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37 Bridging STS and Communication Studies: Scholarship on Media and Information Technologies

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By any measure, media and information technologies—sociotechnical systems that support and facilitate mediated cultural expression, interpersonal interaction, and the production and circulation of information goods and services—are the backbone of social, economic, and cultural life in many societies today. They are important in themselves as cultural and technical artifacts, and they are embedded in almost every other type of specialized technological system, including those used in finance, manufacturing, extractive industries, transportation, utilities, education, health care, defense, and law enforcement. Indeed, it is difficult to identify any aspect of contemporary life that is not affected in some way by the development and use of media and information technologies.

In light of their ubiquity and societal reach, as well as how rapidly the systems themselves have changed over the past three decades, we might expect that studies of this class of technologies would have been central in the research agendas of communication studies, on the one hand, and science and technology studies, on the other. Both disciplines would seem to have an obvious interest in them. However, in each case the story has been more complicated.

The social, psychological and cultural effects of mediated messages and content have been analyzed in communication studies since the field's founding. Interest in the role of technology in such effects rose in parallel with the growing popularity of television between the 1960s and 1980s (Meyrowitz, 1985; McLuhan, 1964; Postman, 1985; Williams, 1975). However, these debates were largely confined to specialized domains of inquiry within mass communication and cultural studies. Only in the 1970s and 1980s, as networked computing and telecommunications technologies diffused rapidly in corporate, entertainment, and academic settings and converged with and challenged the conventional boundaries among "mass media," interpersonal communication, and organizational communication, did the study of these technologies expand into an intellectual space that linked diverse domains of inquiry and become a major topic of interest in its own right in communication studies (Parker, 1970; Pool, 1977, 1983; Rice et al., 1984; Rogers, 1986; Williams et al., 1988).

The centrality of media and information technologies as objects of inquiry has taken even longer to emerge in STS, a field that has tended to focus on complex

as stone) or "space-biased" media (more ephemeral, portable, and easy to revise, such as parchment or paper). Later, Innis's colleague Marshall McLuhan (1964) classified media technologies into the more abstract categories of "hot" and "cool." Hot media, such as print and radio, he said, elicit intense psychological involvement from the audience, while cool media, such as television, provoke psychological detachment and distance.

Another significant tradition of inquiry within communication studies has taken a behaviorally oriented approach to highlight the complexity of contemporary media technologies and their reliance on computing and telecommunications. Wilbur Schramm (1977), for example, classifies media technologies according to their correspondence to human sensory perception: motion versus still images, sound versus silent, text versus picture, one-way/simplex versus two-way/duplex transmission. But he also brings in their institutional context by contrasting inexpensive, local, small-scale "little media," such as newsletters, print shops, or local radio stations, with "big media" having extensive, expensive, complex infrastructures and organizational arrangements, such as telephone systems, national broadcast networks, or communications satellites. In contrast to "mass media," Rice and his associates (1984: 35) define "new media" as "those communication technologies . . . that allow or facilitate interactivity among users or between users and information" owing to the two-way transmission capabilities of their telecommunications- and computer-based infrastructures. Ithiel Pool (1990: 19) includes "about 25 main devices" that incorporate computing and/or telecommunications technologies in a list of "new" communications media.

Despite the differences between them, both approaches share a persistent focus on technical features and capabilities and an enduring concern, particularly in the United States, with the social and psychological "effects" of media technologies and content on individuals and audiences. Effects researchers continue to explore the nature and extent of media effects and to inform the management and regulation of media channels and content.

Definitions of media and information technologies in STS, on the other hand, have tended to focus more on issues of meaning, practice, and the connection of particular technological systems to a broader "landscape" of artifacts rather than technical features alone. A fundamental tenet of STS is that the material aspect of technology must be situated and studied within its various social, temporal, political, economic, and cultural contexts. The critique of technological determinism that catalyzed so much historical and sociological research in the 1980s, both within and outside STS, was partly based on the idea that the technical attributes of technologies matter less than how they are actually used, given the meanings that people attribute to them. For example, Suchman (1987) showed that human-machine interaction, even in situations where technically skilled individuals operate complex computerized devices such as photocopiers, depends on locally contingent attributions of meaning rather than disembodied, decontextualized rules. Similarly, Kling and Iacono (1987) demonstrated that organizational constraints and culture, and institutional forms, do more

to shape computer-based information systems than do data structures, software, or hardware architectures *per se*.

Studies of the origins of radio (Douglas, 1987), telephony (Fischer, 1992; Galambos, 1988), sound technologies (Pinch & Trocco, 2002; Thompson, 2002), videotex (Schneider et al., 1991), and the development of computing and the Internet (Abbate, 1999; Edwards, 1996) have helped establish a broad view of what counts as media and information technologies among STS scholars. Print and broadcasting, computing and telecommunications, "old" and "new" media technologies alike fall within the purview of relevant scholarship in STS. By taking a long-term historical view, and by underscoring issues of meaning and practice, STS has illuminated crucial connections between particular technological systems and the broader world of artifacts and culture.

Interestingly, the historically grounded, meaning- and practice-based scholarship typical within STS resonates with views of media technology commonly held among communication scholars working in the British and European "media studies" tradition. The critical, cultural perspective of this tradition contrasts with the mainly American, "administrative" focus on effects and regulation (Lazarsfeld, 1941). Instead, it emphasizes the cycle of "production-circulation-reception of cultural products" or "media commodities" such as films, television programs, popular music, and fashion (O'Sullivan et al., 2003: 15; see also Williams, 1981). It tends to view media technologies, including newer systems such as mobile telephony and the Internet, as "texts" subject to cultural analysis and critique. They are at once the products and the tools of a cultural and economic system whose aim is the reproduction of social, political, and economic domination, order, and privilege. In different hands, media technologies can also serve the interests of resistance, emancipation, and equity.

