10TH ANNIVERSARY

Communication Technology Update

EIGHTH EDITION

August E. Grant and
Jennifer H. Meadows, Editors
in association with Technology Futures, Inc.

Focal Press

COMMUNICATION TECHNOLOGY UPDATE

8TH EDITION

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Technology Futures, Inc.

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PREFACE

This is the tenth anniversary of the *Communication Technology Update*. Yes, it is also the eighth edition—the first five editions were a year apart, and the last three, two years apart. We've made some additions and changes to reflect this anniversary, including adding a retrospective chapter on the last 10 years of communication technologies (Chapter 25) and moving and extending the chapter providing comparable statistics on all technologies to the front of the book (Chapter 2) to provide context for the discussions that follow.

The first step in preparing this edition was taking a look back at the previous editions. Through all of the changes in technology, cover art, graphics, etc., one constant was apparent—the strong contributions of a host of authors who repeatedly performed the extraordinary feat of synthesizing hundreds of pages of information into chapter form for inclusion in the *Update*.

To acknowledge these authors individually would require a separate chapter. Instead, we want to acknowledge them in groups. The most prominent group is faculty members who have applied substantial expertise in one or more areas of technology to create their chapters. Our special gratitude goes out to those who come back edition after edition, continuing to meet impossible deadlines and producing material that is more up-to-date than can be found in any other book.

The second group consists of students, including both graduate and undergraduate, who took on the challenge of producing updates that had to stand alongside those created by top scholars in the field. It is a testament to these students and their work that we have never received a single negative comment about including student work alongside that of faculty.

We also want to acknowledge the contribution that readers make to the *Update*. Your e-mail and other comments, suggestions, etc. have helped us to improve every edition of the book over previous

editions. The fact that the *Update* has become a staple in so many academic programs is the greatest compliment paid to the book.

Focal Press has proven to be a strong partner in the distribution of the book, and we are grateful for their continuing efforts to introduce new readers to the *Update*.

Finally, we want to express our deepest satisfaction and gratitude to Technology Futures, Inc. for this 10-year partnership. As President of TFI, Larry Vanston was the first to commit himself to this publication, and he has continued to provide valuable advice and direction to this project. Although she is no longer involved with the *Update*, Julia Marsh played a major role in developing the book and overseeing its early growth, and we are grateful for her efforts. Production Director Deb Robison and Art Director Helen Mary Marek have worked tirelessly on each of the eight editions to produce the highest-quality product in an incredibly short period of time. When discussing how we condense all of the editing, layout, etc. into a two-month period, most people express amazement at how that quality is achieved with so much speed. The difference is Deb and Helen Mary, and we appreciate their efforts and their spirit.

What's next for the *Update*? We will periodically update the *Communication Technology Update* home page (www.tfi.com/ctu) to supplement the text with updated information and links to a wide variety of information available over the Internet. And, in Spring 2003, we will begin planning our next edition—and looking for input from you on how the *Update* can best serve your needs.

As always, we encourage you to suggest new topics, glossary additions, and possible authors for the next edition of this book by communicating directly with us via e-mail, snail mail, or voice. Thank you!

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May 13, 2002

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THE UMBRELLA PERSPECTIVE ON COMMUNICATION TECHNOLOGY

August E. Grant, Ph.D.*

Communication technologies are the nervous system of contemporary society, transmitting and distributing sensory and control information, and interconnecting a myriad of interdependent units. Because these technologies are vital to commerce, control, and even interpersonal relationships, any change in communication technologies has the potential for profound impacts on virtually every area of society.

One of the hallmarks of the industrial revolution was the introduction of new communication technologies as mechanisms of control that played an important role in almost every area of the production and distribution of manufactured goods (Beniger, 1986). These communication technologies have evolved throughout the past two centuries at an increasingly rapid rate. The evolution of these technologies shows no signs of slowing, so an understanding of this evolution is vital for any individual wishing to attain or retain a position in business, government, or education.

