CHAPTER 1

New Divisions of Labor

ON MARCH 22, 1964, THE AD HOC COMMITTEE ON THE TRIPLE Revolution sent a fourteen-page memorandum to President Lyndon Johnson. The signers included chemist Linus Pauling (recipient of two Nobel Prizes), economist Gunnar Myrdal (a future Nobel Prize-winner), and Gerard Piel, publisher of *Scientific American*. In the memo, the committee warned the president of long-run threats to the nation beginning with the likelihood that computers would soon create mass unemployment.

> A new era of production has begun. Its principles of organization are as different from those of the industrial era as those of the industrial era were different from the agricultural. The cybernation revolution has been brought about by the combination of the computer and the automated self-regulating machine. This results in a system of almost unlimited productive capacity which requires progressively less human labor. Cybernation is already reorganizing the economic and social system to meet its own needs.[1]

In one respect the committee's warning was prophetic. Computers now replace humans in carrying out an ever widening range of tasks—

filing, bookkeeping, mortgage underwriting, taking book orders, installing windshields on automobile bodies—the list becomes longer each year. And beyond directly replacing humans, computers have become the infrastructure of the global economy, helping jobs move quickly to sources of cheap labor.

But the Ad Hoc Committee also made a major miscalculation. Like many computer scientists of that time, the committee expected computers would soon replicate all the modes by which humans process information. The expectation was only partly fulfilled, and so the committee's warning was only partly right. Computers have not created mass unemployment, but they have created a major upheaval in the nature of human work.

More than two centuries ago, Adam Smith used the words "division of labor" to describe an earlier upheaval—the way in which the first factory systems had reorganized work and dramatically boosted productivity.[2] In today's economy, Smith's words have taken on new meanings. There is a new division of labor between people and computers. And there is a growing division within human labor itself—a divide between those who can and those who cannot do valued work in an economy filled with computers. Bridging this divide involves more than ensuring that the affluent and the poor have access to the same hardware and software. It involves rethinking education and training, beginning with answering four fundamental questions:

- What kinds of tasks do humans perform better than computers?
- What kinds of tasks do computers perform better than humans?
- In an increasingly computerized world, what well-paid work is left for people to do both now and in the future?
- How can people learn the skills to do this work?

Answering these questions is the focus of this book.

HOW WORK HAS CHANGED

One day in June 2003, a General Electric technician made a service call to a suburban house to check on a malfunctioning ice-maker. As he was

writing up the receipt for the repair, he apologized for having had to call for directions thirty minutes before he arrived.

> I carry maps but the work order didn't even have your street address. It just had "HOUSE" and your phone number. The problem is that they've just switched our call center from India to Costa Rica. They're still learning the procedures down there and they must be having trouble with addresses.

The explanation was plausible—a call center that used operators who read scripts on computer screens moved to a source of even cheaper labor. In fact, however, the work order had not been taken by a human operator but by a computer using speech recognition software. By reading menus to the caller, the software could prompt the caller to identify the problem as being in a refrigerator, specifically, the ice-maker. It could also prompt the caller to choose a time he would be at home from a list of times when technicians were available. The speech recognition software could recognize the caller's phone number and establish that the home address was a "HOUSE" rather than an apartment. While the software was not yet good enough to recognize the home address itself, it had captured enough information to print up a work order and append it to the technician's schedule.

In 1990 that work order would have been taken by an operator sitting somewhere in the United States. That operator's job is now gone. Whether the job was displaced by a computer or a Costa Rican call center is unimportant for the moment. What is important is that the loss of the operator's job is part of a much larger pattern.

As recently as 1970, more than one-half of employed U.S. adults worked in two broad occupational categories: blue-collar jobs and clerical jobs (including the operator who would have written up the work order). Few people got rich in these jobs, but they supported middle- and lower-middle-class living and many were open to high school graduates. Today, less than 40 percent of adults have blue-collar or clerical jobs and many of these jobs require at least some college education. The computerization of work has played a significant role in this change.

Had the rest of the economy remained unchanged, the declining importance of blue-collar and clerical jobs might have resulted in the rising

unemployment feared by the Ad Hoc Committee. But computers are Janus-faced, helping to create jobs even as they destroy jobs. As computers have helped channel economic growth, two quite different types of jobs have increased in number, jobs that pay very different wages. Jobs held by the working poor—janitors, cafeteria workers, security guards—have grown in relative importance.[3] But the greater job growth has taken place in the upper part of the pay distribution—managers, doctors, lawyers, engineers, teachers, technicians. Three facts about these latter jobs stand out: they pay well, they require extensive skills, and most people in these jobs rely on computers to increase their productivity. This hollowing-out of the occupational structure—more janitors and more managers—is heavily influenced by the computerization of work.

