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# The Mutual Shaping of Technology and Society in Videotex Newspapers: Beyond the Diffusion and Social Shaping Perspectives

**Pablo J. Boczkowski**

*Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA*

**This article argues that a mutual shaping lens enables a more encompassing account of the joint processes of technological and social change in new media than the diffusion of innovations and social shaping of technology perspectives. Drawing from recent work in sociology and history of technology, organization studies, social informatics, and computer-supported cooperative work, this article suggests that the shaping and diffusion of media artifacts are so intimately tied that they should be seen as the two sides of the same innovation coin. Using examples from the history of videotex newspapers in the United States, the analysis shows that actors simultaneously pursued interdependent technological and social transformations, that this was an ongoing process in which partial outcomes in the technological domain influenced social events at a later phase—and vice versa—and that such process was influenced by historical developments.**

**Keywords** diffusion of innovations, media industry, mutual shaping of technology and society, new media, newspapers, social shaping of technology, videotext

The social study of new media has been strongly influenced by two perspectives: the diffusion of innovations, which has yielded important insights on the direction and pace of technological adoption, and the social shaping of technology, which has generated valuable knowledge on the construction of media artifacts. In a recent comparative analysis of both perspectives, Lievrouw (2002) has discussed their respective intellectual origins and trajectories, and assessed their contributions to the social study of new media. Lievrouw's analysis has also contrasted both perspectives on the tensions between determination and contingency in "conspicuous elements having the potential to move [new media] development in one direction or another" (2002, p. 193). Her analysis marks the extent to which both perspectives have in general presented complementary shortcomings. On the one hand, diffusion scholarship has tended to overlook the degree to which the adoption of media artifacts is tied to their social construction. On the other hand, social shaping research has largely neglected the extent to which the development of artifacts is linked to their planned and actual diffusion.

One factor behind these complementary shortcomings is that both perspectives have separated the processes of construction and adoption of new media artifacts. Focusing on the limitations derived from this analytical separation, this article builds on Lievrouw's analysis and extends it in two ways. First, while Lievrouw contrasts these two perspectives but keeps them separated, this article looks at the interpenetration of the traditional foci of each perspective, namely, the construction and adoption of new media artifacts. Second, while Lievrouw focuses on the tensions between determination and contingency in these two perspectives, this article emphasizes three crucial aspects of new media evolution: the simultaneous pursuit of interdependent technological and social transformations, the ongoing character of this process, and the importance of the historical context in which it unfolds. This suggests that the shaping of artifacts should not be seen as disconnected from how their diffusion is intended to unfold and how it

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Address correspondence to Pablo J. Boczkowski, Assistant Professor of Organization Studies, Cecil and Ida Green Career Development Chair, Massachusetts Institute of Technology, 50 Memorial Drive, E52-568, Cambridge, MA 02142-1347, USA. E-mail: pjb9@mit.edu

actually occurs, and their diffusion should not be examined in isolation from processes of technical construction that do not stop when artifacts are adopted.

The heuristic power of this lens is illustrated by examining the unfolding of videotex newspapers in the United States and showing that the shaping and diffusion of these artifacts were so intimately tied that it is impossible to make sense of one without the other. More specifically, this analysis demonstrates that actors simultaneously undertook interdependent technological and social initiatives, that this was an ongoing process in which partial outcomes in the technological domain affected social events at a later phase—and vice versa—and that such process was influenced by historical developments. Thus, by looking at technological and social change as two sides of the same innovation coin, this article argues that a mutual shaping lens provides a more encompassing account of new media evolution than either the diffusion of innovations or social shaping of technology perspectives.

## THEORETICAL CONSIDERATIONS

The diffusion of innovations perspective has had a long trajectory in the social study of media artifacts—partly as a result of Rogers's seminal work (1995) and centrality in communication scholarship—and its current vitality is expressed in a stream of recent articles on a wide array of information and communication technologies (Atkin et al., 1998; Dupagne, 1999; Garrison, 2001; Lin & Jeffries, 1998; Mahler & Rogers, 1999). This approach has focused on the direction and pace at which members of a social setting adopt a new media artifact. By contrast, triggered by historical and sociological reactions against technological determinism articulated in the mid-1980s (Bijker et al., 1987; MacKenzie & Wajcman, 1985; Misa, 1988; Staudenmaier, 1989; Williams & Edge, 1996), a more recent perspective has centered on the social factors that shape the construction of media technologies in the first place (Bardini & Horvath, 1995; Case, 1994; Flanagin et al., 2000; Fulk, 1993).

Despite these valuable contributions, both perspectives have in general presented complementary shortcomings: Diffusion analyses have generated important contributions about adoption of artifacts but have paid comparatively less attention to their initial construction, and social shaping studies have yielded important insights about the construction of artifacts but have said comparatively less about their subsequent uptake. These shortcomings are not news to scholars of both perspectives. Regarding diffusion research, Rogers (1995) has stated that past studies "typically began . . . with the first adopters of an innovation. The decisions and events occurring previous to this point have a strong influence on the diffusion process" (p. 131). To remove the blind spot, he urged that "the scope of future diffusion research should be broadened to include study of the entire process of how an innovation is generated" (p. 159). Reflecting about the social construction of technology model, Bijker (2001) has suggested that in the mid-1990s "the agenda was broadened to include again the issue of technology's impact on society, which had been bracketed for the sake of fighting technological determinism" (p. 15,524). The analysis presented in this article is informed by these calls for expanding the scholarship of both perspectives, and contributes to them some conceptual tools to address the interpenetration of construction and adoption issues in the evolution of new media artifacts.

Beyond the particularities of new media scholarship, this duality between diffusion and shaping has mirrored more general trends in research on technological and social change, which has often espoused relatively unilateral causal views: Scholars have either concentrated on artifacts' impact on society, or, especially in the last decades, on their social shaping. In this sense, the process of inquiry has a priori fixed either the technological or the social, and turned it into an invariant explanatory factor. However, recent work in sociology and history of technology, organization studies, social informatics, and computer-supported cooperative work, among other areas, has begun to move the focus of inquiry beyond this duality.

After more than a decade of concentrating mostly on social factors that affect the construction of new technologies, recent work in sociology and history of technology has expanded to examine such issues as the politicization of technological culture, the interpenetration of materiality and identity, the role of users as agents of technical change, and the interdependence between artifact designs and consumption experiences (Bijker, 1995; Boczkowski, 1999; Kline, 2000; Pinch & Trocco, 2002). This new work sensitizes the analyst to not take for granted either the technological or the social, to pay attention to temporally extended processes of technological and societal transformations, and to account for transformations in one realm in relation to changes in the other.

Current developments in organization studies have demonstrated that technological innovations are often tied to alterations in organizational structures and work practices (Hargadon & Sutton, 1997; Orlikowski, 2000; Rosenkopf & Tushman, 1998; Yates, 1993). This novel direction of inquiry invites researchers to explore the processes and mechanisms whereby the creation and use of new artifacts are shaped by, and in turn contribute to shape, organizational dynamics at multiple levels of analysis, from workplace behavior to industrial configurations.

Building on more than two decades of scholarship in the social analysis of computing within the field of information science, recent work in the area of social informatics has emphasized the ties between hardware and software

choices and institutional contexts in the development, implementation, and adoption of information and communication technologies (Bishop & Star, 1996; Kling, 2000; Sawyer & Rosenbaum, 2000; Sawyer & Eschenfelder, 2001). Although the majority of work in this nascent area has concentrated on either the construction of these technologies or their adoption, a small but growing body of research has looked at the mutual transformations in material and institutional conditions (Sawyer & Eschenfelder, 2001).

