E-Collaboration: Concepts, Methodologies, Tools, and Applications

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ABSTRACT

This chapter begins with a historical view of the development of electronic collaboration (e-collaboration) technologies, and a look at past research on e-collaboration. It then provides a discussion of fundamental theories of electronic communication (e-communication) and e-collaboration, and of fundamental concepts in e-collaboration. This is followed by a discussion of key issues in connection with managing organizations with Web-based e-collaboration tools, and with using e-collaboration tools to improve university teaching. Next, the chapter provides a discussion of organizational and social impacts of e-collaboration tools, where the fundamental notion of compensatory adaptation is presented. In the concluding section, the issue of how e-collaboration can be designed to facilitated e-collaboration is explored further.

INTRODUCTION

The ability to create and use technology to significantly change the environment that surrounds us is arguably one of the most distinctive characteristics of us humans. No other animal has this ability developed to the extent that we have. Some of the most significant turning points in human civilization have been marked by technological innovations that have increased our ability to store, transport, and communicate information and knowledge. From cave paintings, to the printing press, to e-mail, innovations in communication technologies have significantly changed how we interact with others, and with whom we interact.

This has been particularly true of modern electronic collaboration (e-collaboration) and electronic communication (e-communication) technologies that rely on the processing power of computers, lo-
cally or remotely (e.g., through mobile devices). These technologies challenge conventional notions of media and its use. It is estimated that there are hundreds of millions of users online on the Internet, creating entirely new social situations and communication behaviors. The use of e-collaboration and e-communication technologies for work is commonplace today. E-collaboration and e-communication are becoming an integral part of our lives, at work and at home.

E-collaboration is operationally defined here as collaboration using electronic technologies among different individuals to accomplish a common task. E-communication, on the other hand, is defined as communication through electronic technologies, whether it is for collaborative purposes or not. The definition of e-collaboration adopted here is a broad one that encompasses not only computer-mediated collaborative work, but also collaborative work that is supported by other types of technologies that do not fit most people’s definition of a computer. One example of such technologies is the telephone, which is not, strictly speaking, a computer—even though some of today’s telephone devices probably have more processing power than some of the first computers back in the 1940s. Another example of technology that may enable e-collaboration is the teleconferencing suite, whose main components are cameras, televisions, and telecommunications devices.

The above operational definition, which will be used as a basis for the discussion of other related issues in this chapter, is arguably very broad. Yet, it is probably clearer than the general view of e-collaboration in industry, which some may also see as a bit unfocused. For example, some developers of e-collaboration tools, such as Microsoft Corporation and IBM, emphasize their technologies’ support for the conduct of electronic meetings over the Internet. There seems to be a concern by those developers with offering features that make electronic meetings as similar to face-to-face meetings as possible.

Industry information technology publications such as CIO Magazine and Computerworld, on the other hand, often tend to favor a view of e-collaboration technologies as tools to support business-to-business electronic commerce and virtual supply chain management over the Web. These are business activities that are arguably substantially different from electronic meetings, both in terms of scope and main goals. The primary audiences of industry information technology publications are information technology managers and professionals, who are the consumers of e-collaboration technologies. Given that, one can imagine the possible misunderstandings that may take place when those managers and professionals get together with developers’ sales representatives to discuss possible e-collaboration technology purchases.

The main goals of this chapter are to clearly illustrate what e-collaboration technologies are, what they are not, and what they are capable of contributing to individuals, groups, organizations, and society as a whole. This chapter attempts to accomplish this goal by providing an overview of concepts, theories, tools and applications related to e-collaboration technologies. Also covered to a certain extent is the cousin area of e-communication. E-communication has preceded and essentially provided the basis on which e-collaboration has taken place, and to a large extent these two cousin areas evolved together.

A HISTORICAL VIEW OF E-COLLABORATION

Strictly speaking, e-collaboration could have begun as early as the mid-1800s, with the invention of the telegraph by Samuel F.B. Morse. However, that invention was probably too cumbersome to be consistently used to support the work of individuals engaged in common tasks. Even the invention of the telephone in the 1870s, and its wildfire-like diffusion in the coming years, was not enough to usher in the e-collaboration age.
In fact, e-collaboration did not become a reality with the emergence of the first commercial computers after World War II either. Those computers were generally referred to as mainframes. At that time, organizations were very centralized, which inhibited collaborative work. Moreover, mainframes were then seen as too expensive to be used to support communication and collaboration among groups of individuals. The relatively high cost of mainframes, especially when compared with the cost of labor at the time, restricted their use to very specialized tasks, usually conducted only by specialized operators. Mainframe use was not distributed; it was highly centralized.

Arguably, one of the first and most successful e-collaboration tools, a version of e-mail, was in fact a spin-off of a large wide area computer-networking project called ARPANET. This project was sponsored by the U.S.A. Department of Defense, and was originally implemented in the late 1960s. As the frequently repeated story goes, ARPANET’s inventors did not seem to envision it as an infrastructure to enable group communication or collaboration (Kock, Davison, Ocker & Wazlawick, 2001). At the time of its initial development, ARPANET was apparently seen primarily as a means for researchers and computer scientists to share expensive mainframe resources. Yet, between the early 1970s and 1980s, e-mail was discovered and used by thousands of those researchers and computer scientists. While its developers did not see it as much more than a toy system at the outset, email has become an essential e-collaboration technology.

As the ARPANET grew, so did the use of e-mail. At the same time, new computer chip manufacturing techniques enabled the development of large-scale integrate circuits, with much lower cost and physical space demands than the circuitry used up until then in mainframe computers. This, in turn, led to the development of personal computers that were smaller, less expensive, and often more powerful in terms of processing power than many of the early mainframes. Soon these personal computers were connected into local area networks (LANs) though LAN operating systems, whose market was initially dominated by Novell Corporation with its NetWare operating system.

The wide area network infrastructure created by the ARPANET, together with the development of personal computers and LANs, provided the environment in which early e-collaboration technologies flourished in the 1980s. Some of those technologies, such as Information Lens and The Coordinator, extended the functionality of early e-mail systems. Other e-collaboration technologies, which later become known as group decision support systems (or GDSSs), were aimed at improving the efficiency of same-room-same-place group meetings through features such as anonymous and simultaneous idea generation and voting. Examples of early GDSSs are GroupSystems, Teamfocus, and MeetingWorks. Still other e-collaboration technologies, such as Lotus Notes and Domino, allowed users to create asynchronous e-collaboration spaces. For this reason, they were often called e-collaboration system development suites. These latter e-collaboration technologies were somewhat similar to some of today’s e-learning environments (e.g., Blackboard, WebCT, Angel), but were operated in a more programming-like manner, and provided fewer e-collaboration features to their users. For example, WebCT allows for the easy creation of chat rooms, for synchronous interaction; something that was not easily implemented through early e-collaboration systems development suites.

The early 1990s saw what once was the ARPANET evolve into today’s ubiquitous Internet. Essentially, the Internet is a worldwide network of computers made up of many LANs, interacting through the same general communication protocol (i.e., TCP/IP). The Internet, in turn, provided the infrastructure necessary for the emergence of the Web, which is made up of millions of platform-dependent Web servers providing users access to static and dynamic content through platform-independent Web browsers. Today’s e-collaboration technologies are either browser-based (i.e., run on Web browsers), or non-browser-based. The latter are usually Internet-based tools enabling proprietary client software to interact with other clients either directly (peer-to-peer e-collaboration tools) or through servers (client-server
e-collaboration tools). Examples of browser-based e-collaboration tools are WebEx and eRoom, as well as the previously mentioned e-learning tools Blackboard and WebCT. Examples of non-browser-based e-collaboration tools are Microsoft Office Groove (peer-to-peer e-collaboration), and MSN Messenger and ICQ (client-server e-collaboration).

A LOOK AT PAST RESEARCH ON E-COLLABORATION

A search on ABI/Inform (a widely used database of business articles) containing the term “e-collaboration”, conducted at the time of writing, suggests that the area of e-collaboration has grown a great deal in the last 15 years, to the point of becoming a clearly distinct area of research. E-collaboration research now counts with contributions from researchers from many other broader fields such as information systems, computer science, management, accounting and engineering. The earliest articles dated back to the early and mid-1990s. Yet, research on topics related to e-collaboration has a long history, arguably dating back to the late 1970s. That research was conducted under different banners, some of which reflect distinctly different research traditions.

Among the above-mentioned e-collaboration research traditions is that of computer-supported cooperative work (or CSCW), which dates back to the 1970s, and whose first dedicated conference (called CSCW Conference) took place in the early 1980s (Bannon, 1993; Grudin, 1994). CSCW research has traditionally involved the search for technological solutions to e-collaboration problems, such as that of increasing social awareness of collaborators through the use of “avatars”—i.e., visual and often metaphorical representation of a user (e.g., a unicorn). The CSCW Conference has been regularly held since its first installment, and is considered the principal meeting point for CSCW researchers.

Another e-collaboration research tradition, of a more behavioral nature than CSCW research, is the one targeting group decision support systems (GDSSs) and their effects on group behavior. While there is no single conference dedicated to it, GDSS research has grown over the years to become of the main areas of research in the broader field of information systems. That research has usually focused on the match of GDSS tools and group tasks, particularly decision-making tasks conducted by groups of individuals meeting at the same time and in the same room. In these groups, the communication among individuals is typically mediated by computers running GDSS software.