Beneath the level of the job title, computers are rearranging tasks *within* jobs. The secretary's job provides a prime example. Even as there are relatively fewer secretaries, the job itself is changing. A quarter century ago, the U.S. Department of Labor *Occupational Outlook* described a secretary's job in this way:

> Secretaries relieve their employers of routine duties so they can work on more important matters. Although most secretaries type, take shorthand, and deal with callers, the time spent on these duties varies in different types of organizations.

Compare the description of the same job in today's *Occupational Outlook:*

> As technology continues to expand in offices across the Nation, the role of the secretary has greatly evolved. Office automation and organizational restructuring have led secretaries to assume a wide range of new responsibilities once reserved for managerial and professional staff. Many secretaries now provide training and orientation to new staff, conduct research on the Internet, and learn to operate new office technologies. In the midst of these changes, however, their core responsibilities have remained much the same—performing and coordinating an office's administrative activities and ensuring that information is disseminated to staff and clients.

What is true for secretaries is true for many other jobs. In the chapters ahead we will explain why computerized work has increased the value of

identifying and solving uncharted problems—work that we call "expert thinking." We will also explain why computerized work has increased the importance of "complex communication," conveying not just information but *a particular interpretation of information*.

At the same time, we will see that the ability to apply well-understood routines to solve problems is not valued as it used to be. Twenty years ago, a man or woman could make a good living as a mortgage underwriter, accepting and rejecting loan applications. That work is now almost entirely computerized.

DIFFERENT KINDS OF THINKING

A first step toward understanding these patterns begins with the Ad Hoc Committee's mistake. Start with the fact that all human work involves the cognitive processing of information. The analyst who reads revenue numbers in a spreadsheet, the farmer who looks to the sky for signs of rain, the chef who tastes a sauce, the carpenter who feels his hammer as it hits a nail—all these men and women are processing information to decide what to do next or to update their picture of the world.

For most of economic history, technical innovation involved machines replacing humans in performing *physical* tasks—the shift of weaving from artisans' hands to mechanical looms, the shift of long-distance messaging from Pony Express riders to the telegraph. Through all of these changes, *cognitive* tasks—the information processing that is a part of all work—remained a largely human province.[4] With the 1945 advent of the ENIAC, the first programmable computer, *some* information processing could now be done by "machines that can think."

The Ad Hoc Committee predicted a jobless economy because it had ignored the word *some*. We take for granted that a truck—not a person—is best to carry a set of living room furniture from a showroom to a house. But a person—not a machine—is best to change a newborn's diaper. In a similar way, computers have the advantage over humans in carrying out tasks that involve *some* kinds of information processing. But humans retain an advantage over computers in tasks requiring other kinds of information processing. At any moment in time, the boundary

marking human advantage over computers largely defines the area of useful human work.[5]

This boundary shifts as computer scientists expand what computers can do, but as we will see, it continues to move in the same direction, increasing the importance of expert thinking and complex communication as the domains of well-paid human work. What is true about today's rising skill requirements will be even more true tomorrow.

Who will have the skills to do the good jobs in an economy filled with computers? Those who do not will be at the bottom of an increasingly unequal income distribution—the working poor. The disappearance of clerical and blue-collar jobs from the lower middle of the pay distribution illustrates this pattern of limited job options. People with sufficient workplace skills can move from these jobs into one of the expanding sets of higher-wage jobs. People who lack the right skills drop down to compete for unskilled work at declining wages.

This dynamic, repeated in many workplaces, has contributed to the extraordinary growth over the past twenty-five years in the earnings gap between college graduates and high school graduates. In 1979, the average thirty-year-old man with a bachelor's degree earned just 17 percent more than a thirty-year-old man with a high school diploma. Today, the equivalent college-high school wage gap exceeds 50 percent, and the gap for women is larger. Employers judge that college graduates are more likely than high school graduates to have the skills needed to do the jobs requiring expert thinking and complex communication.

The national challenge is to recognize the inexorable changes in the job distribution and to prepare young people with the skills needed in the growing number of good jobs. As we explain in the chapters that follow, these skills include the ability to bring facts and relationships to bear in problem solving, the ability to judge when one problem-solving strategy is not working and another should be tried, and the ability to engage in complex communication with others.

GRASPING THE RIGHT PROBLEM

The story we tell differs from most other popular accounts of how computers affect human work. Accounts that focused on *individual users* were

often utopian, describing the unlimited gains computers could bring to the workplace. But accounts that focused on the *entire economy* frequently carried the Ad Hoc Committee's warning of mass unemployment. It is easy to see why. When the Ad Hoc Committee wrote its memo, a computer could already play a good game of chess—a sophisticated task for a person. It was easy to assume that computers would soon master simple tasks like making one's way across a crowded room to select an apple from a bowl of fruit, something four-year-olds could do. The logical next step would be to subsume all human work.