Research in the domain of computer-supported cooperative work, particularly those studies influenced by ethnomethodology and situated cognition perspectives, has generated important knowledge about the everyday micropractices that influence the use and experience of computerized artifacts in the workplace (Hutchins, 1995; Heath & Luff, 2000; Suchman et al., 1999; Goodwin & Goodwin, 1996). Developments in this domain of inquiry have broadened our understanding of the situated, ongoing, and emergent practices that affect the interactional patterns and technological fabric of organizational routines.

Taken together, these insights from recent research in these various domains of inquiry highlight three critical aspects of the joint processes of technical construction and societal adoption of new media artifacts: the interdependence of technological and social transformations, the ongoing character of this process, and the influence of the historical context in which it unfolds.

First, actors engaged in the innovation process simultaneously pursue interdependent technological and social transformations. That is, they do not concentrate on either shaping the artifact or influencing decisions to adopt it, but undertake both sets of actions at the same time. Technological shaping and societal adoption are intertwined in multiple forms. For example, sometimes choices about the technical configuration of a new artifact can be influenced by the perceived potential for diffusion of the different alternatives. In other occasions, actions aimed at creating adequate conditions for diffusion while the initial phases in the construction of the artifact are still taking place—such as change agents lobbying government agencies for what the former consider to be a favorable regulatory framework for their intended innovations—can be dependent on prior and concurrent technical choices. Therefore, this first feature of a mutual shaping approach predisposes researchers to focus on this interdependence between the shaping and diffusion of artifacts rather than mostly treating each one independently from the other.

Second, and following from the previous issue, the interweaving of construction and adoption is a dynamic process. Hence the conditions for the diffusion of a new media artifact start being created long before innovators and early adopters decide to use it and the artifact itself can be "reinvented" (Rice & Rogers, 1980) after there is closure about its technical design. In addition, this is a continuous process in which partial outcomes at an earlier stage can influence events at a later phase. This does not mean that the evolution of all new media artifacts is marked by ongoing technological and social transformations, or that these transformations are constant. What a mutual shaping approach implies, though, is that it is in principle possible that these transformations can occur at multiple points in the shaping and diffusion of the artifact. Thus, researchers have to take a symmetric stance toward this process that requires them to account for both the presence and absence of these transformations, and the character of these dynamic processes. This second aspect of the mutual shaping approach invites analysts to adopt a broader view of changes in the evolution of new media artifacts, rather than the more narrow view that focuses mostly on transformations that take place during either technological shaping or societal diffusion.

In the third place, interdependent cultural and material changes do not proceed in a historical vacuum, but are influenced by the legacy of processes that preceded them. One domain in which historical matters becomes crucial is in the study of the infrastructures that subtend the shaping and diffusion of new media artifacts. As Star and Bowker (2002) have argued, an infrastructure itself "does not grow *de novo*; it wrestles with the inertia of the installed base and inherits strengths and limitations from that base. . . . Failing to account for these constraints may be fatal or distorting to new development processes" (p. 152, emphasis in the original). Thus, the actions of relevant social groups in the construction of a new artifact may be informed by issues affecting the diffusion of preexisting infrastructures such as the presence of unfavorable technological standards. By the same token, whether a new artifact is adopted only by innovators and early adopters or also by an early majority of users may be affected by technical decisions made about its construction and having to do with compatibility with a preexisting infrastructure. Although critical, the role of infrastructures, and other embodiments of historical legacies that affect novel artifacts, is often difficult to elicit since they tend to become an invisible aspect of people's routines (Bowker & Star, 1999). Sensitive to the often invisible yet powerful role of historical forces, this third element of the mutual shaping approach encourages the analyst to look not only at ongoing transformations in the artifact under study, but also at related processes that happened sometimes long before such artifact came to being.

These three critical aspects of the evolution of new media complement Lievrouw's (2002) illuminating discussion of the "interdependent and iterative" (p. 183) relationship between determination and contingency. For instance, building on her suggestion to look at issues of dynamics—"the movement and momentum of a new technological

idea, its expression, and its adoption and use" (p. 193)—a mutual shaping approach recasts two popular notions that have stressed the reduction in people's agency once the initial shaping of an artifact achieves closure: "dominant design" (Abernathy & Utterback, 1978) and "momentum" (Hughes, 1969). For instance, Tushman and Murmann (1998) have argued that "where social, political and institutional forces shape technological progress prior to the dominant design, technology drives subsequent technical evolution after the dominant design" (p. 244). Regarding momentum, Hughes has suggested that "mature systems have a quality that is analogous . . . to inertia in motion" (1987, p. 76), and thus, "as they grow larger and more complex, systems tend to be more shaping of society and less shaped by it" (1994, p. 112). Although this reduction in social contingency may be applicable in many cases, for analytical purposes it should not be taken as the norm: In light of the many instances in the history of media technologies of unforeseen contingencies altering what seemed to be have been immutable paths, the analyst has to remain open to changes in the balance of determination and contingency at all moments in the evolution of new media. A mutual shaping perspective invites researchers to be attentive to issues of determination and contingency in the unfolding of a new media artifact without making a priori assumptions about the expected balance between them at the various moments in this process.

To summarize, a mutual shaping approach enables the analyst to challenge the separation between shaping and diffusion matters in the evolution of new media artifacts by looking at the interpenetration of technical construction and societal diffusion, the ongoing character of this process, and the influence of the historical environment in which it takes place. The account that follows will probe its value in illuminating some critical cultural and material dynamics in the making of videotex newspapers.

## THE ORIGINS OF VIDEOTEX NEWSPAPERS IN THE UNITED STATES

Developed at the British Post Office in the early 1970s (Campbell & Thomas, 1981; Sommer, 1983; Tydeman et al., 1982; Tyler, 1979; Wilkinson, 1980), videotex consisted of transmitting information stored in a computer database over phone lines to either a dedicated terminal, a television set equipped with a special decoder, or a personal computer with a modem. The different systems were developed as closed environments—the information and applications of one system could not be accessed by subscribers of others—with their interfaces presenting a series of numerically identified choices, using mostly text with a few rudimentary graphics. When the user selected one choice using a keyboard or a keypad, that information was sent to the computer database, which in turn transmitted the requested content back to the receiving unit.

These developments took place at a time when the "information society" rhetoric was popular in both the press and scholarly works. In a supposedly emerging era of information overload, "the basic premise of videotex and online publishing is that the information-rich society has unmet information needs" (Neuman, 1985, p. 8). Thus, these new technologies became tool and symbol of an epochal change: If print had been an integral part of the industrial society, videotex and its electronic cousins were thought to be constitutive of the upcoming information society (Case, 1994). According to Sigel (1983a), "Since its commercial introduction in 1976, videotex has become a metaphor for a new world of information dissemination . . . [in which] videotex stands for the future, whereas older methods of transmitting information—mainly, print on paper—represent the past" (p. 1).

Not surprisingly, then, government agencies in industrialized nations undertook videotex efforts during the 1970s, most notably in Canada, France, Germany, Japan, and the United Kingdom (Desbarats, 1981; Marchand, 1987; Mayntz & Schneider, 1988; Miles, 1992; Sigel, 1983b; Vedel & Charon, 1989). By contrast, in the United States videotex appeared comparatively later on the scene. In addition, with the exception of a few state-sponsored initiatives like the Project Green Thumb aimed at the rural population (Rice & Paisley, 1982), there was limited "government involvement, leaving venture capitalists and consumers to choose what they are willing to support" (Branscomb, 1988, p. 58).