CSCW and GDSS research can be characterized as distinct lines of research, which notwithstanding a tendency to benefit from multidisciplinary contributions, both have their own separate and somewhat independent traditions. As with most areas of research where the scope is relatively limited, CSCW and GDSS also have distinct communities of scholars associated with them, and, among those, key contributors that are widely perceived as prominent researchers in those areas.

The advent of the Internet, and particularly of the Web, caught many CSCW and GDSS researchers by surprise, in the sense that it brought in researchers from many other areas of investigation into the realm of e-collaboration research. Among those disciplines are marketing, accounting, economics, human resources management, clinical psychology, and education (just to name a few). This has led to two separate and opposing trends.

One of the trends has been the development of many sub-communities dedicated to a particular issue in connection with e-collaboration research—e.g., asynchronous learning networks (Hiltz and Wellman, 1997). Unfortunately, it seems that many of those sub-communities have been unable to (or are still trying) to identify a small set of key issues that would characterize them as legitimate and to some extent independent communities of inquiry.
The other trend is that of integrating separate communities of inquiry (including the CSCW and GDSS communities) through the identification of broad issues likely to be relevant for e-collaboration research as a whole, and the creation of publication outlets aimed at bringing together scholars of different e-collaboration research traditions. Examples of broad issues that have been presented as relevant for e-collaboration researchers in general are compensatory adaptation (Kock, 2001) and collaborative sensemaking (Nosek, 2005). Examples of publication outlets aimed at bringing together scholars of different e-collaboration research traditions are the journal *IEEE Transaction of Professional Communication* (see, e.g., Kock & Nosek, 2005), and the recently created *International Journal of e-Collaboration* (see, e.g., Kock, 2005).

**FUNDAMENTAL THEORIES OF E-COMMUNICATION AND E-COLLABORATION**

As mentioned above, the impact of e-communication at work has been the target of intense research, particularly since the 1990s, an interest that follows from earlier studies addressing communication in organizations. Part of this research tradition has followed a theoretical orientation that would appear to be at odds with the increasingly widespread use of e-communication. That theoretical orientation builds on the assumption that the face-to-face communication medium possesses inherent characteristics that make it more appropriate than other media, particularly media that suppress too many of the face-to-face communication elements, for conducting a variety of collaborative tasks. This has led to the conclusion that the use of e-communication media, which usually do not incorporate all of the elements present in the face-to-face communication medium (e.g., synchronicity, ability to convey tone of voice and facial expressions), often leads to decreased quality of outcomes of collaborative tasks. Two theories that are aligned with this theoretical notion are social presence theory (Short, Williams & Christie, 1976) and media richness theory (Daft and Lengel, 1986; Daft, Lengel & Trevino, 1987).

**Social presence theory.** Short et al. (1976) proposed the social presence theory at a time when the Internet as we know it today was yet to be conceptualized, let alone implemented. In spite of that, the theory has influenced much e-communication and e-collaboration research over the years (Sallnas, Rassmus-Grohn & Sjostrom, 2000). This theory classifies different communication media along a one-dimensional continuum of social presence, where the degree of social presence is equated to the degree of awareness of the other person in a communication interaction. According to social presence theory, communication is effective if the communication medium has the appropriate social presence required for the level of interpersonal involvement required for a task. On a continuum of social presence, the face-to-face medium is considered to have the most social presence, whereas written, text-based communication, the least.

**Media richness theory.** Daft and Lengel’s (1986) media richness theory, similarly to the social presence theory, classifies communication media along a continuum of richness, where richness is based on the ability of media to carry non-verbal cues, provide rapid feedback, convey personality traits, and support the use of natural language (see, also, Daft et al., 1987). The conceptualization of richness can be seen as more elaborate than that of social presence, which has led some to view media richness theory as a refinement and extension of social presence theory (Dennis and Valacich, 1999). According to media richness theory, matching media to collaborative tasks is based on the need to reduce discussion ambiguity (or equivocality, in the terminology used by media richness theorists). The face-to-face communication medium is considered to be the richest and most effective medium for reducing discussion ambiguity (Daft and Lengel, 1986). In contrast, e-communication and e-collaboration media in general
are not considered very rich because of their inherent limitations in, for example, carrying non-verbal cues and providing immediate feedback to those involved in communication interactions (Daft et al., 1987; Lee, 1994).

The social presence and media richness theories led to a vast amount of empirical research, and also led to many new theoretical developments. Several e-communication and e-collaboration theories have been proposed to fill gaps, enhance, or explain findings that were contradictory with the social presence and media richness theories. The discussion below provides a summary, in approximate chronological order, of organizational communication theories subsequent to the social presence and media richness theories, and that have been used in the interpretation and understanding of e-communication and e-collaboration behavior.

**Symbolic interactionism model.** The main foci of this theoretical model are the geographic distribution of and social environment surrounding e-communicators. The symbolic interactionism model has been proposed by Trevino, Daft & Lengel (1990). It argues that contextual factors such as physical separation might constrain the choice of media available, making it necessary to use media that may not be the most appropriate for a given communication interaction. The choice of media may be also be driven by its symbolic value within a given social context.

**Social influence model.** The main focus of this theoretical model is the social environment surrounding e-communicators. The social influence model has been proposed by Fulk, Schmitz & Steinfield (1990). It argues that communication media use behavior, including behavior toward e-communication media, is influenced by a variety of factors and in particular is subject to social influence. Coworkers influence each other’s media perceptions directly and indirectly. They do that directly by discussing different communication media. They influence each other’s media perceptions indirectly by making judgments about different communication media, and by interpreting different actions and events in their organizations in connection with the use of different communication media.

**Network theory.** The main foci of this theoretical model are the social environment surrounding e-communicators, and the social information processing schemas possessed by e-communicators. Network theory has been proposed by Contractor & Eisenberg (1990). It argues that communication media users, including users of e-communication media, actively co-construct meanings of messages they receive. According to network theory, not all communication is necessarily pre-planned and has predictable outcomes, and will always be influenced by the social context of communication.

**Adaptive structuration theory.** The main foci of this theory are e-communication technology features, the social environment surrounding e-communicators, social processes influencing e-communicators’ actions, and the social information processing schemas possessed by e-communicators. Adaptive structuration theory has been proposed by Poole & DeSanctis (1990). It argues that e-communication and e-collaboration technologies have two aspects: the spirit, which is defined as the intent of the technology in promoting certain objectives and attitudes such as democratic decision making; and the specific structural features designed to implement the spirit, such as anonymity in group decision support systems. Structural features, although designed to promote the spirit, are independent of the spirit and their use by different groups may vary considerably.

**Gains and losses model.** The main foci of this theoretical model are the e-collaboration medium, the e-collaboration technology features, and the task in which e-collaborators engage. The gains and losses model has been proposed by Nunamaker, Dennis, Valacich, Vogel & George (1991). It argues that, for many group tasks, gains outweigh losses when e-collaboration technologies are used to support communication in task-oriented groups. For example, more ideas per unit of time (e.g., per hour) are generated in a meeting supported by a group decision support system than an equivalent face-to-face meeting, because the system allows group members to contribute ideas without having to share “air-time” among them.
**Communication genres model.** The main foci of this theoretical model are the e-communication technology features, and the social processes influencing e-communicators’ actions. The communication genres model has been proposed by Yates & Orlikowski (1992). It argues that communication genres in organizations, such as the memo, the report, and the meeting, are viewed as social institutions that both shape and are shaped by individuals’ communicative behavior. A genre may encapsulate the communication medium used, and also expand into other media, including e-communication media. One example is the use of e-mail to send memos.

**Relationship development model.** The main foci of this theoretical model are the social environment surrounding e-communicators, and the social information processing schemas possessed by e-communicators. The relationship development model has been proposed by Walther (1992; 1996). It argues that e-communication media users, as users of other media, are driven to develop social relationships. Even though e-communication media have inherent limitations, users can adapt to them and effectively develop normal interpersonal relations, usually over a longer period of time than face-to-face or through face-to-face-like media.

**Social construction of reality model.** The main foci of this theoretical model are the social environment surrounding e-communicators, and the social information processing schemas possessed by e-communicators. The social construction of reality model has been proposed by Lee (1994). It argues that the recipients of communication messages are active producers of meaning. Interacting with e-communication media such as e-mail, users transform data into information they find meaningful, based on their existing mental schemas. This theoretical model argues that users engage in a social construction of reality by joining a communication medium as co-processors of messages.

**Compensatory adaptation model.** The main foci of this theoretical model are the e-collaboration medium, and the joint task performed by the e-collaborators. The compensatory adaptation model has been proposed by Kock (1998; 2001). It argues that better group task outcomes are possible with the use of lean e-collaboration media like e-mail as group members adapt their behavior toward technology in a compensatory way. According to this theoretical model, users of lean media tend to make generally more elaborate and better quality verbal contributions in electronic meetings than they would in face-to-face meetings.

**Task-technology fit theory.** The main foci of this theory are the e-collaboration technology features, and the joint task that e-collaborators engage in. Task-technology fit theory has been proposed by Zigurs & Buckland (1998). It argues that the type of task and the characteristics of an e-collaboration technology should present a high level of fit to enhance group performance. According to this theory, there are five main task types: simple tasks, problem tasks, decision tasks, judgment tasks, and fuzzy tasks. E-collaboration tools are classified according to three key dimensions: communication support, process structuring, and information processing.

