Who is on the Driver Seat? The Evolution of Collaboration Technologies in Organizations

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Abstract

This paper presents a historical review of the evolution of management thinking and collaboration technologies. This review shows that the gap between management ideas and the functionality available in collaboration technologies has been steadily narrowing since the late 1960s, opening up new opportunities for developers and integrators of these technologies as well as companies that use them. Management ideas have preceded and likely driven the development and use of collaboration technologies up until the early 1990s. This situation has been reversed since the mid-1990s due to circumstances related to the advent of the World Wide Web. One caveat associated with this new state of affairs is that it makes it difficult for companies to achieve or sustain a competitive advantage in their industries, particularly if they use standard technologies that are also available to their competitors. From a traditional management perspective, this is the equivalent to placing the "cart in front of the horses", so to speak. We argue that, to overcome difficulties associated with this situation companies need to instill a new management model into their management ranks. Based on the results of business process redesign projects involving over 10 companies in the Philadelphia Metropolitan Region, we provide a first step toward the development of a generic management model that takes advantage of features of modern collaboration technologies.

Resumo

Este trabalho apresenta uma revisão da evolução do pensamento gerencial e das "collaboration technologies". Esta revisão mostra que o "gap" entre as idéias gerenciais e a funcionalidade presente nas "collaboration technologies" tem diminuído firmemente desde o final dos anos 60, abrindo novas oportunidades para os criadores e integradores dessas tecnologias, assim como para as empresas que as utilizam. As idéias gerenciais precederam e provavelmente impulsionaram o desenvolvimento e uso das "collaboration technologies" até o início dos anos 90. Esta situação foi revertida desde meados dos anos 90 devido a circunstâncias relacionadas ao advento da W.W.W. Uma advertência associada com esta nova situação refere-se às dificuldades que as empresas têm de atingir uma vantagem competitiva, particularmente se elas usam tecnologia padrão, que também estão disponíveis para suas competidoras. Da perspectiva da gerência tradicional, isto corresponde a "colocar o carro na frente dos bois". Nós argumentamos que para vencer estas dificuldades, as empresas devem implantar um novo modelo gerencial em seus quadros. Baseado nos resultados de projetos de reconfiguração dos processos empresariais envolvendo mais de 10 empresas na Região Metropolitana da Filadélfia, nós damos um primeiro passo no sentido do desenvolvimento de um modelo gerencial genérico que leva em conta as características das modernas "collaboration technologies".

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The history of management is intertwined with the history of technological developments, which makes it difficult to establish whether management ideas tend to guide the use of technology in organizations, or commercial technologies tend to guide the development of new management ideas. For example, the "scientific management" approach is often described as having been the product of Taylor's inventive and engineering-oriented mind. Yet, many industries and related productivity improvement opportunities that benefited from the application of scientific management ideas were a direct result of the development of the steam engine in the 1760s. The development of the steam engine helped launch the industrial era, characterized by a tremendous expansion in the markets for machines built around steam engine principles. Steam ships and locomotives were developed, which led to an enormous growth of canal and railroad transport and, in turn, in trade in general. The development of new methods for management of sales and product distribution followed. We can go on and on citing examples that show the close relationship between the development of management ideas and technologies in the three centuries from 1700 to the year 2000.

From the 1960s, information-processing technologies have been particularly important in the shaping of management ideas and organizations. Among these, collaboration technologies have been particularly influential in the 1990s. Collaboration technologies are broadly defined here as technologies that enable collaboration among individuals engaged in a common task. Examples of such technologies are email, Internet email listservs, Web-based chat tools, Web-based asynchronous conferencing tools, collaborative writing tools, group decision support systems, teleconferencing tools, and workflow control tools. Collaboration technology infrastructures, such as the Web, can provide mechanisms for decentralized access to data generated through database query and online analytical processing systems.

