Research Commentary: Desperately Seeking the "IT" in IT Research—A Call to Theorizing the IT Artifact

Wanda J. Orlikowski • C. Suzanne Iacono
Massachusetts Institute of Technology, Cambridge, Massachusetts 02142
National Science Foundation, Arlington, Virginia 22230
wanda@mit.edu • siacono@nsf.gov

The field of information systems is premised on the centrality of information technology in everyday socio-economic life. Yet, drawing on a review of the full set of articles published in *Information Systems Research* (*ISR*) over the past ten years, we argue that the field has not deeply engaged its core subject matter—the information technology (IT) artifact. Instead, we find that IS researchers tend to give central theoretical significance to the context (within which some usually unspecified technology is seen to operate), the discrete processing capabilities of the artifact (as separable from its context or use), or the dependent variable (that which is posited to be affected or changed as technology is developed, implemented, and used). The IT artifact itself tends to disappear from view, be taken for granted, or is presumed to be unproblematic once it is built and installed. After discussing the implications of our findings, we propose a research direction for the IS field that begins to take technology as seriously as its effects, context, and capabilities. In particular, we propose that IS researchers begin to theorize specifically about IT artifacts, and then incorporate these theories explicitly into their studies. We believe that such a research direction is critical if IS research is to make a significant contribution to the understanding of a world increasingly suffused with ubiquitous, interdependent, and emergent information technologies.
(*Information Systems Research; Information Technology; IT Research; IT Theory; Technological Artifacts; Technology Change*)

Introduction

We begin this paper with what we believe is a telling observation: that the field of information systems (IS), which is premised on the centrality of information technology in everyday life, has not deeply engaged its core subject matter—the information technology (IT) artifact. While there have been a number of attempts over the years to conceptualize IT artifacts in various ways (as we will describe below), we find that by and large IT artifacts (those bundles of material and cultural properties packaged in some socially recognizable form such as hardware and/or software) continue to be under theorized. Indeed, IS researchers tend to focus their theoretical attention elsewhere, for example, on the context within which some usually unspecified technology is seen to operate, on the discrete processing capabilities of artifacts (as separate from how they operate in context), or on the dependent variable (that which the technology presumably affects or changes as it is developed, implemented, and used). The outcome is that much IS research draws on commonplace and received notions of technology, resulting in conceptualizations of IT artifacts as relatively stable, discrete, independent, and fixed. As a conse-

1047-7047/01/1202/0121$05.00
1526-5536 electronic ISSN

quence, IT artifacts in IS research tend to be taken for granted or are assumed to be unproblematic.

The status of technological artifacts as taken for granted is not restricted to the IS field but has permeated most studies of technology, including those in sociology (Bijker 1995) and organizational studies (Orlikowski and Barley 2001). For example, Pinch and Bijker (1987, p. 21) argue that "in the economic analysis of technological innovation everything is included that might be expected to influence innovation, except any discussion of the technology itself." Articulations of the nature and role of technology, and theories of its interdependence with social contexts are also missing from classic social theory, where technology is either "black-boxed" and treated as a monolith (Latour 1987), or it "vanishes" from view in the preoccupation with social constructions (Button 1993). Processes such as innovation and change are conceptualized largely in socio-economic terms, while "things" are not considered or are treated as self-evident (Pinch and Bijker 1987). Technology, as the quintessential "thing," dissipates into the atmosphere around us, or it becomes emblematic of our "age." We throw it up as a banner of our times, but then instantly let it recede from view by stereotyping or ignoring it.

In this paper, we present evidence for our assertion that IS research has not seriously engaged its core subject matter: the IT artifact. Our evidence is based on a review of the full set of articles ($N = 188$) published in *ISR* since its inception 10 years ago. For each article, we examined whether and how IS researchers conceptualized and dealt with information technology and then analyzed the results. After presenting the findings, we discuss their implications and then offer some directions for research that are premised on the critical importance of developing and using theories of information technology in IS research.

Conceptualizations of the IT Artifact

During the 1980s, several IS researchers attempted to overcome shortcomings in what they perceived to be overly narrow views of technology in the IS field. They offered alternative conceptualizations of what technology is, how it has effects, and how and why it is implicated in social change. Kling and Scacchi (1982), for example, developed the concept of "web models" of computing in contrast to what they saw as the dominant "discrete-entity" model of computing. From their perspective, information technology is more than just the tools deployed on the desktop or the factory floor. It is the ensemble or "web" of equipment, techniques, applications, and people that define a social context, including the history of commitments in making up that web, the infrastructure that supports its development and use, and the social relations and processes that make up the terrain in which people use it. A few years later, Markus and Robey (1988) presented a number of different ways of understanding and studying the relationship between technology and organizational change. In their analysis, technology can be theorized as playing different roles—as an independent variable, a dependent variable, or as one of a number of players in an emergent process of change (where the outcomes are indeterminate because they are situationally and dynamically contingent).

Given Kling and Scacchi's and Markus and Robey's articulations of alternative conceptualizations of technology in the 1980s, we wondered what IS researchers had done with them since then. Had they used or built on these conceptualizations, elaborated or expanded them, or perhaps even created new ones? Additionally, how had such alternative conceptualizations influenced our collective understanding of the nature and role of technology in organizational and socio-economic practices? To answer these questions we examined the evidence, reviewing every article that has been published in *ISR* since the journal's commencement in 1990 through to the end of 1999—a decade's worth of data on research in the IS field. Categories of information technology conceptualizations were derived inductively from the data using the grounded theory approach known as "open coding" (Strauss 1987). The interpretations and labels we gave to those conceptualizations were informed by the literature on technology, as reflected in the fields of IS, computer science, organization studies, and sociology.

