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Special Section Introduction

Information, Technology, and the Changing Nature of Work

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The information systems field started with the expectation that information and technology will significantly shape the nature of work. The topic provides ample scope for significant scholarly inquiry. Work content, process, and organization are now different from what they were in the 1960s and 1970s, which provided a foundation for theories and understanding. Although investigations about the changing nature of work have been made for years, this special section recognizes that the time of reckoning has come again. There is a growing need for deeper understanding of information, technology, and work. The specific contributions of this special section are at the heart of new frontiers of research in information, technology, and work. We observe a continued need to study their relationships, and to separate short-term and long-term effects. We expect continued surprises and conclude that patience is required to achieve increased understanding in this important domain.

Keywords: information technology; work; information; effects; control; productivity; skills; work organization; sociotechnical systems

1. Introduction

Work has always been necessary to the human condition. Genesis in the Bible and the ancient Hindu veda, the Mahabharata, are both more than 4,000 years old and explicitly discuss work. Genesis Chapter 3 tells of the Fall (expulsion from the Garden of Eden) that forced humans to work in order to eat. The Mahabharata, especially the Bhavagad Gita, says attainment of true potential requires commitment to work. Work historically defines a person's identity and is a key part of the human experience and condition (Applebaum 1992, Habermas 1971).

From its outset, technology has been involved in changing the nature of work. The move from hunter-gatherer societies to settled agricultural societies started about 10,000 years ago and required the invention of agricultural technologies—seeds, the plough, metals, and so on. The move from agrarian societies to industrial societies started about 400 years ago and depended on technologies such as the factory, steam engine, power belt, and the like. More recently, the move from manufacturing and “industrial” societies to postindustrial societies built around services and information has been enabled by technologies for control, communication, automation, etc. (Bell 1973, Beninger 1986, Yates 1989). The pace of

technical change appears to be accelerating, from the management of the biological processes involved in agriculture to the coordination of activities across time and space made possible by gathering and processing large swaths of information (Kurzweil 2001). It is no surprise that some predict a future for work different than we have seen in the past (Malone 2004).

Information has always been intimately related to work processes: knowing how to hunt, when to plant crops, how to pull together a meal, how to shape metals, how to build or use machines. In the last century, knowledge work emerged as a major rather than peripheral factor in society. The work object itself became the focus as different forms of information, and knowledge became mediated by representations (Zuboff 1988). Knowledge professions such as health-care, financial analysis, accountancy, marketing, and engineering now draw on and produce information using a rich array of technologies that shape work content, process, and organization.

Consider the data collection, analysis, writing, revision, submission, and editorial processes associated with publishing a research article. Over the last two decades information technology (IT) has dramatically

changed the nature of this part of scholarly work.¹ These activities now depend on computers, software, and the Internet: they are coordinated through electronic mail and other communication aids. Information repositories and workflow systems are used to run the reviews, to get research funding, and fill out institutional review board applications. Typewritten manuscripts, dependence on snail mail, manual review processes, and even paper-based publication are over or waning. Not all of these changes are positive: there is pressure to do reviews on tightened schedules, the burden of seemingly endless cycles for revision of manuscripts, struggles with the quirks of review and publishing platforms, and the curse of managing the ever-changing passwords needed to get access to systems. But few of us who remember the days of stacked manuscript piles would “go back,” even if we could. In many ways, this observation was the stimulus for the special issue. Work and its environments are now different than what they were a half century ago when the computerization saga started. Work is now knowledge related, abstract, distributed, global, and information intensive, and draws on the use of multiple technologies. Technology mediates nearly every step of the work process. Yet, much of our research on work is founded on theories of design and sociotechnical systems developed in a different era, founded on ideas of colocated, locally controlled manufacturing.