For example, in his historical and institutional analysis of television in the United Kingdom and the United States, Raymond Williams (1975) navigates between the material nature of television technologies and programming, and their social and cultural meanings. He warns against both technological determinism and what he calls "symptomatic technology" (1975: 13), that is, technology as an entirely socially determined "symptom" of the culture that produces it. He argues that while certain technologies may evolve into "new social forms" (1975: 18-19), the path of evolution depends on the actors and interests involved and will produce unpredictable or unintended consequences. Although Williams is primarily concerned with television content, his analysis is nonetheless consistent with what many scholars in STS today would call a "mutual shaping" perspective on technology and society, the interplay of materiality and action.

Since the 1980s and 1990s, many of the views about media and information technologies advanced within STS and media studies have been more broadly adopted among communication researchers dissatisfied with the implicit technological determinism of media effects research and the language of "impacts" of new technologies on society, behavior, and culture. Coincident with a broader shift within the field in the 1980s, away from the administrative perspective and toward a contextual

perspective that stressed local practices, everyday life, subjectivity, interaction, and meaning (Gerbner, 1983), many communication scholars have turned to concepts drawn from STS, such as interpretive flexibility, social shaping, and social construction of technology, in their theorizing and analyses of newer media and information technologies.³ Today, the deterministic language of “effects” and “impacts” has largely been supplanted in communication technology research by more relational, subjective, and meaning-driven frameworks and concepts. The rejection of technological determinism, and the acceptance of a relatively strong form of social constructionism, has become the prevailing perspective in new media studies in Europe, North America, and elsewhere. This development can be counted as one of the most important cross-disciplinary influences of STS on the field (Lievrouw & Livingstone, 2006b; see also chapter 7 in this volume).

Why “Media and Information Technologies”? Notes on Terminology

As stated previously, we have deliberately chosen the term “media and information technologies,” rather than other commonly used labels, to describe the broad class of sociotechnical systems that are studied in both STS and communication studies. In contrast to these other terms, the phrase “media and information technologies” foregrounds four distinctive facets of these systems: their broad historical scope, their infrastructural dimension, their fundamental materiality, and the distinctive interplay of this materiality with symbolic content and meaning.

First, “media and information technologies” is meant to suggest a sense of historical inclusiveness and scope. Consistent with the strong historical, meaning- and practice-oriented approach to technology within STS, these technologies include older craft, mechanical, and electric technologies, such as printing, typewriters, telegraphy, and broadcasting, as well as newer systems such as the Internet, mobile telephony, satellite systems, and search engines. In contrast, terms such as “new media,” “information and communication technologies” (ICT), and “information technology” (IT) have been commonly used to privilege computing and telecommunications technologies relative to other types of artifacts.

Second, taking a cue from Star and Bowker’s (2006) concept of infrastructure (see also Bowker & Star, 1999), the term media and information technologies is used to suggest that particular artifacts should be conceptually situated within a broader landscape of related, and often unnoticed or invisible, material things, such as filing cabinets, magnetic tape and optical disks, telephone poles, library shelves, or wireless bandwidth, for example. That is, even when the object of study is a novel technology, it should always be seen in its relationships to an installed base of related things. Terms like new media, ICT, and IT, on the other hand, often emphasize the novelty and uniqueness of particular devices and obscure their relationships to the broader world of other artifacts on which they depend for their very functioning.

Third, and related to the point about infrastructure, media and information technologies are fundamentally material. That is, people engage with them in space and time, as embodied, situated beings, as they do with other artifacts. Even supposedly

“virtual” media systems and “friction-free” cyberspace are in essence complex configurations of “hard” physical components, from cables to code.

Fourth, drawing from the work of Silverstone and his collaborators (Silverstone & Haddon, 1996; Silverstone & Hirsch, 1992; Silverstone et al., 1992), we want to emphasize the centrality of content and its constitutive articulation with materiality. Media and information technologies are not only artifacts in the material sense but also the means for creating, circulating, and appropriating meaning. Whether they mediate entertainment, arts, interaction, organizing, or data, in no other class of technologies—such as bicycles, missiles, bridges, and electrical grids—are material form and symbolic configurations so intimately tied and mutually constructed. We might say that media and information technologies are at once cultural material and material culture. That is, on the one hand, they are cultural products in themselves, in which constellations of textual, aural, and visual symbols play a central role. On the other hand, they are a key part of the material culture of mediated communication, in which ensembles of technologies acquire a prominence much higher than in unmediated communication. This distinctive quality is to a large extent what has made them so compelling to STS and communication scholars alike.

In a definition that draws from STS and communication research, Lievrouw and Livingstone (2006b) argue that media and information technologies comprise the material systems themselves and their social contexts, including the *artifacts* or *devices* used to mediate, communicate, or convey information; the *activities* and *practices* in which people engage to communicate or share information; and the *social arrangements* or *organizational forms* that develop around the devices and practices. In light of the preceding discussion, we would refine the definition of media and information technologies to highlight the interplay of symbolic content and meaning with the artifacts, practices, and social arrangements that are associated with them. We return to this point in the conclusion of this chapter.

THREE BRIDGES

As we noted at the start of this chapter, over the last few decades the study of media and information technologies, whether in communication or STS, has centered on certain fundamental questions or issues that have ordinarily been framed as binary oppositions between two competing concepts, with a camp of advocates on each side. In our view, three important issues in particular have served as “bridges” between the two fields: causality in technology-society relationships, the technology development process, and the social consequences of technological change. In this section we examine each bridge and the opposing concepts involved in them, illustrating the discussion with relevant examples from the literature in both fields.