**Channel expansion theory.** The main foci of this theory are the e-communication medium, and the social information processing schemas possessed by the e-communicators. Channel expansion theory has been proposed by Carlson & Zmud (1999). It argues that certain experiences of e-communication media users are important in shaping their media richness perceptions, namely: experience with the e-communication medium, experience with the messaging topic, experience with the organizational context, and experience with communication co-participants. According to this theory, users develop associated social information processing schema bases through these experiences that may be used to more effectively encode and decode rich messages.

**Media naturalness theory.** The main foci of this theory are the e-communication medium, and the biological information processing schemas possessed by the e-communicators. Media naturalness theory has been proposed by Kock (2004; 2005b). It argues that, other things being equal, a decrease in the de-
The degree of naturalness of a communication medium (or its degree of similarity to the face-to-face medium) leads to the following effects in connection with a communication interaction: (a) increased cognitive effort, (b) increased communication ambiguity, and (c) decreased physiological arousal.

The proposal of media naturalness theory by Kock (2004; 2005b) marks a departure from previous theoretical models, in that this was the first theory to incorporate evolutionary psychological (Barkow, Cosmides & Tooby, 1992; Buss, 1999) notions into an attempt to understand e-communication and e-collaboration behavior. The main dependent construct of media naturalness theory is cognitive effort, defined as the amount of mental activity, or, from a biological perspective, the amount of brain activity involved in a communication interaction. It can be assessed directly, with the use of techniques such as magnetic resonance imaging. Cognitive effort can also be assessed indirectly, based on perceptions of levels of difficulty associated with communicative tasks, as well as through indirect measures such as that of fluency, proposed by Kock (1998).

The independent construct of media naturalness theory is media naturalness, which is made up of five main elements: co-location, synchronicity, and the ability to convey facial expressions, body language, and speech. Thus, two assumptions can be made which are useful for managers who need to decide which features to have on their e-communication systems in the face of limited resources. The first assumption is that, other things being equal, an e-communication medium that incorporates one of the media naturalness elements—i.e., co-location, synchronicity, and the ability to convey facial expressions, body language, and speech—will have a higher degree of naturalness than another e-communication medium that does not incorporate that element. The second assumption is that, other things being equal, an e-communication medium that incorporates one of the five media naturalness elements to a larger degree than another e-communication medium will have the highest degree of naturalness of the two e-communication media, being full incorporation one in which the element is identical to what would be available in the face-to-face medium.

**FUNDAMENTAL CONCEPTS IN E-COLLABORATION**

What are the main conceptual elements that define an e-collaboration episode? This is a general question whose answer can arguably further shed light on what e-collaboration is, and what it is not. Moreover, identifying the key conceptual elements that make up an e-collaboration episode will inevitable lead to the identification of constructs that can be targeted in future e-collaboration research.

Based on past research on e-collaboration, one could contend that the following conceptual elements define e-collaboration, in the sense that changes in those elements can significantly change the nature of an e-collaboration episode: (1) the collaborative task, (2) the e-collaboration technology, (3) the individuals involved in the collaborative task, (4) the mental schemas possessed by the individuals, (5) the physical environment surrounding the individuals, and (6) the social environment surrounding the individuals. These conceptual elements are also well aligned with the summary of fundamental theories of e-communication and e-collaboration that has just been presented. Each of these elements is discussed next.

**The collaborative task.** An example of generic collaborative task that is often conducted with support of e-collaboration technologies today is that of writing a contract, particularly when the parties involved are geographically distributed. The nature of the collaborative task (e.g., whether it is simple or complex) can have a strong effect on its outcomes when certain e-collaboration technologies are used (Zigurs and Buckland, 1998; Zigurs, Buckland, Connolly & Wilson, 1999).
The e-collaboration technology. This comprises not only the communication medium created by the technology, but also the technology’s features that have been designed to support e-collaboration. The implementation of a particular feature (e.g., video streaming) in a particularly type of e-collaboration technology (e.g., instant messaging) can have a strong effect on how the technology is actually used by a group of individuals to accomplish a given collaborative task (DeSanctis and Poole, 1994).

The individuals involved in the collaborative task. This conceptual element refers primarily to certain characteristics of the individuals involved in the collaborative task, such as their gender and typing ability (which would be relevant in text-based e-collaboration contexts). This conceptual element also refers to the number of individuals involved in the e-collaboration episode, or the size of the e-collaborative group. An individual’s gender, for example, may have a significant effect on how that individual perceives a particular e-collaboration technology (Gefen and Straub, 1997), which may affect that individual’s behavior as part of a group of e-collaborators (Kock, 2001).

The mental schemas possessed by the individuals. This conceptual element refers to mental schemas (also referred to as knowledge or background; see, e.g., Kock, 2004; Kock and Davison, 2003) possessed by the individuals involved in the collaboration task, including socially constructed schemas that may induce the individuals to interpret information in a particular way (Lee, 1994). This conceptual element also refers to the degree of similarity of the mental schemas possessed by the individuals. The degree of similarity among the task-related mental schemas possessed by different individuals engaged in a collaborative task (e.g., whether task experts are interacting with other experts, or novices) may significantly affect the amount of cognitive effort required to successfully accomplish the task using certain types of e-collaboration technologies (Kock, 2004).

The physical environment surrounding the individuals. This comprises the actual tangible items that are part of the environment surrounding the individuals involved in the collaborative task, as well as the geographical distribution of the individuals. Geographically dispersed individuals are more likely than co-located ones to use e-collaboration technologies that are perceived as less rich than face-to-face interaction, and spend time and effort adapting the features of the technologies to their task-related needs (Kock, 2001; Trevino, Daft & Lengel, 1990).

The social environment surrounding the individuals. This conceptual element refers primarily to aspects of the social environment surrounding the individuals involved in the collaborative task that can be characterized as being social influences on those individuals. Those aspects may involve expressed perceptions and/or behavior by peers, managers and other individuals (e.g., customers) toward e-collaboration technologies. For instance, an individual’s behavior toward a particular e-collaboration tool, or certain features of that tool, may be significantly influenced by peer pressure (Markus, 1994), which may take the form of other individuals heavily using the e-collaboration tool and expressing positive opinions about the tool. That behavior may also be significantly influence by the position that the individual occupies in an organization’s hierarchical management structure (Carlson and Davis, 1998).

The above discussion on key conceptual elements should be followed by a couple of caveats. First, the list of key conceptual elements presented is not comprehensive. That is, there certainly are certain elements that are relevant for specific e-collaboration research projects that are not covered by the above list. Second, the conceptual elements above may be (or have been) given different names by different researchers, or the same name but different meanings.

Nevertheless, hopefully one main goal was accomplished though the discussion of the conceptual elements—to provide a glimpse at the complexity of e-collaboration and its many behavioral facets. Each of the conceptual elements above, if significantly manipulated in, say, a laboratory experiment or action research project (Kock, 2003), would potentially lead to variations in key variables. Among those key variables are two favorites of e-collaboration researchers: task outcome quality, and task ef-
ficiency. Task outcome quality is frequently assessed based on how good the task product is, often in terms of customer perceptions. Task efficiency is usually assessed based on how much time and/or cost is involved in accomplishing the task.

MANAGING ORGANIZATIONS WITH WEB-BASED E-COLLABORATION TOOLS

Traditionally, management thinking has preceded and quite possibly driven the adoption and use of information technologies in organizations. That is, management schools (of thought) that emphasize certain types of work structures usually appear earlier than information technologies geared at supporting those work structures. This situation has arguably changed around the mid-1990s, with the explosion in the commercial use of the Internet and particularly the Web. The emergence of e-commerce, e-trade, e-business, and other e-’s has clearly led to the creation of new organizational forms, management challenges, and related management ideas. For example, the Web has led to the development or expansion of:

- **Internet startups**, whose market value vastly exceeds what traditional price/earnings standards for company market valuation stipulate, placing these companies in an advantageous competitive position right at their inception due to the initial amount of capital that is available to them.
- **Internet portals**, whose market value depends much more heavily on the number of visitors (first time or repeat) they can draw than on their revenues, profitability or other traditional market value measures.
- **Virtual organizations**, which operate with little or no of physical assets and distribution channels.
- **Boundaryless organizations**, in which geographical barriers to teamwork and market reach are virtually eliminated.

These examples only scratch the surface as far as the potential that this “disruptive technology” which is the Internet can have on organizational structure and, in consequence, management thinking. For example, the emergence of virtual worlds and their increasing use of e-collaboration and e-commerce have the potential to revolutionize business, in a way that would be similar to the emergence of the Internet and the Web (Kock, 2008b). This “second Internet revolution”, brought about the use of virtual worlds such as Second Life and World of Warcraft for business, will only happen when the current Internet bandwidth problems are at least largely solved.

The adoption of management ideas that are aligned with the collaboration potential afforded by the Internet and the Web can place companies in competitively advantageous positions in their industries, at least at a certain point in the evolution as organizational entities, as illustrated by the past corporate history of companies such as Dell Computer, Federal Express, E-Trade and Amazon.com. The reasons for this are many, and range from the capacity to benefit from lower barriers to new entrants, to the ability to attract large infusions of capital at the beginning of their life cycle, to the development and continuous use of highly streamlined distribution and workflow management processes.