In this context, "newspapers were among the first to perceive the opportunities and threats posed by electronic publishing" (Baer & Greenberger, 1987, p. 56). For instance, this new technical horizon was the "main topic" at the 1981 annual convention of the American Newspaper Publishers Association (At ANPA Convention, 1981, p. 15). Such an interest extended to the investor community; it was also the "hot topic" at that same year's annual "Outlook for Media" conference in New York, with financial analysts wanting to know "how executives from seven publicly owned newspaper companies planned to get their firms involved in the emerging electronic communications fields in 1981 and throughout the decade" (Radolf, 1981, p. 15).

A mix of a changing economic environment, a massive computerization of the industry, and a technologically deterministic ideology paved the way for this interest in consumer-oriented videotex by American dailies (Boczkowski, 2002). To begin, there was a perception among many analysts and actors that trends such as decreasing penetration, rising newsprint and distribution costs, readers moving to the suburbs and getting the news on the radio while driving to work, less homogenized

consumer tastes challenging mass advertising, and difficulties in attracting and retaining younger readers seemed to compromise the long-term viability of print as an information platform (Compaine, 1980; Picard & Brody, 1997; Smith, 1980; Stone, 1987). As Dozier and Rice (1984) wrote back then, "The emergence of the electronic newspaper draws momentum from inherent problems of pulp newspapers" (p. 104). In this sense, electronic alternatives were seen as both a potential solution to the problems posed by a shifting environment and a development that could worsen the situation of print papers.

Yet another set of reasons lies in the massive computerization of the newspaper industry that had been taking place since the 1960s: "Most major U.S. newspapers have or are converting to electronic processing of information . . . [which] means that their product . . . is packaged for digital storage and retrieval . . . [and] is available for uses other than simply printing" (Tydeman et al., 1982, p. 53). To Marvin (1980), because such computerization had happened "behind the scenes, newspapers appear to the public to be no different than before. This appearance is deceptive. . . . The heart of significant technological change in the present is the computer's transformation of print production" (p. 10). Just as an indication of the extent of this process, while in 1969 an annual survey of the American Newspaper Publishers Association did not find a single newspaper using video display terminals, 666 organizations replying to the same survey in 1981 reported using an aggregate of over 46,000 of these units (Weaver & Wilhoit, 1986). An *Editor & Publisher* editorial summarized the issue: "In a technological revolution that has spanned a little more than 10 years, the newspaper business has embraced computers in every department" (It's a Gee, 1986, p. 8).

This "revolutionary" language points to an ideological trait that also contributed to create a context conducive for the appropriation of videotex by American dailies: the technologically deterministic belief that electronic publishing would drive the future of the industry (Bimber, 1990; Kling & Iacono, 1988; Pfaffenberger, 1989; Smith, 1994; Staudenmaier, 1989). As Marx has argued, "a common tendency of contemporary discourse . . . is to invest 'technology' with a host of metaphysical properties and potencies, thereby making it seem to be a . . . disembodied autonomous causal agent of social change" (1994, p. 249). Along these lines, at a seminar organized by the Newspaper Advertising Bureau to discuss alternatives for electronic publishing, Arnold Rosenfeld, editor of the *Dayton Daily News* of Ohio, said that newspapers were going to move in this direction not because their readers wanted it but to respond to a "technological imperative" (Gloede, 1980, p. 30). Furthermore, in an opinion piece entitled "Newspapers: An Endangered Species," William Chilton, president and publisher of the *Charleston Gazette* of West Virginia, wrote: "Technology is unyielding . . . [and] it moves in accord with its own laws and momentum, which human beings adapt to whether we want or not" (Chilton, 1982, p. 31). Moreover, in his keynote address to the North Carolina Library Seminar, James Scofield, chief librarian of the *St. Petersburg Times and Evening Independent* of Florida, said, "We are now in a Technological Revolution which will undoubtedly have the same impact on our world and on our lives as did the Industrial Revolution" (Scofield, 1984, p. 52). Finally, Don Till, director of communications of *The Washington Post*, published an article in which he argued that "virtually all assessments of the so called 'electronic revolution' to date have been upbeat, optimistic and enthusiastic. Normally conservative organizations seem willing to ignore the most fundamental business indicators in a stampede 'to do something'" (1981, p. 36).

In this context marked by a changing economic environment, the computerization of the industry, and a technologically deterministic ideology, the *Columbus Dispatch* of Ohio began publishing its *Electronic Edition* with CompuServe in July 1980. It was the first attempt at videotex newspapering by an American daily (Laakaniemi, 1981; Mantooth, 1982). The *Dispatch* was the first paper to participate in a 2-year test of electronic publishing coordinated by Associated Press, which included a handful other papers such as *The New York Times*, *The Washington Post*, and *The Los Angeles Times*. The mechanics of this operation were simple: Once the *Dispatch* newsroom sent the stories to the newspaper computer system for print production, editors at the electronic newsroom assigned an index category and a priority to each story, adjusted the headline to fit the CompuServe index, and sent the stories to CompuServe computers for final delivery. The content was available Monday through Saturday from 6:00 p.m. to 5:00 a.m., and all day on Sunday, at a cost of $5.00 per hour (Columbus Dispatch, 1980).

The test lasted until June 1982. The overall conclusion was that, as Lawrence Blasko, Associated Press director of information technology, put it, "there is no clear and present danger to newspapers from electronic delivery of information to the home" (Electronic newspaper, 1982, p. 7). Although the Associated Press did not release the full results of this experiment, from partial information that appeared in the press it is possible to list some of the reasons behind this conclusion. First of all, news "accounted for less than 10 percent of the average test family's time . . . [and] this usage was heavily skewed toward a few respondents; one out of ten households accounted for half of all news reading" (Blomquist, 1985, p. 423). Secondly, newspapers tended to offer online the same content appearing in their print editions, which did not satisfy users' interests: the consensus from user feedback was that "electronic home delivery of information represents a new

medium and that simply placing the 'traditional newspaper' in the system was not going to work" (AP Finds, 1982, p. 20). In the third place, the typical "early adopter" user profile—male, young, white, upper income, highly-educated—made up for a specialized audience much different than the usual large audience of mass-circulation publications. Fourthly, there was no critical mass of personal computer users justifying large-scale investments in the short-run.

Another alternative pursued by various newspaper companies was to set up Public Access Videotex: dedicated terminals located in places like malls, hotels and airports. This was partly motivated to increase the people's awareness of videotex and its potential benefits—an attribute of the innovation process known as "observability" in the diffusion perspective. Chronicle Publishing, Harte-Hanks Communications, and Lee Enterprises had already ventured in this area by 1983 (Public Access Videotex, 1985). Moreover, not only the larger and more resourceful papers tested the waters of electronic publishing. For instance, in February 1982 the *Tiffin Advertiser-Tribune*, an under-20,000 circulation daily in Ohio, launched a videotex system, an enterprise that also included developing the "On Line Universal Access" software—sold in local stores—to allow access to the service from a wide variety of personal computers (Gibson, 1983). Furthermore, higher education institutions were also sites of videotex activities: for example, Indiana University organized a conference on electronic news delivery in 1980 (Ahlhauser, 1981; Electronic News, 1980), Brigham Young University's college newspaper set up an experiment on videotex journalism in the summer of 1980 (Test to Offer, 1980), and the University of Florida established an Electronic Text Center in 1981 (University of Florida, 1981).