Causality

Scholarship about media and information technologies has raised important questions about causality in the relationship between technology and society. Research in STS

and communication studies has often espoused different perspectives on this issue, partly as a result of their different intellectual traditions and orientations. On the one hand, given its history of behavioral and cultural theorizing, communication research has tended to see technology as a factor that can generate, or help generate, distinctive social effects, rather than as an object of inquiry worthy of social explanation in itself. On the other hand, STS technology research—with its grounding in contextualist history and constructivist sociology of technology—has often made the social factors that shape the development and, to a lesser extent, the use of technology the central focus of inquiry and has been hesitant to say much about technology's large-scale societal effects.

These different notions of causality, and their associated conceptual and methodological preferences, can be appreciated by contrasting two highly regarded studies of print technology: Eisenstein's *Printing Press as an Agent of Change* (1979) and Johns's *Nature of the Book: Print and Knowledge in the Making* (1998)—as well as the debate between the two authors published in a recent issue of *The American Historical Review* (Eisenstein, 2002a,b; Johns, 2002).⁴

The Printing Press as an Agent of Change has been enormously influential in communication technology scholarship and many other fields. It argues that the advent of the printing press led to the emergence of a "print culture" that reflected the distinctive attributes of the press as a technological system, as contrasted with scribal manuscript production. In turn, this culture ushered in a series of revolutionary transformations that altered almost every aspect of "Western civilization." In Eisenstein's view, a crucial attribute of print is "typographical fixity," that is, a printed text's content and format is preserved in print and thus becomes independent from its use. Prior to mechanical printing, "information had to be conveyed by drifting texts and vanishing manuscripts" (1979: 114). According to Eisenstein (1979: 113),

The great tomes, charts, and maps that are now seen as "milestones" [of the "varied intellectual 'revolutions' of early-modern times"] might have proved insubstantial had not the preservative powers of print also been called into play. Typographical fixity is a basic prerequisite for the rapid advancement of learning. It helps to explain much else that seems to distinguish the history of the past five centuries from that of all prior eras.

To Eisenstein, "the implications of typographical fixity . . . involve the whole modern 'knowledge industry' . . . [as well as] issues that are . . . geopolitical" (1979: 116–17), from the "linguistic map of Europe" (1979: 117)—"a 'mother's tongue' learned 'naturally' at home would be reinforced by inculcation of a homogenized print-made language mastered . . . when learning to read" (1979: 118)—to its legal infrastructure—"laws pertaining to licensing and privileges . . . have yet to be examined as by-products of typographical fixity" (1979: 120).

Johns's (1998) *Nature of the Book* opposes critical aspects of *Printing Press as an Agent of Change* and Eisenstein's theoretical and methodological approach. According to Johns, in Eisenstein's account "printing itself stands outside history" (1998: 19). There-

fore, "its 'culture' . . . is deemed to exist inasmuch as printed texts *possess* some key characteristic . . . The origins of this property are not analyzed" (1998: 19). To resolve what he considers to be the limitations of this approach, Johns (1998: 19–20) proposes that

We may consider fixity not as an *inherent* quality, but as a *transitive* one . . . We may adopt the principle that fixity exists only inasmuch as it is recognized and acted upon by people—and not otherwise. The consequence of this change in perspective is that print culture itself is immediately laid open to analysis. It becomes a *result* of manifold representations, practices, and conflicts, rather than just the monolithic *cause* with which we are often presented. In contrast to talk of a "print logic" imposed on humanity, this approach allows us to recover the construction of different print cultures, in particular, historical circumstances.

The differences between Johns's and Eisenstein's notions of causality are intertwined with epistemic choices that guide the process of inquiry. For example, in his debate with Eisenstein in the *The American Historical Review*, Johns (2002) notes, "Where Eisenstein asks what print culture itself is, I ask how printing's historic role came to be shaped. Where she ascribes power to a culture, I assign it to communities of people. Most generally, where she is interested in qualities, I want to know about processes."

A revealing aspect of Johns's representation of their respective epistemic choices, to some extent echoed by Eisenstein (2002b) in her rebuttal of Johns's comments, is that he frames their choices in oppositional terms. This use of oppositional terms has been a persistent feature of discussions about causality in both communication studies and STS, principally as the debate between societal versus technological determinism.⁵ Yet, although it may be rhetorically advantageous to cast one's arguments against a perceived polar opposite, this strategy can also limit the understanding of phenomena that may exhibit evolving combinations of the features that are portrayed as mutually exclusive.

To overcome this shortcoming, Lievrouw (2002: 192) has proposed to recast this type of opposition as "a dynamic relationship between determination and contingency." In her framework, "determination and contingency are interdependent and iterative, and . . . this relationship can be seen at key junctures or 'moments' in . . . media development and use" (2002: 183). When causality is considered in this way, different factors may determine or be contingent at different points in time as media and information technologies develop. This approach thus casts a broader conceptual net that captures both the social shaping of technology development and use, and the emergence of broad, persistent societal effects.

Such a causal framework aligns with a conceptual move within STS toward understanding technology as an object of inquiry, in terms of an ensemble of social and material elements in which dynamic combinations of determination and contingency generate different sociomaterial configurations (Bijker, 1995a; Callon, Law, & Rip, 1986; Jasanoff, 2004; Latour, 1996; Pickering, 1995). In a recent application of this view to the study of media and information technologies, Boczkowski (2004: 11) used the following lens to look at the development of online newspapers:

Media innovation unfolds through the interrelated mutations in technology, in communication, and in organization. I make sense of any of these three elements in the context of its links to the others, much like a triangle in which the function and meaning of any one side can be understood only in connection to the other two.