Based on our coding of the 188 articles published in the past decade of *ISR,* we identified 14 specific conceptualizations of information technology. We then compared these 14 conceptualizations, looking for commonalities and differences, and found we could cluster them into five broad metacategories, each representing a common set of assumptions about and treatments of information technology in IS research. Our labels for these metacategories signal the primary conceptualization of technology that distinguishes each category: the *tool* view, the *proxy* view, the *ensemble* view, the *computational* view, and the *nominal* view. Below, we discuss these various views of information technology evident in the *ISR* literature, before turning to a discussion of their representation in the literature and the implications of such results for current and future IS research.

I. *Tool* View of Technology

The *tool* view represents the common, received wisdom about what technology is and means. Technology, from this view, is the engineered artifact, expected to do what its designers intend it to do. As such, what the technology is and how it works are seen to be largely technical matters (separate, definable, unchanging, and over which humans have control). Two scholars (Rob Kling and Bruno Latour) have conceptualized this view in the course of moving beyond it. Kling (1987, p. 311) describes the "tool" view of information technology as: "A computing resource (that) is best conceptualized as a particular piece of equipment, application or technique which provides specifiable information processing capabilities." He argues that such a view conceives of information technology independently of the social or organizational arrangements within which it is developed and used. Latour (1987), in turn, argues that the "tool" view "black boxes" technologies and assumes that they are stable, settled artifacts that can be passed from hand to hand and used as is, by anyone, anytime, and anywhere. George et al. (1990), in a study that investigates the impacts of GDSS on group decision making, provide an example of this view. They conceptualize the IT artifact as a set of group communication tools with specifiable features that are hypothesized to produce more effective group outcomes than would result from face-to-face communications without those tools.

We found that the "tool" view was represented in the *ISR* literature in four different ways: as a tool for labor substitution, a tool for enhancing productivity, a tool for information processing, and a tool for changing social relations. These four conceptualizations share a view of information technology as a relatively unproblematic computing resource and similarly treat such technology as the primary independent variable. Little conceptual or theoretical attention is paid to the technology. Often it is just named (as in "Lotus 1-2-3") and its technical features are listed. What matters most in these studies is the dependent variable—that which is affected, altered, or transformed by the tool. What this view suggests is that tool-using humans and organizations can vary labor needs, increase performance, enhance information-processing capabilities, and shift social relations.

Technology as Labor Substitution Tool. Since the days of mechanization and automation, it was assumed that new technologies would substitute for and replace labor. Organizations would be more productive because fewer people could do more work (and more reliable work). Early studies of technologies such as shop-floor numerical control machines ignited age-old fears that machines would replace workers (Castells 1996) and led to predictions of mass unemployment. Similar arguments were made for information technology (Attewell and Rule 1984). Applegate et al. (1988, p. 129), for example, argue that management information systems are organizational "tool[s] for downsizing and restructuring" as they can replace scores of analysts and middle managers and enable organizations to work more cheaply and efficiently.

Technology as Productivity Tool. Subsequent notions of technology shifted from labor substitution to labor augmentation. Technologies here are seen to be "productivity tools," prosthetic devices that enable individuals and social institutions to extend their reach and achieve performance benefits in the course of their ongoing socio-economic activities. To describe the technical features of a new technology is to understand what that technology will do, as its performance capabilities are assumed to be designed *in* the technical features. For example, in the 1980s, the flexible features of PCs were thought to enable more productivity because workers could more easily shift from one task to another. In the 1990s, the collaborative features of groupware were thought to enable increased productivity because workers could more easily develop and maintain work collaborations. In this view, performance outcomes are assumed to be positive and to result from replacing older (read: slower, less efficient, less accurate, more cumbersome, and more time consuming) ways of working with new technology-enabled ways of working.

Technology as Information Processing Tool. In practice, simple substitution of new technologies for older ways of doing things did not always produce the expected labor reductions or performance enhancements. An alternative "tool view" argued that what technology does best is to alter and enhance the ways that humans and organizations process information. For example, at the institutional level of analysis, Leavitt and Whistler (1958) hypothesized that computerization of the firm would allow for information collected at the bottom levels of the firm to flow to the top, thus, recentralizing decision making authority. More recently, the Internet has been conceptualized in information processing terms, being seen as a large-scale repository of information that can be searched, manipulated, and used for socio-economic gain. IS researchers have also conceptualized individuals and small groups as information processing entities and have focused on the ways in which new technologies (for example, e-mail, spreadsheets, electronic brainstorming applications, and executive support systems) can alter information flows and enhance feedback and learning or, more negatively, result in information overload.

Technology as Social Relations Tool. The fourth "tool" conceptualization evident in the *ISR* literature recognizes that in addition to substituting for labor, enhancing performance, and processing information, technologies can and do alter social relations. Following the introduction of new technologies, social roles may change, hierarchies may become more or less salient, business processes may be modified, and communication may require choices among different media and tasks. Over the years, IS researchers have examined shifts in social networks, communication patterns, and work activities associated with the introduction of new technologies that offer different capabilities. For instance, new electronic media have been portrayed as providing different opportunities to convey social presence, social context, and information richness, and such differences have been hypothesized to alter communication behavior and effectiveness.

II. *Proxy* View of Technology

The conceptualizations of technology that we have clustered under the "proxy" label have a focus on one or a few key elements in common that are understood to represent or stand for the essential aspect, property, or value of the information technology. In our set of *ISR* articles, we found three types of proxy logics. All share the assumption that the critical aspects of information technology can be captured through some set of surrogate (usually quantitative) measures—such as individual perceptions, diffusion rates, or dollars spent. For example, the study by Moore and Benbasat (1991) develops an instrument for assessing individual users' perceptions of the new technologies they might consider adopting.

The first proxy logic posits the importance of human understandings in technology use and, thus, focuses on technology as viewed by individual users. Perceptual, cognitive, and attitudinal responses to computers become the critical variables in explaining technology and its effects in the world. The second proxy logic concentrates on the diffusion and penetration of technologies within firms, industries, and economies. Here, the critical aspect of technology is the rate with which particular IT artifacts (hardware, software, techniques) become spread across social systems and the extent to which they become integrated into operational activities. The final proxy logic is constituted by monetary measures of technology, the premise being that a useful indicator of the value of technology to a firm or economy is the amount of money spent on it. Thus, dollar amounts of technological investments and changes in them are tracked over time to understand the essential role of technology in organizations and economies.