This paper reviews the historical evolution of management ideas and contrasts it with the evolution of collaboration technologies. It argues that the gap between accepted management ideas and collaboration technologies has been steadily narrowing since the late 1960s, opening up new opportunities for developers and integrators of such technologies as well as the companies that use them. Based on our business process redesign work with over 10 companies in the Philadelphia Metropolitan Region, the paper also provides a glimpse at a generic management model that takes advantage of features of modern collaboration technologies.

The Evolution of Management Thinking, from Taylor to New Age Process Grinders

It is very difficult to precisely trace the origins of management thinking. While the first organized treatises on management appeared at around the end of the 18th century, it is undeniable that one can find management principles in practice as early as 4,000 BC. At that time, the first civilized group ever, the Sumerians, had already developed careful work coordination, governance and record-keeping procedures. This allowed them to drain the swamps at the head of the Persian Gulf, develop the earliest known form of writing, and invent the wheel. The Egyptians followed, developing precise planning and coordination methods that are reflected in the complexity of irrigation networks build around the Nile River and the Great Pyramids. Other developments in management practices that followed these but that are not usually discussed in traditional management history treatises are:

· The expansion of the Roman Empire and the related development of decentralized governance schemes.

· The development of bookkeeping procedures by Italian merchants in the Middle Ages (including Luca Pacioli's double-entry approach).

· The development of the concept of task specialization by Thomas Moore in England.

· The development by Niccolo Machiavelli in Italy of rudiments of what later became known as strategic management.

A more traditional account of the evolution of management thinking would likely start with the articulation of the division of labor thesis, by Adam Smith, which stated that complex organizational tasks could be split into simpler subtasks carried out by specialized employees. A discussion including the schools of management thought below and respective main figures would follow.

· Scientific management: Frederick W. Taylor.
· Functionalism: Henry Fayol.
· Human relations: Elton Mayo;
· Hierarchy of needs: Douglas McGregor and Frederick Herzberg.
· Organizational learning: Reg Revans, Chris Argyris and Peter Senge.
· Total quality management: William E. Deming and Joseph M. Juran.
· Excellence: Tom Peters and Rosabeth M. Kanter.
· Reengineering: Michael Hammer.

The schools of management thought above are summarized on Table 1, where start and end dates indicate the approximate period in which each management school was at its peak of influence.

Management school	**Main figure(s)**	**Period**	**Main thesis**
Division of labor	Smith	1770s to mid 1800s	Complex tasks can be broken down into simpler tasks by managers and carried out by specialized workers with great productivity gains.
Scientific management	Taylor	Late 1800s to early 1900s	Tasks can be scientifically analyzed and improved by managers. Tying financial rewards to the obedient execution of carefully designed tasks leads to increases in labor productivity.
Functionalism	Fayol	Early 1900s	Organizations should be structured around forecasting, planning and coordination activities led by managers. These activities guide the work of line employees.
Human relations	Mayo	1930s to 1950s	For the average worker, the desire to stand well with one's fellow workers easily outweighs the influence of financial rewards and physical working conditions.
Hierarchy of needs	McGregor, Herzberg	1950s to 1970s	Workers have a hierarchy of needs, going from basic animal to intellectual needs, which have to be satisfied for optimum job productivity to be achieved.
Organizational learning	Revans, Argyris, Senge	Began in the 1960s	Workers as well as managers can continuously improve the organization in which they work by freely sharing and questioning their knowledge and personal beliefs in a trusting organizational environment.
Total quality management	Deming, Juran	1950s to 1980s	Organizational improvement should focus on processes, not problems, and related quality issues. Productivity improvement cannot be realized without quality improvement. Line employees and customers, not only managers, should be deeply involved in quality improvement initiatives.

Excellence	Peters, Kanter	1980s	Excellent organizations change continuously in order to satisfy their customers. This change is both top-down and bottom-up, i.e. it is driven by managers as well as line workers.
Reengineering	Hammer	Began in the 1990s	Organizations should radically redesign their processes from time to time in order to remain competitive. This redesign should be top-down, i.e. primarily led by top managers.

Table 1: The evolution of management thinking

Management schools usually emerge as an attempt to overcome problems posed by current management thinking or, in earlier stages, the absence of management concepts and ideas. As such, Table 1 can be seen from an evolutionary perspective, where the ideas that became popular at a certain period in time emerged from the critical evaluation of previous ideas and related consequences.

