Chapter 20 Comparative Perspective on Computerization Movements: Implications for Ubiquitous Computing

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Abstract [A]

The collection of papers in this book highlight the importance and impact of computerization movements on individuals, organizations, and society. We have shown how CMs, which are driven by utopian visions of a specific technology's use, are generated and modified in response to realities in organizations and society, or move on to the "next big thing." In this final chapter, we draw conclusions from the historical evolution of CMS across four eras of computerization: Mainframe, PC, Internet, and Ubiquitous Computing. We present five generalizations of CMs across the four eras based on the chapters in this book. The study of CMs is intended to deepen understanding of how a special kind of technological social movement influences people in how they think about computing and communications technology and thereby shape technology decisions in organizations and society.

Keywords [A]

Computerization movements, ubiquitous computing, mainframes, personal computers, internet, technological diffusion

Introduction [A]

The collection of papers in this book highlights the importance and impact of computerization movements (CM)s on individuals, organizations, and society. We have shown how CMs, which are driven by utopian visions about the technology's use, are generated and change in response to realities on the ground, or move on to the "next big thing." We have also shown that these movements range from those promoting hardware technologies (mainframes, PCs, PDAs, digital cameras, or mobile phones) to infrastructures such as the Internet, extranets and intranets, to software applications such as expert systems (e.g., mortgage banking) and to software genres such as free/open source software (F/OSS) (e.g., GNU/LINUX).

In this final chapter, we draw conclusions from the historical evolution of CMs across four eras of computerization: Mainframe, PC, Internet, and Ubiquitous Computing. We then present five generalizations gleaned from looking across these eras. They are summarized below and discussed more fully later in the chapter.

- There is a continuing gap between CM visions and the reality of technology use in organizations and society.
- CM rhetoric tends to shift from the utopian to the pragmatic with experience and contending discourse.
- Technologies that require a support infrastructure to be built as part of their implementation take longer to diffuse than those that can use existing infrastructures, resulting in a lower probability that a CM requiring a new infrastructure will lead to successful diffusion.

- The realities of day-to-day use of a CM's promoted technology cannot be predicted precisely in advance, but informed technology assessments can be made by better understanding of similarities and differences of emerging and earlier technologies. Such assessments can improve the success of a CM.
- The social context shapes technology use as much or more than the technology per se. New technology often reinforces existing organizational and social arrangements, rather than disrupting, changing, or transforming them. CMs that leverage the technology-organization linkage will be more successful than those that do not.

We conclude with the contributions of this book and the implications of our generalizations for vendors, managers, users, and scholars.

Comparative Analysis of CMs in Four Computerization Eras [A]

In general, CMs have been instrumental in promoting the diffusion and use of computing innovations since the first mainframe computers were introduced the 1950s. As new technologies have emerged, new CMs have also emerged to create visions of the technology's use and value that promote their adoption and use. Although the individual technologies have been many, they can be clustered around the four computerization eras associated with key technologies that represent strategic inflection points (Grove, 1996) in the history of computing. We have identified four eras and related CMs: the Mainframe era, Personal Computer (PC) era, Internet era, and Ubiquitous Computing era. We use these eras to provide a comparative perspective on the creation, maintenance, and outcomes of CMs over time.

Table 20.1 shows the four eras and corresponding time periods. Although several of the eras overlap in time, we show the new technologies that were prevalent during each era (column 1), and how they influenced the emergence of CMs. We then list the key CM activists for the technology (column 2) and the major venues for the CM discourse of the activists during each era (column 3). Next, we show the CM frames and visions (column 4) and, finally, examples of some outcomes of CMs that emerged during each era. In the next four sections, we discuss each of the four eras and elaborate on the key dimensions for each.

[Insert TABLE 20.1 Here]

The Mainframe Era [B]

Mainframe computers were the first practical application of computer technology for important business functions such as numerical analysis of actuary or mortality studies, fast numerical computations, and military or scientific large-scale applications. During the 1950's and 1960's, large companies started investing in mainframes across a wide range of industries and firms. During the 1950's and 1960's, large-scale calculations such as billing, which previously required many clerks for completion, were being calculated with mainframe computers. Centralized database management systems became common for record keeping and by the 1970's word processing on mainframes was coming of age in most businesses.

Along with the mainframe paradigm came centralized processing with "dumb" terminals connected from various locations to enter or retrieve information. Since companies were investing vast amounts of money to acquire a mainframe computer, internal departments for maintenance and security of such systems became a requirement. Most organizations were vertically-integrated with shared access to the mainframe's vast computing capacity. Many

Management Information Systems (MIS) departments formed within organizations to develop and manage the complex computing applications offered by use of a mainframe.

During this period, mainframes were manufactured and advertised by large vendors such as IBM, Burroughs, Honeywell, NCR, Sperry Rand, and Digital Equipment Corporation (DEC), to name a few. The hardware itself was very bulky and expensive and the typical customers in the 1950's were large enterprises such as government agencies, aerospace firms, financial institutions, and insurance companies. The software for this technology included compilers for scientific programming languages such as FORTRAN or for business languages such as COBOL. The targeted market for large mainframes was mainly financial executives and engineers. The discourse was highly technical and in the form of advertising, direct-mail brochures and "team" sales calls (Jabloner, 2006). The dominant frame was that computers could increase speed of scientific and business calculations and thereby make businesses more productive. An interesting example of the utopian writing appears in a 1948 brochure in which the Eckert-Mauchly Computer Corporation (later Sperry-Rand) advertised the benefits of the UNIVAC computer as follows:

> "WHAT'S YOUR PROBLEM? Is it the tedious record-keeping and the arduous figure-work of commerce and industry? Or is it the intricate mathematics of science? Perhaps your problem is now considered impossible because of prohibitive costs associated with conventional methods of solution. The UNIVAC SYSTEM has been developed by the Eckert-Mauchly Computer Corporation to solve such problems. Within its scope come applications as diverse as air traffic control, census tabulations, market research studies, insurance records, aerodynamic design, oil prospecting, searching chemical literature and economic

planning." (cf. www.computerhistory.org/brochures/ for a detailed display of computer brochures of the 1950's-1980's available as a download by the Computer History Museum in Mountain View, California)

During the 1960's, mainframes were more integrated into businesses and the advertisements started showing signs of targeting the business manager for use in MIS (www.computerhistory.org/brochures/). The predominant CM that emerged was what Kling and Iacono (1988) called the "general CM" promoting computerization in society and businesses as a way to improve productivity and reform society. Advertisements emphasized the flexibility and versatility of using a computer as well as the advantages of having a machine that can make logical decisions. By the 1970's, the CM activists included vendors as well as business managers and employees who felt there were significant benefits from using computers at work. During this period, the size of the mainframe became smaller with companies such as DEC producing a smaller version of a mainframe at a reduced price. Computer vendors started marketing computers to new groups: managers of departments within large organizations and small scientific and technical organizations.

Computer vendors such as IBM and Digital Equipment formed and supported so-called "user groups" comprised of the computer professionals from their major customers. The vendors promoted concepts for computer use to business and government executives through meetings and publications such as "application briefs" which detailed different organizations' computer applications and success in glowing terms. They also showcased the lead executive, his computing manager, and his organization at user group meetings. In addition, CM activists influenced others to join the computerization bandwagon through CM discourse in user groups formed around software languages such as FORTRAN and COBOL.

The primary motivation for computer use was organizational productivity. For example, Kling and Iacono (1988) analyzed the formation and strength of four CMs of the mainframe era: Urban Information Systems, AI, Computer-Based Education, and Office Automation. They showed that activists for these CMs proclaimed that the use of mainframe computers would enhance productivity in business, government, and education. Other themes espoused by activists were either reformist (computer-based technologies are essential for a reformed society, improved computer-based technologies are needed to carry out reform, greater computerization is required for reform, and there are benefits for everyone from such computer-based reform) or anti-Luddite (the notion that uncooperative people were the main reason for lack of reform through computerization) (Kling & Iacono, 1988). The CM activists essentially tried to persuade business and government organizations to invest vast amounts of money in computer technology in all sectors of society to achieve greater productivity and organizational reform.

The outcomes of the CMs which emerged during this period are varied. The AI CM started with the utopian vision of creating machines that can "think like humans" – a vision not yet achieved today even though IBMs Deep Blue computer with AI software has beaten world class chess players. The office automation and computer-based education CMs began with claims of completely transforming the way people conduct business and the way children learn, but the claims became tempered as people began to realize how difficult it was to do.

However, the utopian visions portrayed in the CM rhetoric of this period did not necessarily meet with the reality of use in society and organizations as evidenced in the case studies of Kling and Iacono (Chapter Two, this volume).

The PC Era [B]

The PC era, which emerged full blown in the 1980's, created a completely new paradigm for computer investment and use in organizations. However, it had earlier roots in the 1972 HP 9830 all-in-one desktop computer; in the 1975 PC kit from Altair and the BASIC programming language that ran on the Altair; and in the early 1980's, the Apple PC. By the 1980's, computer vendors were mass marketing the sale of personal computers to business users and to computer hobbyists. The PC Era activists included vendors, department managers in organizations, user group members, and home hobbyists.

The hardware of this period included small-scale PCs for home and office use as well as large-scale versions of PCs called workstations, which were capable of running the UNIX operating system. These larger PCs were later connected with local area networks using client-server technology. The software for PCs ranged from programming language compilers, software systems to design graphical user interfaces, graphics design systems, word processors, games, and others. Eventually, in the early 1980's electronic mail surfaced on small mainframes called minicomputers, such as the DEC VAX computers, enabling small and large corporations to use e-mail for communication through distributed processing.

But the PC era really began in 1983 when IBM teamed up with Microsoft to create the DOS operating system running on an IBM PC, the forerunner to the WINDOWS operating system. With the advent of DOS, both hobbyists and business users could "program" their computers and easily manage file systems with simple English-like commands. In an effort to promote widespread diffusion, IBM had created an open architecture, which meant that any firm could build and sell PC clones - even using components from suppliers to IBM. The low price

and widespread availability of PCs coupled with the proliferation of software systems during this period promoted the purchase and use of PCs for home, office, and education.

In 1984, Apple unveiled its Macintosh computer with its innovative and snazzy graphical user interface (GUI), and by 1985 Microsoft released the Windows operating system for the PC with a similar GUI. By 1985 there were over 200 firms building and selling computers in the U.S.

Although PCs were sold through the vendor's sales force, they were broadly available in computer stores, electronics stores, department stores, and discount stores. The PC also spawned new user groups for computer applications and particular platforms (Macintosh vs. IBM PC) adding to the growing set of CM activists for this era. Trade shows began featuring large, splashy demonstrations of PC applications by vendors. By the 1990's, home-based computing was increasingly popular both with computer hobbyists and those who work at home.