Technology as Perception. In this conceptualization, information technology is represented in terms of measures of users' perceptions of the technology. The variables of study typically include "ease of use," "usefulness," and "intention to use the technology."

Researchers are interested in examining individuals' perceptions to better understand what motivates them to accept or use new technologies such as spreadsheets, electronic mail, word processing applications, etc. Many of the articles categorized here draw on theories such as the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB). These theories assume that how individuals perceive a new technology (and make choices about their intention to use it) is based on an internal cost-benefit analysis. Users assess a technology's usefulness and evaluate whether that usefulness exceeds the costs associated with gaining access to it or learning to use it. Over the years, more variables have been added to these theories resulting in more sophisticated approaches to understanding user perceptions and attitudes towards new information technologies.

Technology as Diffusion. Technology is represented in this category by measures of diffusion and penetration of a particular type of IT artifact (e.g., electronic mail) within some socio-institutional context such as a firm, industry, or society. What researchers want to know is how many people, organizations, or nations are currently using the technology. The focus is on understanding the processes of diffusion (Rogers 1983) and/or penetration of the technology within and across these settings. If the technological innovation is not diffusing or being used as widely as expected, researchers want to understand the barriers to such processes. These barriers tend to be conceptualized in cultural, organizational, or economic terms, and typical questions include: Why are firms slow to implement the new technology? How can the new technology be integrated into an organization's workflow? What is the critical mass that is needed for widespread use of the new technology? What can a nation do to not be left behind technologically? Such questions have been used to help understand important societal problems such as, why developing countries are slow to embrace the Internet or why there appears to be a digital divide in the United States today.

Technology as Capital. In this category, technology is conceptualized and measured in terms of dollars—usually the costs associated with the tools themselves (e.g., dollars spent on hardware and/or software) or the information systems infrastructure (e.g., dollars of IS department budget)—and then treated as either an independent or a dependent variable. This view of technology is grounded in the economics discipline, and focuses specifically on the value of the information technology resource or investment to firms, industries, or economies. Typical questions addressed by this literature include: What is the spending on information technology in firms and/or industries? How has spending on information technology changed over time? What is the productivity impact of investing in information technology? These studies examine all manner of industries, firms, and technologies, an analytic move made possible by the abstraction of technology to a homogenized and fairly general (if not completely universal) representation of value: dollars. Such conceptual abstraction facilitates this literature's interest in seeking regularities that hold across organizations and types of information technologies. In particular, this stream of research has been helpful in articulating the so-called "productivity paradox," a phenomenon recognized in the late 1980s and early 1990s as organizations increasingly invested in information technologies with apparently little return on their investments.

III. *Ensemble* View of Technology

Over the years, a number of researchers have been dissatisfied with the *tool* and *proxy* views of technology. Kling and Dutton (1982) point back to a key insight of Ivan Illich (1973) who argued that while the technical artifact may be a central element in how we conceive of technology, it is only one element in a "package," which also includes the components required to apply that technical artifact to some socio-economic activity. Kling and Scacchi (1982) further developed this insight into what they called the "web of computing," which includes the commitments, additional resources such as training, skilled staff, and support services, and the development of organizational arrangements, policies, and incentives to enable the effective management and use of new technologies. Latour (1987), similarly dissatisfied with prevailing views, took a different tack. He argued that social scientists tended to make new technologies into "black boxes" and argued for unpacking those boxes. He observed that if one takes a tool such as a pestle grinder, ties it to a wooden frame, which is then tied to sails that catch the wind, and, then, if the wind can be cajoled to cooperate, one has an "assembly of forces" or what he refers to as a "machine." For Latour, these forces comprise a "systems of alliances" that tie together not only cogs, winds, and sails, but inventors, research and development organizations, commercial companies, and national governments, which can all be enrolled to develop and maintain a machine's existence. Latour examines various technologies—the diesel engine, Eastman's new Kodak camera, and the telephone—and asks, "How did this machine get to be the way it is?" "What were the various alliances that had to be formed?" "What were the various interests that had to be negotiated, so that a black box could emerge?" He claims "Understanding what . . . machines are is the same as understanding who the people are" (1987, p. 140). Thus, Latour theorizes about how new technologies come to *be;* Kling and Scacchi theorize about how new technologies come to be *used.*

We identified four variants of the "ensemble" view in the *ISR* data, with all variants focusing on the dynamic interactions between people and technology—whether during construction, implementation, or use in organizations, or during the deployment of technology in society at large. For example, Robey and Sahay (1996) examined the processes and outcomes associated with the introduction of a geographical information system into two different user groups, and investigated how differential use of the system was influenced by a variety of cultural and social factors. Among the four variants of the ensemble view in the *ISR* data, we found (following the Kling/Latour theoretical split) two conceptualizations focused primarily on the ways in which technologies come to be developed (with secondary emphasis on use) and two conceptualizations focused primarily on how technologies come to be used in certain ways (with secondary emphasis on development).

Technology as Development Project. The conceptualization of technology represented by the articles in this category is that of an artifact in formation, a "work in progress." The focus is on the social processes of designing, developing, and implementing technical artifacts, usually in specific organizational contexts. These articles examine the roles of key stakeholders in IS development projects, how such roles engender conflict, power moves, and symbolic acts, and the influence of more or less inclusive methodologies on development processes. Many of the articles adopted a socio-technical perspective, and most of the articles were field studies, examining one or more particular information systems development projects. These studies have helped to deepen understanding of information systems development as a complex sociopolitical process, and the ways in which these processes are played out in actual organizations and over time.

