

DESIGNING SOCIO-TECHNICAL SYSTEMS FOR UBIQUITOUS INFORMATION ENVIRONMENTS

RAMANJIT SINGH*, TREVOR WOOD-HARPER, BOB WOOD

*Manchester Business School, University of Manchester, Booth Street West,
Manchester M15 6PB, United Kingdom*

(Received 01 28, 2007; In final form 11 04, 2007)

Due to advances in information and communication technologies (ICTs), the cost of communicating declined and organizing from distant places was possible. This along with the increasing competitive pressures gave rise to the decentralized form of organizing where decisions were made locally. In addition, organizations encouraged its workforce (knowledge workers) to work from home, while travelling or from the client site. So, the nomadic work practices of the workers resulted in a loose organizational hierarchy and a cost effective workspace. For cutting the costs further, a group of freelancers are employed temporarily to provide specialized skills to the project team. In the case of manufacturing firms, one or more functions are outsourced to other firms. Hence, as the nature of work is clearly changing, there is a need to reconsider the socio-technical design principles of the past. Based upon the new work order, a new way of thinking in socio-technical system design is proposed and will be discussed in this paper.

Keywords: Nomadic work, decentralized decision-making, knowledge work, freelancing, outsourcing, ubiquitous information environments, Socio-technical system design.

1. INTRODUCTION

The socio-technical theory was first applied in the organizations in the 1970s. It was believed that socio-technical ideas could enrich jobs and thereby increase job satisfaction of the workers. So, jobs were enriched using flexible work methods, empowerment strategies and new technologies. Although many organizations have applied the principles of socio-technical theory for restructuring jobs, people still have jobs that are routine, closely monitored and provide little room for personal development (Checkland *et al.*, 2006; Mumford, 2006). Today, organizations are surrounded by a complex economic environment that influence the way they function in the society. In order to realize production efficiency, clear specification to goals need to be followed and control structures need to be in place. Even though the visionary group at Tavistock institute believed in participative goal setting, many organizations today pay no attention to employee participation when designing jobs. Hence, when jobs are designed by management, social risks and consequences of work are often overlooked (Mumford, 2003, 2006). The socio-technical school of thought wanted to change this perception regarding jobs. According to the socio-technical theory, jobs should be designed in a way that fosters creativity, flexibility, and intellectual growth.

Centralized work methods have been widely practiced in the organizations in the past, however, the norm of 21st century is decentralization as competitive pressures have increased considerably

* Corresponding author: ramanjit.singh@postgrad.manchester.ac.uk

(Malone, 2004). In order to keep the size of the office small, workers are encouraged to work from home, client site or while travelling using wireless technologies (Sorensen, 2004). In addition, contract workers are employed temporarily to provide specialized skills to the project team. When compared to traditional ways of working, decentralized work methods provide greater flexibility while allowing workers to access data, compute and communicate from anytime anyplace (Davis, 2002). So, it is believed that ubiquitous access to the organizational data may change important aspects of knowledge work such as management, communication, information sharing, knowledge exchange, and teamwork. In the case of manufacturing organization, production work is outsourced to other firms and coordination of work activities is maintained on the Web. As the nature of work is clearly changing, there is a call for designing ubiquitous information system for supporting the decentralized work practices of the organizations. The socio-technical theory may be fruitful for designing information system in the 21st century if following principles are applied in the organizations. First, organizations need to develop systems that provide ubiquitous access to the informational resources from various wireless devices and platforms. Then, it is important to design systems that facilitate sharing of information between organizational members. Lastly, it is important to involve workers in the system design process so that work processes can be supported better with new technologies. This will not only increase the likelihood of system acceptance, but also contribute to the job satisfaction of the workers (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006).

Although it is important to develop ubiquitous information systems for supporting decentralized work practices of the organizations, it is equally important to provide secure access to the organizational data (Sorensen, 2004). Due to the limited computing resources, wireless technologies require different set of programming languages, network protocols, and encryption techniques and security measures. In addition, it is easier to intercept wireless transmission in the open air. Even though code division multiple access (CDMA) signals are harder to intercept, it is not an impossible task for the hackers (Brewin, 2002). In addition, WiFi 802.11b standard designed to provide wireless networks with the same level of security as a wired network have been vulnerable due to the open broadcasting of service set identifiers (SSID) over access points (APs) (Bahli *et al.*, 2004; Henry *et al.*, 2002). Hence, it is suggested that future research take into consideration the security aspects of ubiquitous information environments and the need for increasing the security and privacy of the users.