At the time of writing, the type of management thinking discussed above was not well defined and shaped in the form of a single management school. Nevertheless, is has been easy to find organizations trying to adapt ideas from old and existing management schools to the new environment of Web-based information technologies. Table 1 summarizes key management schools that emerged in the late 1900s, before the use of the Web became widespread (for more details, see Kock, 1999).
Trying to adapt ideas from old and existing management schools (such as those schools in Table 1) to the new environment of Web-based information technologies has its advantages, but is difficult to implement in practice. There are two key reasons for this. The first is that some of the new Web-based information technologies have emerged to support new organizational forms that are often incompatible with one single management school. The second reason is that existing management schools usually propose ideas that are, at some level, contradictory, often because they were developed on the premise that other management schools proposed ideas that did not work in practice (e.g., reengineering vs. total quality management). Moreover, given the tendency of business writers to focus on one or a few business ideas and propose them as a panacea, it is difficult to find a good match between single existing management schools and emerging Web-based information technologies. What is needed is a generic framework that ties together relevant management ideas that help organizations strategically and operationally align themselves with new Web-based information technologies.

It is beyond the scope of this chapter to propose a new management school. Even “describing” in the detail a new management school would increase the length of this chapter beyond what would be reasonable. Given this, a revised version of a new management framework to help organizations benefit from modern Web-based information technologies (Kock, 2002) is proposed and discussed below. The goal here is to provide some basic elements that can be used by managers and researchers as a starting point for a broader management model. As such, we focus on a particular set of activities associated with team coordination and communication in production and service delivery business processes.

A great deal of the author’s work since the late 1980s has revolved around the use of information technologies to support different forms of teamwork, particularly e-collaboration technologies. From 1997 until approximately 2002, several colleagues and the author have worked with a number of companies in the Philadelphia Metropolitan Area in the analysis and redesign of their business processes, leveraging the resources provided by the Web to support new intra-organizational processes, through “intranets”, and new inter-organizational processes, through “extranets”. Some of the companies we have worked with toward this end were Prudential Insurance, Metro One Telecommunications, Sheraton Hotels, Day & Zimmermann, Lockheed Martin, Delaware Investments, Penn Mutual and Andersen Consulting. More recent projects also involved various organizations in Texas.
After several projects, each involving different managers, consultants and key employees, some patterns started to emerge that seemed relatively independent of characteristics of the organization, processes, or people involved. While the organizations and processes targeted had their own peculiarities, we seemed to invariably arrive at a similar final result. This final result was, in all projects, a new process (we have analyzed and redesigned over 100 business processes from dozens of organizations over the years). Processes analyzed included marketing, sales, inventory control, production, distribution, and service delivery. Production and service delivery processes were the most frequent types of processes redesigned. In these, some generic features were particularly similar across redesigned processes in different companies. These are illustrated in Figure 1 and can be summarized as follows:

A Web-based workflow control module, represented in Figure 1 by the oval described as “Process automation application (workflow control module)”. This is a computer application module that automates the execution of a process, from beginning to end, reminding process team members of tasks under their responsibility and allowing them to update the execution status of those tasks. This module populates a process execution database that stores data about process execution, represented in the figure by the drum symbol described as “Process execution database”.

A Web-based customer query module, represented in Figure 1 by the oval described as “Process automation application (customer query module)”, whose main function is to give customer access to process execution status data. For customers requesting an external telephone line repair, for example, this module would provide information about repair status.

A Web-based OLAP (Online Analytical Processing) application, represented in Figure 1 by the oval described as “OLAP application”, whose main function is to allow the process manager to generate (and customize the generation of) process metrics periodically. Process metrics provide a simplified view of
the productivity and quality of a process and can be used for continuous improvement of the process.

A Web-based process communication application, represented in Figure 1 by the oval described as “Process communication application”, which populates and provides access to a process communication database. This application supports continuous communication between the process manager, process customers, and process team and may incorporate the following Web-based components:

- **A repository of summarized process metrics and process improvement initiatives** aimed at improving the outcomes of the metrics. Usually the process manager maintains this repository.
- **A discussion forum** that allows process customers to communicate with each other as well as with process team members and the process manager.
- **A knowledge base** with key data needed by process team members to execute their respective activities in the process, and process customers, so they can use outputs of the process more efficiently and effectively. In the case of a help desk process, for example, this knowledge base would contain equipment and software support information to be used by process customers for self-help.

One of the most common processes of information technology organizations (e.g., a division of information technology services of a large bank) that provide technology support to parent companies is what is often called the help desk process. It is through the help desk process that internal users are enabled to do their work using information technologies. Help desk activities include new accounts (e.g., email, proxy, dial-up, selected applications) creation, office applications training, general hardware and software support, network cabling set up, and database hosting, among others. The help desk process is a key process for both information technology organization and parent company. The information technology organization’s budget is often defined by the quality and volume of help desk-related services provided to internal information technology users.

A practical implementation of a help desk process using the Web-based information technology model depicted in Figure 1 and discussed in the previous paragraphs is shown in Figure 2. The relative position and shape of the main process elements is the same as in Figure 1 so that the reader can easily relate generic elements (shown in Figure 1) with their counterparts in the implementation example shown in Figure 2.

In this practical implementation, the user interface is a Web browser (e.g., Firefox, Internet Explorer etc.) and, as such, is common to all users. All applications are Web-enabled and run on single Web servers, running on virtual servers or not, or on clusters of Web servers. The communication medium between Web servers and browsers is the Internet; although it could have been an intranet or local area network supporting Web communication protocols. This configuration allows any of the process “actors”—such as the process manager, process team members and process customers—to use the system anywhere-anytime. Specific implementation elements are discussed below.

The Web-based workflow control module is implemented as a help desk job allocation and escalation application, developed using ColdFusion by a third-party software developer. ColdFusion is a Web development platform previously commercialized by Allaire Corporation, and now owned by Adobe Systems. This help desk application is modeled after the popular Remedy Help Desk system. The application populates an Oracle help desk database that stores data about help desk “jobs”—e.g., requests for support and follow-up activities.

The Web-based customer query module is implemented as a help desk job query application, developed with Java Server Pages—or Servlets, which are standard pieces of Java code that run on the
Figure 2. A Web-based “help desk” implementation of the generic Web-based information technology model

Web server. This application allows information technology users to monitor the status of their help desk jobs. The application runs on the same group of Web servers, which could be seen as one large Web server, as the help desk job allocation and escalation application. It performs queries against the same help desk database populated by that application, although without modifying the database.

The Web-based OLAP (Online Analytical Processing) application is implemented as a help desk OLAP application, developed using ColdFusion and SAS (an OLAP application development platform), that allows the help desk manager to generate (and customize the generation of) help desk quality and productivity metrics periodically. The application populates an Oracle help desk metrics database. Examples of metrics are number of help desk jobs of a certain category (e.g., network troubleshooting) solved within 2 hours of the request for help, number of complaints by information technology users, number of help desk jobs handled by a particular individual or group of individuals, percentage of recurring problems etc.

The Web-based process communication application is implemented as a knowledge management and conferencing application, developed with Active Server Pages (standard pieces of VBScript code—itself similar to Microsoft’s Visual Basic language code—that run on the Web server), which populates and provides access to two databases: an Access knowledge base and a Sybase discussion board database. The application also allows the help desk manager to post process metrics periodically, which are converted by the application into standard HTML and shown as a series of static Web pages. This application supports continuous communication between the help desk manager, information technology users, and the help desk team. It incorporates the following Web-based components:

- A discussion forum that allows information technology users to communicate with each other as well as with help desk consultants and the help desk manager in a more personal and less struc-
tured way than through help desk jobs. This discussion forum also works as a continuous two-way information exchange forum between local information technology “gurus” and help desk consultants. One example of local information technology “guru” would be a salesperson who knows a lot about a sales information technology application and who helps his colleagues in the Sales Department.

- **A knowledge base** with key knowledge needed by help desk consultants to execute their respective activities in the process. This knowledge base is also used by selected information technology users for self-help, such as the local information technology “gurus” mentioned above.

It is important to stress that the process redesign initiatives that led to variations of the generic model discussed here were guided by a common methodology called MetaProi, which stands for Meta-process for Process Improvement (see Kock, 2005c). In spite of this, the fact that the model shown on Figure 1 emerged from process redesign efforts involving different people in different companies is still remarkable. After all, senior management and consultants were involved, and they agreed that the new processes were either optimal or close to optimal. This convergence is also an indication of the existence of underlying management ideas that are likely to surface if awareness about current Web-based information technology potential exists. Further inspection also suggests that even though these management ideas, which surfaced in process redesign discussions, are not tied to a single management school, they are obviously aligned with several schools (as shown on Table 2).

The “Process feature(s)” column on Table 2 describes features of the generic process model that are highly dependent on information technologies, particularly in the last two rows—improvement initiatives repository, discussion forum, and knowledge base. Those features would not have been present if senior management was not willing to implement the management ideas described in the first column of Table 2, which in turn became more popular with the emergence of four contemporary management schools: total quality management, organizational learning, excellence, and reengineering. Still, one cannot convincingly argue that management thinking is driving the use of the technology. Not only do these four management schools differ significantly from each other, but they also have a different following. For example, organizational learning proponents often suggest their management school as a “softer” and more “people-oriented” alternative to reengineering. It is more likely that modern Web-based information technologies force the adoption of management ideas that do not have a single and coherent source.