Technology as Production Network. In this conceptualization (like that of the development project) the focus is on the supply side of technology. But here, technology development is viewed at the levels of industry and nation-state, and much like Latour's view, the focus is on the building of "systems of alliances," which tie together inventors, research and development organizations, corporations, and governments who work together to develop new technologies and maintain their competitiveness. Unlike Latour, however, the questions in these articles were not focused on understanding how a particular "machine" emerged into its current form. Rather, the questions include: How did this (part of the) computer industry evolve into its present global structure? Why have some (particular) countries succeeded more than others? To answer these questions, researchers examined national and international IT policies and the market forces operating within specific countries and regions.

Technology as Embedded System. The conceptualization of technology represented by the articles in this category is that of an evolving system embedded in a complex and dynamic social context. Technology is neither an independent nor dependent variable but instead is seen to be enmeshed with the conditions of its use—hence, our label "embedded system." This view is similar to the "web model" articulated by Kling and Scacchi with a focus on better understanding how technologies come to be used in particular ways. These articles examined the ways in which various social influences shaped how a technology is introduced into a situation, and how different user groups engaged with that technology. Most of the articles viewing technology as an embedded system drew heavily on sociohistorical, cultural, and political perspectives, and tended to examine a specific technology as it was embedded in one or a few particular social contexts.

Technology as Structure. The conceptualization of technology as structure is also focused on the ways in which technology is enmeshed in the conditions of its use. However, this conceptualization is grounded specifically in ideas drawn from the structuration theory of social theorist Anthony Giddens (1984). Technology here is seen to embody social structures (conceptualized in terms of Giddens' notion of structure as sets of rules and resources), which presumably have been built into the technology by designers during its development and which are then appropriated by users as they interact with the technology. Typical questions addressed by this literature include: How do users appropriate the social structures embodied in a given technology and with what outcomes? What are the intended and unintended consequences of using a given technology? The articles categorized here were informed by either Orlikowski's (1992) structurational model of technology or DeSanctis and Poole's (1994) adaptive structuration theory. They tended to focus on technologies as concrete, particular technical artifacts such as a specific group decision support system, a type of electronic meeting software, or a customized groupware application.

IV. *Computational* View of Technology

Not all research in the field of IS is interested in the interaction of people with technology in various social contexts. Some research concentrates expressly on the computational power of information technology. Articles embracing this view are interested primarily in the capabilities of the technology to represent, manipulate, store, retrieve, and transmit information, thereby supporting, processing, modeling, or simulating aspects of the world. For example, Trice and Davis (1993) describe a project that generated an algorithm for reconciling discrepant knowledge bases and then built a working program to implement and test it.

We found two types of computational views represented in the *ISR* literature. The first involves the actual development of algorithms and the production of running code by researchers to demonstrate the computational power of the technology as applied to particular domains (e.g., medical diagnosis). The second involves the development and use of computational capabilities by researchers to create models that represent or simulate specific social, economic, or informational phenomena of interest (e.g., decision making, information retrieval).

Technology as Algorithm. Technology is represented here through algorithmic endeavors to build new or enhance existing computational systems that can support some human activity. All the articles in this category both named and described (in considerable technical detail) the computational system in question. In addition, most articles also reported on the prototyping and testing of the system, which was not simply modeled, but actually implemented and operating. Most of the studies specified the actual design and building of the computational system (typically through detailed articulation of innovative or improved algorithms) and then offered some validation through testing or provisional use. Articles in this category assumed (whether implicitly or explicitly) that once the algorithmic issues had been resolved, the technology would necessarily be effective and would usefully support the intended human endeavor.

Technology as Model. Research in this category attempts to represent social, economic, and informational phenomena (e.g., processes, structures, events, knowledge, etc.) through the methodology of data modeling or simulation. The focus is on developing mathematically specified mechanisms, techniques, and approaches for what Agre (1997) has called the craft of "research programming" or using computers as "language machines." Specifying, building, and programming models—often based on game theory, information theory, or systems dynamics—are distinctive ways of representing (and thus examining) a range of organizational phenomena. Some of the research we have categorized here might fit database research, while other articles might be labeled as decision science, information retrieval, or artificial intelligence research. We have put them together here because these streams of research have in common the intent to build new computational capabilities that facilitate the representational and modeling work of the researcher.

V. *Nominal* View of Technology: Technology as Absent

Our label for this category is intended to indicate that the articles in this group invoke technology "in name only, but not in fact" (as "nominal" is defined in Webster's dictionary). Typically, the terms "information technology," "information system," or "computer" are used a few times in the articles, but these references to technology are either incidental (as in studies of CIO compensation or computer security) or used as background information (as in studies of IS personnel or outsourcing practices in the IS industry). The conceptual and analytical emphasis is elsewhere, typically focused on a range of topics of broad interest to the IS field. For example, Beath and Orlikowski (1994) describe a content analysis of a particular systems development methodology (Information Engineering) and highlight contradictions in the methodology's prescriptions for user involvement. Their study makes no reference to any specific technology that might support the use of the methodology or any technology that might be developed using the methodology in question.

Thus, in the nominal view, IT artifacts are not described, conceptualized or theorized; technology is essentially absent from these articles. Constituting neither an independent nor a dependent variable, technology here is the *omitted variable.*

Implications of the Conceptualizations of the IT Artifact

ISR published 188 articles in the decade beginning in 1990 and ending in 1999. While analyzing these articles to see how IS researchers had conceptualized information technology in their studies, we encountered 11 articles that offered broad commentaries on the literature (e.g., Orlikowski and Baroudi 1991, Robey and Boudreau 1999). We excluded all such metaresearch articles (distributed across the ten years of *ISR*) from consideration, leaving a total of 177 articles. Our analysis of the 177 articles yielded the 14 categories and the five metacategory clusters (tool, proxy, ensemble, computational, and nominal views of technology) described above. Table 1 shows the distribution of the 177 articles across these 14 categories and 5 clusters.