Table 1 suggests that the evolutionary process underlying the emergence of management schools is a gradual one. The division of labor, scientific management and functionalism schools obviously focused on managers as the "designers" of work procedures, which are at the center of the creation of wealth. Apparently, workers and their perceptions of the workplace were irrelevant during this period.

The situation above started to slowly change with the development of ideas related to human relations and hierarchy of needs schools. These two management schools do not necessarily question management's lead in making organizations more efficient, but they decisively point out the importance of satisfying workers needs as a way of achieving productivity gains. The focus in this period lay primarily on workers' needs and their satisfaction, to which workers would respond by becoming "happier and more productive".

The next wave of management schools built on ideas put forth by the human relations and hierarchy of needs schools. Three management schools represent this next wave: organizational learning, total quality management, and excellence. These three schools clearly placed the source of organizational change in the hands of workers, and argued that managers should become "teachers and motivators", rather than organizational designers and controllers. These three schools, the total quality management school in particular, have also emphasized the importance of continuous redesign of business processes as a way to achieve gains in productivity and quality. Also, these three schools stressed the need for "quality" improvement, which contrasted with the previous focus on "productivity" of earlier management schools. Finally, these schools called for decentralized access to information and knowledge, as well as increased horizontal (i.e. between peers) and vertical (i.e. between different levels) communication.

In the evolutionary context described above, the last management school described in Table 1, reengineering, seems to be a reverse leap back to ideas that are closely aligned with the division of labor, scientific management, and functionalism schools. It is unclear whether this is the beginning of a new cycle, where organizations will resume their reliance on managers for work design and control or an unsuccessful attempt to revive old ideas. The apparent failure in the application of many of the "radical" ideas associated with the reengineering movement in its pure form, observed from the beginning of the movement, suggests that reengineering is more likely to become known in the future as an unsuccessful attempt to revive old ideas. Nevertheless, the reengineering school has been hailed, even by some of its critics, for its stress on business processes as the fundamental units of organizational productivity and quality.

Yet, even though the reengineering school appears to try to revive some of the ideas that permeated the division of labor, scientific management, and functionalism schools, its object of attention is different. While the focus of those

schools was on manufacturing processes, reengineering's was, from the very beginning and through the peak of the movement, on service processes. And, since service processes usually require more communication than their manufacturing counterparts, it is no surprise that one of reengineering's guidelines for process streamlining was to cut down on unnecessary horizontal and vertical information flow contact points in business processes. One way this can be achieved is through the replacement of middle managers whose main role is to act as information broadcasters (from the top to the bottom of the organizational ladder) and filters (from the bottom up) with email, groupware, and decision support applications. This has, in many cases, increased direct and indirect communication between line employees and senior managers, upsetting previous hierarchical structures that set a clear path for information flow through middle managers.

As it can be noticed from the discussion above, management ideas evolved in a way that has increasingly endorsed, over time, the need for technologies that support decentralized access to information and knowledge as well as opening up new and broadening existing horizontal and vertical communication channels. Yet, this need alone did not guarantee that related technologies, collaboration technologies in particular, would find their way into organizations. Other important factors were the availability and cost of such technologies at the time the management ideas are in place. This suggests the need for an analysis of how these technologies evolved over time, which is summarized in the following section.

The Evolution of Collaboration Technologies, From Mainframes to the Internet

The evolution of the collaboration technologies begins with the period that immediately followed the development of the first computer, after World War II. This period is called here "the mainframe era" because of the predominance of mainframes, i.e. large central computers connected to several "dumb" terminals, and goes from the early 1950s to the late 1960s (see Table 2). The mainframe era