While sharing this basic stance regarding causality, and of technologies as sociomaterial ensembles, different scholars have underscored different dimensions in the relationships between determination and contingency. Three of these dimensions—discourse, practice, and pragmatics—demonstrate the value of taking a more encompassing and complex perspective on causality that at the same time allows for different conceptual foci.

Edwards's (1996) study of the interpenetration of politics, technology, and popular culture in America during the Cold War furnishes a powerful illustration of an analysis that highlights the discursive dimension.⁶ According to Edwards (1996: 120), this period was marked by a "closed-world discourse" in which computerized technologies were at once symbol, tool, embodiment, and conduit and always deeply integrated with military procedures, cultural life, and subjective experiences.

The Cold War can be best understood in terms of *discourses* that connect technology, strategy, and culture: it was quite literally fought inside a quintessentially semiotic space, existing in models, language, iconography, and metaphor, embodied in technologies that lent to these semiotic dimensions their heavy inertial mass. In turn, this technological embodiment allowed closed-world discourse to ramify, proliferate, and entwine new strands.

Edwards uses the notion of discourse neither to highlight computerized technologies' discursive "impact" on society nor the discursive "choices" made by groups of powerful actors to shape these technologies, but he "views technology as one focus of a *social process* in which impacts, choices, experiences, metaphors, and environments all play a part" (1996: 41). This social process is a quintessentially dynamic one that unfolds over time and in which different material and nonmaterial elements shift from more determined to more contingent, and vice versa.

The role of practice is illuminated in a study of the production and consumption of sound reproduction technologies by Sterne (2003), in which he examines, among other issues, practice under the label of "audile technique."⁷ By choosing the term "technique" rather than "practice" to make sense of actions related to the manipulation of sound reproduction technologies, the author blends the material and nonmaterial. In his analysis, the emergence of a set of audile techniques is contingent on constellations of bodily, cultural, material, and economic factors. But once stabilized as part of people's sociomaterial repertoire, techniques can play a determining role in the emergence of novel technologies and their associated sensations, symbols, and markets. Thus, in opposition to the argument that media and information technologies cause or constitute an extension of human senses and sensorial practices, as argued by McLuhan (1964), Ong (1982), and Stone (1991), among others, Sterne (2003: 92) shows that

All the *technologies* of listening that I discuss emerge out of *techniques* of listening. Many authors have conceptualized media and communication technologies as prosthetic sense. If media do, indeed, extend our senses, they do so as crystallized versions and elaborations of people's prior practices—or techniques—of using their senses.

Finally, in their study of classification systems and standards embodied in infrastructures, Bowker and Star (1999) propose a turn toward pragmatism to account for the development and use of information and media technologies. Following the lead of W. I. and Dorothy Thomas ([1917]1970), Bowker and Star (1999: 289) invite scholars to focus on the "definition of a situation," because "that definition . . . is what people will shape their behavior toward." Their approach to causality turns consequences from determined to determining and remains open about the social and material factors that affect the emergence of consequences:

[This approach] makes no comment on where the definition of the situation may come from—human or nonhuman, structure or process, group or individual. It powerfully draws attention to the fact that the materiality of anything . . . is drawn from the consequences of its situation. (Bowker & Star, 1999: 289–90)

To summarize, scholarship on media and information technologies at the intersection of STS and communication studies has historically enacted a treatment of causality that focused on the agency of either technological or societal factors. An alternative treatment has more recently gained currency by characterizing technology as socio-material configurations in which the different elements exhibit different degrees of determination and contingency at different moments in the unfolding of their relationship.

Process

Production and consumption form one of the major conceptual pairs in social and cultural theorizing, including work in STS and communication studies. As with notions of causality, general theorizing in both fields has espoused different orientations toward the relationships between production and consumption in the process of technology development.

On the one hand, because most of the initial technology scholarship in STS centered on articulating alternatives to technological determinism, studies during this period tended to focus more on the production of new artifacts and less on their consumption. As Bijker (2001: 15524) put it in a review of the social construction of technology model, until the mid-1990s, "the issue of technology's impact on society . . . had been bracketed for the sake of fighting technological determinism."

On the other hand, technology research in communication studies has centered on either production dynamics, often with a political economy focus (Gandy, 1993; Mosco, 1989; Robins & Webster, 1999; Schiller, 1999), or on the consumption side (Meyrowitz, 1985; Katz & Rice, 2002; Reeves & Nass, 1996; Walther, 1996), but less on the connection between the spheres of production and consumption. For instance,

the diffusion of innovation framework, very popular in communication studies' technology research, commonly begins the process of inquiry once artifacts have been developed. As Rogers (1995: 159) wrote in a review of this framework, "past diffusion researchers usually began with the first adopters of an innovation . . . [and did not address] events and decisions occurring previous to this point."

Building on these traditions of inquiry, but also extending them, the thrust of scholarship on media and information technologies at the intersection of STS and communication studies has been to interrogate the links between production and consumption, developing concepts that shed light on the different processes that connect these two spheres.

STS researchers began to open the "black box" of production in ways that shed light on consumption by the early 1990s. For example, Woolgar (1991) showed that the process of software production "configures the user;" that is, it embeds the producer's vision of consumers and consumption practices in the design of the technology and thus influences technological adoption. Drawing from this notion as well as from Akrich's (1992, 1995) related idea of "inscription,"⁸ a growing line of research bridging STS and communication studies has argued that in the technology development process, technical choices are made, artifacts are symbolically framed, and regulatory environments are fostered in ways that have consequences for consumption. Two recent studies of media and information technologies illustrate this approach at two extremes of social experience: the personal, small-scale realm of the body, and the impersonal, large-scale domain of the market.