Newspapers also participated in founding trade groups such as the Videotex Industry Association, which in 1982 included, among its 125 members, companies such as Hearst Corporation, Knight-Ridder Newspapers, and Times Mirror (Radolf, 1982). The Videotex Industry Association engaged a wide array of activities, including research efforts such as the development of an "Application Level User Protocol Guide" for videotex to improve interface design. According to Larry Pfister, the association chairman and Time, Inc., executive, "The current random approach to designing user interface functions to appear unique and helpful may become a barrier rather than a boon to the commercial success of videotex" (Videotex group, 1982, p. 35).

The intensity of the early 1980s videotex efforts also manifested in the legislative arena. Together with the cable industry, newspapers lobbied before Congress to keep AT&T at bay when it came to videotex content (Branscomb, 1988; Mosco, 1982; Neustadt, 1982; Pool, 1983). These efforts resulted in a 1982 prohibition for AT&T to enter into the electronic publishing field—a ban that was lifted seven years later. The newspaper industry put forward two arguments:

> One was that AT&T's size, perhaps including its monopoly power in other markets, distorted the market in such a way as to provide unfair competition with newspapers. This could damage the diversity of the press and therefore the freedom of the press. Its other argument was that vertical integration, provision of both the content of an information service and the conduit over which it is conveyed to its recipient, is a form of control regardless of the size of the provider. (LeGates, 1984, p. 291)

But no other development in this period illustrates the extent and character of American dailies' videotex endeavors better than the Viewtron project—the only initiative comparable in scope and size was Times Mirror's *Gateway* system, which followed relatively similar paths than Viewtron. It is to this case that the next section turns.

## VIEWTRON

After following the evolution of the British Post Office's *Prestel* videotex, and other related projects outside the United States, top executives at the newspaper chain Knight-Ridder became concerned about the implications that these systems could have in the American scene. As James Batten, then Knight-Ridder's vice-president for news, stated before the U.S. Senate Committee on Commerce, Science and Transportation during hearings on telecommunication legislation:

> In the mid-1970s, Knight-Ridder began a careful exploration of the various new electronic information technologies sprouting on the horizon. Our initial concern was defensive. For years there's been talk about "the electronic newspaper." We were concerned that some of these new systems might someday represent a competitive threat to the daily newspaper. And if that was to be the case, we wanted to discover that fact earlier rather than later. (Batten, 1981, p. 18)

Knight-Ridder established a wholly owned subsidiary, Viewdata Corporation of America, which in 1979 announced a joint venture with AT&T to develop a videotex system modeled after Prestel (K-R Plans, 1979). AT&T provided the hardware, including the dedicated terminals used by consumers, and Knight-Ridder was in charge of the rest, including content, advertising, marketing, and general management. In July 1980 the company began a field test in which several dozen families of Coral Gables, an upscale Miami neighborhood, were given free access to Viewtron several weeks at a time (Viewtron Test, 1980). The system consisted of around 15,000 screens of news, information, and services such as shopping and banking, transmitted over regular phone lines to a specially modified TV set equipped with a keyboard. Consumers used

the keyboard to select from the different choices presented through an interface composed mostly by text and some crude graphics. The notion of an active user, as opposed to the more passive one of traditional print and broadcast media, was seen by people like Batten as a distinctive feature of Viewtron: "The system puts the viewer in the driver's seat. He asks for what he wants, when he wants it" (Radolf, 1980a, p. 8).

Knight-Ridder expressed great enthusiasm during the field test. For instance, at a gathering of over 100 financial analysts in the Downtown Athletic Club in Manhattan, Viewdata Corporation of America's president Al Gilen said, "Our research is encouraging . . . people use Viewtron for news, shopping, and sending messages," and announced plans for a full market trial after the field test ended (Radolf, 1980b, p. 23). Alvah Chapman, Jr., Knight-Ridder's president and chief executive officer, added that this project gave the firm "expertise in software, and nobody else has it . . . . Viewtron's information is part and parcel of today's newspaper" (Radolf, 1980b, p. 23).

The field test ended in October 1981. Knight-Ridder was satisfied with outcomes such as significant interest for news and usage of shopping and banking capabilities, as well as consumers' manifestations in favor of the technology and of their willingness to pay for the service (Silverstein, 1983). When the test formally ended, plans for a market trial—also in the Miami area, where Knight-Ridder had its headquarters—were already under way. As opposed to the field test, this second phase would have consumers paying for the reception unit and the use of the system, and advertisers for their promotional messages. This change of focus was common to videotex developments around that time: "Unlike the tests that started in 1978, the current wave of experimentation is designed to answer crucial marketing rather than technical questions," wrote Silverstein in 1983 (p. 57). Thus, the logistics of this second phase included opening up advertising sales offices in Chicago, Miami, and New York, and hiring a national ad-sales force. Furthermore, between 1981 and 1983 Knight-Ridder sold Viewtron franchises to newspaper companies around the country; partners were given access to market trial data, and the rights to launch their own local Viewtron system (Compaine, 1984). Finally, this second phase also involved changes in the reception unit: In July 1983 AT&T unveiled the Sceptre equipment used to add videotex capabilities to the television set. It consisted of a wireless keypad with a Qwerty keyboard, a communication link with a speed of 1200 baud, and the option of connection to a printer (American Bell, 1983).

The market trial began in October 1983 (Knight-Ridder's Viewtron, 1983). Six months later there were only 1500 subscribers—Knight-Ridder expected 5000 subscribers in the first year—so access rates were lowered (Viewtron Growth, 1984). At the end of the first year, there were 2800 subscribers, so Knight-Ridder laid off 41 full-time employees and announced plans to make Viewtron available through personal computers (Knight-Ridder Cuts, 1984). A similar strategy was pursued by other videotex efforts, which, like Times Mirror's Gateway, were confined to dedicated terminals during a period in which penetration of personal computers was already experiencing significant growth. Things continued downhill though, and in March 1986 Knight-Ridder announced the end of Viewtron (Knight-Ridder "Pulls Plug," 1986). The system had been made available to personal computer users nationwide, thanks to partnerships with local newspapers, which had helped it growing to 20,000 users nationally. But Viewtron kept losing great sums of money; although no official figures were made available, Knight-Ridder reportedly lost around $50 million in this venture. James Batten, then president of Knight-Ridder, put an end to Viewtron using words that echoed those uttered at the end of the Associated Press–CompuServe test: "Videotex is not likely to be a threat to newspapers in the foreseeable future" (Knight-Ridder "Pulls Plug," 1986, p. 14).