The economic and political challenges faced by the United States and other countries since the beginning of the new millennium clearly illustrate the central role these communication systems play in our society. Just as the prosperity of the 1990s was credited to advances in technology, the economic challenges that followed were linked as well to a major downturn in the technology sector. The

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aftermath of the September 11 tragedy led many to propose security measures, including control and monitoring of communication technologies that make extensive use of the technologies discussed in this book.

This text provides you with a snapshot of the process of technological evolution. The individual chapter authors have compiled facts and figures from hundreds of sources to provide the latest information on more than two dozen communication technologies. Each discussion explains the roots and evolution, the recent developments, and the current status of the technology as of mid-2002. In discussing each technology, we will deal not only with the hardware, but also with the software, organizational structure, political and economic influences, and individual users.

Although the focus throughout the book is on individual technologies, these individual snapshots comprise a larger mosaic representing the communication networks that bind individuals together and enable us to function as a society. No single technology can be understood without understanding the competing and complementary technologies and the larger social environment within which these technologies exist. As discussed in the following section, all of these factors (and others) have been considered in preparing each chapter through application of the "umbrella perspective." Following this discussion, an overview of the remainder of the book is presented.

DEFINING COMMUNICATION TECHNOLOGY

The most obvious aspect of communication technology is the hardware—the physical equipment related to the technology. The hardware is the most tangible part of a technology system, and new technologies typically spring from developments in hardware. However, understanding communication technology requires more than just studying the hardware. It is just as important to understand the messages communicated through the technology system. These messages will be referred to in this text as the "software." It must be noted that this definition of "software" is much broader than the definition used in computer programming. For example, our definition of computer software would include information manipulated by the computer (such as this text, a spreadsheet, or any other stream of data manipulated or stored by the computer), as well as the instructions used by the computer to manipulate the data.

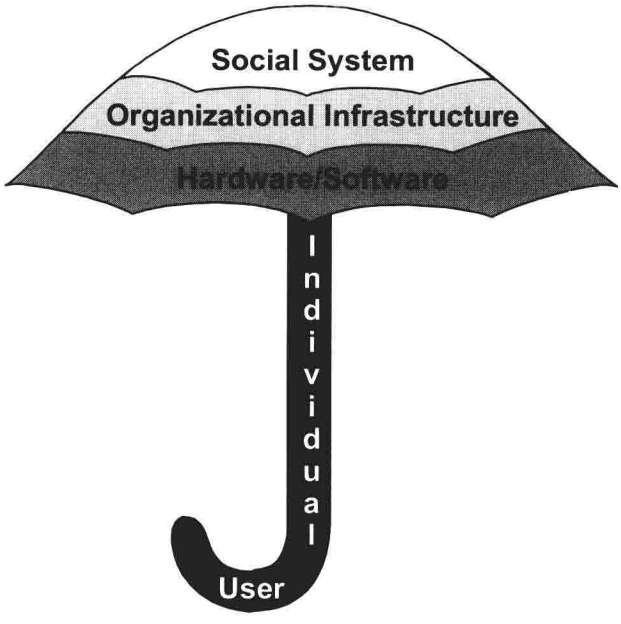
The hardware and software must also be studied within a larger context. Rogers' (1986) definition of "communication technology" includes some of these contextual factors, defining it as "the hardware equipment, organizational structures, and social values by which individuals collect, process, and exchange information with other individuals" (p. 2). An even broader range of factors is suggested by Ball-Rokeach (1985) in her "media system dependency theory," which suggests that communication media can be understood by analyzing dependency relations within and across levels of analysis, including the individual, organizational, and system levels. Within the system level, Ball-Rokeach (1985) identifies three systems for analysis: the media system, the political system, and the economic system.