In his account of Douglas Engelbart's role in the development of computer interface technologies such as the mouse, Bardini (2000) shows that Engelbart and his collaborators incorporated their ideas about users' bodies into their technical design choices, which subsequently influenced consumption. "Engelbart wasn't interested in just building the personal computer. He was interested in building the person who could use the computer to manage increasing complexity efficiently" (Bardini, 2000: 55). Engelbart and his colleagues thought that interface alternatives that took greater advantage of bodily capabilities had better chances of succeeding, that is, of "augmenting" users' cognition. This notion guided the design of tools such as the mouse, which complemented the movement of the hand and the dynamics of hand-eye coordination:

The user's hands and eyes were limited input and output devices in the human-computer interface. In developing the mouse and the chord keyset in the early 1960s, Engelbart and his group at [the Stanford Research Institute] made a quantum leap in human-computer interaction: the introduction of the body as whole as a set of connected, basic sensory-motor capabilities. (Bardini, 2000: 102)

The market is another important dimension for exploring the relationships between production and consumption. The commercial success of new artifacts depends not only on their technical functionality but also on their appropriation by users. Instead of seeing markets as asocial entities that obey only economic laws of supply and

demand, scholars looking at the commercial fate of media and information technologies have focused on how market-making affects production and consumption simultaneously, and on the social construction of goods and their cultures of consumption (Douglas, 1987; Millard, 1995; Smulyan, 1994; Yates, 2005). For instance, in their history of electronic music synthesizer technologies, Pinch and Trocco (2002) examined the practices involved in the creation and growth of markets for musical instruments. They found that selling strategies affected both production and consumption of different kinds of synthesizers and proposed that salespeople "are a crucial link between the worlds of production and consumption. Whether through their interactions with users or by moving from use to sales, salespeople tie the world of use to the world of design and manufacture" (Pinch & Trocco, 2002: 313).

Parallel to opening the black box of production, scholarship on media and information technologies has also aimed to unpack consumption practices in ways that illuminate their links to production dynamics.⁹ This effort partly originated in analyses of these technologies that account for the agency of users in both historical (Douglas, 1987; Fischer, 1992; Martin, 1991; Marvin, 1988) and contemporary settings (Ang, 1991, 1996; Lull, 1990; Morley, 1992; Silverstone, 1994).¹⁰ This line of research has made substantive progress toward a better conceptual understanding of this agency particularly on three fronts: the domestication of new artifacts, the role of users as agents of technological change, and the resistance to new technologies.

Combining a focus on meaning informed by audience research and an approach to materiality inspired by social constructionist technology scholarship, Silverstone and Hirsch (1992) argue that when users bring new artifacts into the familiar household setting, they "domesticate" them by investing them with meaning and situating them within a material environment, both of which are locally contingent. In other words, in the process of domestication "new technologies . . . are brought (or not) under control by and on behalf of domestic users. In their ownership and in their appropriation into the culture of family or household and into the routines of everyday life, they are at the same time, cultivated. They become familiar, but they also develop and change" (Silverstone & Haddon, 1996: 60). Domestication unfolds in four stages—appropriation, objectification, incorporation, and conversion—in which new communication opportunities are opened up for both actors and artifacts (Aune, 1996; Laegran, 2003; Silverstone & Haddon, 1996).

Whereas the notion of domestication underscores the interpretive agency of users, research on the role of users as agents of technological change examines situations in which unanticipated user practices trigger material transformations of artifacts, and the mechanisms by which makers incorporate such changes into subsequent versions of their design (Boczkowski, 1999; Feenberg, 1992; Fischer, 1992; Orlikowski et al., 1995; Suchman, 2000).¹¹ For instance, Douglas (1987: 301–2) has shown that users of early radio broadcasting equipment were instrumental in turning what was initially a point-to-point communication system into a mass communication medium:

The amateurs and their converts had constructed the beginnings of a broadcasting network and audience. They had embedded radio in a set of practices and meanings vastly different from those

dominating the offices at RCA. Consequently, the radio trust had to reorient its manufacturing priorities, its corporate strategies, indeed, its entire way of thinking about the technology under its control.

A third stream of work that highlights user agency examines resistance to new technologies, particularly the intentional opposition to technological change and its implications for production dynamics (Bauer, 1997; Kline, 2000, 2003; Wyatt et al., 2002). In his study of the introduction of the telephone in rural America in the early parts of the twentieth century, Kline (2000) has documented that established traditions of country life such as eavesdropping and visiting informed the ways that people in rural areas used the telephone: they listened to others' conversations and participated in multiple-party calls via party lines. Telephone companies tried to discourage these practices, but users actively resisted their attempts: "recognizing the difficulty of exerting social discipline over thousands of far-flung, rather independent-minded consumers . . . commercial firms redesigned the telephone network to fit the social practices of this 'class' of customer" (2000: 48). Thus, Kline argues, "producers, rather than consumers, adapted the new technology to fit the social patterns of daily life" (2000: 48).

To sum up, the treatment of the technology development process in scholarship on media and information technologies has challenged stark distinctions between the spheres of production and consumption as well as built theoretical resources to illuminate the various forms and mechanisms that connect these two spheres.

Consequences

Debates have also ensued in both communication studies and STS about the social consequences of media and information technologies. Although historians have noted that utopian and dystopian claims have been made about virtually every new communication device or information service to come along (Lubar, 1993), as Marvin (1988) points out, predictions about technologies are not always borne out by their actual consequences. In STS and communication studies, two main views of the consequences of media and information technologies have emerged.