Although Knight-Ridder did not reveal much of the market trial's data, some information moved to the public domain over the years, helping to account for its outcome. To begin, the service was rather slow, to the point that occasionally company officials would find out copies of Viewtron ads with the original slogan "The Waiting Is Over" crossed out by users and turned into "The Waiting Has Just Begun" (Fidler, 1997). This slow performance, coupled with the high cost of access and reception unit, did not make the service appealing to users who had to pay for it—as opposed to getting it for free during the 1980–1981 field test. Moreover, it was difficult to retain usage after the first weeks: People subscribed, started using the system, but ceased doing so when the novelty wore off (Ashe, 1991). Also, making the service available through personal computers came too late in the process, when the fate of Viewtron was almost decided. Aumente has employed the image of "an overbuilt luxury liner that could not negotiate tight turns to reach safe harbor" (1987, p. 4) to describe Viewtron's and Times Mirror's Gateway's failed attempts to reach personal computer users. Finally, the system did not appropriately serve users' demand for interpersonal communication. According to Aumente (1987), in the initial trials newspaper people were "cool to the idea of even including an alphanumeric keyboard, the heart of such interactivity, but AT&T prevailed" (p. 57). As Roger Fidler, Viewtron's team member, reflected years later:

> In retrospect, the interviews and usage data clearly revealed that access to databases of general news, information, and advertising was less exciting to subscribers than the ability to easily communicate with other subscribers. But that was not what anyone was prepared to hear at this time. Nearly everyone involved in the trial saw Viewtron as an

> advertiser-supported electronic newspaper. Its potential role as an interpersonal communication medium was considered secondary. (1997, p. 148)

By the end of Viewtron there was already a much less enthusiastic atmosphere among the people engaged with videotex. For instance, a reporter covering "Videotex'84" for *Editor & Publisher* summarized the collective mood: "Videotex these days is like the grand piano on the porch—it's nice, but how do you get it into the house?" (Fitzgerald, 1984, p. 36). David Simons, president of Video Corporation, was more ironic when at one of the conference's seminars he stated that "videotex is like a religion . . . it requires faith and is non-profit" (Fitzgerald, 1984, p. 36). Jodi Greenblatt, director of electronic publishing for Aspen Systems Corporation, used a quite telling metaphor a year later: "Traditional videotex up to now is an abortion. Never born. Never died. Just conceived" (Miller, 1985, p. 26). In this climate it is not surprising that newspaper-related videotex efforts decreased significantly during the second half of the 1980s. However, activity in this area was far from disappearing—modest services that used the personal computer as the reception unit persisted in the second half of that decade—and experienced a resurgence in the early 1990s, until the World Wide Web became the dominant online environment circa 1995.

## ACCOUNTING FOR THE EVOLUTION OF NEW MEDIA ARTIFACTS

How are we to account for the technological and social transformations that took place in the early videotex newspapers? This section argues that a mutual shaping lens illuminates critical aspects of this process in a way that could not be captured by traditional diffusion of innovation and social shaping of technology perspectives. It does this by showing that actors simultaneously pursued interdependent initiatives of technical construction and societal adoption, that this was an ongoing process in which partial outcomes in the construction domain influenced adoption events at a later phase—and vice versa—and that such process was both enabled and constrained by historical conditions.

To begin, the actors involved in the innovation process undertook a multiplicity of intertwined construction- and adoption-related initiatives. At the same time that they tinkered with alternative machine configurations—from sophisticated stand-alone systems to small-scale bulletin board services to public access terminals—change agents in the newspaper industry tried to create what they considered to be the most suitable environment for diffusion by such actions as lobbying legislators to prevent AT&T from becoming a competitor and forming a high-profile trade association. The simultaneous pursuit of related technical construction and societal adoption paths was also visible in the Viewtron case: Field trials probed both technical capabilities and adopters' behavior, and market deployment was as much about fostering diffusion as about continuing reinvention of the artifacts. In other words, society became the technical lab, and the resulting artifacts were embodiment of the compromises between producers' preferences and adopters' behavior. Also, building Viewtron involved not only technical work but also developing organizational capabilities that could best accommodate, and profit from, the new artifact through initiatives like establishing alliances and joint ventures, engaging the financial analyst community, and expanding the labor force.

Rather than first constructing the artifact and then diffusing it through society, actors seamlessly wove these two dimensions of new media evolution in an ongoing fashion. As a result, changes in one dimension influenced alterations in the other at a later stage. For instance, the creation of the Videotex Industry Association, something that could be seen as a "social" event trying to shape the conditions for diffusion, quickly led to a "technical" initiative in interface standardization to foster further market acceptance of videotex. Along the same lines, the increased penetration of personal computers in the home, coupled with the lower than predicted Viewtron sales, triggered the hardware and software transformation that enabled the system to be accessed through nondedicated terminals with the hope that this would accelerate its rate of adoption. However, these technical changes did not lead to commercial success. Like most early electronic newspapers in the United States, Viewtron was technically functional but unable to reach a critical mass of adopters by either influencing people's practices in the intended direction or altering technical configurations in a commercially fruitful manner. Where did this social inability and/or technical obduracy come from? A brief international comparison will help to elucidate why the answer to this question is partly historical.[1]

To ramp up usage of its telephone system, the French government sponsored a nationwide videotex initiative, Télétel, starting in the late 1970s. The government developed dedicated terminals and distributed them for free among the population—users only paid for the services utilized. Like Viewtron, the system was originally conceived as a way of providing users with an array of useful data; hence its initial configuration did not prominently feature one-to-one and many-to-many message flows. However, in a 1982 trial in Strassbourg, France, which included the participation of the local paper, *Les Dernieres Nouvelles d'Alsace*, a "fortunate accident" happened:

> The newspaper's technical manager developed an application to correspond on line with users so as to help them or to monitor their uses. Service users quickly discovered that it

> was also possible to communicate in real time with each other. This application soon became so popular that it attracted users from all over France although it was only available through a local telephone number. Later it was reproduced by many other information providers. (Vedel & Charon, 1989, p. 101)

This was the origin of Télétel's messaging system, which quickly became one of its most popular features and entailed a host of technical and social transformations, from enabling a multitude of messaging systems to redefining the whole enterprise as a communication space (Charon, 1987; Iwaasa, 1988; Marchand, 1987).[2] Analysts have argued that creating a common and subsidized technical infrastructure, and reinventing Télétel's messaging capabilities in response to early adopters' behavior were key contributing factors in this videotex comparative commercial success vis-à-vis its European and North American counterparts (Mayntz & Schneider, 1988; Schneider et al., 1991).

The early electronic newspapers in the United States originated in a different historical context than Télétel. By contrast to the French government, American dailies pursued videotex initiatives without the advantage of a publicly subsidized infrastructure, and not on the public interest but with a dual business motivation: to explore the new domain and to assess its threat to print (Carey & Pavlik, 1993; Davenport, 1987; Ettema, 1989). This duality can be seen in the ambivalent public reactions of Associated Press and Knight-Ridder officials to the end of their videotex endeavors—its commercial failure reassured them about the viability of print. In addition, in a context marked by the information society rhetoric, the ideology of technological determinism, and the preexisting computerization of the industry, newspapers appropriated videotex from the standpoint of a publishing mindset that had historically evolved over a couple of centuries of producing content for a large number of readers. Thus, they pursued videotex less out of a conviction that they needed to alter their production procedures and values to create an entirely different media artifact than because this was something that they "had to do."

Print's stand-alone technical infrastructure and unidirectional flow of information were reproduced in Viewtron. First, like a newspaper, each videotex was a closed system accessed only by its subscribers. Hence, it is not surprising that Viewtron was made available to personal computer (PC) users too late in the game. Secondly, Viewtron simply reused content initially authored for its print counterpart—a practice that was common among videotex newspaper during this period (Blomquist, 1985; Brown & Atwater, 1986; Mantooth, 1982; Overduin, 1986; Weaver, 1983). In addition, adopters were seen as active consumers able to choose from different options furnished by the newspaper, but not as producers of their own information. Hence, user-authored content was not fostered and its potential was mostly overlooked. As a result, Viewtron neglected its own usage data showing that adopters were more interested in communicating with each other than reading newsroom-generated content.