**Table 2. Management ideas, related schools and process features**

<table>
<thead>
<tr>
<th>Management idea</th>
<th>Management schools</th>
<th>Process feature(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct management control on teams should be reduced to a minimum. Process-level control should be automated as much as possible.</td>
<td>Excellence, Reengineering.</td>
<td>Workflow control automation.</td>
</tr>
<tr>
<td>Customers should have instant access to process execution status.</td>
<td>Total quality management, reengineering.</td>
<td>Automated customer query support.</td>
</tr>
<tr>
<td>Process metrics should be periodically analyzed and used to incrementally improve processes.</td>
<td>Total quality management.</td>
<td>OLAP-based process metrics generation.</td>
</tr>
<tr>
<td>Customers should be allowed access to process performance data and related process improvement initiatives, and asked for their advice on how to improve processes.</td>
<td>Excellence, total quality management, organizational learning.</td>
<td>Process metrics and improvement initiatives repository, discussion forum.</td>
</tr>
<tr>
<td>Customers should be given decentralized access to process-related knowledge so they can solve some process-related problems themselves.</td>
<td>Reengineering, organizational learning.</td>
<td>Process knowledge base.</td>
</tr>
</tbody>
</table>
The idea that information technology should drive organizational design has been proposed by many business thinkers, including reengineering co-inventor Davenport (1993)—in fact, this was one of the early areas of disagreement between him and other proponents of reengineering led by Hammer & Champy (1993). Yet, letting information technology define how processes are structured shifts a great deal of the responsibility on how to manage organizations to software developers and systems integrators, who arguably do not know the processes of the organizations they serve as well as their (internal or external) customers do. Moreover, software developers and system integrators need to sell their products and services to many organizations in order to maximize their profits. This is bound to decrease potential competitive advantages for their corporate customers. After all, if you have the same processes and enabling technologies as your competition, how can you possibly get significantly ahead of them?

From a practical perspective, the generic process model discussed above can be seen as an “archetype process”, which can be used as a “template” for the design of optimal business processes. After all, it is based on a number of process redesign efforts that led to the same high-level result. Using it may save organizations precious time and resources that would otherwise be wasted reinventing the wheel.

From a more philosophical perspective, the process model discussed here can be seen as a first step in the direction of a new management school. This new school’s principles should guide the selection and implementation of Web-based information technologies to enable optimal processes, rather than the other way around. One of the key concepts underlying this new management school is that of virtual communities of e-collaborators—process team members, users and managers—brought together in creative ways through the use of Web-based e-collaboration technologies. Such virtual communities should, among other things, promote collaboration between customers and suppliers, by allowing them to communicate and share information and knowledge independently of traditional time and distance constraints.

USING E-COLLABORATION TOOLS TO IMPROVE UNIVERSITY TEACHING

Collaboration initiatives between industry and university units are often referred to in the literature as industry-university partnerships, and rely heavily on e-collaboration. In the following paragraphs a discussion of the role of e-collaboration tools, particularly Web-based ones, is provided in the context of an actual industry-university partnership that took place in Philadelphia. The partnership’s main goal, from an academic perspective, was to give students real world experience while at the same time teaching advanced business and technology topics.

But before we talk about the actual partnership, let us take a brief look at the background of these types of collaborative efforts. Industry-university partnerships, particularly those involving research universities, are commonplace and on the rise. They allow industry access to quality research and consulting services at subsidized costs as well as to potential future employees while still in their formative years. Universities benefit from such partnerships through research grants and consulting contracts that complement dwindling government funding, and provide student exposure to current “real-world” problems and issues.

Some sectors of the economy are more active than others in research involving industry-university collaboration. The manufacturing sector is arguably the most active. Often companies surveyed on the benefits of research involving industry-university collaboration praise the concept and highlight the crucial importance of industry-university partnerships for competitiveness improvement. In the U.S.A., one association of manufacturers in particular, Sematech, made up of companies in the American semiconductor industry, has frequently stated that a considerable portion of its membership had at differ-
ent points in time been literally rescued from their competitiveness downslide by industry-university research partnerships.

Irrespective of economic sector or industry, the majority of industry-university partnerships are of the research partnership type, which predominantly involves applied firm-specific research. In this type of partnership, funding from the industry partner is received in exchange for “intellectual horsepower” in the form of research services and technology transfer. In science-based fields, universities focus on basic research, and the main interest of industry partners is in the commercial and industrial implications of a scientific project and how they can be taken advantage of by internal research and development departments. In less science-based fields, which include information technology as taught in colleges of business, the solution of technical problems is a major concern of industry. In all fields, the exchange of knowledge in techno-scientific communities is a crucial element of interaction in research partnerships.

A much less common type of industry-university partnership is what is referred here to as a “course partnership”, which gravitates around a regular university course (or set of courses) rather than a research project or program. In these types of partnerships, the industry partner agrees to sponsor one of more courses in which the students are expected to apply concepts and theory learned in class to the solution of some of the industry partner’s key problems. Students benefit from the direct contact with the industry they are likely to join after they graduate as well as professional relationships they are able to establish during the course.

A discussion is provided below of a course partnership involving a large engineering and professional services company, and a public university, both headquartered in Philadelphia. This discussion is provided here as an example of a best practice and successful experience of collaboration between one employer and one academic unit focusing on information technology subjects. The lessons learned through this example highlights the invaluable role played by e-collaboration, and arguably can be extrapolated to similar initiatives other universities may be interested in implementing in the future.

The main goal of the course that was the focus of the partnership was to teach students business process redesign concepts and techniques, which were then used to redesign several real processes at the industry partner. The students participated actively in the business process redesign efforts, often offering business-specific suggestions. Information technology was expected to be used by the partner organization as an enabler of the new business processes. One salient aspect of this case is the role played by a Web-based collaboration system as a communication hub and information repository during the course partnership.

The idea for this course partnership originated at a panel discussion on the information technology gap between industry and academia, sponsored by the Philadelphia Chapter of the Society for Information Management (SIM Philadelphia). Six panelists representing Philadelphia-area universities (including the author) addressed the need for expanded internship programs and industry-oriented programs, such as technical information technology diplomas, and suggested that courses should be designed to address immediate industry needs. However, these approaches were seen as traditional ways of addressing the industry-university gap, so the panelists also discussed a novel and promising approach: conducting courses, particularly senior undergraduate and graduate courses, in partnership with Philadelphia companies. Such courses would be designed to apply concepts and theory discussed in class in a team course project geared at solving immediate company problems.

It was clear to the audience of executives and academics that such course partnerships would likely require considerable extra time and effort from the students and instructor, well beyond what is usually expected in traditional courses. In addition to applying the concepts and theory learned in class, students would also have to learn “on-the-fly” how to effectively deal with real-world issues, such as
organizational culture and politics. The instructor, on the other hand, would have to take on project management, industry-university liaison, and inter-organizational team facilitation responsibilities in addition to traditional course delivery and student mentoring.

Given this, and the prospect that partnerships could lead to valuable business improvements, organizations were identified as potential partnership sponsors. They would be expected to sponsor projects financially through small grants covering project expenses, equipment and software, and a stipend for the instructor. The idea was positively received by the majority of the 30 industry representatives, mostly chief information officers (CIOs) present at the panel discussion. As for the fundamental characteristics of course partnerships, the panelists and the audience converged on the following:

• **All team projects should be conducted in a single organization.** Letting student teams identify organizations they want to work with, based on instructor-provided criteria, usually leads to different student teams conducting projects in different organizations, and thus to significant team discrepancies in project complexity and scope, and organizational support. These problems can have a negative impact on learning. The solution proposed was to have all student teams conduct their projects in one single organization.

• **Potential projects should be identified in advance.** Identifying a potential project can take up to 5 weeks of a 15-week course. This may be acceptable, as long as concepts and theory are covered during those initial five weeks, but a student team also needs to learn about the organizational culture and specific business processes they will be dealing with. This can easily take another five weeks, leaving little time for key project activities, such as business process redesign and information technology implementation. One solution proposed to solve this problem, employed in the course partnership discussed here, was to identify potential projects before the formal start of the course, and distribute them among student teams in the first week of the course.

• **Top management should personally support the course partnership.** If students develop their own course projects, it may be more difficult to gain approval for organizational changes or necessary hardware and software purchases. But if top management directly and personally supports team projects, such difficulties are significantly reduced, and in some cases completely eliminated.

The course partnership was implemented by two partners: Temple University, a large research university located two miles from downtown Philadelphia; and Day & Zimmermann, Inc., an engineering and professional services company headquartered in downtown Philadelphia with approximately $1.5 billion in yearly revenues at that time. The course was a pilot version of “Process Design and Information Technology”, a new course dealing with process analysis and redesign issues.

The course project required students to analyze and redesign five of Day & Zimmermann’s business processes using the concepts, theory, and techniques taught in class. Brad King, Day & Zimmermann’s CIO, pledged his personal and direct support for the partnership. Camille Auspitz, a senior manager at Day & Zimmermann, was assigned to manage the project together with the course instructor, the author (then an information systems professor at Temple). The project involved over 30 Day & Zimmermann employees and 26 Temple students.