As evident in Table 1, those articles that engage with information technology minimally or not at all represent the largest cluster of *ISR* articles. This cluster, which we labeled the *nominal* view, accounted for 25 percent of all the articles published in a decade of *ISR* issues. As we noted, these articles essentially treat technology as absent, referring to it in passing as the context, motivation, or background against which to set examinations of phenomena such as IT governance mechanisms, IS professionalism, and IS strategy or planning approaches. In many of these articles, we noticed that we could have substituted another term for "IS"—for example, "HR" personnel, "logistics" outsourcing, or "marketing" strategy—and the articles would still have made sense. IS personnel, IS outsourcing, and IS strategy are nonetheless different from the personnel, outsourcing, and strategy issues of other disciplines and functional areas in that they must engage with a changing and evolving set of IT artifacts. This distinction, however, was not always evident in

Table 1 **Classification of Articles in *ISR* (1990–1999) by Conceptualization of Information Technology**

Cluster	Conceptualization of Technology	Freq.	%	Freq.	%
Nominal View	Absent			44	24.8
Computational View				43	24.3
	Algorithm	6	3.4		
	Model	37	20.9		
Tool View				36	20.3
	Labor Substitution Tool	1	0.5		
	Productivity Tool	12	6.8		
	Information Processing Tool	15	8.5		
	Social Relations Tool	8	4.5		
Proxy View				32	18.1
	Perception	8	4.5		
	Diffusion	8	4.5		
	Capital	16	9.0		
Ensemble View				22	12.5
	Development Project	7	4.0		
	Production Network	2	1.1		
	Embedded System	7	4.0		
	Structure	6	3.4		
Total				177	100%

the IS research articles, and an opportunity was missed for such studies to offer more grounded insights into IS phenomena by including and articulating the role of information technology, for example, in the lives of IS professionals, the practices of IS outsourcing, and the processes of IS planning.

Almost tied for first place, the second largest cluster of *ISR* articles is the group of articles that we have labeled as taking a *computational* view of the IT artifact. The focus here is on the underlying processing capabilities of the technology, expressed through the construction and running of algorithms (3.4 percent) or through the creation and processing of computational models and simulations (20.9 percent). This view reflects the traditional computer science approach to the IT artifact, representing a strong and lively research stream within the *ISR* research community. However, there is often an unproblematic reliance in these studies on assumptions that may be outdated or one-sided, and an opportunity exists for this paradigmatic view of information technology to include the insights from more recent social and economic theories that account for how people understand, adopt, use, and change their artifacts in complex and dynamic social contexts.

The third largest view of information technology in a decade of *ISR* literature is represented by the *tool* view at 20.3 percent of the articles. This cluster includes articles that treat information technology as a relatively straightforward, unchanging, and discrete technical entity with the focus being on the impacts/effects of this independent variable on such outcomes as information processing (8.5 percent), productivity (6.8 percent), social relations (4.5 percent), and labor substitution (0.5 percent). We were surprised to find the variety of ways that the tool view has been applied since Kling and Scacchi (1982) first articulated it in the early 1980s. While the tool view helps to explain how technologies alter various aspects of social and organizational life, many of the studies retain the kind of latent determinism that Markus and Robey (1988) cautioned us against. As they argued, there is much potential in seeing technologies and organizations as mutually dependent and dynamically emergent, and there is still much opportunity for the IS field to move beyond relatively simple black-boxed views of technology towards more powerful conceptualizations of the role of IT artifacts in organizations.

The fourth largest cluster of *ISR* articles is represented by a *proxy* view of information technology, where one or a few abstracted elements are focused on and assumed to represent the critical aspects of the technology. This cluster represented 18.1 percent of the articles published in a decade of *ISR*, and was comprised of three categories: articles that focus on users' perceptions of and intentions to accept the technology (4.5 percent), articles that focus on the rate of diffusion and penetration of technology within and across organizations (4.5 percent), and articles that focus on the monetary value of the technology as capital (9 percent). Studies conducted from this proxy view have pointed out interesting socio-psychological and socio-economic patterns, such as the lack of acceptance or diffusion of apparently useful new technologies, and the presence or absence of business value from investments in information technology. A risk of this view is that the proxy becomes confused with what it is intended to represent or measure. Because such studies deal with technologies through surrogates, they tend not to conceive of historical or cultural variations in IT artifacts given that those variations may not be evident in the surrogate measures. Thus, proxy studies lack the means to account for temporal and contextual variations in the patterns discerned. To do so will require more careful theorizing about differences in IT artifacts and their role and use in different contexts and over time. Such theoretical elaboration would have to give up some conceptual parsimony to gain increased explanatory power.

Those articles that we have grouped under the ensemble view represent the fifth and smallest cluster. Accounting for 12.5 percent of the total set of articles, this cluster is characterized by treatments of technology as a socio-technical development project (4 percent), as a system embedded in a larger social context (4 percent), as a social structure (3.4 percent), and as enmeshed within a network of agents and alliances (1.1 percent). Given the high visibility of Kling and Scacchi's and Markus and Robey's work in articulating versions of the ensemble view during the 1980s, we were surprised to see the low number of articles adopting such a view during the 1990s. Given the kind of emergent IS phenomena we are witnessing today (open source software, electronic commerce, virtual teams, globally-distributed work, new challenges to privacy and intellectual property rights, etc.) there clearly is scope for more work to be done from an ensemble view.

Taken together we see that 88 percent of all papers published in *ISR* over the past 10 years adopt a nominal, proxy, tool, or computational view of the IT artifact. Examined over time, this combination of four views dominates each of the past ten years, ranging from a low of 64 percent in 1991 to a high of 100 percent in 1993 and 1995. The number of published articles taking the remaining ensemble view was low throughout the 10 years, including 0 percent (in 1993 and 1995), 1 percent (in 1994 and 1999), and 2 percent (in 1990, 1992, and 1997). However, it reaches an important peak in 1996 when 7 articles representing the ensemble view were published (representing 28 percent of the articles for the year). Six of the seven articles were published in a single special issue that called specifically for this type of research, and was edited by researchers specializing in the ensemble view.