During this period, the mass media played a major role in the promotion of the PC movement with PC magazines proliferating-- at least a dozen PC magazines sprang up during this era serving as a venue for CM discourse. PC columns appeared in major newspapers, as did computer stories in general circulation magazines, including the in-flight magazines of airlines. In 1982, Time Magazine named the PC its "Machine of the Year" and in 1983 Business Week referred to it as the "Office PC." In a 1983 brochure from IBM advertising the PC, the utopian vision is not only that of increased productivity, but anything that one can imagine:

> "The IBM Personal Computer" is a versatile, reasonably priced computer with many advanced hardware features that have set new industry standards since the computer's introduction. It could increase productivity in business, at home, or

wherever it is used. Its true capabilities are a function of your own imagination and creativity." (cf. www.computerhistory.org)

Vendors, retailers, and media represented a large group of activists who, collectively without any intended coordination, led the public discourse about personal computing resulting in a vast distributed CM. One of the most famous mass media advertisements is Apple's "1984" Super Bowl commercial (cf. en.wikipedia.org/wiki/1984_(television_commercial)) in which Apple launched its Macintosh PC during a break in the third quarter of Super Bowl XVIII. The ad showed a young woman running through a futuristic world to throw a sledgehammer at what was implied to represent IBM Corporation as a way to show the demise of mainframe monopoly and the rise of the Macintosh PC. At the end, the following message was displayed referring to the novel, 1984 by George Orwell, in which technology is viewed as dystopian with a computer-system dubbed "Big Brother" watching peoples' everyday lives: "On January 24th, Apple Computer will introduce Macintosh. And you'll see why 1984 won't be like 1984.

The productivity theme surfaced often in the early writings about the wonders of PCs, but was focused on "personal productivity" with organizational productivity as a by-product. Eventually, the PC became a household item where the number of American households owning a PC went from 8% in 1983 to 62% in 2003 (55% of those households had Internet access). Along with the investments by companies into outfitting their business with PCs came an interest and corresponding surge in the purchase of networking hardware and software. Companies began networking PCs together into client/server Local Area Networks (LANs). As more and more companies invested in network technology, CM activists began promoting the democratization theme - that work groups and departments would have control over their own computing rather than be subservient to the high priests in the MIS Department, and that as a

result of this control over information, they would also gain more power and influence within organizations, leading to the end of hierarchy.

One of the key beliefs regarding organizational productivity during this era was that computer-supported group work had the potential to exceed what had been achieved with PCs used by individuals (Bullen and Bennett, 1991). Researchers and vendors started promoting the use of computer-supported cooperative work (CSCW) systems to facilitate information sharing and collaboration. Furthermore, the democratization frame was emphasized proclaiming that CSCW systems would transform communication in organizations so that almost everyone in an organization would have access to organizational information and be empowered to make decisions. Forecasts were made by researchers that new technologies would decentralize authority, engage employees at all levels of a typical hierarchical organization, and create collaborative work settings (Castells, 2000; Leavitt & Whisler, 1958; Wilke, 1993). While some studies of organizational communication have shown that computer-mediated communication (CMC) can enhance levels of information exchange (Sproull & Kiesler, 1991; Quan-Haase & Wellman, 2006), others have shown it has had little effect on organizational structure (Franz, Robey, & Koeblitz, 1986; Roehrs, 1998; Zack & McKenney, 1995).

The Internet Era [B]

With the advent of e-mail and widespread use of the Internet, media and academic writers began emphasizing the advantages of CMC technologies with the themes of democratization, death of distance, and information rights. Studies by scholars (Sproul & Kiesler, 1991; Mantovani, 1994) on the use of CMC in organizations to engender democracy in managerial-employee relations emphasized the dependence on the social context of CMC and on the rules

determining its use. Several specific CMs were activated during this period such as computer games, digital photography, desktop computing, information rights, and community networking to name a few. When use of the Internet became widely available through web servers and browsers such as Netscape during the 1990's, PC vendors started including modems and connectors for broadband technology.

During the late 1980's, businesses and universities began taking advantage of the availability of LAN and wide area network (WAN) connections to use e-mail for internal and external communication. Businesses began wiring PCs together for peer-to-peer networks enabling individuals to communicate globally. With the advent of the Web and Internet browsers such as Netscape and Microsoft's Explorer in the early 1990's, many more people could easily access information and exchange data on a trans-global scale. The themes of productivity, democratization, and death of distance were promoted in academic and mass media publications. The Internet with its "network of networks" links over two million host or server computers around the world.

The Internetworking CM (Iacono & Kling, 2001) incorporated more activists than previous eras due to the increasingly computer-literate public who serve as activists in businesses and homes. Government sponsored initiatives such as the National Internet Infrastructure (NII) promoted the spread of Internetworking use during the 1980's. During the 1990's with the advent of the Web, more and more individuals and businesses created Websites which also served as venues for CM activists. For example, the Free Software Foundation (FSF) and the Open Source Initiative (OSI) both created Websites during this period to promote membership in their foundations in support of the F/OSS movements (cf. www.fsf.org and www.opensource.org).