Five student redesign teams met periodically with key Day & Zimmermann employees at the company’s headquarters. Each team analyzed and redesigned one process, generated three reports, and delivered one oral presentation to Day & Zimmermann management at the end of the course. The first team report contained a detailed description of the team’s target process; the second a detailed description of the redesigned process and the rationale behind the redesign; and the third a detailed analysis of the information technology solutions enabling the redesign.
Before initiating the course partnership, two main obstacles had to be dealt with. First, Day & Zimmermann employees needed to actively participate in the redesign efforts, understanding the concepts and theory used by the students. The problem was that most of the Day & Zimmermann participants were unable to come to Temple to audit the course. Second, given the students’ and employees’ different schedules, frequent face-to-face meetings between students and employees were impractical. A password-protected Web-based e-collaboration site addressed both of these issues, allowing Day & Zimmermann employees online access to all course material, and supporting student-employee interaction through shared document areas, multimedia components, and discussion boards.

The Web-based e-collaboration site had three main areas. The general area contained links to the main page of the Web site, the Amazon.com entry for the course textbook, and a description of the free Web browser plug-ins needed to view the various multimedia components of the site. The project area contained descriptions of target processes, contact information for project participants, bulletin boards for threaded discussions, and links to student photos and video clip introductions. The course area contained a link to the instructor’s Web page, slides covering concepts and theory related to process analysis and redesign, and related audio clip files. It also contained video clips with full-motion screen-captured demonstrations of the information technology tools that were expected to be used in the project.

Both Temple students and Day & Zimmermann participants considered the partnership and related projects to be fairly successful, in spite of the low expectations of some Day & Zimmermann employees early on. Temple students emphasized the real world experience as a positive aspect of the course. In an anonymous course evaluation form, one student wrote the following comment, which is representative of the students’ perceptions in general about the course partnership: “The learning experience was very rich. The group project gave us hands-on experience in applying the redesign techniques we learned in the course. It was a great experience to work with upper level IT management!” Several students noted that the course required considerably more time and effort than most traditional university courses taken previously, but still their comments were generally positive.

Brad King and Camille Auspitz emphasized the anytime/anyplace collaboration enabled by the Web-based e-collaboration site as a key element in the success of the course partnership. In general, Day & Zimmermann managers perceived the student input as valuable and likely to lead to concrete business process improvements. An added benefit for Day & Zimmermann was the ability to identify young talent in action. Even internships do not offer such fertile ground for identifying new graduates for hiring, since most organizations can only afford to hire a small number of interns for a two-month period. Moreover, the tasks interns usually are assigned to are not nearly as complex and strategically relevant as those carried out in this course partnership, preventing managers from seeing prospective employees dealing with complex real world problems.

What was learned along the way may be useful for universities and companies planning to implement similar course partnerships in the future. In the course partnership between Temple and Day & Zimmermann it was found that an ideal course partnership should:

- **Be managed by both academia and industry.** Students are more responsive to instructor requests, and employees are more responsive to requests from someone with formal authority within their organization. The course instructor should share project responsibility with a member of the partner organization with enough formal authority to oversee all the team projects.
- **Include at least one purely social activity.** Social activities allow for important information exchanges that often do not occur in formal meetings. After a pizza party for team members held in
downtown Philadelphia, several students commented on the valuable insights gained from informal conversations. The party was also seen as a “thank you” gesture to the students, which not only boosted morale, but also helped students relax for their final presentation the next day as they got to know employees at a more personal level.

- **Address highly relevant business problems.** Partner organizations may be tempted to create “toy” problems for students because they fear project failure and the ensuing internal conflicts that could hinder future organizational change efforts. But students do not learn as much from toy problems, and employees are less motivated to get involved in them. Also organizations miss the chance to benefit their bottom line from student-employee efforts if toy problems are targeted instead of real organization problems.

The course partnerships discussed above far exceeded the typical approach of involving students in simulated projects in organizational environments. It seems that the close cooperation between Temple University and Day & Zimmermann, Inc. that characterized the partnership was the key reason for its success. This type of cooperation requires extra effort from everyone—students, instructor, company management and employees. Yet, the positive outcomes appear to easily outweigh the costs. The course partnership also clearly illustrates the need for project management techniques and social processes’ enablers to be put in place so that e-collaboration technologies can be used to their full potential.

**ORGANIZATIONAL AND SOCIAL IMPACTS OF E-COLLABORATION TOOLS**

E-collaboration technologies have impacts on human behavior that can fundamentally affect organizational and social structures and processes. One of the most interesting, intriguing, and potentially far-reaching effects of e-collaboration tools on people is that of inducing them to compensate for the obstacles posed by e-collaboration media. Since e-collaboration media suppress face-to-face communication elements, they tend to generally pose obstacles to e-collaboration, while at the same time making collaborative work possible when it would not otherwise be. For instance, asynchronous e-collaboration media enable collaborative work among geographically dispersed and time-disconnected individuals.

Media richness theory (Daft and Lengel, 1986; Daft et al., 1987) has been one of the most influential e-communication and e-collaboration theories since its inception in the 1980s, well before the Internet came about. Yet, there has been mounting evidence over the years that key predictions of the media richness theory do not hold in a number of situations. For example, a number of studies indicate that a lean e-collaboration medium can be the choice of groups engaged in complex tasks, even when richer media are available. (Most e-collaboration media are lean, according to media richness theory.) However, there has been very little research evidence that the adoption of a lean e-collaboration medium can lead to an actual increase in group outcome quality, when compared with a richer medium.

In the paragraphs below, a fundamental notion in the understanding of the organizational impacts of e-collaboration technologies, the compensatory adaptation notion (see Kock, 1998), is expanded upon. This notion goes some way towards filling the research gap left in connection with tests of media richness theory, by providing evidence that groups can adapt their behavior in order to overcome the limitations of a leaner e-collaboration medium and produce outcomes that are perceived by group members as being of higher quality than in richer media. Some colleagues and the author studied five process improvement groups in a New Zealand university; the groups voluntarily conducted most of their interactions through an e-mail conferencing system developed by me using Novell GroupWise as the e-collaboration tool development platform.
The increasing use of e-collaboration technologies as tools to enable efficient communication in organizations has led to a growing literature on the impact of group support technologies on groups in the 1980s and 1990s. This literature, however, has been filled with mixed findings, where success in the introduction and use of e-collaboration systems has been as commonplace as failure. A number of theories and theoretical frameworks have been proposed which provide a basis for the understanding of these mixed findings. Examples of such theories are media richness theory (Daft and Lengel, 1986), adaptive structuration theory (Poole & DeSanctis, 1990), and the communication genres model (Yates & Orlikowski, 1992).

Among the many theories devised, media richness stands out for its influence as a deterministic theory of communication media adoption and use since its development in the mid-1980s, in both academic and software development communities. Media richness theory claims that different communication media can be classified as lean or rich, according to their ability to convey knowledge and information. The classification scheme proposed by media richness theory places face-to-face as the richest communication medium, and e-mail as a relatively lean medium (Fulk, Schmitz & Steinfield, 1990; Lee, 1994). Media richness theory claims that lean media are not appropriate for knowledge and information communication (i.e. equivocality and uncertainty reduction), and that the adoption of media and the outcomes of its use will usually reflect this fact (Daft et al., 1987; Lengel and Daft, 1988).

The influence of these claims can be felt in academic circles by the number of positive references to media richness theory in the group support systems and business communication research literatures; and in industry practitioner circles by the persistent attempts of developers of commercial e-collaboration software, through adding features to their products, to achieve the elusive communication richness of face-to-face interaction. This section goes some way towards dispelling these claims, based on a study of five process improvement groups. It presents empirical findings that beg a new theoretical framework to explain them.

As mentioned above, we studied five process improvement groups conducted at the University of Waikato in New Zealand over seven months. The groups had from seven to thirteen members, and took on average forty-one days to be completed. Each group selected, analyzed and conceptually redesigned one or more business processes; redesign proposals were later implemented and led in most of the cases to process quality and productivity improvements. Most of the group members had been recently involved in face-to-face process improvement groups. Forty-six structured interviews addressing perceived e-collaboration technology effects were conducted with group members within two weeks of the completion of their groups.

The groups conducted their work through four main group stages. These stages highlight the media adoption choice made by the groups, which have consistently lain on a leaner e-collaboration medium; and the behavioral adaptation of the group members to overcome the communication limitations posed by the lean e-collaboration medium. All groups voluntarily adopted an e-mail conferencing system developed by the author as their main communication medium. The system was implemented using Novell Groupwise, and allowed members to post e-mail messages and attachments to their groups. The e-collaboration system was offered to the groups as a service by the author in exchange for being allowed to collect research data. However, the decision as to whether the e-collaboration system would be used or not, and how much, was completely left to the groups themselves.

All five groups have voluntarily chosen the e-collaboration medium for the vast majority of the group interactions; that is, those interactions in which the communication mode was many-to-many. Phone and face-to-face media were used predominantly for one-to-one communication. In interviews, members were asked about the amount of time spent interacting through each medium. An aggregate analysis of the responses to this question indicates that the mean proportion of time the e-collaboration medium was
used by group members for either many-to-many or one-to-one interaction was seventy-six per cent, whereas the phone and face-to-face media were used about twenty-four per cent of the time.

