

The Digital Hand: How Computers Changed the Work of American Manufacturing, Transportation, and Retail Industries. *By James W. Cortada.* New York: Oxford University Press, 2004. xvii + 494 pp. Illustrations, tables, figures, notes, index. Cloth, \$34.95. ISBN: 0-195-16588-8.

Reviewed by Martin Campbell-Kelly

There is an extensive literature on the business history of computing, but almost all of it relates to the supply side—computers, software, and services. Hence, any sound book on the demand side of computing is bound to be welcome. However, James Cortada's *The Digital Hand* does much more than fill a lacuna: it is an encyclopedic contribution that—when it is joined by two promised further volumes—will increase what we know about demand-side computing by an order of magnitude.

The title of this book, *The Digital Hand*, is both a conscious tribute to Alfred D. Chandler's *Visible Hand* and an encapsulation of Cortada's basic thesis. In 1977, when Chandler published his pathbreaking book, his proposition was that in the decades following the Civil War the “visible hand” of managerial capitalism superseded Adam Smith's invisible hand of the marketplace. Cortada argues that since the 1950s business has been as radically transformed by the digital hand of information technology as it was by the managerial revolution in the period Chandler described. Cortada establishes a taxonomy of U.S. industry and systemically analyzes the impact of information technology on each industry.

In this volume, Cortada describes three major sectors: manufacturing, transportation, and wholesale/retail. Of the unpublished volumes to follow, the second will examine telecommunications, finance, media and entertainment, and the third will describe the digitizing of the public sector: local, state, and federal government, the military, and education. He promises that, together, the three volumes will “describe enough industries to account for roughly 80 percent of the U.S. economy . . . so that my observations and conclusions are based on a sufficient level of detail to be creditable” (p. xiii).

Cortada begins with discrete manufacturing. He takes us from the 1950s world of drawing offices, milling machines, and production lines, showing how digitization has changed almost every aspect of that world. The drawing office has been completely refurbished with computer-aided design software. The production line was metamorphosed, first by integrated manufacturing systems and then by flexible manufacturing (computer-augmented just-in-time, team-oriented assembly). In Cortada's narrative, these shifts are correctly portrayed as evolutionary, not revolutionary. Thus, the milling machine successively became numerically controlled, then used embedded microprocessors, and finally became fully integrated into manufacturing through CAD/CAM (computer-aided design/computer-assisted manufacturing), whereby an engineer's drawing fed directly into milling machines almost without human agency. Comparable transformations occurred in the process industries, of which three examples are studied: petroleum, chemicals, and pharmaceuticals. Falling somewhere between discrete manufacturing and the process industries are the information-technology (IT) industries themselves—semiconductors, hard drives, and software. It is sometimes said that, just as cobblers' children are the worst shod, so are the IT industries laggards in adopting their own products, an observation that seems to be borne out in this study. For example, the software industry, which “fueled the economy with digital tools, remained a craft-based industry” (p. 222). Its productivity has indeed been relatively stagnant compared with the massive improvements in other sectors.

In transport, we see how road and rail transport were drastically altered by on-board automation, signaling technologies, containerization, and computerized resource allocation and scheduling. In the process, digitization pushed ever-greater volumes of goods through an existing infrastructure. Perhaps the most engaging part of the book is on the retail industry, because shopping is such a universal social and cultural experience. The headline story, as might be expected, is the bar code. However, Cortada, explains that the real innovation was not the device per se, but the way in which it was a catalyst for integration. He paints a colorful chronology, following information from checkout scanners as it is being aggregated into replenishment orders with wholesalers, which in turn trigger manufacturing activities further up the supply chain. A great strength of the book is its richly layered detail and its constant emphasis on the gradual and evolutionary

nature of these dramatic changes in business procedures. For example, bar codes were not an overnight event, suddenly arriving in the local supermarket one day, but were ten years in the making while many actors negotiated their requirements. It then took another twenty years for their nearly universal adoption to be accomplished.

If this were a lesser book, Cortada's title might seem a presumption. However, Cortada is a long-term colleague of Chandler (their joint works include the excellent coedited volume, *A Nation Transformed by Information* [2000]), and this book is by any standard an outstanding contribution to the field. However, I do not think it will prove pathbreaking to the same extent as *Visible Hand* for the following reason: Chandler painted on an enormous canvas. He showed that there were multiple factors in the transformation of American business—cheap and fast railroads, innovations in marketing, financial improvements such as clearing banks and credit reporting, the telegraph and telephone, and so on. By contrast, in Cortada's account, information technology is almost the sole factor considered, whereas there were actually multiple forces involved—such as the business schools, venture capital, off-shore production, and horizontal integration. It is quite plausible that information technology has been the most important agent of transformation, but it is not the only one. However, whether or not one wholeheartedly subscribes to Cortada's vision, there is a huge value in his richly detailed narrative. This set of books will be the standard source on demand-side computing for perhaps a generation.

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