As we will see, the trip for the apple has proved extremely difficult to program—the problem is yet to be solved. But neither this difficulty nor the continued growth of jobs has put the unemployment fear to rest. In 1995, science writer Jeremy Rifkin argued that computer-driven unemployment was already upon us:

> In the past, when new technologies have replaced workers in a given sector, new sectors have always emerged to absorb the displaced laborers. Today, all three of the traditional sectors of the economy—agriculture, manufacturing, and service—are experiencing technological displacement, forcing millions onto the unemployment rolls. The only new sector emerging is the knowledge sector, made up of elite entrepreneurs, scientists, technicians, computer programmers, professionals, educators, and consultants. While this sector is growing, it is not expected to absorb more than a fraction of the hundreds of millions who will be eliminated in the next several decades in the wake of revolutionary advances in the information and communication sciences.[6]

As Rifkin was writing, other analysts were making more refined predictions of job loss. Michael Hammer, a founder of the re-engineering movement, argued that computer-driven re-engineering would "obliterate" large numbers of management jobs. Neil Rackham, a prolific author on salesmanship, predicted that web-based e-commerce would radically reduce the number of sales jobs.[7] None of these predictions has come to pass.

Hindsight makes everything obvious, but better predictions existed even as the Ad Hoc Committee was writing. A decade earlier, Peter Drucker had published *The Practice of Management,* the book that estab-

lished his reputation as a preeminent management theorist. Drucker predicted computers would affect jobs, but not through mass unemployment:

> The technological changes now occurring will carry [the Industrial Revolution] a big step further. They will not make human labor superfluous. On the contrary, they will require tremendous numbers of highly skilled and highly trained men—managers to think through and plan, highly trained technicians and workers to design the new tools, to produce them, to maintain them, to direct them. Indeed, the major obstacle to the rapid spread of these changes will almost certainly be the lack, in every country, of enough trained men.[8]

Many writers could have profited from reading Drucker. But had someone offered a prize for foretelling the future, Herbert Simon would have won it for his obscure 1960 essay, "The Corporation: Will It Be Managed by Machines?"

Herbert Simon himself was far from obscure. Over his career, he established international reputations in economics (winning a Nobel Prize), organizational behavior, artificial intelligence, and psychology. With this background, he was perfectly positioned to understand the interplay between computers and work. But his 1960 essay was issued under modest circumstances, a chapter in a symposium volume marking the tenth anniversary of his institution, the Graduate School of Industrial Administration of the Carnegie Institute of Technology (now Carnegie-Mellon University). It was not among the best known of his many writings.

In the essay, Simon explained why computerized work would lead not to mass unemployment but rather to substantial shifts in the economy's mix of jobs. He explained why these shifts would involve movement away from blue-collar and clerical work (something we have already seen). And finally, he offered this prediction:

> [I]n the entire occupied population, a larger fraction of members than at present will be engaged in occupations where "personal service" involving face-to-face human interaction is an important part of the job. I am confident of stating this conclusion; far less confident in conjecturing what these occupations will be.[9]

Unlike many other technology prophets, Simon was largely right. We return to his predictions in the chapters that follow.

THE PLAN OF THE BOOK

We have argued that computers' real impact on work is hollowing out the occupational distribution. The result is a significant increase in the demand for people who perform jobs requiring expert thinking and complex communication. Both U.S. firms and the nation as a whole ignore at their peril how computers are raising the cognitive bar.

In the chapters that follow, we make our case in three parts. In Part I—Computers and the Economy—we explain the kinds of information-processing tasks in which computers dominate humans and the tasks for which the opposite is true (chapter 2). We then show how both the economy's occupational structure and the work done within occupations have changed over the past thirty-five years and the critical role computerization has played in bringing about these changes (chapter 3).

In Part II—The Skills Employers Value—we use workplace examples to describe the two kinds of tasks that computers make more valuable and the skills humans need in order to be good at these tasks. We first examine expert thinking—solving new problems for which there are no routine solutions (chapter 4). We next examine complex communication—persuading, explaining, and in other ways conveying a particular interpretation of information (chapter 5).

In Part III—How Skills Are Taught—we examine how people can learn to become proficient at expert thinking and complex communication. We begin by explaining why strong literacy and numeracy are preconditions (chapter 6). We next describe how corporations are teaching the skills critical to complex communication and expert thinking (chapter 7). We then turn to elementary school classrooms to show what is needed if the standards-based educational reforms now sweeping the country are to prepare American students to thrive in computerized workplaces (chapter 8). Along the way, we show why an emphasis on education for earning a good living does not necessarily conflict with the education needed to be a contributing citizen in a democracy where

computers raise issues of privacy, workplace monitoring, and the length of the workday.

In chapter 9, we conclude by addressing whether our story and prescriptions have staying power. We explain why the evolutionary path of work we have described in this book is likely to persist for some time. The result is a polarized job market. Good jobs will increasingly require expert thinking and complex communication. Jobs that do not require these tasks will not pay a living wage. Preparing the work force to deal with this reality presents a formidable economic problem. Broadly shared prosperity—the American dream—depends on the problem's solution.