The non-profit FSF was established and proliferated during this era and continues today to promote the freedom and information rights themes. As a result of the availability of broadband connections, many new CMs emerged during the Internet Era such as distributed work, CSCW, knowledge management, F/OSS, E-business, E-democracy, and E-Health among others. Many of the CMs that emerged during this era are ongoing and their outcome is yet to be determined. Two examples of relative success in terms of diffusion are the F/OSS movements. The Free Software Movement (FSM) CM is an interesting example of a new genre of CM which emerged during this period (Elliott, Chapter 13, this volume) in which the acquisition of technology is assumed to be readily available and the mobilization for membership in the CM is related to software development of free software (as opposed to purchasing new technology). The utopian vision of eliminating all proprietary software and replacing it with free software is so far-fetched that it will probably never be realized. However, this movement has reached a certain level of diffusion with regard to its software projects. The www.gnu.org Website now boasts about 43,000 registered GNU projects with about 2,800 registered users, so it has made an impact on the development and use of software systems in our society. Their counterpart, the OSI organization, lists over one million projects with about 100,000 users (www.opensource.org). Since they advocate mixing free and proprietary source code, the OSI's membership has swelled faster than the FSM. The increasing use by businesses of the GNU/LINUX operating system is a testament to the successful diffusion of the F/OSS. The study by Dedrick and West (Chapter 16, this volume) illustrates how the ideology of the FSM is not a factor when businesses decide to use open source software as an option. They are more interested in profit savings and reduction of dependence on vendors for software changes. Two papers in this book illustrate the difficulties in implementing distributed work technology for video

conferencing in organizations (Kiesler, Chapter Nine; Mark, Chapter Ten). These CMs are discussed in more detail in the discussion section below.

The Emerging Era of Ubiquitous Computing [B]

The "ubiquitous computing" era takes it name from the term coined by Mark Weiser at the Computer Science lab at Xerox PARC. He envisioned future computing devices that would fade into the background of peoples' lives, becoming more or less invisible (Weiser, 1991). During the period of 1988-1994, Xerox PARC built several experimental devices to support this vision in the form of "tabs," "pads," and "boards." Tabs are inch-scale machines that resemble active Post-It notes; the pads are foot-scale ones that are similar to a sheet of paper (or a book or a magazine); and the boards (which are now commercial products) are yard-scale displays that are the electronic equivalent of a blackboard or bulletin board.

Activists of this CM predict that people will use "wearable computing" with devices becoming part of clothing, connecting people to each other via wireless technology. Indeed, wireless technologies such as PDAs and mobile phones have become extremely popular, particularly in Asia and increasingly in Europe and the U.S., for providing access to the Internet, instant messaging, digital cameras, computer games, video clips, and execution of Java programs (Mattern, 2001) and are becoming popular with business executives, professionals and academics for constant e-mail access (Middleton & Cukier, 2006).

But, the ubiquitous computing CM is not just about hardware devices. So-called "ubiquitous software development environments" are now being promoted by F/OSS developers. For example, the MIT Project Oxygen has a vision of computation focused on the ability of users and accompanying technology to move around freely in a nomadic environment, according to

their needs (www.oxygen.csail.mit.edu/Overview.html). Several technical challenges wait, as the requirement for Oxygen systems must be “pervasive,” “embedded,” and “nomadic.” Software systems will adapt with minimal user intervention and without interruption to services they provide. An example of this nomadic-type system is the Knoppix GNU/Linux distribution available on a real-time CD that boots and runs the Linux operating system completely from the CD. Users of Knoppix can work on software development on any hardware platform that accepts Linux, providing F/OSS developers the ability to work on F/OSS projects “anytime, anywhere” in the world.

As this software sub movement illustrates, the utopian vision created by Weiser (1991) inspired others in industry and academia to follow. It led to the creation of annual workshops and conferences such as the IFIP UBICOMP (Ubiquitous Computing) workshops (Dourish, 2006) and the IFIP Working Group 8.2 conferences (e.g., “Designing Ubiquitous Information Environments: Socio-Technical Issues and Challenges” (Sorensen, Yoo, Lyytinen, & DeGross, 2005). Specialty academic journals have formed such as IEEE Pervasive Computing, Journal of Ubiquitous Computing and Intelligence, and Personal and Ubiquitous Computing. Although the movement has been largely confined to industry and academic circles, it is beginning to have traction in the public media as the wearable Apple iPod has become ubiquitous almost overnight.

The potential for CM activists during this era include just about everyone everywhere due to the widespread prevalence of Internet connections and handheld devices for instant communication, such as the popular Instant Messaging (IM) which enables silent messaging using handheld devices. Now CM discourse can be found on blogs, wikis, and special Websites for communicating personal thoughts to the world at large (cf. www.myspace.com).

The Ubiquitous Computing Era promotes a utopian vision that people will be able to connect to other people and computers "anytime, anywhere" and that this will be unambiguously beneficial to individuals, organizations, and society. However, we show in the discussion sections below that the realization of being connected "anytime, anywhere" is not always as utopian as CM activists portray it.

Generalizations Concerning CMs [A]

Looking across these eras of computerization, and the material presented in the chapters of this book, we develop six generalizations with implications for the emerging era of ubiquitous computing and for future research and practice.

Gap between CM Vision and Reality [B]

The case studies show a persistent, and sometimes large gap between the vision and reality of CMs. Examples of this gap range from the use of the Internet to improve democratization in organizations (Quan-Haase and Wellman, Chapter Six) and communities (Carroll, Chapter Seven) to large-scale implementations of communication technologies to improve collaboration among distributed teams in national and multinational corporations (Kiesler et al., Chapter Nine; and Mark, Chapter Ten).