2. HISTORICAL OVERVIEW OF ORGANIZING

The human evolution can be described as people living on the African continent for thousands of years ago. They lived their daily lives by hunting and gathering food (Diamond, 1992). Eventually, the early humans started to migrate to other continents for further exploration. This kind of separation from one place to another resulted in the formation of small tribes, kingdoms and later to societies on different continents (Diamond, 1999). The industrial revolution with the discovery of vehicles and railways affected the movement of people considerably. Nevertheless, it was the declining cost of communication that facilitated the movement of ideas and knowledge from one continent to another. The ability to communicate over great distances enabled the human beings to move from one place to another without the fear of being isolated or lost. Societies emerged from small kingdoms as advances in communication made organizing from distant places possible (Malone, 2004).

Until 1800, families ran most of the businesses (Alfred *et al.*, 1977). While these family run businesses were different from those early hunters and gathers, their organizational formation had several similarities. For example, they were both small in size, interacted through face-to-face communication, and had plenty of freedom in making decisions, and did not communicate with people from distant groups (Malone, 2004). During the 1870s, world saw the emergence of organizations where the decision was centralized. The transportation industry was one of the first to adopt this control oriented form of organizing. The organizational hierarchies were sub divided and a top down control prevailed in the organizations. Every low-level decision had to be agreed by the top-level managers before it could be implemented (Alfred *et al.*, 1977). This new form of organizational structure gained widespread popularity during the 1900s. As centralization continued to be the norm in the 20th century, it still exists in many parts of the world today. The merger of large conglomerates

such as the Citibank and Travelers and the acquisition of Time Warner by AOL are a few indications that centralization is still in existence (Malone, 2004).

3. THE RISE OF DECENTRALIZATION

Late 20th century saw the emergence of decentralized decision-making as many organizations embraced the idea of sharing power and making joint decisions (Malone, 2004). Although many loose hierarchies exist in the world, a landmark case is that of the Linux operating system for PCs. The development work of Linux started as a basement project, but later gained popularity in the Web among software developers worldwide. As Linux source code was freely available for anyone to examine and make modifications, hundreds and thousands of programmers worldwide started to develop Linux operating system in a loose organizational structure (Lee *et al.*, 2003; Malone, 2004). Another example of a loose hierarchy is that of Wikipedia. Anyone can add or make modifications to the articles, and there is no review committee or approvals for uploading the articles on Wikipedia. Although the lack of supervision may result in low quality, articles posted on Wikipedia undergo numerous reviews as quality is perceived very important at the Wikipedia community (Stvilia *et al.*, 2005; Wikipedia, 2006b). The success story of Wikipedia has been great and it has motivated people across the globe to work together to generate knowledge. Even though work guidelines and policies were imposed initially by the Wales and Sanger (founders of Wikipedia), the community now operates without much management interference (Wikipedia, 2006a).

The loose hierarchies of Linux and Wikipedia may not portray the true picture of decentralized conventional organization. The example of AES Corporation, however, is significant in this sense. The AES Corporation was founded in 1981 by Roger Sant and recently retired chief executive Dennis Bakke. Although firm's operations are similar to other global electric suppliers, its management philosophy differs significantly. It was observed that there is a major emphasis on having fun while working at AES. Decisions are made locally and employees are held accountable as well as responsible for their actions. To account for the democratic philosophy, AES has a very careful recruitment process. Training is provided to all new employees, including employees of acquired companies so that they are aware of the AES values. Rewards and profit-sharing programs are linked with the performance of employees. Then, there is a frequent communication between top and lower level employees. E-mail is commonly used to discuss work-related issues and make joint decisions. In addition, financial as well as the market information is available to all employees and it can be accessed anytime and anyplace using the Internet (AES, 2006; Bowers, 2000).

Another example of decentralized work is apparent at W.L.Gore. The W.L.Gore and Associates is a US\$1.2 billion firm with six thousand workers. Although W.L.Gore is known for its water-proof fabrics among consumers, its managing approach is one of the most groundbreaking in industry. Participative decision-making prevails in the entire organization, and employees are referred to as "associates". Promotion to "manager" occurs if a group of associates agree to work under one's supervision. Operational decisions are made in an informal meeting and everyone involved has equal say in the decision-making process (Brooks, 2003; Malone, 2004).