Stage	Period	Description
The mainframe era	Early 1950s to late 1960s	Although mainframes had the necessary resources to implement collaboration technologies, such technologies were practically nonexistent during this period. Data access was centralized and CPU time very expensive.
The emergence of computer networks	Late 1960s to mid 1980s	Development of the ARPANET, primarily to connect geographically distributed mainframes. Development and use of email and other asynchronous collaboration technologies in experimental ways.
The expansion of local area networks	Mid 1980s to early 1990s	Emergence of PCs and LANs connecting them. Development of more sophisticated collaboration technologies, such as Lotus Notes and several varieties of group decision support systems. Most of these technologies were designed for LANs.
The Internet era	1990s	Emergence of the Internet as a public wide area network. Development and widespread use of more sophisticated email systems. Development of Web browsers. Development and widespread use of Web-based collaboration technologies such as asynchronous Web discussion forums, and Web-based chat.

Table 2: The evolution of collaboration technologies

was characterized by an almost complete absence of collaboration technologies, even though mainframes had the necessary resources to support communication between workers using terminals. Mainframes were used primarily for calculations and centralized data processing in this period, due to a key reason — a very high hourly operating cost. For example, the cost of an IBM-7094 in 1966 was approximately $2 million, and its life span was approximately five years, which gives an hourly cost of about $45. At the same period, salaried workers' wages were as low as $1 per hour.

The mainframe era was followed by the emergence of the first computer networks, between the late 1960s and mid 1980s. A key development in this period is the ARPANET project, the precursor of the Internet. The main goal of the ARPANET project was to build a dispersed and heterogeneous network of mainframes, where the resources of one mainframe would be accessible from terminals connected to different mainframes in the network. ARPANET provided one of the earliest versions of email, which was not seen by its developers as one of its most significant component systems at that time. In spite of this, email use grew exponentially to support collaboration between researchers, university professors and students. At the same time, pioneering implementations of collaboration systems happened elsewhere in the US and Europe. These implementations led to the first organized workshop on collaboration systems (the first installment of the now well-established CSCW conference), which took place in 1984. The end of this period was also marked by a phenomenal growth in the use of minicomputers, which were less powerful, stripped down, and cheaper versions of mainframes.

The development in the mid and late 1970s of large-scale integrated circuits, whose transistor capacity was much higher than in normal integrated circuits, led to the development of smaller and more powerful computers, the personal computers or PCs. This led, from the mid-1980s to the early 1990s, to the development and accelerated growth of local area networks (LANs). Many synchronous and asynchronous collaboration systems were developed in this phase. Some of these, such as Information Lenz and The Coordinator, extended the basic features present in early email systems. Other collaboration systems provided support for decision-making meetings, e.g. GroupSystems, Teamfocus, and MeetingWorks. Still others, such as Lotus Notes and Domino, were suites on which customized collaboration systems could be developed to support group processes. Most of the collaboration systems developed in this period were a result of the work of researchers in universities, government agencies, and corporate research centers.

The 1990s have seen the emergence of what we refer here to as the Internet era, where many of the collaboration systems discussed above migrated from LANs to Internet-based platforms. The Internet era began in the early 1990s with the development of the HTTP communication protocol and the HTML language, and really started to show signs of exponential growth in 1993, when the Web browser Mosaic was developed. This set the stage for the migration of collaboration systems from LANs to the Internet, mostly as client-server systems running on platforms made of generic, platform-independent Web browsers (on the client side), and platform-dependent Web servers (on the server side). In the Internet era, the Web browser interface has become the standard interface for collaboration systems.

Closing the Gap: The Convergence of Management Ideas and Collaboration Technologies

Since one of the main goals of this paper is to build a link between the evolution of management thinking and collaboration technologies, our analysis

would benefit from a representation of the several stages described in the two preceding sections using a common scale. Such representation is provided in Figure 1, which shows the chronological evolution of management thinking and collaboration technologies.