The gap between the expectations of the "democratization" frame and the reality of use are evident in the organizational case study by Quan-Haase and Wellman (Chapter Six). The vision of technology creating a more democratized organization did not come to fruition in their study of instant messaging (IM) and e-mail in a high-tech organization. Employees of the firm KME used both technologies for local and global communication, but the expectation that this

would lead to flattening of the firm's hierarchical management structure did not occur. Workers focused more attention on and responded quicker to IM or e-mail from a superior than from a colleague. Although an increase in egalitarian relationships between management and workers did not occur, there was greater collaboration among co-workers within and between departments. In Carroll's (Chapter Seven) study of Blacksburg, West Virginia, the entire community had been networked with the vision that citizens would become more civic minded and community-oriented. However, the technology merely reinforced the civic involvement of people who were already interested in the community affairs. Thus, in both the organization and the community cases, there was a considerable gap between the CM vision of "democratization" and the actual use of such technology to "democratize."

There was also a gap between vision and reality with regard to the "death of distance" theme of CMs. Kiesler and colleagues' (Chapter Nine) study of the American Institute for Research (AIR), showed that groupware that had been adopted to enable virtual meetings among distributed teams, was used for low-level day-to-day business operations because the technology could not support higher level activities. As a consequence, AIR used face-to-face meetings for decision making and complex coordination and virtual meetings for routine messaging and exchange of information. Mark (Chapter Ten) identified an unanticipated consequence of technology use with distributed teams - one not addressed in CM discourse on the death of distance. She found that a large engineering team located at different sites faced serious tensions between the demands of their collocated, local environments and those from the overall team management. The utopian vision is that the technology enables people to collaborate easily, but its implementation failed to address the need to establish complementary social conventions to deal with the conflict in demands between local and global environments.

As these chapters illustrate, the reformist rhetoric in CM visions of what the technology can do for organizations and society tends to differ from the reality of use. Vendors and other promoters of particular CMs need to recognize that such gaps between utopian visions and the reality of technology use may prevent successful diffusion. Users, in particular, need to be aware of the impending gap between the benefits promoted by CM activists (vendors, technologists, media, academics) for a newly formed CM vision and the actual costs and benefits, including the distribution of costs and benefits. In addition, these chapters suggest that the utopian visions for "anywhere, anyplace" ubiquitous computing are likely to be very difficult to achieve. As illustrated in Sorensen and Gibson's chapter (Chapter 17) on the use of PDAs and cell phones by professionals, there is a need for technical staff to provide on-going support to ensure integrity and security of organizational information because most users simply cannot do it on their own. Indeed, learning to use and maintain these devices poses challenges that make the device appear as a "disturbing nuisance" rather than a "calming assistant" as claimed by Weiser (1991).

CM Rhetoric Shifts from Utopian to Pragmatic [B]

The cases in the book have shown that as technology is deployed and used, the related CM rhetoric eventually shifts from utopian to pragmatic as described in our conceptual model in Chapter One. Experience with technology use results in contending discourse that leads to counter-CMs, changes in design or changes in use of the technology and, in turn, to change in the dominant technological frame or vision that promotes its use. This occurs when people develop greater understandings of the technology's use, when they adopt selected aspects of the technology, or when they focus on areas of the technology's greatest benefit to them. This

evolution towards pragmatism can lead to a new CM or to modification of the original CM vision that is more suited to realistic work practices.

The digital camera CM illustrated by Meyer (Chapter Five) is an example of this shift in paradigmatic view in discourse. In the initial stages of the production and sales of digital cameras, the magazine and Web discourse promoted the advantages of digital cameras peppered with utopian predictions of what this type of camera could do for a professional photographer's productivity. The initial costs, which were in the range of $5,000 to $7,000, could be justified by professionals but were beyond the general public's reach. As prices closed on $1,000, the advantage of using digital cameras by the general public began to appear in public discourse, but grew dramatically when lower priced ($300-$500) digital cameras became available. Visions for the camera's use shifted to everyday rationales related to personal and family use. Digital photograph quality improved dramatically at the same time as prices fell. Thus, by the end of 2004, a high-quality camera with four to five mega pixels could be purchased for $200-$300 with high-end six mega pixel cameras for under $1,000. The shift in the technology, and in the vision and rhetoric about the inherent value of digital photography helped to spur digital camera purchases from 6.5 million units in 2001 to 15.7 million units by 2004 (Gleeson, 2004).

Thus, CM rhetoric tends to shift from the utopian to the pragmatic over time, as participants become aware of the actual uses and impacts of new technology. However, the time gap for such information to reach decision makers, organizational users, and the general public can be large. Thus, there is a clear role for social informatics research to speed up feedback about usability and impacts of new technology to designers, user organizations, the media, and the general public.

Diffusion Time Longer for CM Technology with Complex Infrastructures [B]

For those CMs in which the technology and surrounding infrastructure are broad, complex, and multi-faceted, it takes longer than usual for the technology to diffuse. Markus and colleagues' (Chapter Three) example of automated underwriting in mortgage banking provides an excellent example of how this occurs when user applications rely on large physical infrastructure, which itself underwent repeated change during the 20 year period of the case (see earlier discussion in this chapter). Elliott (Chapter 13) and Dedrick and West (Chapter 16) illustrate how the complexity of the human infrastructure can also slow diffusion. Elliott's analysis of the FSM gives examples of how a free software project - GNUe (www.gnuenterprise.org) - sought to build a business application intended to replace proprietary ERP systems. The project had only one-half the planned modules completed and only 15 companies using them after ten years of work.