4. ON NOMADIC WORK, FREELANCING, AND OUTSOURCING

More recently, work conducted by an emerging workforce known as "knowledge workers" is an important area of consideration and a subject worthy of further investigation (Davis, 2002). Since an important part of knowledge work consists of nomadic computing, the positive and negative impacts on productivity are subject to work processes of knowledge workers. Knowledge work can be defined as intellectual work performed to generate valuable information and knowledge. So, knowledge work is an important part of many organizations today (Grudin, 2002). When compared to traditional ways of working, knowledge work provides greater flexibility while freeing knowledge worker from time and place constraints, allowing workers to access data, compute and communicate from anytime anyplace using the Internet. Hence, it is believed that most knowledge workers are mobile workers who perform work by accessing data from various work locations and time (Davis, 2002). The need

for ubiquitous access to data may change many important aspects of work. For instance, use of wireless technologies may extend work-day of knowledge workers (Jessup *et al.*, 2002). In traditional computing arrangements, there is often information handling delay or movement of goods delay between work processes. With ubiquitous computing, tracking of work and instant movement of goods is ongoing and available on demand. In addition, unlimited access to computing and communication tools also changes the nature of knowledge work activities such as management, communication, information sharing, knowledge exchange, and teamwork (Banavar *et al.*, 2002). Knowledge work may be performed individually, in small group or in geographically dispersed teams spanning multiple continents. One way knowledge work differs from clerical work is that dominant part of knowledge work consists of “reasoning” while clerical work may involve mainly administrative activities. Also, knowledge worker have freedom in structuring and managing his or her own work whereas traditional clerical worker may have little discretion. Although some organizations may have standards and control measures such as deadlines, evidence of progress, benchmarks to regulate knowledge work, self-management and self-pacing is important for becoming an effective knowledge worker (Davis, 2002; Sorensen *et al.*, 2005).

The norm of 21st century may be decentralization as competitive pressures in the market have increased considerably (Malone, 2004; Sorensen, 2004). Firms commonly freelance or outsource work to other professionals or manufactures to cut operational costs. Instead of hiring people to conduct work on a permanent basis, a temporary worker is employed. In the case of manufacturing organizations, one or more production functions are outsourced to other firms. This is the underlying objective of the e-lance economy work tends to be broken down into smaller pieces and outsourced at a minimum cost. The work processes are not managed by multilevel management, but by a series of independent freelancers. Freelancers commonly come together to work as a team on a given project and adjourn upon the project completion . The trend toward freelancing is reflected in the U.S. labour statistics. It is estimated that one quarter of U.S. labour force in 2003 were freelancers (U.S. Department of Labor, 2006). Elance, Inc. is a U.S. based firm that specializes in matching freelancers with freelance work. Elance, Inc. was founded in the 1990s to meet the demand of freelance work. It offers a list of auctioned services of various software developers, graphic designers, market researchers, and language translators on the Web. Another example of e-lance firms includes the Asynchrony Software, which specializes on creating industry for software projects. Anyone with an idea for software can post the offering on the Web site of Asynchrony Software. Then, individuals interested in developing the idea join as a team and a project leader is appointed. Before project starts, the project leader makes a joint agreement regarding revenue distribution between team members (Malone, 2004).

Due to the advances in the information and communication technologies (ICTs), the cost of communicating at distant places has reduced considerably. Hence, global organizations no longer rely on local software developers. These multinationals take advantage of low cost, skilled labour, and outsource software production to developing countries (Bartlett *et al.*, 2000). Upon building a network of information, knowledge, and expertise exchange, even local firms play the role of global firms (Sxenian, 2001). Although global outsourcing of manufactured goods has been practiced for many years, the outsourcing of software development is still a new phenomenon. In 2001, major U.S. corporations such as Cisco, IBM, GE and Ford made significant investments in joint development programs with Indian firms. To communicate, the software giants established local development centres across Indian cities and control of activities were coordinated on the Web (Netscribes *et al.*, 2001; Sahay *et al.*, 2003).

