the latest chapter in computing, the Internet. The focus is on the World Wide Web and its precedents in the information sciences.

This book, perhaps more than many others, is a product of its time. The computer technology that we are studying is evolving rapidly. Over the five years during which this book was written, we used three generations of personal computers. The material in the last section is at particular risk of looking dated within a few years, after the computing field has moved off in some new direction. The historical study of computing itself is also a young discipline. Historians have passed beyond the period where their focus was on desk calculators and number-crunching computers. Our work falls in the present generation of scholarship based on the broader definition of the information machine, with strong business and other contextual factors considered in addition to technical factors. We anticipate that within the next decade, a new body of historical scholarship will appear that will enable someone to write a new synthetic account that will deepen our understanding of computers in relation to consumers, gender, labor, and other social and cultural issues.

There are a few gaps in this book that cannot be explained by the absence of a secondary literature. We have not, for example, attempted to discuss computer science and computer theory, nor have we treated artificial intelligence. We felt that the former would be too arcane and “internalist” for the general reader, while the latter—though full of interest—has not yet advanced sufficiently for us to be able to evaluate its contributions, separate hype from reality, and incorporate the subject meaningfully into the mainstream history of computing.

We have included notes on our sources at the end of the book. These indicate the exact sources of our quotations and lead the interested reader to some of the major literature on the history of computing.