2. Aims and Scope of the Special Section

We proposed this special section for *Information Systems Research (ISR)* because there is widespread belief and growing evidence that the nature of work continues to change. This story is not new. Arguments about unprecedented changes in work due to information and technology have been made for years (e.g., National Academy of Sciences 1999, Malone 2004, Brynjolfsson and McAfee 2014). These arguments have highlighted that information and technology, and especially information technologies, facilitate intense collaboration and other activity within and between firms, bringing changes to the geographic distribution of work (e.g., Cairncross 1997, Gaspar and Glaeser 1998). New forms of digitally mediated contracting make short hold-time collaborations viable as alternatives to earlier models of long-term employment (Aguinis and Laval 2013). There has been discussion of shifting demands for skills (e.g., Autor et al. 2003), and some claim

that the shifting is accelerating and touches previously untouched workers, including middle management and knowledge workers (Brynjolfsson and McAfee 2014). “Open” models of production (e.g., open source software), open sourcing of ideas and solutions (e.g., crowdsourcing and collective intelligence), and open access to information resources (e.g., open educational resources) are also seen as important sources of change (Puranam et al. 2014). Finally, the use of information technologies now pervades human enterprise and thereby blurs the classic divide between work and leisure established at the dawn of industrial work organizations (e.g., technostress, fragmented work regimes). Some argue that such blurring is now experienced broadly and spills over to other life regimes (Brod 1984, Guest 2002).

The information systems field has always sought to examine changes in work that might be attributed to information and technology. These include work content and design, work coordination and control, organization, and sustainment of work competencies and skills in what has been historically called “livelihood” or “career” (see, e.g., Kling 1980, Attewell and Rule 1984, Zuboff 1988). Such work has long been regarded as derivative of organizational decisions and actions, but new capabilities might be reversing that and making organizations more dependent on the nature of work. It is again time to examine work seriously in light of deep changes in information and technology, to stimulate new thinking and innovative research in the area.

ISR invited scholars to submit papers for a special issue focused on information, technology, and the changing nature of work. Different investigative approaches were welcome: strategic, organizational, behavioral, economic, technical, and so on, limited only by the nexus of information, technology, and work. Submissions were expected to contribute significantly to understanding and planning the next steps for work-related research, addressing what changes are happening, whether or not these changes are fundamental, whether information and/or technology mediate work in new ways, and irrespective of what effects such mediations might have. Addressing these issues would help guide future research and inform policy makers.

Inevitably, ventures like this depend on what gets submitted, and submissions tend to follow the topical interests of researchers at a given time. There were few submissions on the changing control of or character of work or how work is designed, and more on open modes of production and crowdsourcing. We did not publish everything we received; the review process produced what we accepted, and what we accepted should not be seen as representative of all

¹ It might now be doing the same for teaching, as reflected in content distribution systems, massive open online courses, high-definition video conferencing, and the like.

we received. Control and character of work are longstanding issues in the field. Some might see them as “old” or “resolved,” and they are old, but they are hardly resolved. Open production and crowdsourcing are popular right now. Authors probably submitted what they had in hand at the time, and many are working on these topics. The number of submissions was lower than that for some recent calls for special issues of *ISR*, and the number of papers accepted was similarly smaller. This is not because the topic lacks importance; on the contrary, this has been one of the most persistent and important topics in information and technology discussions over the last five decades. Rather, the work being done gives way to topics that are considered particularly salient at the moment. This suggests a need for ongoing consideration of the issues raised in this special section. Indeed, it seems that occasional, concentrated efforts to elicit contemporary thinking and research on this important topic are needed.

3. Papers Accepted for this Special Section

Five papers follow, discussed in order of presentation:

In his paper, “Social Media, Knowledge Sharing, and Innovation: Toward a Theory of Communication Visibility,” Leonardi (2014) uses a field study of enterprise social networking in a large financial services organization to formulate a grounded theory of communication visibility. His focus is how new information technologies are changing the social organization and relationships within the work and thereby influencing work processes and outcomes. His work suggests that making visible once invisible communication can benefit third parties through metaknowledge (“who knows what” and “who knows whom”). Inferences can be drawn about other people’s areas of expertise and communication networks, helping third parties understand what others know and with whom they talk. Such metaknowledge can lead to more innovative products and services. Less knowledge duplication is possible, and individuals can use existing ideas to create new ideas more effectively by learning vicariously rather than through their own experience. If workers aggregate information proactively rather than depending on reactive search, they might deal more effectively with work-related problems. The implications of this emerging theory for work in the knowledge economy are discussed.