In summary, a review of the articles published over the past 10 years of *ISR* reveals a broad array of conceptualizations of IT artifacts. Despite this array, however, it seems that even today—in the year 2001 and several decades into the development of our field—many people are still relying on received notions of technology and viewing technology primarily through their disciplinary lenses. Thus, management and social scientists tend to engage IT artifacts only minimally—as seen by our largest category, the nominal view—or to focus primarily on their effects (or those of their surrogates)—as seen by the tool and proxy views; computer scientists publishing in the *ISR* journal tend to abstract IT artifacts from contexts and practices of use to focus principally on their computational capabilities. We believe that moving beyond received disciplinary notions towards broader and deeper interdisciplinary conceptualizations of IT artifacts is not only possible, but essential if the IS field is to make important contributions to the understanding of a world become increasingly interdependent with ubiquitous, emergent, and dynamic technologies.

Research Directions: Reconceptualizing the IT Artifact

Currently, in the one journal most focused on publishing IS research, we see that information technology is not a major player on its own playing field. In the majority of articles over the past decade, IT artifacts are either absent, black-boxed, abstracted from social life, or reduced to surrogate measures. We believe that this lack of attention to the core subject matter of our field represents both a unique opportunity and an important challenge for us to engage more seriously and more explicitly with the material and cultural presence of the information technology artifacts that constitute the "IT" in our IT research. The opportunity arises because the diversity of IS researchers uniquely qualifies our field to pay special attention to the multiple social, psychological, economic, historical, and computational aspects of an evolving array of technologies and the ways in which they are developed, implemented, used, and changed. The challenge in realizing this opportunity lies—as Adam (1995) notes about the role of time in social analysis—"in making the implicit visible and turning our attention to the taken for granted." We have tended to take information technology for granted in IS research, and we now need to turn our attention to specifically developing and using interdisciplinary theories of IT artifacts to inform our studies. Such theories would provide a distinctive foundation for the IS field and serve to guide ongoing research into all manner of IT phenomena.

In this final section, we propose a research agenda that can begin to take up this challenge. In particular, we see two general directions for such an agenda: developing conceptualizations and theories of IT artifacts; and incorporating such conceptualizations and theories of IT artifacts expressly into our studies. In proposing these research directions, we are not arguing for or against any particular perspective or methodology. On the contrary, we believe all perspectives and methodologies offer distinct and important analytic advantages. What we are arguing for is increased attention and explicit consideration of IT artifacts in all studies whatever their epistemological perspective or methodological orientation. Thus, all studies of IT, quantitative or qualitative, large-scale or in-depth, experimental, survey-based, modeling, ethnographic, or case study, can advance our theoretical understandings of IT artifacts. But to do so, we will need to stop taking IT artifacts for granted and begin to take them seriously enough to theorize about them. We believe all IT research will benefit from more careful engagement with the technological artifacts that are at the core of our field.

Theorizing about IT artifacts might take many forms, but as a starting point we offer the following five premises (Orlikowski and Iacono 2000).

(1) IT artifacts, by definition, are not natural, neutral, universal, or given. As Grint and Woolgar (1995, p. 292, emphasis added) note, objects "are never merely and automatically *just objects;* they are always and already implicated in action and effect." Because IT artifacts are designed, constructed, and used by people, they are shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users, etc.

(2) IT artifacts are always embedded in some time, place, discourse, and community. As such, their materiality is bound up with the historical and cultural aspects of their ongoing development and use, and these conditions, both material and cultural, cannot be ignored, abstracted, or assumed away. For example, when studying the use or productivity impacts of electronic mail, it makes a difference to the findings whether the technology in question is IBM's Profs system or Qualcomm's Eudora, and whether the study is being conducted in large manufacturing companies in 1980, or small startups in 2000.

(3) IT artifacts are usually made up of a multiplicity of often fragile and fragmentary components, whose interconnections are often partial and provisional and which require bridging, integration, and articulation in order for them to work together. We have a tendency to talk of IT artifacts as if they were of a piece—whole, uniform, and unified. For example, we talk about "the Technology," "the Internet," "the Digital Economy," as if these are single, seamless, stable, and the same, every time and everywhere. While such simplifications make it easy to talk about technologies, they also make it difficult to see that such technologies are rarely fully integrated, flawless, and unfailing, and that they can and often do break down, wear down, and shut down.

(4) IT artifacts are neither fixed nor independent, but they emerge from ongoing social and economic practices. As human inventions, artifacts undergo various transitions over time (from idea to development to use to modification), while coexisting and coevolving with multiple generations of the same or new technologies at various points in time. For example, the World Wide Web (WWW) technology was first proposed in 1989 by Tim Berners-Lee of CERN as a hypertexted, networked system for sharing information within the high-energy physics research community. Planned and designed as a particular information technology for a particular community, the WWW has been (and continues to be) taken up by other individuals, organizations, and communities (both locally and globally), used in different ways, and adapted, enhanced, and expanded to accommodate a diversity of evolving interests, values, assumptions, cultures, and other new technologies.

(5) IT artifacts are not static or unchanging, but dynamic. Even after a technological artifact appears to be fixed and complete, its stability is conditional because new materials are invented, different features are developed, existing functions fail and are corrected, new standards are set, and users adapt the artifact for new and different uses. Understanding how and why IT artifacts come to be "stabilized" in certain ways at certain times and places are critical aspects of understanding the range of social and economic consequences associated with particular technologies in various socio-historical contexts. Together, they comprise a critical baseline for understanding the consequences of IT artifacts in different conditions, and how such artifacts (and their uses and consequences) come to be changed over time.