This analysis shows that the shaping of videotex newspapers cannot be understood disconnected from how their diffusion was intended to unfold and how it actually happened, and their diffusion cannot be understood in isolation from the ongoing process of technical construction. The technical configuration and societal adoption of videotex newspapers were not distinct outcomes but two sides of the same process of evolution of new media. These dynamics would have been missed by analyses focusing on either the social construction of videotex artifacts or their slower than intended diffusion through society.

## CONCLUDING REMARKS

This article has argued that a mutual shaping perspective provides a more encompassing account of the joint process of technical construction and societal adoption than either the diffusion of innovations or social shaping of technology perspectives. Drawing from recent scholarship in sociology and history of technology, organization studies, social informatics, and computer-supported cooperative work, the analysis has focused on the interplay between construction and adoption in the evolution of new media artifacts. More specifically, it has looked at three critical aspects of this evolution: the simultaneous pursuit of interdependent technological and social transformations, the ongoing character of this process, and the importance of the historical context in which it unfolds. Using examples from the origins of videotex papers in the United States this analysis has shown that (a) the actors undertook a multiplicity of intertwined technical shaping and societal diffusion initiatives from developing software to lobbying legislators to building hardware to generating suitable organizational designs, (b) partial outcomes of shaping initiatives altered diffusion events at a later stage and vice versa, and (c) American newspapers' ambivalent appropriation of videotex was partly a result of the historical context marked by a desire to explore the electronic terrain with the somewhat conflicting concern of preserving the viability of the print domain.

Additional research is needed to further the development of the mutual shaping lens in the analysis of new media. I would like to emphasize one area that appears particularly relevant for theory building. This article has drawn from multiple scholarly sources to shed light on the evolution of new media artifacts. However, future work could expand the process of theory building by linking general dynamics of technological and social change with an exploration of potentially specific features of various kinds of artifacts. That is, are there particular dynamics that are

more salient in the construction and adoption of new media artifacts than in other kinds of technologies? For example, the work of Silverstone and his colleagues (Silverstone & Haddon, 1996; Silverstone et al., 1992) on the notion of "double articulation"—"the ways in which information and communication technologies, uniquely, are the means (the media) whereby public and private meanings are mutually negotiated; as well as being the products themselves, through consumption, of such negotiations of meaning" (Silverstone et al., 1992, p. 28)—suggests that a focus on the potential distinctiveness of new media may contribute to developing a mutual shaping approach in a way that is sensitive to both shared dynamics of multiple technologies and specific features of different kinds of artifacts. This iteration between the general and the particular is one critical way in which future empirical analyses could further new media theorizing while contributing to broader pursuits in the study of innovation.

## NOTES

1. The following paragraphs center on one set of differences between the American and French experiences with videotex. This comparison is meant to illustrate the role of historical factors in shaping this set of differences, not to present a comprehensive comparative analysis of videotex development and use in different countries. For an example of this kind of more comprehensive comparative analysis, see the study of Schneider et al. (1991) about the dissimilar trajectories pursued by videotex in France, Germany, and United Kingdom. Space limitations prevent this analysis from engaging with this broader matter in the context of this paper. However, these authors' finding that historically anchored contextual features partly account for these dissimilar trajectories underscores my more general claim about the heuristic power of looking at historical dynamics in the evolution of new media.

2. This kind of "fortunate accident" has an important antecedent in the history of computerized communication systems: the role that early users of ARPANET had in turning electronic mail from a secondary technical capability into a major source of its attractiveness and further use (Abbatte, 1999; Campbell-Kelly & Aspray, 1996; Ceruzzi, 1998; Norberg & O'Neill, 1996).

## REFERENCES


Abbate, Janet. 1999. *Inventing the Internet*. Cambridge, MA: MIT Press.

Abernathy, William, and Utterback, James. 1978. Patterns of industrial innovation. *Technology Review* June–July:59–64.

Ahlhauser, John, ed. 1981. *Electronic home news delivery*. Bloomington: School of Journalism and Center for New Communication, Indiana University.

American Bell unveils videotex terminal. 1983. *Editor & Publisher* 2 July:29.

AP finds meager demand for electronic news. 1982. *Editor & Publisher* 2 October:10, 20.

Ashe, Reid. 1991. The human element: Electronic networks succeed with relationships, not information. *The Quill* September:13–14.

At ANPA Convention: Publishers to discuss new video technologies. 1981. *Editor & Publisher* 2 May:15, 38.

Atkin, D., Jeffries, L., and Neuendorf, K. 1998. Understanding Internet adoption as telecommunications behavior. *Journal of Broadcasting & Electronic Media* 42:475–490.

Aumente, Jerome. 1987. *New electronic pathways*. Beverly Hills, CA: Sage.

Baer, Walter, and Greenberger, Martin. 1987. Consumer electronic publishing in the competitive environment. *Journal of Communication* 37:49–63.

Bardini, Thierry, and Horvath, August. 1995. The social construction of the personal computer user. *Journal of Communication* 45(3):40–65.

Batten, James. 1981. A history of K-R's Viewdata project. *Editor & Publisher* 4 July:18, 20.

Bijker, Wiebe. 1995. *Of bicycles, bakelites, and bulbs: Toward a theory of sociotechnical change*. Cambridge, MA: MIT Press.

Bijker, Wiebe. 2001. Social construction of technology. In *International encyclopedia of the social & behavioral sciences*, eds. N. J. Smelser and P. B. Baltes, vol. 23, pp. 15522–15527. Oxford: Elsevier.

Bijker, W., Hughes, T., and Pinch, T. eds. 1987. *The social construction of technological systems: New directions in the sociology and history of technology*. Cambridge, MA: MIT Press.

Bimber, Bruce. 1990. Karl Marx and the three faces of technological determinism. *Social Studies of Science* 20:333–351.

Bishop, Ann, and Star, Susan Leigh. 1996. Social informatics and digital library use and infrastructure. *Annual Review of Information Science and Technology* 31:301–401.

Blomquist, D. 1985. Videotex and American politics: The more things change . . . *Information and Behavior* 1:406–427.

Boczkowski, Pablo. 1999. Mutual shaping of users and technologies in a national virtual community. *Journal of Communication* 49:86–108.

Boczkowski, Pablo. 2002. The development and use of online newspapers: What research tells us and what we might want to know. In *The handbook of new media*, eds. L. Lievrouw and S. Livingstone, pp. 270–286. London: Sage.

Bowker, Geoffrey, and Star, Susan Leigh. 1999. *Sorting things out: Classification and its consequences*. Cambridge, MA: MIT Press.

Branscomb, Anne. 1988. Videotex: Global progress and comparative politics. *Journal of Communication* 38:50–59.

Brown, Natalie, and Atwater, Tony. 1986. Videotex news: A content analysis of three videotex services and their companion newspapers. *Journalism Quarterly* 63:554–561.

Campbell, James, and Thomas, Hillary. 1981. The videotex marketplace—A theory of evolution. *Telecommunications Policy* 5:111–120.

Campbell-Kelly, Martin, and Aspray, William. 1996. *Computer: A history of the information machine*. New York: Basic Books.

Case, Donald. 1994. The social shaping of videotex: How information services for the public have evolved. *Journal of the American Society for Information Science* 45:483–497.