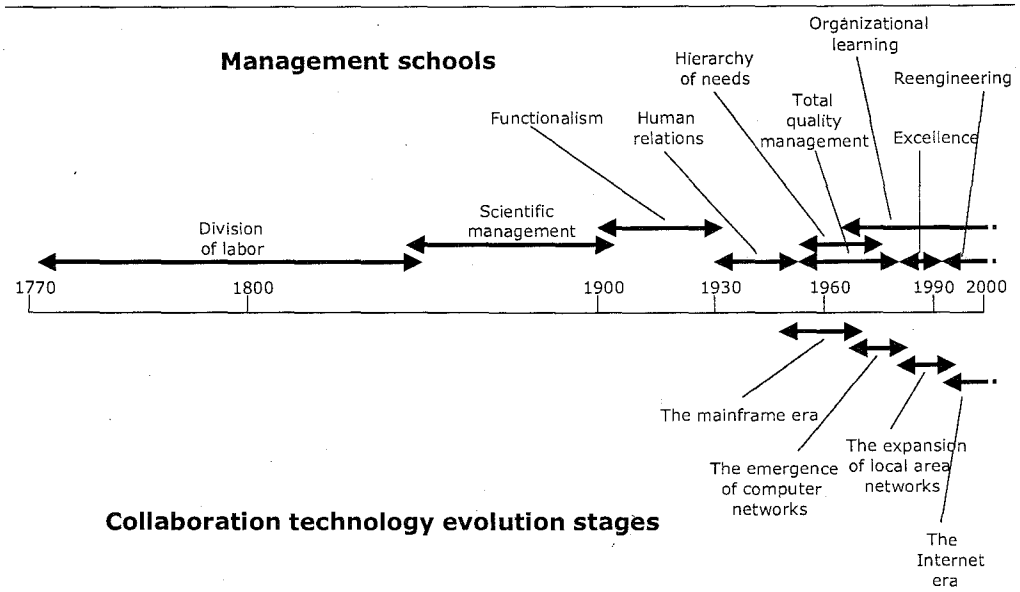

Figure 1: Management schools and collaboration technologies

The top of Figure 1 shows the management schools previously discussed (details can be found in Table 1), whereas the collaboration technology evolution stages (detailed in Table 2) are shown at the bottom. As noted before, the beginning and end dates shown for management schools and collaboration technology evolution stages were estimated based on historical records, as well as literature on management history and technological developments. They suggest collaboration technologies are very new when compared with management ideas and related schools of thought. In addition, these dates suggest that collaboration technologies that enabled management ideas associated with less managerial control of workers, decentralization of decisions, and decentralized access to information were available very close to the time those management ideas emerged. Yet, this was not always at the "right price". For example, the high cost of CPU time and mass storage space in mainframes during the mainframe era was very high, which prevented their use to support collaborative group work.

The diagram in Figure 1 suggests that several management schools and collaboration technologies emerged after 1950, which makes the right part of the diagram quite cramped. This is corrected in Figure 2, which zooms in on that part of the diagram. The top part of the Figure 2 shows management schools and collaboration technology evolution stages from 1950 on. The bottom part of Figure 2 shows a simple depiction of the gap between management thinking and collaboration technologies.