These two approaches have been synthesized into the "Umbrella Perspective on Communication Technology" illustrated in Figure 1.1. The bottom level of the umbrella consists of the hardware and software of the technology (as previously defined). The next level is the organizational infrastructure: the group of organizations involved in the production and distribution of the technology. The top

level is the system level, including the political, economic, and media systems, as well as other groups of individuals or organizations serving a common set of functions in society. Finally, the "handle" for the umbrella is the individual user, implying that the relationship between the user and a technology must be examined in order to get a "handle" on the technology. The basic premise of the umbrella perspective is that all five areas of the umbrella must be examined in order to understand a technology.

(The use of an "umbrella" to illustrate these five factors is the result of the manner in which they were drawn on a chalkboard during a lecture in 1988. The arrangement of the five attributes resembled an umbrella, and the name stuck. Although other diagrams have since been used to illustrate these five factors, the umbrella remains the most memorable of the lot.)

Figure 1.1
The Umbrella Perspective on Communication Technology



Source: A. E. Grant

Factors within each level of the umbrella may be identified as "enabling," "limiting," "motivating," and "inhibiting." *Enabling factors* are those that make an application possible. For example, the fact that coaxial cable can carry dozens of channels is an enabling factor at the hardware level, and the decision of policy makers to allocate a portion of the spectrum for cellular telephony is an enabling factor at the system level (political system).

Limiting factors are the opposite of enabling factors. Although coaxial cable increased the number of television programs that could be delivered to a home, most analog coaxial networks cannot transmit more than 100 channels of programming. To the viewer, 100 channels might seem to be

more than is needed, but to the programmer of a new cable television channel unable to get space on a filled-up cable system, this hardware factor represents a definite limitation. Similarly, the fact that the policy makers discussed above permitted only two companies to offer cellular telephone service in each market is a system-level limitation on that technology.

Motivating factors are those that provide a reason for the adoption of a technology. Technologies are not adopted just because they exist. Rather, individuals, organizations, and social systems must have a reason to take advantage of a technology. The desire of local telephone companies for increased profits, combined with the fact that growth in providing local telephone service is limited, is an organizational factor motivating the telcos to enter the markets for new communication technologies. Individual users who desire information more quickly can be motivated to adopt electronic information technologies.

Inhibiting factors are the opposite of motivating ones, providing a disincentive for adoption or use of a communication technology. An example of an inhibiting factor at the software level might be a new electronic information technology that has the capability to update information more quickly than existing technologies, but provides only "old" content that consumers have already received from other sources. One of the most important inhibiting factors for most new technologies is the cost to individual users. Each potential user must decide whether the cost is worth the service, considering his or her budget and the number of competing technologies.

All four types of factors—enabling, limiting, motivating, and inhibiting—can be identified at the system, organizational, software, and individual user levels. However, hardware can only be enabling or limiting; by itself, hardware does not provide any motivating factors. The motivating factors must always come from the messages transmitted (software) or one of the other levels of the umbrella.

The final dimension of the umbrella perspective relates to the environment within which communication technologies are introduced and operate. These factors can be termed "external" factors, while ones relating to the technology itself are "internal" factors. In order to understand a communication technology or to be able to predict the manner in which a technology will diffuse, both internal and external factors must be studied and compared.

Each communication technology discussed in this book has been analyzed using the umbrella perspective to ensure that all relevant factors have been included in the discussions. As you will see, in most cases, organizational and system-level factors (especially political factors) are more important in the development and adoption of communication technologies than the hardware itself. For example, political forces have, to date, prevented the establishment of a world standard for high-definition television (HDTV) production and transmission. As individual standards are selected in countries and regions, the standard selected is as likely to be the product of political and economic factors as of technical attributes of the system.

Organizational factors can have similar powerful effects. For example, the entry of a single company, IBM, into the personal computer business in the early 1980s resulted in fundamental changes in the entire industry. Finally, the individuals who adopt (or choose not to adopt) a technology, along with their motivations and the manner in which they use the technology, have profound impacts upon the development and success of a technology following its initial introduction.