In their paper, “Patient Data as Medical Facts: Social Media Practices as a Foundation for Medical Knowledge Creation,” Kallinikos and Tempini (2014) study a patient self-reporting network collecting data on patients’ health statuses via a web-based application. The network captures details of patient

experience that have heretofore been unavailable to medical research and pioneers ways of conducting such research at the boundaries of prevailing practices and institutions. Data collection relies on a system architecture that shapes patient self-reporting and boosts network interactions essential to patient activity and patient data entry. The network uses innovative computational and networking solutions to collect and analyze patient-generated health data. Patients are essential collaborators in research. The network exploits patient-generated health data that, until recently, may have been deemed irrelevant, costly, or impossible to manage.

In their paper, “Infrastructuring Work: Building a State-Wide Hospital Information Infrastructure in India,” Aanestad et al. (2014) report on the design, development, implementation, and scaling of an open-source hospital information system (an electronic patient record system) in a network of Indian district hospitals. The implications of these interventions for work, competencies, and organization are examined within a single hospital, at the level of the state, and within the nongovernmental organization that conducted the development and implementation work. Computerization of work creates demand for new knowledge and competencies, and shapes the division of work, roles, and responsibilities. The authors build on Zuboff’s (1988) notions of automating and informing work and describe the nature of these processes related specifically to the introduction of an information infrastructure. The process of mutual shaping between the technology and the organization of work is analyzed as a recursive relationship between the “work of infrastructuring” and “infrastructuring of work.”

In their paper, “Efficacy of R&D Work In Offshore Captive Centers: An Empirical Study of Task Characteristics, Coordination Mechanisms, and Performance,” Mani et al. (2014) analyze survey data from 132 captive, foreign multinational research and development (R&D) centers in India to examine innovative labor across distance. Performance data from projects using different types of technology-enabled coordination to manage work across multiple locations shows that modularization across locations is not optimal for tasks that are not analyzable, routinized, or common to captive centers. Alternate coordination strategies relying on information and knowledge sharing might overcome these challenges and prove more useful for the coordination of complex distributed work.

In their paper, “Doing Business with Strangers: Reputation in Online Service Marketplaces,” Moreno and Terwiesch (2014) study an online software development service marketplace that allows buyers to post project requests and providers to bid for them.

Examination of more than 1,800,000 bids corresponding to 270,000 projects between 2001 and 2010 showed effects of reputation on market outcomes. Buyers trade off reputation and price, and accept higher bids posted by reputable bidders. The reputation score is less important when there is a previous relationship between the buyer and seller, when the seller has certified skills, when the seller is local, or when there is higher interpersonal trust. Sellers sometimes increase the price of bids when their reputation improves (price effect), but more often use superior reputation to increase likelihood of selection (volume effect). Declines in reputation can cause seller exit (exit effect), but investment in the site (e.g., skill certifications, detailed user profiles) can counteract such an effect. Verbal praise or complaint from previous buyers can affect future buyers, suggesting that unstructured reputational information can have similar effects as structured numerical reputation scores, while providing complementary information.

4. Putting Work in Context

A primary mission of *ISR* is to examine interactions between information, technology, and organizational context. As noted, the changing nature of work has been around in the studies of computerization from the early days of digital computers, and even before. Consider works like E. M. Forster's 1909 science fiction story "The Machine Stops," which was concerned with what happens when a machine that meets human needs stops unexpectedly (Forster 1909). Ninety years later, the U.S. National Academy of Sciences (NAS) published "*The Changing Nature of Work: Implications for Occupational Analysis*" (National Academy of Sciences 1999). The report acknowledged the role played by technology in the ongoing "transformation" of work, noting that technologies of the second industrial revolution such as interchangeable parts, electric power, the electric motor, dedicated machine tools, the internal combustion engine, the telephone, the typewriter, and vertical filing systems made many occupations obsolete (National Academy of Sciences 1999, pp. 36–40). The report went on to say that digital technologies including microelectronics, robotics, computer-integrated manufacturing, artificial intelligence, electronic data exchange, and the Internet would do many of the same things, and more. The report said that control of machines and creation and manipulation of digital information would rival the effects on work brought by electrification.