5. SOME GENERAL FINDINGS ON DECENTRALIZATION

In general, there are several advantages of decentralization; it promotes enthusiasm and creativeness among employees; it leads to teamwork, enabling multiple heads to be used concurrently in problem solving; and it provides room for flexibility and freedom in conducting work. Then, it is very flexible and cost effective, since firms do not need to hire staff on a permanent basis or invest heavily in facilities. Although decentralization sounds good, there are a few drawbacks associated with this approach. First, it may be difficult to make fast decisions since no one is in charge. Then, it is time-

consuming to make joint decisions. E-mail communication is asynchronous; hence no immediate response (Davis, 2002; Malone, 2004). Ensuring quality and ethical work practices may not be possible in decentralized organization, as no supervision exists. While careful selection of project members can be accomplished, work cannot be controlled (Dellarocas, 2002; Merchant, 1982; Resnick *et al.*, 2000).

6. THE FUTURE OF SOCIO-TECHNICAL SYSTEM DESIGN

The socio-technical design principles (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006) as listed in Table 6-1 have been fruitful in the development of socio-technical system in the past (Mumford, 2006). However, due to the decentralized work practices of organizations and the changing nature of work (Davis, 2002; Sorensen *et al.*, 2005), a new way of thinking in socio-technical system design is proposed and will be discussed next.

Organizations are open and composed of two major independent yet interrelated elements, the social and the technical (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006). Social elements of the organization are composed of work-related aspects such as task variety, task identity, and autonomy that provide satisfaction and motivation for organizational employees (Mumford, 2006). In addition to the work-related aspects, structural elements such as adequate workload, co-worker support, management support, bright career prospects and lucrative reward and pay structures may also increase the overall job satisfaction of the workers (Seo *et al.*, 2004).

Table 1. The Socio-technical Design Principles
(Fok *et al.*, 1987; Wood-Harper *et al.*, 2006)

Socio-technical Design Principles
1. Assumptions about Organisation <ul style="list-style-type: none"> ▪ Organizations an open systems interacting with environment. ▪ Organizations as work system with two independent but interrelated subsystems, social and technical.
2. Assumptions about People <ul style="list-style-type: none"> ▪ ‘Theory Y’ orientation toward people, hence it’s morally right to let them participate in decision making process.
3. Socio-technical Design Goals <ul style="list-style-type: none"> ▪ Jointly satisfy technical (efficiency goal) and social requirements (social goal) of work.
4. Assumptions about the Socio-technical Design Process: <ul style="list-style-type: none"> ▪ Workers should participate.
5. Socio-technical Design Concepts <ul style="list-style-type: none"> ▪ Work system, not single job, as design unit. ▪ Workgroup not single jobholder. ▪ Internal regulation of group. ▪ Redundancy of function, not redundancy of part. ▪ Members have discretion, not highly prescribed work. ▪ Develop flexible learning system. ▪ Autonomous workgroup is superior form of organisation. Role changes: Designer: facilitator not “expert”. Worker: “designer” of the system. Manager: “boundary manager”, not supervisor of workers.

Technical elements, on the other hand, are concerned with the process, tasks, and technology needed to transform inputs in desired outputs. Also, it was found that the technical elements focus on the identification of possible deviations in the transformation process and then aim to control them (Fok *et al.*, 1987). Although the two elements described above differ considerably, their interplay and harmony is essential for organization’s success in the business. For instance, introducing a new

technology that considers social requirements of work is more likely to increase job satisfaction than introducing a technology that merely considers technical requirements (Kling, 1999; Kling *et al.*, 2001).

Due to the nomadic work practices of knowledge workers, ubiquitous information environments may pose numerous socio-technical challenges for utilizing wireless technologies at workplace (Krogstie *et al.*, 2004). More specifically, since place and time differences are significant to mobile work, there is a need to design systems that are synchronized frequently to enable retrieval of correct and consistent information. Second, since team members in each project may be in multiple countries, informational content on the Web may require some customization. Customization is adapting the Web portal's presentation according to meet the needs of individual users (Perkowitz *et al.*, 2000). Studies have found that adapted content on the corporate Web portal enhances usability, accessibility, and interactivity of the information (Fock, 2000). Additionally, (Singh, 2003) reports on the need for customization due to the differing cultural values found in Indian, Japanese, Chinese and American websites. According to (Anderson, 1991), culture should not be taken as an objective fact. Cultural aspects cannot be ignored as they serve as significant sources of rules and resources that shape the interaction and communication practices within organizations. Thus, it is important that cultural differences are acknowledged and corporate Web portals for each country use appropriate language, icons, and colours while presenting the information on the Web.