These figures suggest that the e-collaboration medium was consistently favored by the groups as their main medium for communication, in spite of being a leaner medium than the phone and face-to-face media. When asked to explain their choice, the overwhelming majority of the interviewees assigned a reduction in disruptiveness, typically linked with the possibility of interacting with the group at the most convenient time for them, as the main reason for the choice of the e-collaboration medium.

After the initial choice, however, several members pointed out that they had perceived the new medium as likely to increase the ambiguity in the discussion. The main reasons given by members were the lack of immediate feedback and the filtering of verbal cues inherent in the electronic medium. These perceptions are highly consistent with predictions based on the media richness theory (Daft and Lengel, 1986).

Plausible predictions based on the media richness theory, for future scenarios involving the five groups would be: (a) the perception by group members of an increase in ambiguity in individual member contributions; and (b) either a move to richer media (such as face-to-face) or the discontinuation of the groups, both as a consequence of the higher perceived ambiguity.

None of these scenarios became reality. On the contrary, not only did the groups continue using the e-collaboration medium for most of their many-to-many interactions, but, somewhat surprisingly, most respondents spontaneously reported a perceived increase in member contribution quality. A quote from one of these members illustrates this perception: “You think more when you’re writing something, so you produce a better quality contribution. Take for example what [group member’s name - removed] wrote, she wrote a lot and it seemed that she thought a lot about it before she e-mailed it to the group. She wasn’t just babbling off the top of her head, she tended to think out what she was writing. I know I did it a lot, specially my first message. I really thought a lot to put it together.”

The perceived increase in member contribution quality can be explained by an adaptation of the members to the leaner medium (Kock, 1998). Three main pieces of hard evidence strongly suggest this adaptive behavior and some traits of its dynamics. Firstly, members spent more time preparing their individual contributions, which is evidenced by a dramatic decrease in member contribution speed through the e-collaboration medium, in comparison with face-to-face meetings. The mean contribution speed in the e-collaboration medium was approximately 6 words per minute. In face-to-face meetings, this contribution speed has been estimated at 113 words per minute (McQueen, Payner & Kock, 1999; Kock, 2007). The contribution speed in the e-collaboration medium was calculated based on group members’ estimates (as well as direct measurements) of time spent preparing and posting contributions to their groups and the actual word count of their postings. The low contribution speed through the e-collaboration medium could not be explained only based on the fact that typing is slower than speaking, as average typists are expected to be able to type between 50 and 70 words per minute, which points to a better preparation of the postings as an alternative explanation for the low speed observed.

Secondly, group members seemed to have taken much longer to provide their contributions to the group through the e-collaboration medium than in typical face-to-face meetings, which may be seen as partially suggesting that members reflected more on their contributions prior to posting them; it is not clear, however, whether this was a result of a conscious and voluntary effort by the members. An aggregate analysis of the time members took to respond to postings from the group leaders provides some support for this assumption; most of postings from ordinary members were responses to group leaders’ postings. According to this analysis, the mean response time to contributions by the group leaders was 138 hours (between 5 and 6 days) through the e-collaboration medium. In face-to-face meetings this response time was estimated by us at no more than 1 hour (McQueen, Payner & Kock, 1999).
Thirdly, group members seemed to have provided much longer contributions (in number of words) through the e-collaboration medium than they would have usually done in face-to-face meetings, which suggests that their electronic contributions probably had more information and knowledge content than oral contributions in typical face-to-face meetings. An aggregate analysis of word counts per posting provides support for this perception. According to this analysis, the mean contribution length (per posting) was 297 words through the e-collaboration medium. In face-to-face meetings, this mean contribution length has been estimated at 18 words (McQueen, Payner & Kock, 1999).

The three pieces of hard evidence presented above—based on estimates of member contribution speed, response time, and contribution length—suggest that the adoption of a leaner e-collaboration medium by the groups led members to adapt their group communication behavior in a way that seems to have led them to overcome the limitations posed by the leaner electronic medium. This adaptation apparently led group members to prepare longer and better thought out contributions than in typical face-to-face meetings.

Given that members perceived an increase in member contribution quality as a consequence of the adoption of the e-collaboration medium, it seems plausible to expect that group outcome quality—i.e., the quality of process redesign proposals—would also be seen by members as being increased. In fact, this has been the trend of the perceptions gauged in interviews with group members. Forty-eight per cent of the interviewees perceived an increase in group outcome quality; twenty-two per cent perceived a decrease; the remaining respondents perceived no variation in this variable. It is important to note that over ninety per cent of the forty-six interview respondents had recently participated in face-to-face process redesign groups, which lends more weight to their perceptions.

One of the two main reasons given by members for the increase in group outcome quality was an increase in member contribution quality; the other reason being a higher departmental heterogeneity enabled by the low disruptiveness inherent in the e-collaboration medium. The main reason given by the respondents who perceived a decrease in outcome quality was a higher ambiguity in the discussion; also seen as directly caused by the e-collaboration medium. These explanations partially confirm the hypothesis that group members perceived the e-collaboration medium as a lean medium, but nevertheless decided to use it for the majority of their group interactions and adapt their behavior to overcome the limitations posed by a high medium equivocality.

In summary, the groups in the study have initially chosen the leaner e-collaboration medium for group communication because of some of its advantages, notably a low disruptiveness. Immediately after they have begun using the new medium, group members perceived the medium as equivocal and in consequence adapted their behavior in order to overcome the limitations posed by the new medium, rather than moving to a richer medium such as face-to-face meetings. This adaptation involved members preparing longer and more elaborate messages, which partially offset the higher equivocality perceived as inherent in the e-collaboration medium.

While the initial perceptions of group members of the e-collaboration medium were consistent with predictions based on the media richness theory (Daft and Lengel, 1986), the adaptive behavior displayed by the groups in this study was not so. This behavior is, nevertheless, remarkably consistent with that of groups in similar circumstances in different organizational settings (DeLuca, Gasson & Kock, 2006), and partially consistent with previous studies in which the adaptive power of groups has been illustrated (Markus, 1992; 1994; Orlikowski, Yates, Okamura & Fujimoto, 1995). The final and somewhat surprising conclusion of the study is that the existence of media constraints to group communication can paradoxically lead to an improvement in group outcome quality!
CONCLUSION

This chapter began with a historical view of the development of e-collaboration technologies, and a look at past research on e-collaboration. It then provided a discussion of fundamental theories of e-communication and e-collaboration, and of fundamental concepts in e-collaboration. Following was a discussion of key issues in connection with managing organizations with Web-based e-collaboration tools, and using e-collaboration tools to improve university teaching. Finally, the chapter provided a discussion of organizational and social impacts of e-collaboration tools, where the fundamental notion of compensatory adaptation is presented. In this concluding section, the issue of how e-collaboration can be designed to facilitated e-collaboration is explored a little further.

It was argued in this chapter that e-collaboration technologies often pose obstacles to effective communication in complex collaborative tasks. The reason seems to be that typically those technologies selectively suppress face-to-face communication elements that human beings have been designed by Darwinian evolution to use extensively while communicating with each other (Kock, 2004). That is, the naturalness (Kock, 2005b) of the media created by e-collaboration technologies is usually low, posing obstacles for effective communication. It was also argued here that technology users invariably react to those obstacles by engaging in compensatory adaptation, whereby they change their communicative behavior in order to compensate for the obstacles.

The notion of media naturalness, on which media naturalness theory (Kock, 2004; 2005b) is based, comes from the anthropological finding that the human species has evolved over millions of years communicating through two main interaction modes. One involves co-located face-to-face communication, and the other involves the use of sounds alone in situations where line-of-sight is obstructed. Both interaction modes involve synchronous communication with the use of sounds, which over millions of years have evolved from simple grunts to complex speech. The increase in complexity of speech seems to be positively correlated with the historical increase in hominid brain size (see Figure 3).

Figure 3. Hominid evolution stages and respective communication modes
The first and predominant mode, face-to-face communication, is one in which individuals see and hear each other. In this mode individuals communicate primarily through sounds, facial expressions, and body language; and to a lesser extent by touch and smell (e.g., through pheromones). This seems to have been the principal communication mode used for the exchange of knowledge, such as the knowledge involved in shaping a spear out of a stone or a tree branch.

The second main interaction mode, employing sounds alone, has arguably been necessary whenever line of sight was obstructed by trees or other objects. This latter mode of communication is extensively employed by modern primates for quick information exchange, which suggests that it has been used in similar fashion by our hominid ancestors. For example, chimpanzees use it while hunting, to indicate their position and the position of prey to other members of a hunting group. Several primates use this mode of communication while alerting others of the same group about the presence of predators, and when issuing mating calls.

Human beings have many obvious biological adaptations for synchronous and voice-enabled communication. Some of these adaptations are costly from a survival perspective, which suggests that they have also led to key survival (or mating) advantages of their own. For example, complex speech is enabled by a vocal tract whose design makes human beings much more likely to choke on ingested food and liquids than other primates. Therefore, complex speech must have conferred evolutionary advantages that offset the survival costs of having a vocal tract designed for complex speech.