The sentiment of the 1999 NAS report has been reflected in the last decade in works that examine a range of new changes in work brought about by exponentially growing computing power and storage

and transmission capacity (see, e.g., Brynjolfsson and McAfee 2014). The issue of what effects are occurring and the time frames in which they take place remains a challenge to those who want to understand work-related changes induced by information and technology.

The papers in this special section tell complementary stories about the changing nature of work. The order of these papers progresses from broad but detailed grounded theory in Leonardi (2014), in Kallinikos and Tempini (2014), and in Aanestad et al. (2014). It next moves to the more focused analyses of changes in innovation work in Mani et al. (2014) and in the paper by Moreno and Terwiesch (2014) on the effects of reputation on the work of buyers and sellers in an online marketplace. This is a progression of topics, from increasing knowledge of social relations, to provision of new information for decisions, to creating new forms of work across scale, to mediating complex work coordination tasks, to influencing how information about work outputs and work competencies are used to allocate work to different actors. It progresses from what is possible in the social construction of meaning to the direct effects on the nature and organization of work. It allows commentary on these papers and permits a description of how this special section affects understanding of the relationship between information, technology, and work.

The papers in this issue highlight the ways technology reduces coordination frictions in work, and identifies new consequences for work. For example, Mani et al. (2014) examine IT-enabled coordination in the context of R&D and new product development work—an area of growing importance that has been understudied. Moreno and Terwiesch (2014) study an online labor market where work is distributed and digitally mediated, but is also made more anonymous and less socially embedded. Traditional concerns about adverse selection and moral hazard in employer–worker relationships become more pronounced. At the same time, reputation systems in such markets might allow employers to observe past worker behavior and work outcomes at a level of granularity not previously feasible, with implications for the nature of work relationships, the size and duration of projects, etc.

Past research on work (Attewell and Rule 1984, Kling 1980) showed that work practices can and often do change significantly (but in unpredictable ways) as a result of information and technology. Likewise, individual, organizational, and institutional factors can alter the pace and nature of change (Kling 1980). Such changes are possible in the future. The papers here do not merely predict *that* change can happen; they explain *how* by illustrating specific mechanisms of change associated with new affordances

with information and technology that shape an individual's work, work process, or work organization. The paper by Kallinikos and Tempini (2014), for example, shows in detail how new mechanisms built around digital technology affected patient reporting and how new forms of social organization for analyzing and interpreting these reports evolved to generate new medical work practices. Similarly, as markets for short-term labor contracting become increasingly digitalized, reputation systems and similar mechanisms might emerge to address traditional concerns of adverse selection and moral hazard (Moreno and Terwiesch 2014).

The papers here also address the fact that change in work can be complicated and time consuming. For example, the paper by Aanestad et al. (2014) provides a detailed account of how social context shaped the introduction and deployment of electronic medical record systems, and how that context changed as the system was scaled across time and space to meet new constraints and regulations. The papers also examine specific consequences of change. The paper by Mani et al. (2014) shows that new project coordination strategies could lead to change in project performance outcomes.