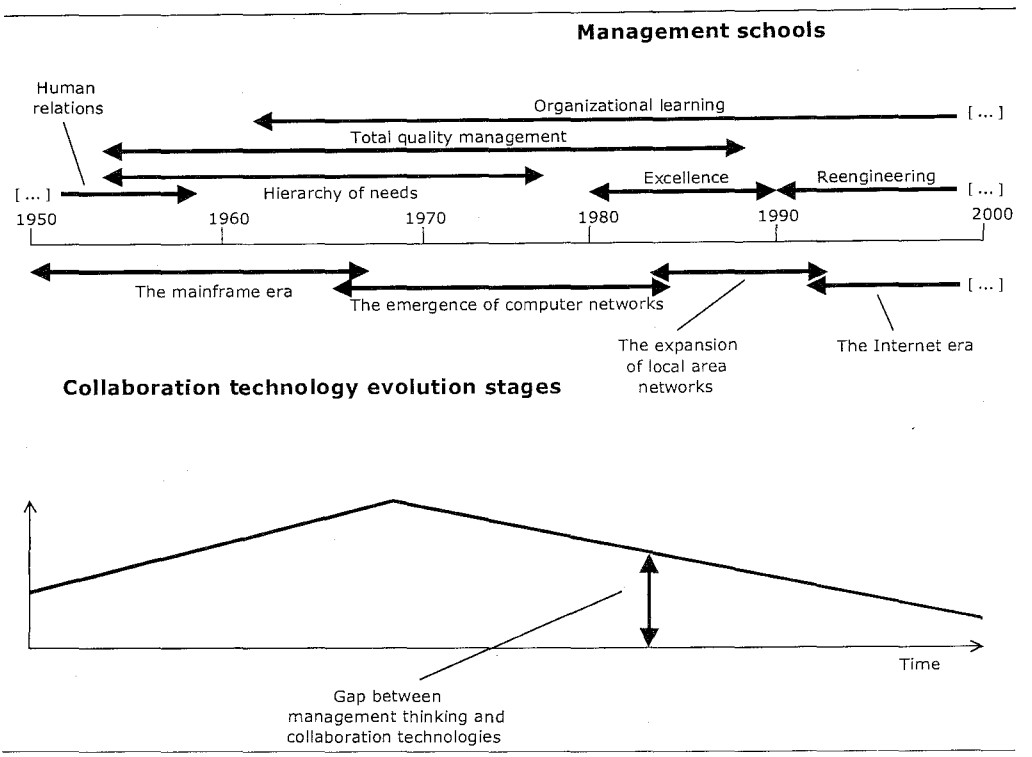

Figure 2: Gap between management thinking and collaboration technologies

The gap shown on the bottom of Figure 2 does not apply to the period preceding the mainframe era, as no computer technologies existed then. The gap starts small, because the push toward teamwork was only starting to emerge as part of management thinking in the early 1950s. This push became stronger toward the end of the 1960s, leading the gap to reach its peak right before 1970. This was a time when management movements geared toward the empowerment of workers and collaborative work obviously clashed with the economic and technical obstacles of providing workers with decentralized access to computing resources.

The gap began to narrow from around 1970 onwards, with the gradual reduction in the cost of mainframe use, the commercial debut of minicomputers, and the consequent development of early collaboration technologies. This period is also marked by wide area computer networking initiatives such as ARPANET, which only later would become available to organizations other than universities and research centers.

The three decades from 1970 to 2000 have seen a progressively closer alignment between management thinking and the capabilities afforded by collaboration technologies. Total quality management, organizational learning, and excellence are management schools with strong roots in worker empowerment, decentralized access to information, and teamwork. Looking at the diagram on Figure 2, one can argue that the more influential these management schools became, the stronger was the push to develop collaboration technologies to support decentralized information access and decision making as well as teamwork. The emergence of reengineering in the early 1990s has not upset this picture, even though some may think it has. Reengineering itself incorporated ideas that have not been very popular since the scientific management movement, and that emphasize top-down organizational development and thus, in a sense, a reduction in worker empowerment. Yet, as discussed before in this paper, successful

reengineering tends to change organizations so as to increase (after reengineering projects are completed) direct and indirect communication between line employees and senior managers, breaking down previous hierarchical structures that set a clear path for information flow through middle managers. This also calls for the support of collaboration technologies.

Contemporary Trends: Who is in the Driver Seat, Management Thinking or Collaboration Technologies?

Our investigation of the evolution of management thinking and collaboration technologies, discussed above, suggests that the former have preceded and quite possibly driven the latter for a long period of time. That is, management schools that emphasized certain types of collaborative work appeared earlier than collaboration technologies geared at supporting those forms of work.

This situation has undoubtedly changed recently, arguably 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 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.
- "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 no or little of physical assets and distribution channels.
- "Boundaryless organizations", in which geographical barriers to teamwork and market reach are virtually eliminated.

The examples above 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. The adoption of management ideas that are aligned with the collaboration potential afforded by the Internet and the Web can place companies in tremendously advantageous positions in their industries, as illustrated by 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 collaboration technologies. This approach has its advantages but is difficult to implement in practice, because some of the new collaboration technologies have emerged support new organizational forms (some of which have been listed above), which are often incompatible with old management schools. 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 collaboration technologies. What is needed is

a generic framework that ties together relevant management ideas that help organizations strategically and operationally align themselves with new collaboration technologies.