Although wireless technologies are not generally problematic to use, a more important concern is to what extent does the organizational system allow access to data or files from various wireless technologies and application platforms. An effective information system infrastructure for supporting ubiquitous computing must be capable of finding, adapting and delivering the appropriate information depending on the user's computing device and platform (Banavar *et al.*, 2002). "Context-aware computing describes a situation in which a mobile system is aware of its user's state and surroundings and modifies its behaviour based on this information" (Siewiorek, 2002, p. 80). For example, context-aware systems can deliver information in a format which is supported by user's wireless device. Also, as mobile workers may not have time to check their calendars, e-mails, or bulletin boards, context-aware systems can send relevant information when it is required. Other constraints to ubiquitous computing include the battery power, screen size, networking bandwidth, etc (Siewiorek, 2002). These constraints together provide additional socio-technical requirements and they must be addressed for enabling ubiquitous access to organizational data from various wireless devices (Singh *et al.*, 2007).

The main goal of socio-technical design is to jointly satisfy both the technical as well as the social requirements of work (Avison *et al.*, 1986; Fok *et al.*, 1987; Wood-Harper *et al.*, 2006). For instance, the use of laptops should be considered appropriate if workers are constantly working out of the office. For in-office work, desktop should be a viable solution. Another example includes a study that was conducted to discover whether mobile information and communication technology devices (MICT) could facilitate doctors in conducting ward rounds more effectively (Martins *et al.*, 2005). With the use of MICT devices, doctors could gather patient-related information, make on-site decisions, and even formulate treatment plans for the patients. Upon analyzing the findings, it was found that most doctors did not see the laptop fit into their daily routines and managing the laptop added more complexity to their work. Five points of consideration may be important for understanding the research results. First, not all ward rounds require mobility since sitting ward rounds may be well supported by a desktop computer. Second, varying perceptions (in-office collective decision-making as opposed to on-site decision-making) regarding the functioning of ward rounds resulted in the low use of laptops. Third, doctors' had differing attitudes toward wireless technology, but also regarding the effectiveness of timely and rich data, existing practices, and change. Fourth, due to the lack of measurable evidence, most doctors based cost/benefits analysis on the subjective individual perceptions. So, non-use reasons related to device reliability or device size may be not as serious as initially reported. Fifth, grades of power between doctors, work routines, group dynamics, and department work policies such as device sharing also influenced laptop utilization. Also, it was found that staff had difficulty using the laptops due the inadequate training and support for operating the laptops and applications. Likewise, hospital's infrastructure, combined with device configuration difficulties caused problems for even IT savvy users. For instance, due to the risk of theft, laptops were attached to a trolley. Although this safety measure was important from

the security point of view, doctors' mobility was reduced considerably. Even without the trolley, anytime anyplace use of laptops was not always practical due to the short battery life. Thus, it can be concluded that both technical as well as social aspects of system design should be considered before introducing a new technology in the organization.

According to (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006), socio-technical design process is participative. It is important that power in the organization is shared and technology acquisition decisions are consulted with workers. In addition, technology introduced in the organization should not merely maximize profits but its application should fit workers everyday work processes. As workers have the first-hand knowledge about the work itself, their participation is essential in the system design phase (Kling, 1999; Kling *et al.*, 2001). (Wood-Harper *et al.*, 2006) propose few additional system development design concepts that should be considered when developing a new system in the organization. First, information systems should be constructed as a complete work system and not to do a single job. "An information system is the system of persons, data records and activities that process the data and information in a give organization, including manual processes or automated processes" (Wikipedia, 2007). As work is conducted in multiple places and time, the new system should be able to integrate the entire value chain (Schultze *et al.*, 2002). Then, focus should be on the workgroup and not on the individual job holder. Due to the changing nature of work, more and more organizations are applying team-based approaches to conduct work. Individuals come from various organizational units or even outside (freelancers) to form project teams. These teams work on domestic as well as on multinational projects that span many countries. Hence, it is important that new systems provide group collaboration as well as video-conferencing mechanisms to tackle space and time constraints (Sorensen *et al.*, 2004).