On the one hand, the technologies are thought to be "revolutionary," that is, they are a challenge to, and a radical departure from, existing media and information systems and impose new practices and institutional arrangements. Eisenstein's work, discussed above, takes this strong revolutionary view regarding the advent of the printing press. In the case of newer technologies, advocates of the revolutionary perspective contend that, because the technologies are designed, built, organized, distributed, and used differently from conventional mass media and information systems, they have the potential to overturn the social relations, work patterns, cultural practices, and economic and political orders created and fostered by industrial-era communication and information technologies (Beniger, 1986; Castells, 2001; Harvey, 1989; Pool, 1983; Zuboff, 1988). This position has been characterized as the "discontinuity" perspective (Schement & Curtis, 1995; Schement & Lievrouw, 1987; Shields & Samarajiva, 1993; Webster, 2002).

After the Second World War, the discontinuity perspective was fostered by inventors, engineers, designers, and planners involved in the defense projects, academic labs, and industries where many of the technologies were first developed (Light, 2003). They foresaw the integration of broadcasting and print with computer- and telecommunications-based systems that would provide interactive services and information delivery on demand. The dramatic growth of new computing and media technologies in this period prompted a number of prominent intellectuals and social scientists to look for corresponding changes in Western society and culture (e.g., Drucker, 1968; McLuhan, 1964; Mumford, 1963). Some asked whether these new technologies might be driving a transition as important as that from agricultural to industrial society in Europe and the United States in the eighteenth and nineteenth centuries, ushering in a late-twentieth-century "post-industrial" or "information" society (Bell, 1973; Machlup, 1962; Porat & Rubin, 1977; see also Schement & Lievrouw, 1987). Some speculated that a "communications revolution" might well be at hand (Gordon, 1977; Williams, 1983; see also Cairncross, 2001).

The opposing continuity view rejects the revolutionary rhetoric and asserts that the social consequences of technological change tend to be more gradual and incremental because they are necessarily situated within the context of established technologies, practices, and institutions. Partly in relation to its historical and ethnographic grounding and its focus on practice and meaning, STS scholarship has generally adopted the continuity view. Johns, for example, takes this more gradualist approach to the consequences of the printing press in his account of "print and knowledge in the making," discussed above.

Within communication studies, the continuity perspective was first articulated in the 1970s and 1980s by scholars trained in political economy and critical theory. In their view newer media and information technologies, like earlier mass media systems, are conceived, organized, and operated according to the logic of mass production, capitalism, commodification, and market economics. They reinforce inequitable systems of social and economic organization and control and help extend those systems into domains that were formerly resistant to rationalization and the industrial model of production (e.g., education, health care, law, and cultural production). According to this view, even if information rather than physical goods is the new commodity, the commodity system itself still rules, and its negative consequences persist (Garnham, 1990; Mosco, 1996; Robins & Webster, 1999; Schiller, 1981; Slack & Fejes, 1987; Traber, 1986).

By the early 1990s, the continuity and discontinuity perspectives had come to an impasse, despite attempts to negotiate a middle view (Schement & Curtis, 1995; Schement & Lievrouw, 1987) or to identify a range of views on media and information technologies and social change (Shields & Samarajiva, 1993). Influenced by the political economy of media, the critical/cultural turn noted above, and the critique of technological determinism advanced by STS, younger researchers in both communication and STS have increasingly tended to reject the revolutionary "new technologies, new society" discourse of information society research and have focused on the

micro-scale, everyday, social and cultural contexts, uses, and meanings of newer communication technologies. Continuity has become the predominant perspective in social-scientific studies of media and information technologies and social change since the 1990s (Lievrouw & Livingstone, 2006b).

The discontinuity view was not dead, however. Artists, creative writers, historians, and critics who encountered networked computing for the first time in the early 1990s were well aware of the dangers of technological determinism; nonetheless, many of them used the novel technical features of these technologies as a point of departure for conceptualizing new kinds of digital media products (Bolter & Grusin, 1999; Hayles, 1999; Manovich, 2001; Murray, 1998; Poster, 1990; Stone, 1995). This scholarship presents a different stance on the continuity-discontinuity issue by balancing claims about the perceived newness of novel digital artifacts with an understanding of their links to previously developed media and information technologies and the symbolic and social processes associated with them.

As media and information technologies have become commonplace over the last decade, some scholars in both STS and communication studies have begun to consider the consequences of new technologies as infrastructures, that is, as they become embedded in an existing technological base, transparent, and visible only when they break down (Star & Bowker, 2006; Star & Ruhleder, 1996). As Edwards (2003: 185) puts it, "the most salient characteristic of technology in the modern—industrial and postindustrial—world is the degree to which technology is *not* salient for most people, most of the time." For example, although the gradual integration of media and information technologies into existing systems and practices has made them more usable, convenient, and reliable, it has also created vast new possibilities for undetected surveillance and invasions of privacy (Agre & Rotenberg, 1997). It also has generated tools that allow individuals to resist such intrusions (Brook & Boal, 1995; Phillips, 2004).

The increasingly routine quality of media and information technologies has also been characterized as "banalization" (Lievrouw, 2004). For instance, contributors to a recent special issue of *New Media & Society* suggest that the late-twentieth-century information technology "revolution" is over, supplanted by incremental improvements in stability, security, reliability, ubiquity, and ease of use. The current sense is one of "slouching toward the ordinary" (Herring, 2004: 26), of "new and improved without the new" (Lunenfeld, 2004: 65). Stephen Graham (2004), a critic of the discourse of technological discontinuity, revolution, and "transcendence," finds that routinization largely confirms the continuity perspective. Calabrese (2004) argues that the reassertion of a familiar, mass-media "pipeline" style of sales and distribution online by traditional media and content industries has produced new media genres that look much like the old.