It is beyond the scope of this article to propose a new management school. Even "describing" in the detail a new management school would increase the length of this paper beyond what is expected from a journal article. Given this, a first step towards a new management framework to help organizations benefit from modern collaboration technologies is proposed and discussed in the next section. Our goal 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.

Managing With Modern Collaboration Technologies in Mind: A Generic Framework Based on Practice

A great deal of our work since the late 1980s (particularly the first author's) has revolved around the use of collaboration technologies to support different forms of teamwork. Since 1997, we have been working with several companies in the Philadelphia Metropolitan Area in the analysis and redesign of their business processes, leveraging the resources provided by local area networks, wide area networks, and the Internet. Some of the companies we have worked with toward this end include Prudential Insurance, Metro One Telecommunications, Sheraton Hotels, and Day & Zimmermann.

After several projects, each involving different managers, consultants and key employees, some patterns started to emerge that seemed relatively independent of characteristics of the company, 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 analyzed and redesigned over 20 processes from more than 10 organizations from 1997 to 1999). 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 3 and can be summarized as follows:

A workflow control module, represented in Figure 3 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 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 customer query module, represented in Figure 3 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.

An OLAP (Online Analytical Processing) application, represented in Figure 3 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.

A process communication application, represented in Figure 3 by the oval described as "Process communication application", which populates a **process communication database**. This application supports continuous communication between the process manager, process customers, and process team. This is the key collaboration technology used in the process and may incorporate the following Web-based components:

- A repository of process metrics and process improvement initiatives aimed at improving the outcomes of the metrics. This repository will usually be maintained by the process manager.
- 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.

It is important to stress that the process redesign initiatives that led to variations of the model above were guided by a common methodology called MetaProi, which stands for Meta-process for Process Improvement (see Kock, 1999). In spite of this, the fact that the model shown on Figure 3 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 collaboration technologies 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 3).

Management idea	Management schools	Process feature(s)
Direct management control on teams should be reduced to a minimum. Process-level control should be automated as much as possible.	Excellence, Reengineering.	Workflow control automation.
Customers should have instant access to process execution status.	Total quality management, reengineering.	Automated customer query support.
Process metrics should be periodically analyzed and used to incrementally improve processes.	Total quality management.	OLAP-based process metrics generation.
Customers should be allowed access to process performance data and related process improvement initiatives, and asked for their advice on how to improve processes.	Excellence, total quality management, organizational learning.	Process metrics and improvement initiatives repository, discussion forum.
Customers should be given full and decentralized access to process-related data so they can solve some process-related problems themselves.	Reengineering, organizational learning.	Process knowledge base.

Table 3: Management ideas, related schools and process features

The "Process feature(s)" column on Table 3 describes features of the generic process model that are highly dependent on collaboration technologies, particularly in the last two rows (repositories, 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 3, which in turn became more popular with the emergence of four contemporary management schools: organizational learning, total quality management, excellence and reengineering. Still, one cannot convincing 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 (e.g. organizational learning proponents often suggest their management school as a "softer" and more "people-oriented" alternative to reengineering). It is more likely that modern collaboration technologies force the adoption of management ideas that do not have a single and coherent source.

The idea that information technology should drive organizational design has been proposed by many business thinkers, including reengineering co-inventor Tom Davenport (1993) — in fact, this was one of the early areas of disagreement between him and other proponents of reengineering. 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, which 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 ahead of them?

The generic process model discussed above can be seen as a first step in the direction of a management school whose principles should guide the selection and implementation of collaboration technologies to enable optimal processes,

rather than the other way around. The key concept underlying this new management school is that of "virtual communities" of process team members, users and managers, brought together in creative ways through the use of collaboration technologies. Such virtual communities should, among other things, promote collaboration between customers and suppliers, by allowing them to communicate and share data independently of traditional time and distance constraints.

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