Another important socio-technical design aspect of participative system development is the internal regulation of the "work group" (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006). As workers move from project to project, it becomes difficult to monitor their overall performance. In order to ensure successful completion of the project work, it is important that management provides right mixes of skills in each team (Malone, 2004). Also, cultural aspects such as ethnicity and language are important to consider if project is to be conducted in a foreign country (Hofstede, 2005). Consequently, it is essential that organizations develop systems that are capable of appraising team members. Information regarding workers and freelancers need to be stored so that managers can easily form resourceful and efficient team for the next project. Furthermore, newly developed systems need to be flexible learning systems (Fok *et al.*, 1987; Wood-Harper *et al.*, 2006). As workers are commonly dispersed across the globe, organizations find it difficult to educate or update staffs' skills. Therefore, it is important that new system development projects take into account the necessity to provide e-learning capabilities for the mobile staff (Guerrero *et al.*, 2004; Raitman *et al.*, 2005). It is important to realize that autonomous work group may be a superior form of organization. The new system should, therefore, provide workers with the possibility of accessing the organizational knowledge from multiple places and time. This would not only provide workers with more autonomy but also benefit the organization as decisions would be more accurate and timely (Ptak *et al.*, 1999). Finally, in order to realize the true benefit of the mentioned socio-technical design principles, role changes of "actors" are essential in the system design process. First, it is suggested that "designer" be a facilitator and not an expert. This would ensure that new solution is based on social requirements of work and not merely on technical requirements. Second, it is recommended that "worker" be a designer of the system. This would ensure that the new system fits workers' daily routines, and not vice-versa. Third, it is proposed the "manager" be a boundary manager, and not a supervisor of employees. This would provide freedom and discretion in work; which would subsequently lead to work satisfaction and motivation for the workers (Institute of Management, 1998; Sahay *et al.*, 2003; Wood-Harper *et al.*, 2006).

7. CONCLUSION

It is clear that the norm of 21st century is decentralization as competitive pressures have increased in the market. Organizations empower its workforce (knowledge workers) to work anytime anyplace while providing ubiquitous access to the organizational information. The nomadic work arrangements

do not just increase work flexibility, but it also enables the firms to save cost associated with office space and office supplies. In addition to the loose relationship with the knowledge workers, freelancers are often employed on temporary basis to cut costs. In the case of manufacturing organizations, work is commonly outsourced to other firms where it can be performed at a lower cost. Hence, as the nature of work is clearly changing, there is a call for reconsidering the socio-technical design principles of the past. There are six main elements that need rethinking from the system development point of view. First, since organizations nowadays are open, it is essential that the new systems be designed from the interoperability point of view. Second, differences in place and time have important impact on the system design process; thus, organizations need to customize and synchronize organizational data frequently. Third, as wireless technology is on the rise, new systems need to be context dependent and allow access to data from multiple devices. Fourth, technology introduced in the organization should not merely intend to maximize profits, but its application should fit workers everyday work routines. Fifth, as workers have first-hand knowledge of the work tasks; their participation is essential in the system design process. And sixth, the democratic system design process will not merely increase the likelihood of system acceptance but will even lead to job satisfaction and motivation for the organizational workers.

Acknowledgements

We greatly acknowledge the two anonymous reviewers and the guest editor for their valuable insights and much appreciated advice for revising the paper.