Each chapter in this book has been written from the umbrella perspective. The individual writers have endeavored to update developments in each area to the extent possible in the brief summaries provided. Obviously, not every technology experienced developments in each of the five areas, so each report is limited to areas in which relatively recent developments have taken place.

OVERVIEW OF BOOK

The next chapter, "Communication Technology Timelines," provides a broad overview of most of the technologies discussed later in the book, allowing you to compare them along a number of dimensions: the year each was first introduced, growth rate, number of current users, etc. This chapter co-anchors the book to highlight commonalties in the evolution of individual technologies, as well as present the "big picture" before we delve into the details.

The technologies discussed in this book have been organized into three sections: electronic mass media, computers and consumer electronics, and telephony and satellite technologies. These three are not necessarily exclusive; for example, direct broadcast satellites (DBS) could be classified as either an electronic mass medium or a satellite technology. The ultimate decision regarding where to put each technology was made by determining which set of current technologies most closely resembled the technology from the user's perspective. Thus, DBS was classified with electronic mass media. This process also locates the discussion of a cable television technology—cable modems—in the "Broadband Networks" chapter in the telephony section.

Each chapter is followed by a brief bibliography. These reference lists represent a broad overview of literally thousands of books and articles that provide details about these technologies. It is hoped that the reader will not only use these references, but will examine the list of source material to determine the best places to find newer information since the publication of this *Update*.

Most of the technologies discussed in this book are continually evolving. As this book was completed, many technological developments were announced but not released, corporate mergers were under discussion, and regulations had been proposed but not passed. Our goal is for the chapters in this book to establish a basic understanding of the structure, functions, and background for each technology, and for the supplementary Internet home page to provide brief synopses of the latest developments for each technology. (The address for the home page is http://www.tfi.com/ctu.)

The final two chapters attempt to draw larger conclusions from the preceding discussions. The first of these two chapters presents a look back at how the communication technology landscape has developed by comparing the current state of the technologies in this book with their status 10 years ago. The final chapter then attempts to place these discussions in a larger context, noting commonalties among the technologies and trends over time. It is impossible for any text such as this one to ever be fully comprehensive, but it is hoped that this text will provide you with a broad overview of the current developments in communication technology.

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2

COMMUNICATION TECHNOLOGY TIMELINE

Dan Brown, Ph.D.*

Following in the footsteps of earlier works, this chapter traces the timelines of various American communication media from their outsets, (Brown & Bryant, 1989; Brown, 1996; Brown, 1998; Brown, 2000). The goal is to provide consistent data across these media that allow you to better understand each medium, as well as identify patterns across media.

Consideration of the "big picture" is important before addressing individual technologies. Figure 2.1 compares the introduction date of each technology. The timeline provides context for the data that appear in this chapter. The focus on entertainment among Americans is reflected in the ubiquity of television and radio, technologies that exist in nearly every U.S. household. These devices required nearly 50 years to reach current penetration levels. What new technologies will nearly all households use three or four decades from now? The Internet appears to be the most likely choice, and computers must necessarily precede the Internet in penetration as long as computers remain the primary vehicle for Internet access.

Figure 2.1 also shows that the number of new communication technologies introduced in each decade appears to be accelerating. Technology had become more pervasive at the time of introduction of the VCR as compared with the level of technological sophistication in effect when the telephone was introduced. However, many technologies from earlier years do not appear in the graph, usually because they have since become less important or have failed. Examples include 8-track audiotapes, quadraphonic sound, 3D television, CB radios, 8mm film cameras, etc. In their day, each of these technologies would have earned its own chapter in this book, but history has banished them to