Dedrick and West's (Chapter 16) study of Linux use found that, contrary to the FSM and OSI movements' vision that source code should be free so that users can modify it as they wish, business users were adopting the technology primarily for low cost and freedom from the vendor lock-in that comes with commercial software (e.g., Windows, Unix). They were agnostic about the ideologies of the FSM and OSI movements, but very concerned about the stability and the support infrastructure for Linux-based applications - the chief factor reported as preventing greater diffusion. These examples illustrate that as the Internet has made available a global physical infrastructure, the human infrastructure becomes a more significant factor shaping technology diffusion.

Difficulty in Technology Prediction and CMs [B]

As the foregoing sections illustrate, the realities of day-to-day use of a CM's promoted technology cannot be precisely predicted in advance. Often the outcome of a CM evolves to include unexpected uses of the technology promoted by a CM, and these may swamp the original intended uses. For example, Culnan (Chapter Eight) reports that the Bruce Springsteen (BTX) online Website and chat rooms/bulletin boards were set up for fans to meet online and exchange tickets, but the site has evolved to promote donations to charities recommended by Springsteen. Ekbia and Gasser's (Chapter 15) analysis of the reliability of F/OSS systems shows that some outcomes are totally unexpected. Their study of the bug reports of F/OSS systems showed that some bugs are inherently difficult to resolve in the F/OSS method of software development because of its decentralized nature. The software proponents of F/OSS promote the CM by proselytizing the benefits as more reliable than typical software systems due to the many "eyes" that view and fix the code (Raymond, 2001). In reality, some bugs might never get resolved. Ekbia and Gasser found 129,000 problem reports listed in the bug reporting system for Mozilla, yet only 88,000 had been resolved over a five year period. For one particular bug, there were 280 comments over the period, yet the bug remained open. Traditional software development, with a central manager responsible for a project, is much more successful at ensuring bugs are fixed than the decentralized approach touted by the F/OSS movement. As the old adage goes, "when everybody is responsible, nobody is responsible."

Thus, the capabilities of the technology are almost never what is advertised in the vision of the CM by the activists, whether vendors, users, journalists, or academics. This is exacerbated by the promotion rhetoric surrounding technology introduction and use. Vendors have an economic interest in promotion of benefits and downplaying costs and problems. Even if

problems are known by the vendors, they have commercial interests in not sharing them with users. Thus, it may take users a long time to find out that the promoted vision does not match reality. It may also take vendors a long time to realize that their vision does not fit the reality of the market and what users want or need (Allen, Chapter Four). Once they have invested in new technology, users also have an interest in highlighting the positive and downplaying the negative. Journalists can be independent and take a critical stance, but their deadline driven work tends to prevent follow-up and long term analysis of new technologies. Only academics are in a position to take the long view and do serious social analysis of the uses, impacts, and interactions of technology and organizations. In the short to mid-term, however, academics can provide useful assessments and predictions by looking for parallels in the experiences with earlier technologies.

For example, in the book Computers and Politics (Danziger, Dutton, Kling and Kraemer, 1982), the authors argued that although the findings were based on the mainframe era, they applied to subsequent eras (mini-computer and PC) because they were based on fundamental relationships between technology, organizations, and people. The authors argued that the central concern of the Computer and Politics book for greater equality of access to computing resources in governments had not been resolved by the advent of the PC, despite the rhetoric of democratization in the PC era. The continuing concern about democratization in the Internet era in chapters by Quan-Haase and Wellman (Chapter Six) and Carroll (Chapter Seven) illustrates that neither the democratization of computing, nor of governments had been greatly advanced by any of the technologies although they are increasingly used. The theoretical rationale supporting Danziger and his colleagues' argument was the "reinforcement politics" hypothesis, which posits that computing will always be used to reinforce the existing political and managerial elites in organizations and society.

This example illustrates the need for, and the usefulness of, academic efforts to do long-term technology assessments based on their own and others' research. Rob Kling was often heard to say that technology impact assessments ought to be required for IT projects in the same way that they are required for environmental projects, and that the information and computer sciences would do well to provide students with the tools to do so.

Context Shapes Computing Use and Effects [B]

Perhaps the most fundamental theme in the CM literature is that computing use is shaped by the organizational and institutional context, including the political context. This was illustrated in the work of Markus and colleagues, Quan-Haase and Wellman, Mark, and Lamb and Poster (in their discussion of the politics of information sharing in intranets, Chapter11). Dutton (Chapter 19, this volume) also illustrates this point in his chapter on the conceptualization of the Internet emergence and ongoing maintenance as an "ecology of games." The games perspective compliments the CM perspective by helping to explain the intertwined social, technical, organizational, and other forces that shape the emergence of changes tied to the increasingly ubiquitous use of the Internet. In this chapter, Dutton illustrates how social movements, such as the CMs whose goals are to promote open source or to employ ICTs for development, are critical to many games shaping the future development, use, and governance of the Internet.

Mark Ackerman (Chapter 18) points out that the technology's architecture might carry hidden assumptions about political relationships among the stakeholders who construct, adopt, and use computing. He analyzes two CMs - the Semantic Web and pervasive computing - and shows that the technologies being built with non-transparent political assumptions about the

relationships among the stakeholders. Ackerman argues that neither of these CMs deals sufficiently with the tension of updates and maintenance and who will control competing designs in the future. He suggests that because of its participative roots, the Web might move towards democratic efforts to reconcile differences, but it also could be controlled by corporate concerns, given its historical mixture of F/OSS and corporate-sponsored software and projects. Ackerman's analysis suggests that although many of the CMs described in this book evolve from the libertarian-infused infrastructures of the Internet, networking technologies and distributed computing, how these disparate parts work together in the future to ensure the resolution of conflicts is an empirical question.