Whether, and to what extent, media and information technologies have become "banal" remains an open question. What is certain, however, is that as they have become more pervasive, familiar, and integrated into everyday practices and larger social, cultural, and institutional arrangements and structures, it is no longer possible

to view the consequences of media and information technologies as a matter of *either* continuity *or* discontinuity. Recent studies at the intersection of communication studies and STS have adopted a view of social change that encompasses both the continuous and the discontinuous, the evolutionary and the revolutionary qualities and characteristics of media and information technologies and their effects (Boczkowski, 2004; Thompson, 2002; Turner, 2005).

CONCLUDING REMARKS: IMPLICATIONS AND DIRECTIONS FOR NEW RESEARCH

In the preceding sections we have proposed that the study of media and information technologies, especially in communication research and STS over the last twenty years, can be mapped around three main conceptual bridges: *causality*, comprising a tension between determination and contingency; *process*, conceived as multiple relationships between production and consumption; and *consequences*, contrasting continuity and discontinuity views of social change. These three concepts have often been represented in terms of opposing binaries; however, we have argued that they are better viewed as mutually determining, dialectic pairs in which each half of the pair assumes and builds on the other.

The map presented here is descriptive in that it organizes two broad, disparate bodies of work in terms of their common concerns, problematics, and mutual intellectual influence. But maps are not only descriptive tools; they also have a performative function. They help people navigate territories, locate landmarks in space, arrive at known destinations, discover previously unknown places, and make new connections between old and new locations. Like a map, the framework proposed here provides a tool for navigating the "problem space" of the social study of media and information technologies, both within and beyond communication studies and STS. It may also suggest new connections among the different disciplinary and intellectual traditions engaged in the study of these systems.

These connections have become essential as media and information technologies have proliferated and become more ubiquitous, and as mediation has become a central feature of social life over the last century. The technologies have been incorporated into a vast range of artifacts, practices, and social arrangements, including many that lie outside of what have been traditionally seen as "media" or "information technologies," such as finance, transportation, and health care. Recent empirical research at the intersection of STS and communication studies has demonstrated the growing ubiquity and centrality of mediation over time and in a variety of social and cultural contexts (Bowker & Star, 1999; Boczkowski, 2004; Downey, 2002; Light, 2003; Sterne, 2003; Thompson, 2002; Turner, 2005). In parallel, this proliferation and ubiquity may recently have helped rekindle interest in media and information technologies in fields where the topic has long been considered peripheral, such as economics (Hamilton, 2004), anthropology (Ginsburg et al., 2002), and sociology (Starr, 2004).

Taking advantage of the pervasiveness of media and information technologies today and of the dramatic rise of interest in them and their social/cultural contexts and

implications, and building on the conceptual framework advanced here, we would like to suggest three possible avenues for continuing scholarship at the intersection of STS and communication studies. Consistent with our framework, they broadly concern the relationship between technology and society, technology development processes, and the consequences of sociotechnical change.

First, with regard to the causal relation between technology and society, and the tension between determination and contingency, given the growing turn to “mutual shaping” or “co-production” approaches, future work might address the particular conditions that may tilt the balance toward determination or contingency, or the specific mechanisms and processes that “harden” sociotechnical configurations under certain conditions or make them more malleable in other conditions. Scholarship that takes a historical or comparative perspective could be especially useful in both cases. For example, future studies might take as their point of departure a still-emerging body of research that takes an environmental perspective, analyzing technological systems, social structures and relations, and action together. These studies often seek to identify factors that can make such environments more determined, or “closed,” on the one hand, or more contingent or open on the other (Davenport, 1997; Lievrouw, 2002; Nardi & O’Day, 1999; Verhulst, 2005).

Second, regarding the roles of production and consumption in the technology development process, two complementary directions for further work might contrast cases in which the boundary between production and consumption blurs or even disappears with those where production and consumption are so clearly segregated that they have minimal influence on each other. For instance, in the domain of so-called “citizen journalism,” the success of South Korea’s *OhMyNews*, which thousands of citizens-turned-journalists have transformed into a popular and politically influential online news site, might be compared with the failure of the *Los Angeles Times*’s attempt to utilize WIKI TOOLS to make its editorials user-driven. The forum was shut down days after being launched because editors felt that some postings had become too aggressive. The first case demonstrates that people’s engagement with media and information technologies is not easily reduced to the roles of producers *or* consumers,¹² while the second case shows that the production-consumption divide is still an important dynamic in many media and information contexts. Perhaps casting these as a dynamic of integration and separation could shed additional light on production and consumption as heuristic constructs.

Third, regarding the consequences of sociotechnical change, the increased sense of ordinariness and banality of media and information technologies could open the way for future work that might reconcile or at least recast the relationships between observed continuities and observed discontinuities, whether at the micro-scale of everyday life, practice, particular inventions, and meanings or at the macro-level of large-scale social relations and change.¹³ Continuities and discontinuities are both observable across many levels of analysis, yet few theorists have attempted to integrate or frame them relative to each other.

We must add one critical point about all three suggested avenues for study: they must also account for the tightly interwoven relationship between the material and the symbolic, which, as we noted earlier, distinguishes media and information technologies from other types of sociotechnical infrastructures. Although it is tempting to classify and analyze these two dimensions of media and information technologies as distinct phenomena, they are in fact inextricably bound together. Future studies must confront the ways that meaning and forms of content contribute to influence material alternatives, and by the same token, how the physical materiality, durability, and format of specific technological devices and systems help shape content and meaning. This fundamental dialectic is at the heart of the interplay of determination and contingency, production and consumption, and continuity and discontinuity.