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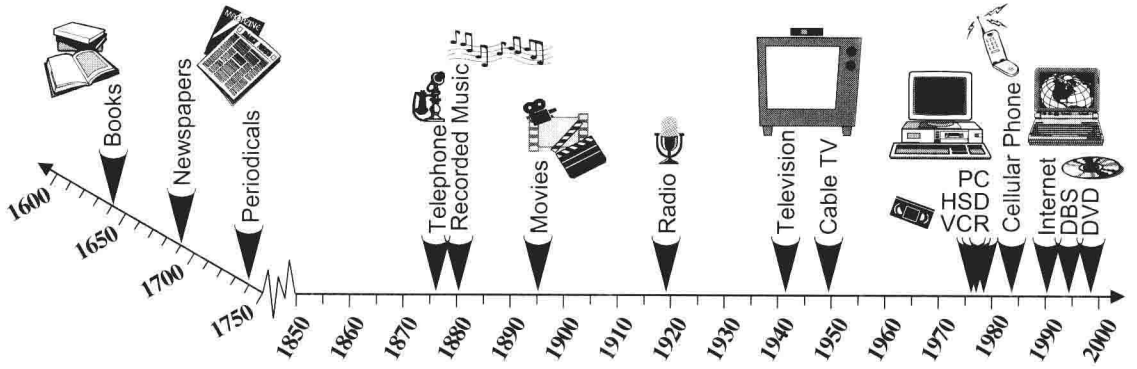
footnotes. Many of the technologies that receive attention in this volume may suffer the same fates in the coming years. The remainder of this chapter attempts to provide one way to help predict which ones will succeed or fail by studying the history of comparable technologies.

Figure 2.1
Communication Technology Timeline



Source: Technology Futures, Inc.

To aid in understanding rates of adoption and use, a premise of this chapter is that non-monetary measures are a more consistent measure of a technology's impact than the dollar value of sales. More meaningful media consumption trends emerge from examining changes in non-monetary media units and penetration (i.e., percentage of marketplace use, such as households) rather than on dollar expenditures. Box office receipts from motion pictures offers a notable exception, with unit attendance figures reported along with the dollar amounts.

Another premise of this chapter is that government sources should provide as much of the data as possible. Researching the growth or sales figures of various media over time quickly reveals conflict in both dollar figures and units shipped or consumed. Such conflicts exist even among government reports. For example, marked differences occurred for some years between the *Statistical Abstract* tables and *Industrial Outlook* tables in reporting motion picture box office receipts. From time to time, unit definitions changed, as with newly published book titles, sometimes resulting in a loss of meaningful trend portrayals. Government sources, although frequently based on private reports, provide some consistency to the reports. Readers should use caution in interpreting data for individual years and instead emphasize the trends over several years.

PRINT MEDIA

The American printing industry is the largest such industry among the printing countries of the world. Although competition and consolidation of ownership reduced the number of American printing firms to 62,000 in 1999, 4.6% fewer than the figure for a decade earlier, the printing industry still enjoyed "unparalleled demand for its products" (U.S. Department of Commerce/International Trade Association, 2000, p. 25-1). Foreign investment in printing is bringing a more global characteristic to the industry, with half of the 20 largest American book publishers having foreign ownership (U.S. Department of Commerce/International Trade Association, 1999, p. 25-5).

NEWSPAPERS

Publick Occurrences, Both Foreign and Domestick was the first American newspaper, appearing in 1690 (Lee, 1917). Figure 2.2 and Table 2.1 show extremely slow growth in American newspaper firms and newspaper circulation until the 1800s. Early growth suffered from relatively low literacy rates and the lack of discretionary income among the bulk of the population. The progress of the industrial revolution brought money for workers and improved mechanized printing processes. Lower newspaper prices and the practice of deriving revenue from advertisers encouraged significant growth beginning in the 1830s. Newspapers made the transition from the realm of the educated and wealthy elite to a mass medium serving a wider range of people from this period through the Civil War era (Huntzicker, 1999).