Computing technologies and their architectures have political implications about the distribution of costs, benefits, and control, which are seldom apparent to all participants in CMs. These political implications are often buried in CM rhetoric, and therefore it is incumbent upon participants to bring them into the open.

Conclusions [A]

The main focus of this book has been on the question of why organizations adopt computing technologies. The simplistic answer is that organizations can achieve economic benefits from computer use (i.e. improved productivity), but a richer answer can be found in the concept of CMs. We used the CM construct from Kling and Iacono (1998) to characterize adoption decisions as occurring within the broader social context of organizations, where public discourse about computerization in general, and specific technologies in particular, create utopian visions about the benefit of computer use. These visions are created and promoted by futurists, vendors, journalists, academics, and organizational users who play various roles as

activists, followers, sideliners, skeptics, and critics; all are participants in a special kind of technological social movement that influences how people think about computing and communications technology and thereby shape technology decisions in organizations and society. These movements tend to have an underlying bias towards computerization, and although occasionally there are counter movements that temporarily halt or redirect things, and although there may be disappointing gaps between the vision and reality of specific movements, the overall effect of CMs is to create a pro-computerization bias "in the air." The study of CMs is intended to deepen understanding of how these movements form, evolve, and have impacts in organizations and society.

Contributions [B]

In their seminal publication on CMs, Kling and Iacono (1988) characterized the effort as "…a first step in bringing attention to the evolution of CMs and how they influence organizations and societies." This book is a second step that has sought to extend research into CMs in several ways: (1) bringing together a group of leading researchers in social informatics to address CM theory and concepts in their work; (2) addressing contemporary CMs focused around the Internet; (3) showing how CMs have changed since the earlier research by Kling and Iacono; and (4) drawing implications from earlier computerization eras for the emerging era of ubiquitous computing and for research and practice.

This book includes chapters by 32 authors from the U.S., Canada, and Europe. The authors were specifically commissioned to apply CM theory and concepts to their work for this book. Therefore, this book is the single largest collection of research on CMs to date.

Although some specific CMs such as automated underwriting in the mortgage banking industry extend over several eras, nearly all the CMs described in this book have been fueled by the rise of the Internet and are contemporary. The free Internet and Web technology have made a larger number of applications possible, helped them to reach millions of potential CM participants, and enabled many of them to flourish as a result of such broad reach. The technological action frames of "death of distance," "democratization," and "freedom/information rights" can all be attributed to the vast array of Web information and applications that have become available on a global scale over the last 10-15 years.

Another change is that the technological action frames or themes of earlier CMs have extended into later CMs and computerization eras, although sometimes defined in different ways. For example, the theme "productivity" referred to labor savings in the mainframe era; to "greater output for the same labor" in the PC era; and to "productivity in collaboration among distributed teams" in the Internet era. In addition, subsequent CMs adopt more than one theme such that a contemporary CM might encompass all that have gone before. This can be seen in the Virtual Teams CM (Kiesler et al., Chapter 9, this volume) in which both organizational and individual productivity are promoted through the use of virtual teams with sophisticated networking technology.

A major change in the nature of CMs is scope of influence and the rapidity with which they can influence vast numbers of people to invest time and money into new technology promoted by CMs. For example, consider the latest handheld device, the Blackberry, in comparison to the "old" CM that promoted AI technology. The AI CM started in the 1960's in academic circles. Businesses began investing in expert system development and implementation in the 1970's, AI was transformed into a CM in the 1980's when mainstream business

magazines (e.g., Fortune, Business Week) and noted academics began to write stories about AI applications that aggressively promoted a fantasy vision of powerful and accessible AI being "here today." Thus, AI technology moved slowly over the course of a 20-year period before becoming a CM. In contrast, Blackberry PDAs first came on the market in 1999 and by 2006 (only seven years later), there were nearly five million people acting as active proponents and users of Blackberries for reading and sending e-mail “anytime, anywhere.”

Not only can CMs generate membership faster than in previous decades, CMs have taken on a global aspect to their mobilization for membership. Even third world countries are exploring ways to leverage hand-held technologies (PDAs, smart phones, miniPCs) and open software such as Linux as a means of providing computing capabilities to impoverished populations. The Shuttleworth Foundation (www.tsf.org.za) funds efforts to educate people in Africa by sponsoring F/OSS projects that enable more people to have computers and Internet connections. One recent project entails the implementation of kiosks in libraries and other public places in areas where Internet connections are too expensive or impossible. All people need is a CD to take advantage of these kiosks which offer “free” downloads of F/OSS software for people who otherwise would not have access to such products of the F/OSS CM.

A final change in the nature of CMs is that they are starting to merge as suggested by Scacchi (Chapter 14) and Clement and Hurrell (Chapter 12), and the influence of specific CMs will not only continue to reach membership on a global scale, but increase in size and potential impact.

Implications [B]

The studies and cases in this book suggest several implications for designers, managers, users and scholars in the ubiquitous computing era.

Designers - People designing ubiquitous computing devices, applications and systems need to be aware that the utopian visions of much, if not most, CM rhetoric rarely becomes reality. Unrealistic visions may not do well in the market and represent an opportunity cost for the vendor. Designers also need to be more aware of the negative aspects of their designs, such as the addictive nature of instant messaging, interactive gaming, and other problematic activities enabled by mobile devices (Middleton & Cukier, 2006). Privacy issues should also be considered when designing ubiquitous computing devices, especially devices that are part of sensor laden environments and "wearable" computing that may intentionally or unwittingly assault individual privacy in the name of security or health (Jarvenpaa, Lang, and Tuunainen, 2005). Designers also need to pay attention to the complexities inherent in Web-based technology and political implications must be carefully considered in the design of future systems.