The implications of changes in work detailed in these papers can be subtle. Changes in information, technology, and work can have complicated effects on workers that are hard to discern and take place over considerable periods of time. For example, skill-biased technical change suggests that increasing use of computers can displace and decrease the demand for routine task-intensive occupations while increasing demand for high-skilled work involving problem-solving and coordination tasks (e.g., Autor et al. 2003). Changes in demand for skills has long been a topic of speculation regarding automation; see Kurt Vonnegut's (1952) novel *Player Piano*, which foresees a world in which automation replaces human labor to the point that few people have the skills to work. This theme was picked up in the "deskilling" discussion that has been a focus of computerization and work for decades, and figures prominently in the National Academy of Sciences (1999) report. In fact, demand for highly skilled workers seems to be rising (Autor et al. 2003), and recent work suggests that computerization might lead to increased earnings for low-skill as well as high-skill service workers, with more negative labor market prospects for many who are "in between" (Autor and Dorn 2013). Could this be a manifestation of the remarkable 1958 prediction that "computers" would cause the shrinkage of the middle of the management pyramid (Leavitt and Whisler 1958)?

It is difficult to predict the effects of information and technology on work, and it might be more difficult in the future. It is *possible* that geographically

distributed work can shift demand for "tradable" occupations that can be performed at a distance from final demand (e.g., Tambe and Hitt 2012), but there is no guarantee that this will happen. Similarly, increasing digitization of the contract labor market *might* affect geographic and income distributions of work (e.g., Agarwal et al. 2014), but will it? Recent changes to work might make it easier to learn the answers to some questions, but more difficult for others. For example, crowdsourcing can operate through short-term contracts or no contracts at all, making it harder to observe some aspects of work (e.g., details about the relationship between those who employ workers and those doing the work) and easier to observe others (e.g., workers' long-run reputation within the platform). Crowdsourcing platforms offer a wealth of data on work relationships and outcomes within the platform, but as yet we know little about the implications of these forms of work for other types of employment relationships. Traditional mechanisms of empirical research on information, technology, and work might be rendered less effective by changes in precisely these things.

The scope of research might also need some readjustment. In the last decade, the information systems literature has focused on geographical and governance aspects of work organization, as exemplified by outsourcing and offshoring of virtual teams (e.g., effects of trust, team composition, and distance on team performance). This research has sometimes been prone to narratives of technological determinism, and its claims have been proven wrong many times. For example, the radical "deskilling" (substituting automation for skilled labor) predicted in the 1990s never occurred, and "telecommuting" has seen ups and downs, including recent bans by high-tech companies (Wright 2013). Are information and technology giving rise to a "flat" world or do we need a more nuanced understanding of the relationships between technology, geography, and the characteristics of work?

Finally, the time frames of explorations are limited by surveys and case studies. Major changes in work take time, and it takes even longer to fully understand those changes. More longitudinal, historical, and grander analysis is needed to understand work-related change. Such work is valuable even though it might never meet some expectations for rigor. Patience and being long-sighted are virtues we are called on to exercise in this domain. This special section offers examples and motivations for how to do it.

5. Process Details

This special section on information, technology, and the changing nature of work started as a 2012 proposal to *ISR* Editor-in-Chief Ritu Agarwal. After

approval, associate editors were selected (see the appendix), and a call for papers was issued. The deadline for consideration was June 30, 2013. Forty-nine papers were submitted. After the first round of reviews, 13 papers remained. Authors were invited to a workshop at New York University's Stern School of Business on November 22 and 23, 2013, where developmental feedback was offered by other authors and invited participants. After the workshop, authors resubmitted papers and responses to initial review and feedback from the workshop. These were due February 15, 2014. Of these, the five papers here were accepted with minor revisions. Some papers continue in consideration for publication in regular issues of *ISR*.

6. Conclusion

There is need for ongoing study of the relationship between information, technology, and the changing nature of work. This special section of *ISR* highlights the importance of the topic, but also demonstrates that the topic has a long history. At any given time, the topic is likely to be influenced by issues that are particularly salient at that moment. Concerns about work are no more likely to dissipate over the next 20 years than they have over the last 4,000 years. Information and technology have major consequences for work, but the relationship among these factors remains poorly understood. Some implications can only be observed after sufficient time has passed. As time goes on, this area of study should reward those who are perseverant and attentive, as well as those who are willing to be surprised.

Acknowledgments

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Appendix

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