The presence of observable biological adaptations for synchronous and voice-enabled communication implies the presence of corresponding brain adaptations. And, given the relatively recent emergence of written communication, it is reasonable to assume that our brain has not been shaped by evolutionary forces to handle written communication particularly well. The reason is that evolutionary pressures typically take a long time in slow reproducing species, like the human species, to shape biological traits. The first forms of written communication have emerged approximately 5,000 years ago, among the Sumerians in what is today Iraq. This 5,000-year period is a blink in a lifetime in evolutionary terms, and amounts to less than 1 percent of our hominid evolutionary history. Moreover, when we look at hominid evolution, we find a high correlation between brain size and the ability to employ complex speech for communication.

Some would argue that cave paintings are the main precursors of symbolic communication. Most of the evidence gathered by anthropologists, however, suggests that cave paintings were not used for communication, but rather as the backdrop for rituals. This prevalent view is known as the shamanist theory of the origin of cave paintings. Even if cave paintings were seen as the first forms of symbolic communication, their relatively recent emergence (about 30,000 years ago) would also be considered too recent to have led to any major changes in our biological communication apparatus.

The media naturalness notion is essentially that we are not well adapted to employ communication media that suppress elements found in unconstrained face-to-face communication, particularly synchronicity and support for speech-enabled communication. This notion is analogous to the one that argues that our brain is designed to maximize our intake of high calorie nutrients, because high calorie nutrients were scarce in our ancestral evolutionary environment. Since high calorie foods and drinks are both cheap and abundant in modern urban societies, brain design today leads to diabetes, heart disease, and a host of other health problems.

Using media of low naturalness, such as e-mail, is not hypothesized to lead to such pernicious health problems as those related to our attraction to high calorie foods and drinks. Nevertheless, using media of low naturalness (e.g., e-mail) is hypothesized to lead to higher levels of cognitive effort than more
natural media (e.g., telephone), especially when communication of knowledge is the goal. One of the key pieces of evidence supporting this prediction is the dramatic decrease in communication fluency (i.e., number of words conveyed per minute) that results when one attempts to use a medium of low naturalness to convey knowledge. For example, while communication fluency has been found to be close to 100 words per minute face-to-face, it often drops to as little as 6 words per minute through e-mail, when what is being communicated is complex knowledge (Kock, 2001b).

A reduction in fluency of this level of magnitude (i.e., 100 down to 6 words per minute) cannot be easily explained based on the known fact that people generally type slower than they speak. While it is mechanically more difficult to type than to speak, this difficulty alone usually leads to decreases in fluency of 50% or less. That is, let us assume that there were no other serious obstacles to communication, such as the cognitive obstacles discussed earlier. In that case, one would expect to see a drop in fluency from 100 to about 50 words per minute (or a 50% reduction), as one goes from interacting face-to-face to interacting through e-mail, not a drop from 100 to 6 words per minute (or a 94% reduction).

Given the discussion above, one could argue that it makes good sense to design e-collaboration technologies to facilitate compensatory adaptation. Yet, rarely one finds e-collaboration tools that have features designed to enable users to change their communication behavior in a way that makes up for the absence of face-to-face communication elements. One example is the absence of multimedia discussion board capabilities in many of the e-collaboration tools available today, including some widely used courseware tools such as WebCT. By multimedia discussion board capabilities what is meant here are capabilities that would allow one to respond to a text posting using a voice (or video) posting, and vice-versa.

What is sometimes even worse than the absence of compensatory adaptation features in an e-collaboration tool is the inclusion of those features in such a way that they do not work as intended. For example, features that allow for the inclusion of emoticons in e-mails have been added to many e-mail systems, yet their use by e-mail senders often irritates the receivers (Kock, 2008). The irritation seems to be typically caused by the emoticons being used in ways that add little meaning to the message being conveyed, and in some cases by the emoticons conveying the opposite of what was intended.

An instance of this type of miscommunication would be the following. A colleague wants to make a constructive critical comment about what someone else said, which in a face-to-face meeting would be accompanied by a very specific type of smile to soften the tone of the critical comment. The goal of the smile would be to make the comment sound constructively critical, instead of a personal attack. The use of a smiley face emoticon instead, as a replacement for the smile in a face-to-face meeting, may add insult to injury by being interpreted as a mocking attempt.

The reason is that emoticons are perceived by many as cartoon-like and somewhat odd representations of facial emotions. Interestingly, their current use highlights the need of a better understanding of the nature of our biological communication apparatus. Evolution has endowed the human species with a very complex web of facial muscles, more complex than almost any other animal. That complex web of facial muscles seems to have been evolved chiefly for communication of emotional states. Very few of those muscles are used for purposes other than communication, such as chewing. Emoticons certainly do not convey the range of emotions that facial expressions do, and thus their indiscriminate use may lead to more harm than good.

As with emoticons, there are other examples of bad implementations of features aimed at incorporating media naturalness elements into e-collaboration technologies. Table 3 summarizes some of these possible implementations. For simplicity, the examples provided refer to basic implementations of media natural-
ness elements using standard e-mail systems. The reference to “speech synthesis” in Table 3 assumes that voice intonations are not automatically added when the text is read aloud. This could arguably be achieved in the future through artificial intelligence solutions that are not currently available, and make the widespread use of speech synthesis more promising in the context of e-mail communication.

So how can e-collaboration technology designers figure out ways in which they can design technology features to effectively facilitate compensatory adaptation? The obvious answer here is that they must invest in behavioral research, whereby compensatory adaptation enablers are incorporated into technologies and their effects are tested through methodologically rigorous investigations. This approach, sometimes referred to as human factors research, has been and is being employed by some of the most successful software developers in the world today. Google, IBM and Microsoft have been doing that for years.

In the absence of much needed additional human factors research, particularly in connection with specific e-collaboration technologies and features used in specific organization contexts, certain assumptions may be made based on what we now know about good technology design practices. Table 4 summarizes what could arguably be presented as good implementations of features aimed at incorporating media naturalness elements into e-collaboration technologies. Those implementations should be aimed at facilitating compensatory adaptation by allowing for their selective use in specific contexts, and not by forcing their use all the time. As with Table 3, the examples provided in Table 4 refer to simple implementations of media naturalness elements using standard e-mail systems. The reference to “generic” files in Table 4 highlights the need for the use of files that will be easily viewed by users with commonly available and free multimedia players (e.g., Media Player Classic, RealPlayer, Windows Media Player, and QuickTime Player).

Since e-collaboration technologies are often used in particular contexts, and to automate specific tasks, behavioral investigations of technology enablers of compensatory adaptation should also be carried out with those contexts and tasks in mind. That is, there is a danger in trying to derive conclusions about an enabler’s effect in a particular organizational context, and extend those conclusions to a significantly different context. Let us say that we tested the use of multimedia discussion boards in the context provided

Table 3. Media naturalness elements and examples of bad implementation through e-mail

<table>
<thead>
<tr>
<th>Media naturalness element</th>
<th>Bad implementation</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support for use of speech</td>
<td>Use of speech synthesis to read aloud text from e-mails</td>
<td>Removes voice intonations that add meaning to messages</td>
</tr>
<tr>
<td>Support for use of facial expressions</td>
<td>Emoticons added to e-mails</td>
<td>Do not capture the nuances of facial expressions</td>
</tr>
<tr>
<td>Support for use of body language</td>
<td>Stick figures signaling different body positions added to e-mails</td>
<td>Do not capture the nuances of body positions and movements</td>
</tr>
</tbody>
</table>

Table 2. Media naturalness elements and examples of good implementation through e-mail

<table>
<thead>
<tr>
<th>Media naturalness element</th>
<th>Good implementation</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support for use of speech</td>
<td>Generic audio clip files attached to e-mails</td>
<td>Capture voice intonations that add meaning to messages</td>
</tr>
<tr>
<td>Support for use of facial expressions</td>
<td>Generic facial photo files conveying specific emotions attached to e-mails</td>
<td>Capture the nuances of facial expressions</td>
</tr>
<tr>
<td>Support for use of body language</td>
<td>Generic video clip files showing the sender’s whole body attached to e-mails</td>
<td>Capture the nuances of body positions and movements</td>
</tr>
</tbody>
</table>
by, say, drug development in a pharmaceutical company. The results of that test may not be very useful for conclusions about how the same technology would be used in the context of budget allocation in a government defense agency.

One main conclusion from the above discussion is that a lot more behavioral research must be conducted on e-collaboration, and that research should be closely tied to research on the design of e-collaboration technologies. Those two types of research are more often than not done in a disconnected manner. Moreover, that behavioral research on e-collaboration should be conducted more often in the organizations that use the e-collaboration technologies. Up until now most of that research has been conducted in universities and research centers, with some notable exceptions, and based on experimental scenarios that are frequently disconnected from the reality faced by organizations. An increase in the amount of action research (Kock, 2006) on e-collaboration would certainly meet that need head on.

ACKNOWLEDGMENT

The author would like to thank those who participated in the studies discussed here for their time; and Temple University and Texas A&M International University, for their institutional support. Thanks are also due to John Nosek, Heinz Klein, Allen Lee, Ravi Patnayakuni, Leda Cosmides, and John Tooby for ideas and suggestions regarding several of the issues discussed here. All errors and omissions are the sole responsibility of the author. Several documents previously published by the author have been used as a basis for this chapter; the author thanks the copyright holders for allowing text and figures from those documents to be used. Publicly available images were used in the development of some of the figures; the author thanks the individuals and organizations who maintain the following Web sites for making them available: www.microsoft.com and www.google.com.

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