Thus, our first premise requires a shift of attention from taking IT artifacts for granted towards explicit theorizing about specific technologies with distinctive cultural and computational capabilities, existing in various social, historical, and institutional contexts, understood in particular ways, and used for certain activities. Given the context-specificity of IT artifacts, there is no single, one-size-fits-all conceptualization of technology that will work for all studies. As a result, IS researchers need to develop the theoretical apparatus that is appropriate for their particular types of investigations, given their questions, focus, methodology, and units of analysis. We anticipate that multiple conceptions and theories of technology will emerge and be modified, generating a rich and growing repertoire of useful concepts and theories of IT artifacts. The point is not to develop *the* theory of IT artifacts (that is not possible in any case) but that we begin to develop *some* useful theories—both for ourselves and for researchers in other fields who will want to learn from our examinations and explanations of IT phenomena.

Second, to conceptualize IT artifacts as embedded in specific social and historical contexts requires that the detailed practices of their use be recognized and integrated into extant theories. Thus, how people engage with various technological artifacts in the course of working, learning, communicating, shopping, or entertaining themselves must become a central theoretical concern (Orlikowski 2000). At a recent Academy of Management meeting, one interesting session raised the question of whether virtual teams were different from colocated ones. To our surprise, a vote taken at the end of the session showed that almost half the audience believed that the teams were the same. In essence, they were saying that the ongoing use of technology by virtual team members did not matter. With such a starting premise, we can hardly expect these researchers to theorize how virtual team members engage with IT artifacts in the course of working, and to consider the consequences of such engagement for changes in work practices and modifications in the use and design of work technologies. If, as IS researchers, we believe that information technology can and does matter—in both intended and unintended ways—we need to develop the theories and do the studies that show our colleagues how and why this occurs.

Our third premise requires researchers to conceptualize and explain IT artifacts as multiple, fragmented, partial, and provisional. Letting go of a monolithic view of technology implies recognizing that technologies such as the Internet and other distributed applications do not provide the same material and cultural properties in each local time or context of use. Differences in system configurations, infrastructures, bandwidth, interfaces, accessibility, standards, training, business models, and citizens rights' and responsibilities guarantee that the experience of, say, "being on the Internet" in China will be different from that in Saudi Arabia or in the United States, let alone in various microcontexts of use. Research on the uses of distributed complexes of applications may require new theories and methods to understand how the various elements of interdependent systems (and their uneven development) interact to provide different types and levels of service. For example, more research on the kinds of workarounds (Gasser 1986) and forms of articulation work (Suchman 1996) that enable people to make dynamically complex systems work in practice may be critical.

Our fourth and fifth premises point to the emergence and evolution of IT artifacts as complex and changing technosocial processes existing in time and over time. We need to generate new theories to help us make sense of these processes, particularly if we are to understand the dynamic and unprecedented technologies and uses comprising contemporary initiatives in electronic business and virtual organizing, innovations in mobile computing and telecommuting, developments in wireless and wearable technologies, and the predicted convergence of nanotechnology, biotechnology, and information technology, to name a few. Even the ensemble views of technology, which do engage with the social and embedded aspects of technology development and use, tend not to take into account the multi-generational and emergent aspects of technological artifacts that arise as designers, developers, users, regulators, and other stakeholders engage with evolving artifacts over time and across a variety of contexts.

To better understand such evolving dynamics, ongoing and longitudinal studies of information technology are particularly useful—whether conducted by individuals or teams of researchers. By following specific artifacts over periods of time, it should become clear that changes occur not only in the social, behavioral, and economic circumstances within which the artifacts are embedded (resulting in the so-called "societal" or "organizational transformations" that we hear so much about) but also that changes are constantly occurring in the IT artifacts themselves—whether through invention, innovation, regulation, expansion, slippage, upgrades, patches, cookies, viruses, workarounds, wear and tear, error, and failure. The Internet that we are developing and using in new ways today is not the Internet that we developed and used in new ways in the 1980s or even the 1990s. That the Internet is not static or fixed should be obvious. But, where are the theories of how such large-scale and densely interconnected IT artifacts coevolve with the various social institutions and communities (both local and global) that develop, regulate, use, and change them? For example, how, exactly, is the Internet of the 1980s different from that of the 1990s Internet, how do those differences shape contemporary uses of the Internet, and what do these differences bode for the future—for the Internet-worked technologies of the 2000s and the ways in which they will mutually constitute organizations and society?

It seems that we have left much of our understanding of IT artifacts to the technology vendors and the mass media journalists and pundits who cover them, while the associated social changes have been left to social scientists, economists, and media theorists (Iacono and Kling, 2001). However, none of these groups attempts to understand the complex and fragmented emergence of IT artifacts, how their computational capabilities and cultural meanings become woven in dense and fragile ways via a variety of different and dynamic practices, how they are shaped by (and shape) social relations, political interests, and local and global contexts, and how ongoing developments in, uses of, and improvisations with them generate significant material, symbolic, institutional, and historical consequences. Yet, this is precisely where the IS field (drawing as it does on multiple disciplines and different types of analyses) is uniquely qualified to offer essential insights and perspectives.

Conclusion

Our commentary has been motivated by a belief that the tendency to take IT artifacts for granted in IS studies has limited our ability as researchers to understand many of their critical implications—both intended and unintended—for individuals, groups, organizations, and society. We believe that to understand these implications, we must theorize about the meanings, capabilities, and uses of IT artifacts, their multiple, emergent, and dynamic properties, as well as the recursive transformations occurring in the various social worlds in which they are embedded. We believe that the lack of theories about IT artifacts, the ways in which they emerge and evolve over time, and how they become interdependent with socio-economic contexts and practices, are key unresolved issues for our field and ones that will become even more problematic in these dynamic and innovative times.