Carey, James, and Pavlik, John. 1993. Videotex: The sword in the stone. In *Demystifying media technology: Readings from the Freedom Forum Center*, eds. J. Carey and E. Dennis, pp. 163–168. Mountain View, CA: Mayfield.

Ceruzzi, Paul. 1998. *A history of modern computing*. Cambridge, MA: MIT Press.

Charon, Jean-Marie. 1987. Videotex: From interaction to communication. *Media, Culture & Society* 9:301–332.

Chilton, William. 1982. Newspapers: An endangered species. *Editor & Publisher* 20 November:31, 44

*Columbus Dispatch* starts electronic edition. 1980. *Editor & Publisher* 12 July:42.

Compaine, Benjamin. 1980. *The newspaper industry in the 1980s*. White Plains, NY: Knowledge Industry.

Compaine, Benjamin. 1984. Videotex and the newspaper industry: Threat or opportunity? In *Understanding new media*, ed. B. Compaine, pp. 319–326. Cambridge, MA: Ballinger.

Davenport, Lucinda. 1987. *A coorientation analysis of newspaper editors' and readers' attitudes towards videotex, online news and databases: A study of perception and options.* Unpublished doctoral dissertation, Ohio University.

Desbarats, Peter. 1981. *Newspapers and computers: An industry in transition* (Research Studies vol. 8). Ottawa, Canada: Royal Commission on Newspapers.

Dozier, D., and Rice, R. 1984. Rival theories of electronic newsreading. In *The new media*, ed. R. Rice, pp. 103–128. San Francisco: Jossey-Bass.

Dupagne, Michel. 1999. Exploring the characteristics of potential high-definition television adopters. *Journal of Media Economics* 12:35–50.

Electronic news conference set. 1980. *Editor & Publisher* 27 September:45.

Electronic newspaper found unprofitable. 1982. *Editor & Publisher* 28 August:7–8.

Ettema, James. 1989. Interactive electronic text in the United States: Can videotex ever go home again? In *Media use in the information age*, eds. J. Salvaggio and J. Bryant, pp. 105–123. Hillsdale, NJ: Lawrence Erlbaum Associates.

Fidler, Roger. 1997. *Mediamorphosis*. Thousand Oaks, CA: Pine Forge Press.

Fitzgerald, Mark. 1984. Videotex verdict: Still unclear. *Editor & Publisher* 19 May:36, 38.

Flanagin, A., Farinola, W., and Metzger, M. 2000. The technical code of the Internet/World Wide Web. *Critical Studies in Media Communication* 17:409–428.

Fulk, Janet. 1993. Social construction of communication technology. *Academy of Management Journal* 36:921–950.

Garrison, Bruce. 2001. Diffusion of online information technologies in newspaper newsrooms. *Journalism*, 2:221–239.

Gibson, B. 1983. "On the shelf" software developed for videotex. *Editor & Publisher* 7 May:64.

Gloede, Bill. 1980. NAB conference stresses profits in new technology. *Editor & Publisher* 4 October:12, 30.

Goodwin, Charles, and Goodwin, Marjorie. 1996. Seeing as situated activity: Formulating planes. In *Cognition and communication at work*, eds. Y. Engestrom and D. Middleton, pp. 61–95. New York: Cambridge University Press.

Hargadon, Andrew, and Sutton, Robert. 1997. Technology brokering and innovation in a product development firm. *Administrative Science Quarterly* 42:716–749.

Heath, Christian, and Luff, Paul. 2000. *Technology in action*. Cambridge, UK: Cambridge University Press.

Hughes, Thomas. 1969. Technological momentum in history: Hydrogenation in Germany 1898–1933. *Past & Present* 44:106–132.

Hughes, Thomas. 1987. The evolution of large technological systems. In *The social construction of technological systems*, eds. W. Bijker, T. Hughes, and T. Pinch, pp. 51–82. Cambridge, MA: MIT Press.

Hughes, Thomas. 1994. Technological momentum. In *Does technology drive history? The dilemma of technological determinism*, eds. M. R. Smith & L. Marx, pp. 101–114. Cambridge, MA: MIT Press.

Hutchins, Edwin. 1995. *Cognition in the wild*. Cambridge, MA: MIT Press.

It's a gee whiz world. 1986. *Editor & Publisher* 1 February:8.

Iwaasa, Raymond. 1988. Convivial messaging systems: Startling facts and figures about electronic mail (messageries) for French households. *The Information Society* 5:265–269.

Kline, Ronald. 2000. *Consumers in the country: Technology and social change in rural America*. Baltimore, MD: Johns Hopkins University Press.

Kling, Rob. 2000. Learning about Information technologies and social change: The contribution of social informatics. *The Information Society* 16:217–232.

Kling, Rob, and Iacono, Suzanne. 1988. The mobilization of support for computerization: The role of computerization movements. *Social Problems* 35:226–243.

Knight-Ridder cuts Viewtron staff. 1984. *Editor & Publisher* 3 November:32.

Knight-Ridder 'pulls plug' on its videotex operation. 1986. *Editor & Publisher* 29 March:14.

Knight-Ridder's Viewtron available to public this week. 1983. *Editor & Publisher* 29 October:16.

K-R plans 1980 pilot test for Viewtron. 1979. *Editor & Publisher* 21 April:117.

Laakaniemi, Ray. 1981. The computer connection: America's first computer-delivered newspaper. *Newspaper Research Journal* 2(4):61–68.

LeGates, John. 1984. Changes in the information industries: Strategic implications for newspapers. In *Understanding new media*, ed. B. Compaine, pp. 285–298. Cambridge, MA: Ballinger.

Lievrouw, Leah. 2002. Determination and contingency in new media development: Diffusion of innovations and social shaping of technology perspectives. In *The handbook of new media*, eds. L. Lievrouw and S. Livingstone, pp. 181–199. London: Sage.

Lin, Carolyn, and Jeffries, Leo. 1998. Factors influencing the adoption of multimedia cable technology. *Journalism & Mass Communication Quarterly* 75:341–352.

MacKenzie, Donald, and Wajcman, Judy, eds. 1985. *The social shaping of technology: How the refrigerator got its hum*. Milton Keynes, UK: Open University Press.

Mahler, Alwin, and Rogers, Everett. 1999. The diffusion of interaction communication innovations and the critical mass: The adoption of telecommunications services by German banks. *Telecommunications Policy* 23:719–740.

Mantooth, Sara. 1982. *The electronic newspaper: Its prospects and directions for future study*. Unpublished doctoral dissertation, University of Tennessee, Knoxville.

Marchand, Marie. 1987. *La grande aventure du Minitel* [The great adventure of Minitel]. Paris: Larousse.

Marvin, Carolyn. 1980. Delivering the news of the future. *Journal of Communication* 30:10–20.

Marx, Leo. 1994. The idea of "technology" and postmodern pessimism. In *Does technology drive history? The dilemma of technological*

*determinism*, eds. M. R. Smith and L. Marx, pp. 237–257. Cambridge, MA: MIT Press.

Mayntz, Renate, and Schneider, Volker. 1988. The dynamics of system development in a comparative perspective: Interactive videotex in Germany, France and Britain. In *The development of large technical systems*, eds. R. Mayntz and T. Hughes, pp. 263–298. Boulder, CO: Westview Press.

Miles, Ian. 1992. When mediation is the message: How suppliers envisage new markets. In *Contexts of computer-mediated communication*, ed. M. Lea, pp. 145–167. London: Harvester-Wheatsheaf.