References

- AES. (2006). *AES Corporation: The Power of Being Global*. Retrieved 11 May, 2006, from www.aes.com
- Alfred, D., & Chandler, J. (1977). The Visible Hand: The Managerial Revolution in American Business. In (pp. 51, 107-108). Cambridge, MA: Harvard University Press.
- Anderson, B. (1991). *Imagined Communities: Reflections on the Origin and Spread of Nationalism (Paperback)*: Verso.
- Avison, D. E., & Wood-Harper, A. T. (1986). Multiview-an exploration in information systems development. *Australian Computer Journal*, 18(4), 174-179.
- Bahli, B., & Benslimane, Y. (2004). An exploration of wireless computing risks: Development of a risk taxonomy. *Information and Management & Computer Security*, 12(3), 245-254.
- Banavar, G., & Bernstein, A. (2002). Software infrastructure and design challenges for ubiquitous computing applications. *Commun. ACM*, 45(12), 92-96.
- Bartlett, S. C., & Ghoshal, S. E. (2000). *Transnational Management: Text, Cases, and Readings in Cross Border Management*. Boston: McGraw-Hill Higher Education.
- Bowers, C. (2000). The Amazing Rise of AES. *Utility Business*, 3(4), 38.
- Brewin, B. (2002). *Watch out for wireless rogues*. Retrieved 09 August, 2007, from <http://www.computerworld.com/mobiletopics/mobile/story/0,10801,72664,00.html>
- Brooks, D. (2003). "Site Makes Use of Useful, Useless Facts," *Nashua (NH) Telegraph*. Retrieved 11 May, from <http://www.nashuatelegraph.com/Main.asp?SectionID=30&SubSectionID=90&ArticleID=73632>
- Checkland, P., & Poulter, J. (2006). *Learning for action : a short definitive account of soft systems methodology and its use for practitioner, teachers and students*. Chichester: Wiley.
- Davis, G. B. (2002). Anytime/Anyplace Computing and the Future of Knowledge Work. *Communications of the ACM*, 45(12), 67-73.
- Dellarocas, C. (2002). *The Digitalization of Word-of-Mouth: Promise and Challenges of Online Reputation Mechanisms*. Paper presented at the Working Paper, MIT Sloan School of Management, Cambridge, MA.
- Diamond, J. (1992). The Third Chimpanzee. In (pp. 36, 45). New York: Harper Collins.
- Diamond, J. (1999). Gun, Germs, and Steel. In (pp. 215). New York: W.W. Norton & Company Inc.
- Fock, H. (2000, September). *Cultural influences on marketing communication on the world wide web*. Paper presented at the Multicultural Marketing Conference, Hong Kong.
- Fok, L. M., Kumar, K., & Wood-Harper, A. T. (1987, December.). *Methodologies for Socio-Technical Systems (STS) Development : A Comparative Review*. Paper presented at the 8th International Conference of Information Systems, Pittsburg, USA.
- Grudin, J. (2002). Group Dynamics and Ubiquitous Computing. *Commun. ACM*, 45(12), 74-78.