Managers and Professionals - Executives, managers and professionals need to be more sophisticated consumers of computing rather than simply responding to vendor and media discourse regarding the "next big thing" in computing. Technology professionals along with users can conduct careful analysis of the fit of new technology with particular individuals and groups in the organization, perhaps even investing in experimental uses, before a broad commitment. Managers considering investment in ubiquitous computing devices such as Blackberries or MP3 phones should be aware of the addictive nature and possible misuse of these technologies such as the potential for identity theft (Mazmanian, Orlikowski, & Yates, 2005; Middleton & Cukier, 2006). Middleton & Cukier, 2006) conducted a study of Blackberry

usage patterns finding them to be both negative – dangerous, distracting, anti-social and infringing on work-life boundaries – and at the same time, positive – increasing efficiency, enabling multi-tasking, improving response time to managers, and providing freedom to work "anywhere, anytime". Middleton and Cukier (2006) suggested that businesses and individuals need to be cautious of negative consequences when using Blackberries, and consequently, to try and determine which work practices really warrant being connected "anytime, anywhere."

Given the potential problems with these devices, managers, executives, and professionals might want to consider measures such as clearly de-limiting their use for work, home and home-work life connections. Even when there is a clear fit of technology with the organization's activities, managers need to consider how assimilation will occur as the cases in this book illustrate that some people may not be able to easily adapt to new technologies without adequate preparation or training (Mark, Chapter Ten; Kiesler, et al., Chapter Nine).

Organizational Users – Organizational users have the most at stake in understanding CMs because they make the investments in technology. They need to become sophisticated consumers of computing and communications technologies and skeptical of utopian claims for the technology. In the emerging era of ubiquitous computing, they need to be aware that Ubicomp devices and applications that enable work connections "anytime, anywhere" will involve frequent replacement during this period of radical innovation with many different kinds of products, and continuing support for a wide variety of products. These devices may also have problematic side effects such as addiction, intrusion on personal work time, obnoxious disregard for social etiquette, and intrusion of work life into home life.

CM Scholars - Academic and industry researchers have a tremendous opportunity to apply CM analysis and concepts to the emerging Ubicomp devices. In doing so, it would be

useful to engage in more historical analysis of previous technologies and to bring knowledge about the effects and implications of previous technologies to bear on predictions about new technologies. The insights and tools used in such analysis and prediction might form the basis for educational programs aimed at training a new generation of social analysts and practitioners who can do useful technology assessment in both vendor and user organizations.

At the most recent IFIP workshop on ubiquitous computing, Yvonne Rogers (2006) published a very significant paper suggesting that the technically-oriented research and design efforts in ubiquitous computing needs a new direction. She identified three areas of current ubiquitous computing research and their key limitations:

- Context-Aware Computing – Detecting, identifying, and locating people's movements, routines or actions with the purpose of assisting people with this information. For example, the military originated the term "augmented cognition" to assist human cognition in the sensing of what is happening around them with recommended actions. Context-aware computing works best in highly constrained environments given the complexity and difficulty in modeling predictable human behavior, and thus, it is unlikely to be effective on a grand scale.
- Ambient/Ubiquitous Intelligence – Computational intelligence involving both physical and digital worlds where "smart devices" will be capable of predicting people's needs and reacting accordingly. Ambient and ubiquitous intelligence has proven equally difficult to implement in workable systems on a large scale.
- Recording/Tracking and Monitoring – Ubiquitous computing systems with sensors for alerting caregivers concerning the whereabouts and health of the elderly and

physically and mentally disabled individuals. Privacy and ethical problems arise when using such systems that are not easy to resolve.

Rogers (2006) suggests that ubiquitous computing researchers change the direction of such work, given the limited success of current research. Rather than attempt to resolve these grand challenges, she suggests that researchers pursue more limited goals focused on specific activities performed by people in bounded locations. This requires that researchers move "…from a mindset that wants to make the environment smart and proactive to one that enables people, themselves, to be smarter and proactive in their everyday and working practices."

Finally, there is another mindset that might warrant change on a broader scale. It is an inherent problematic of the utopian rhetoric of a positive future from technology-driven change even in the fact of evidence to the contrary. There is too much of a tendency in the computer, information and communications communities to follow the "preachin," "accentuate the positive" and "eliminate the negative" suggested by Johnny Mercer in his popular song of the 1940's, "Accentuate the Positive," shown in the selected lyrics below.

Gather 'round me, everybody
Gather 'round me while I'm preachin'
Feel a sermon comin' on me
The topic will be sin and that's what I'm ag'in'
If you wanna hear my story
Then settle back and just sit tight
While I start reviewin'
The attitude of doin' right

You've got to accentuate the positive
Eliminate the negative
And latch on to the affirmative
Don't mess with Mister In-Between

You've got to spread joy up to the maximum
Bring gloom down to the minimum
Have faith or pandemonium's
Liable to walk upon the scene
To illustrate my last remark
Jonah in the whale, Noah in the ark
What did they do just when everything looked so dark?

(Man, they said "We'd better accentuate the positive")
("Eliminate the negative")
("And latch on to the affirmative")
Don't mess with Mister In-Between (No!)
Don't mess with Mister In-Between

Source: Lyrics from http://www.lyricsdepot.com/Johnny-mercer/accentuate-the-positive.html

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