Miller, Tim. 1985. Videotex market shaken up by PC boom. *Editor & Publisher* 9 March:26–27.

Misa, Thomas. 1988. How machines make history, and how historians (and others) help them to do so. *Science, Technology, & Human Values* 13:308–311.

Mosco, Vincent. 1982. *Pushbutton fantasies*. Norwood, NJ: Ablex.

Neuman, W. Russell. 1985. The media habit. In *Electronic publishing plus*, ed. M. Greenberger, pp. 5–12. White Plains, NY: Knowledge Industry.

Neustadt, Richard. 1982. *The birth of electronic publishing: Legal and economic issues in telephone, cable and over-the-air teletext and videotex*. White Plains, NY: Knowledge Industries.

Norberg, Arthur, and O'Neill, Judy. 1996. *Transforming computer technology*. Baltimore, MD: Johns Hopkins University Press.

Orlikowski, Wanda. 2000. Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization Science* 11:404–428.

Overduin, H. 1986. News judgment and the community connection in the technological limbo of videotex. *Communication* 9:229–246.

Picard, Robert, and Brody, Jeff. 1997. *The newspaper publishing industry*. Boston: Allyn & Bacon.

Pfaffenberger, Brian. 1989. The social meaning of the personal computer: Or, why the personal computer revolution was no revolution. *Anthropological Quarterly* 61:39–47.

Pinch, Trevor, and Trocco, Frank. 2002. *Analog days*. Cambridge, MA: Harvard University Press.

Pool, Ithiel. 1983. *Technologies of freedom*. Cambridge, MA: Belknap/Harvard University Press.

Public access Videotex. 1985. *Editor & Publisher* 23 March:40–42.

Radolf, Andrew. 1980a. Knight-Ridder to test home electronic info system. *Editor & Publisher* 12 April:7–8.

Radolf, Andrew. 1980b. KRN gives sharp picture of Viewtron. *Editor & Publisher* 6 December:23.

Radolf, Andrew. 1981. Public Firms Expand Electronic Horizons. *Editor & Publisher* 3 January:15, 28a.

Radolf, Andrew. 1982. New videotex association seeks conciliatory role. *Editor & Publisher* 14 August:19.

Rice, Ronald, and Paisley, William. 1982. The green thumb videotex experiment. *Telecommunications Policy* 6:223–235.

Rice, Ronald, and Rogers, Everett. 1980. Reinvention in the innovation process. *Knowledge* 1:499–514.

Rogers, Everett. 1995. *Diffusion of innovations*, 4th ed. New York: Free Press.

Rosenkopf, Lori, and Tushman, Michael. 1998. The coevolution of community networks and technology: Lessons from the flight simulation industry. *Industrial and Corporate Change* 7:311–346.

Sawyer, Steve, and Eschenfelder, Kristin. 2001. Social informatics: Perspectives, examples, and trends. *Annual Review of Information Science and Technology* 35:427–465.

Sawyer, Steve, and Rosenbaum, Howard. 2000. Social informatics in the information sciences: Current activities and emerging directions. *Information Science Research* 3:89–95.

Schneider, V., Charon, J. M., Miles, I., Thomas, G., and Vedel, T. 1991. The dynamics of videotex development in Britain, France and Germany: A cross-national comparison. *European Journal of Communication* 6:187–212.

Scofield, James. 1984. The mission of newspaper libraries. *Editor & Publisher* :41, 52.

Sigel, Efrem. 1983a. Introduction. In *The future of videotex*, ed. E. Sigel, pp. 1–13. White Plains, NY: Knowledge Industry.

Sigel, Efrem. 1983b. Videotext in other countries. In *The future of videotext*, ed. E. Sigel, pp. 149–160. White Plains, NY: Knowledge Industry.

Silverstein, Jeffrey. 1983. Videotext in the United States. In *The future of videotext*, ed. E. Sigel, pp. 51–79. White Plains, NY: Knowledge Industry.

Silverstone, Roger, and Haddon, Leslie. 1996. Design and domestication of information and communication technologies: Technical change and everyday life. In C*ommunication by design*, eds. R. Mansell and R. Silverstone, pp. 44–74. New York: Oxford University Press.

Silverstone, R., Hirsch, E., and Morley, D. 1992. Information and communication technologies and the moral economy of the household. In *Consuming technologies*, eds. R. Silverstone and E. Hirsch, pp. 15–31. London: Routledge.

Smith, Anthony. 1980. *Goodbye Gutenberg*. New York: Oxford University Press.

Smith, Merrit Roe. 1994. Technological determinism in American Culture. In *Does technology drive history? The dilemma of technological determinism*, eds. M. R. Smith and L. Marx, pp. 1–35. Cambridge, MA: MIT Press.

Sommer, P. 1983. Videotext in the United Kingdom. In *The future of videotext*, ed. E. Sigel, pp. 81–111. White Plains, NY: Knowledge Industry.

Star, S. L., and Bowker, G. 2002. How to infrastructure. In *Handbook of new media*, eds. L. Lievrouw and S. Livingstone, pp. 151–162. London: Sage.

Staudenmaier, John. 1989. *Technology's storytellers*. Cambridge, MA: MIT Press.

Stone, Gerald. 1987. *Examining newspapers*. Newbury Park, CA: Sage.

Suchman, L., Blomberg, J., Orr, J., and Trigg, R. 1999. Reconstructing technologies as social practice. *American Behavioral Scientist* 43:392–408.

Test to offer in-depth news via computer. 1980. *Editor & Publisher* 26 July:19.

Till, Don. 1981. Electronic revolution: A consumer view. *Editor & Publisher* 26 December:19, 36.

Tushman, Michael, and Murmann, Johann. 1998. Dominant designs, technology cycles, and organizational outcomes. *Research in Organizational Behavior* 20:231–266.

Tydeman, J., Lipinski, H., Adler, R., Nyhan, M., and Zwimpfer, L. 1982. *Teletext and videotex in the United States*. New York: McGraw-Hill.

Tyler, Michael. 1979. Videotex, Prestel and teletext: The economics and politics of some electronic publishing media. *Telecommunications Policy* 3:37–51.

University of Florida opens electronic text center. 1981. *Editor & Publisher* 14 November:38.

Vedel, Thierry, and Charon, Jean-Marie. 1989. Videotex in France: The invention of a mass-medium? In *Pathways to telematics*, eds. V. Schneider, G. Thomas, T. Vedel, J. M. Charon, and I. Miles, pp. 83–147. Unpublished manuscript.

Videotex group to study simpler access methods. 1982. *Editor & Publisher* 11 December:35.

Viewtron growth has been slow. 1984. *Editor & Publisher* 19 May:38.

Viewtron test started by Knight-Ridder. 1980. *Editor & Publisher* 26 July:18–19.

Weaver, David. 1983. *Videotex journalism*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Weaver, David, and Wilhoit, G. Cleveland, 1986. *The American journalist: A portrait of U.S. news people and their work*. Bloomington: Indiana University Press.

Wilkinson, M. 1980. Viewdata: The Prestel system. In *Videotext*, ed. E. Sigel, pp. 57–85. White Plains, NY: Knowledge Industry.

Williams, Robin, and Edge, David. 1996. The social shaping of technology. *Research Policy*, 25:865–899.

Yates, JoAnne. 1993. Co-evolution of information-processing technology and use: Interaction between the life insurance and tabulating industries. *Business History Review* 67:1–53.