Figure 2.2
Newspaper Firms & Daily Newspaper Circulation

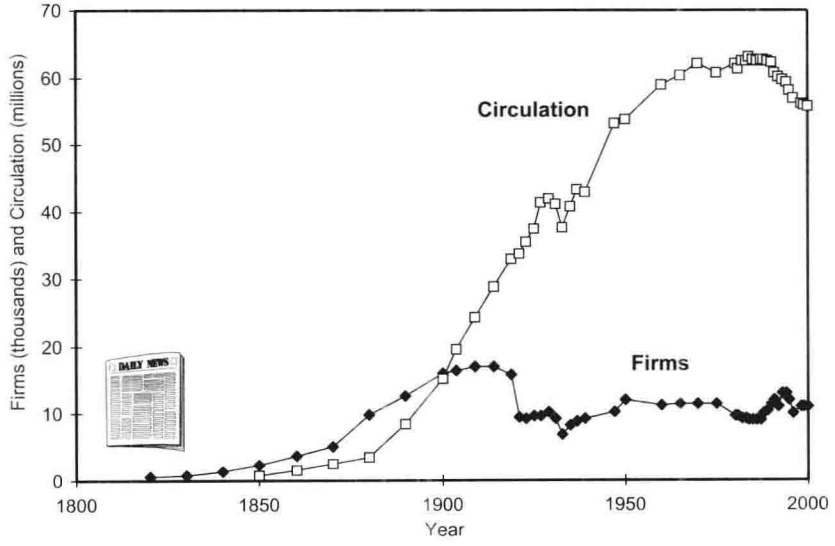


Table 2.1
Newspaper Firms & Daily Newspaper Circulation, 1704-2000

Year	Firms	Circulation*	Year	Firms	Circulation*
1704	1		1933	6,884	37.6
1710	1		1935	8,266	40.9
1720	3		1937	8,826	43.3
1730	7		1939	9,173	43.0
1740	12		1947	10,282	53.3
1750	14		1950	12,115	53.8
1760	18		1960	11,315	58.9
1770	30		1965	11,383	60.4
1780	39		1970	11,383	62.1
1790	92		1975	11,400	60.7
1800	235		1980	9,620	62.2
1810	371		1981	9,676	61.4
1820	512		1982	9,183	62.5
1830	715		1983	9,205	62.6
1840	1,404		1984	9,151	63.1
1850	2,302	0.8	1985	9,134	62.8
1860	3,725	1.5	1986	9,144	62.5
1870	5,091	2.6	1987	9,031	62.8
1880	9,810	3.6	1988	10,088	62.7
1890	12,652	8.4	1989	10,457	62.6
1900	15,904	15.1	1990	11,471	62.0
1904	16,459	19.6	1991	11,689	60.0
1909	17,023	24.2	1992	11,339	60.0
1914	16,944	28.8	1993	12,597	60.0
1919	15,697	33.0	1994	12,513	59.0
1921	9,419	33.7	1995	12,246	57.0
1923	9,248	35.5	1996	10,466	57.0
1925	9,569	37.4	1997	10,042	57.0
1927	9,693	41.4	1998	10,504	56.2
1929	10,176	42.0	1999	10,530	56.0
1931	9,299	41.3	2000	10,696	55.8

* In millions

Note: The data from 1704 through 1900 are from Lee (1973). The data from 1904 through 1947 are from U.S. Bureau of the Census (1976). The number data between 1947 and 1986 are from U.S. Bureau of the Census (1986). The data from 1987 through 1988 are from U.S. Bureau of the Census (1995c). The data for 1988 and 1989 are from U.S. Bureau of the Census (1997). Data from 1989 through 1997 are from U.S. Bureau of the Census (1999). Data after 1997 are from U.S. Bureau of the Census (2001).

The Mexican and Civil Wars stimulated public demand for news by the mid-1800s, and modern journalism practices, such as assigning reporters to cover specific stories and topics, began to emerge. Circulation wars among big city newspapers in the 1880s featured sensational writing about frequently outrageous stories. The number of newspaper firms and newspaper circulation soared. Although the number of firms would level off in the 20th century, circulation continued to rise.