- Guerrero, L. A., Pino, J. A., Collazos, C. A., Inostroza, A., & Ochoa, S. F. (2004, 2004//). *Mobile support for collaborative work*. Paper presented at the Groupware: Design, Implementation, and Use. 10th International Workshop, CRIWG 2004. Proceedings, 5-9 Sept. 2004, San Carlos, Costa Rica.
- Henry, P. S., & Luo, H. (2002). WiFi: what's next? *Communications Magazine, IEEE*, 40(12), 66-72.
- Hofstede, G. (2005). *Culture's Consequences, International Differences in Work-Related Values (Cross Cultural Research and Methodology) (Hardcover)*. Newbury Park, California: Sage Publications.
- Institute of Management, F. (1998). *Frederick Herzberg : the hygiene-motivation theory*. Corby: Institute of Management Foundation.
- Jessup, L. M., & Robey, D. (2002). The Relevance of Social Issues. *Commun. ACM*, 45(12), 88-91.
- Kling, R. (1999, January, 1999). What is Social Informatics and Why Does it Matter? *D-Lib Magazine*, 5.
- Kling, R., & Iacono, S. (2001). *Information technology and organizational transformation : history, rhetoric, and practice*. California: Sage Publications.
- Krogstie, J., Lyytinen, K., Opdahl, A., Pernici, B., Siau, K., & Smolander, K. (2004). Research areas and challenges for mobile information systems. *International Journal of Mobile Communications*, 2(3), 220-234.
- Lee, G. K., & Cole, R. E. (2003). From a Firm-Based to a Community-Based Model of Knowledge Creation: The Case of the Linux Kernel Development. *Organization Science*, 14(6), 633-649.
- Malone, T. W. (2004). *The future of work: how the new order of business will shape your organization, your management style, and your life*. Boston: Harvard Business School Publishing.
- Martins, H. M. G., & Jones, M. R. (2005, 1-3 August). *Mobility In The Round: Use of Wireless Laptop PCs In Clinical Ward Rounds*. Paper presented at the Designing ubiquitous information environments: sociotechnical issues and challenges: IFIP TC8 WG 8.2 international working conference, Cleveland, U.S.A.
- Merchant, K. A. (1982). The Control Function of Management. *MIT Sloan Management Review*, 23(4), 43-55.
- Mumford, E. (2003). Redesigning human systems. In (pp. 12-32, 265-283). Hershey, Pa. ; London: Irm.
- Mumford, E. (2006). The story of socio-technical design: reflections on its successes, failures and potential. *Information Systems Journal*, 16, 317-342.
- Netscribes, & Ramamoorthy, G. (2001). *U.S firms bullish on India development centres*. Retrieved 10 October, 2006, from <http://www.rediff.com/money/2001/mar/20spec.htm>
- Perkowitz, M., & Etzioni, O. (2000). Adaptive Web Sites: Examining the potential use of automated adaptation to improve Web sites for visitors. *Communications of ACM*, 43(8), 152-158.
- Ptak Carol, A., & Schragenheim, E. (1999). *ERP : tools, techniques, and applications for integrating the supply chain*. Boca Raton, FL: St. Lucie Press.
- Raitman, R. A., & Zhou, N. W. (2005). *Employing Wikis for Online Collaboration in the E-Learning Environment: Case Study*. Paper presented at the Information Technology and Applications 2005, ICITA 2005. Third International Conference on 2.
- Resnick et al., P. (2000). Reputation Systems. *Communications of the ACM*, 43(12), 45-48.
- Sahay, S., Nicholson, B., & Krishna, S. (2003). *Global IT outsourcing: software development across borders*. Cambridge: Cambridge University Press.
- Schultze, U., & Boland, R. J. (2002). Place, space, and knowledge work: a study of outsourced computer systems administrators. *Accounting, Management and Information Technologies*, 10, 187-219.
- Seo, Y., Ko, J., & Price, J. L. (2004). The determinants of jobsatisfaction among hospital a model estimation in Korea. *International Journal of Nursing Studies*, 41(2004), 437-446.
- Siewiorek, D. P. (2002). New frontiers of application design. *Commun. ACM*, 45(12), 79-82.
- Singh, N. (2003). Analyzing the cultural content of web sites: A cross-national comparison of China, India, Japan, and US. *International Marketing Review*, 22(2), 129-146.
- Singh, R., Wood-Harper, A. T., & Wood, B. (2007, 11-13 April, 2007.). *The changing nature of work and the system design process of future*. Paper presented at the ISOOneWorld, Las Vegas, USA.
- Sorensen, C. (2004). *The Future Role of Trust in Work - The Key Success Factor for Mobile Productivity: Optimising the knowledge supply-chain*: Microsoft.
- Sorensen, C., & Gibson, D. (2004). Ubiquitous visions and opaque realities: professionals talking about mobile technologies. *Info: The journal of policy, regulation and strategy for telecommunications*, 6(3), 188-196.
- Sorensen, C., & Yoo, Y. (2005, 1-3 August). *Socio-technical Studies of Mobility and Ubiquity*. Paper presented at the Designing ubiquitous information environments : sociotechnical issues and challenges : IFIP TC8 WG 8.2 international working conference, Cleveland, U.S.A.
- Stvilia, B., Twidale, M. B., Gasser, L., & Smith, L. C. (2005). *Information Quality Discussions in Wikipedia: Technical Report ISRN UIUCLIS--2005/2+CSCW*.
- Sxenian, A. (2001). *The Silicon Valley connection: transnational networks and regional development in India, Taiwan and China, Final Report for the project The Context of Innovation of the Information Technology Industry*. New Delhi: University of Pennsylvania Institute for the Advanced Study of India.
- U.S. Department of Labor. (2006). *Bureau of Labor Statistics Data*. Retrieved 11 May, 2006, from <http://www.bls.gov/data/home.htm>
- Wikipedia. (2006a). *Policies and guidelines*. Retrieved 23 May, 2003, from www.wikipedia.org/wiki/Wikipedia:Policiesandguidelines

- Wikipedia. (2006b). *Wikipedia: About*. Retrieved 11 May, 2006, from <http://en.wikipedia.org/wiki/Wikipedia:About>
- Wikipedia. (2007). *Information Systems*. Retrieved 20 September, 2007, from http://en.wikipedia.org/wiki/Information_system
- Wood-Harper, T., & Wood, B. (2006). *Enid Mumford: Your Way and our Way for the Future*. Manchester: University of Manchester.