To conclude, we have proposed that concerns with causality, process, and consequences have delineated the domain of media and information technologies across STS and communication studies alike. Our aim has been to propose a broad framework for articulating shared concepts, problems, and interests in this rapidly growing area of study. Causality, process, and consequences, regardless of the particular contexts, settings, or applications in question, are fundamental concerns in the understanding of these and other technologies. Building on and transcending the binaries that have characterized research and scholarship to date may also help build dialogue and collaboration across these two traditions of inquiry and institutional boundaries.

Notes

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1. These bridges also correspond to fundamental issues in social, cultural, and historical studies of all technologies.
2. At several points in this chapter, we make a distinction between two schools of thought or traditions of inquiry within communication studies. On the one hand is a broadly behaviorist, medium-oriented, social science-based tradition that has tended to focus on the social and psychological effects of media and applied research regarding media professions and industries. The other tradition draws more from critical/cultural theory and political economy and tends to focus on issues of economic inequities and power, institutional structures, and cultural domination/hegemony. We have attempted to show how both traditions have played a role in the linkages between communication studies and STS. We thank an anonymous reviewer for reminding us that the first tradition, historically located in North America and East Asia, is often viewed critically by adherents of the second tradition, which is historically associated with the British/Birmingham school of media studies and is the predominant perspective in the United Kingdom and parts of Europe and Latin America.

3. In organizational communication research, where a substantial body of administrative research already existed regarding the implementation and management of ICTs in the workplace, the move to the contextual perspective, and the influence of concepts from STS, was particularly significant (see, e.g., Fulk, 1993; Jackson, 1996; Jackson et al., 2002; Orlikowski & Gash, 1994).
4. In addition to illustrating two different treatments of causality in technology-society relationships, these two books are also examples of two ways of conceptualizing technology as an object of inquiry, both discussed in the introductory section of this chapter. Eisenstein's book, influenced by the work of medium theorists like Innis and McLuhan, is inscribed within the tradition of scholarship that has characterized technology in terms of its technical features. Johns's book, drawing from constructivist scholars like Shapin and MacKenzie, is part of a mode of inquiry that has tended to stress issues of meaning, practice, and broader cultural connections of technological systems.
5. For an extended treatment of this matter, see chapter 7 in this volume. For additional discussions about this matter in general, see Bijker (1995b), Brey (2003), MacKenzie (1984), Staudenmaier (1989), and Williams and Edge (1996). For discussions focused on media and information technologies, see Dutton (2005), Edwards (1995), Kling (1994), Pfaffenberger (1988), Slack and Wise (2002), and Winner (1986).
6. It is important to note that Edwards's treatment of the notion of discourse draws partly from Foucaultian theory, which emphasizes the ties between symbolism and materiality in discursive configurations. We include Edwards's work as a powerful illustration of the discursive dimension precisely because his multilayered attention to symbolism, from micro-level metaphoric language to macro-level constructions of popular culture, is not in opposition to materiality but inextricably tied to it. For additional treatments on discursive aspects of media and information technologies, see, for instance, Bazerman (1999), Carey (1989), Gillespie (2006), and Wyatt (2000).
7. For a broader discussion on the "turn to practice" in social and cultural theory, see Schatzki et al. (2001). For additional treatments on practice issues in the study of media and information technologies, see, for instance, Boczkowski and Orlikowski (2004), Foot et al. (2005), Heath and Luff (2000), and Orlikowski (2000).
8. According to Akrich (1992: 208), producers "define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of '*inscribing*' this vision of—or prediction about—the world in the technical content of the new object."
9. Mackay et al. (2000: 737) have argued that this move has been part of a larger shift in social and cultural theorizing: "the turn to 'the user' is a feature of broader discourses, including that of the social sciences, not just the sociology of technology." For more on this matter in STS, see Oudshoorn and Pinch (2003) and chapter 22 in this volume.
10. Another early example of this line of work is Rice and Rogers's notion of "reinvention" in the diffusion of innovations, defined as "the degree to which an innovation is changed by the adopter in the process of adoption and implementation after its original development" (1980: 500–501). Subsequent research on reinvention added significant empirical detail, but provided not so much conceptual elaboration about the dynamics of user agency.
11. "Users" need not be individuals: in her study of the co-evolution of users and technologies in the life insurance industry, Yates (2005) has shown the value of focusing on a previously overlooked level of analysis, that of the collective—as opposed to individual—user. According to the author, "although individual agents clearly played critical roles, they could not act alone but had to mobilize those above and below them in the company hierarchy, as well as their peers, to acquire and apply such technology . . . This firm and industry focus illuminates a level thus far studied on the producer side but rarely on the user side" (2005: 259).

12. In communication studies, a reassessment of the notion of "audience," which equates engagement with media and information technologies with consumption, has been under way for over a decade (Abercrombie & Longhurst, 1998; Ang, 1991; Gray, 1999; Livingstone, 2004). Interactivity, another fruitful window into the production-consumption relationship, has been a locus of STS scholarship since the pioneering work of Suchman (1987). In communication studies, interactivity and related concepts, such as telepresence and propinquity, have been investigated since the 1970s (see Rafaeli, 1988; McMillan, 2006).

13. This is not a technology research issue that is new in either communication studies or STS, as evidenced in both early scholarship such as Marvin (1988) and recent scholarship such as Boczkowski (2004) and Yates (2005). But more remains to be done in specifying the more general mechanisms whereby discontinuity arises from continuity.

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