Our future is becoming increasingly dependent on a multiplicity of pervasive and invasive technological artifacts. As IS researchers we have the opportunity and responsibility to influence what future is enacted with those technological artifacts. To do so, however, we must engage deeply and seriously with the artifacts that constitute a central component of that future. Otherwise, we will remain passive observers of the techno-social transformations occurring around us, and we will risk fulfilling our own worst prophecies of technological determinism. A basic presumption of the IS field is that IT matters in everyday social and economic practice. We also need to make it matter in our research practice.

Acknowledgments

The authors would like to thank Izak Benbasat and the anonymous reviewers for their very helpful comments on this paper. The authors are also grateful to Rob Kling for his valuable feedback on an earlier version of this paper. Any opinions, findings, and conclusions (or recommendations) expressed in this material are those of the authors and do not necessarily reflect the view of the National Science Foundation.

References

Adam, B. 1995. *Timewatch: The Social Analysis of Time.* Polity Press, New York.

Agre, P. E. 1997. *Computation and Human Experience.* Cambridge University Press, Cambridge, U.K.

Applegate, L. M., J. I. Cash Jr., D. Q. Mills. 1998. Information technology and tomorrow's manager. *Harvard Bus. Rev.* **66**(6) 128–136.

Attewell, P., J. Rule. 1984. Computing and organizations: What we know and what we don't know. *Comm. ACM*, **27**(12) 1184–1191.

Beath, C. M., W. J. Orlikowski. 1994. The contradictory structure of systems development methodologies: Deconstructing the IS-user relationship in information engineering. *Inform. Systems Res.* **5**(4) 350–377.

Bijker, W. E. 1995. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change.* MIT Press, Cambridge, MA.

Button, G. 1993. The curious case of the vanishing technology. Graham Button, ed. *Technology in Working Order: Studies of Work, Interaction and Technology.* Routledge, London, U.K., 10–28.

Castells, M. 1996. *The Rise of the Network Society.* Blackwell, Malden, MA.

DeSanctis, G., M. S. Poole. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organ. Sci.* **5**(2) 121–147.

Gasser, L. 1986. The integration of computing and routine work. *ACM Trans. Office Inform. Systems* **4**(3) 205–225.

George, J. F., G. K. Easton, J. Nunamaker, G. B. Northcraft. 1990. A study of collaborative group work with and without computer-based support. *Inform. Systems Res.* **1**(4) 394–415.

Giddens, A. 1984. *The Constitution of Society: Outline of the Theory of Structure*. University of California Press, Berkeley, CA.

Grint, K., S. Woolgar. 1995. On some failures of nerve in constructivist and feminist analyses of technology. *Sci. Tech., Human Values* **20**(3) 286–310.

Iacono, S., R. Kling. 2001. Computerization movements: The rise of the internet and distant forms of work. JoAnne Yates and John Van Maanen, eds. *IT and Organizational Transformation: History, Rhetoric, and Practice*. Sage Publications, Newbury Park, CA, 93–135.

Illich, I. 1973. *Tools for Conviviality*. Harper and Row, New York.

Kling, R. 1987. Defining the boundaries of computing across complex organizations. Richard J. Boland Jr. and Rudy Hirschheim, eds. *Critical Issues in Information Systems Research*. John Wiley & Sons, New York, 307–362.

——, W. H. Dutton. 1982. The computer package, dynamic complexity. J. N. Danziger, W. H. Dutton, R. Kling, and K. L. Kraemer, eds. *Computers and Politics: High Technology in American Local Governments*. Columbia University Press, New York, 22–50.

——, W. Scacchi. 1982. The web of computing: Computer technology as social organization. *Adv. Comput.* (21) 1–90.

Latour, B. 1987. *Science in Action*. Harvard University Press, Cambridge, MA.

Leavitt, H. J., T. L. Whisler. 1958. Management in the 1980s. *Harvard Bus. Rev.* **36**(6) 41–48.

Markus, M. L., D. Robey. 1988. Information technology and organizational change: Causal structure in theory and research. *Management Sci.* **34**(5) 583–598.

Accepted by Izak Benbasat, Senior Editor.

Moore, G. C., Benbasat, I. 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Inform. Systems Res.* **2**(3) 192–222.

Orlikowski, W. J. 1992. The duality of technology: Rethinking the concept of technology in organizations. *Organ. Sci.* **3**(3) 398–427.

——. 2000. Using technology and constituting structures: A practice lens for studying technology in organizations. *Organ. Sci.* **11**(4) 404–428.

——, S. R. Barley. 2001. Technology and institution: What can research on information technology and research on organization studies learn from each other. *MIS Quart.* **25**(2).

——, J. J. Baroudi. 1991. Studying information technology in organizations: Research approaches and assumptions. *Inform. Systems Res.* **2**(1) 1–28.

——, C. S. Iacono. 2000. The truth is not out there: An enacted view of the digital economy. Erik Brynjolfsson and Brian Kahin, eds. *Understanding the Digital Economy: Data, Tools, and Research*. MIT Press, Cambridge, MA, 352–380.

Pinch, T. J., W. E. Bijker. 1987. The social construction of facts and artifacts. W. E. Bijker, T. P. Hughes, and T. J. Pinch, eds. *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*. MIT Press, Cambridge, MA, 17–50.

Robey, D., M. C. Boudreau. 1999. Accounting for the contradictory organizational consequences of information technology: Theoretical directions and methodological implications. *Inform. Systems Res.* **10**(2) 167–185.

——, S. Sahay. 1996. Transforming work through information technology: A comparative case study of geographic information systems in county government. *Inform. Systems Res.* **7**(1) 93–110.

Rogers, E. 1983. *The Diffusion of Innovation*. Free Press, New York.

Strauss, A. L. 1987. *Qualitative Analysis for Social Scientists*. Cambridge University Press, New York.

Suchman, L. A. 1996. Supporting articulation work. Rob Kling, ed. *Computerization and Controversy*, 2nd ed. Academic Press, San Diego, CA, 407–423.

Trice, A., R. Davis. 1993. Heuristics for reconciling independent knowledge bases. *Inform. Systems Res.* **4**(3) 262–288.