Shifting the focus of process redesign from activity flows to communication flows

Final Report

Research project funded by the External Acquisition Research Program
EARP DUE 013100

Ned Kock
Temple University
1810 N. 13th Street, 210C Speakman Hall, Philadelphia, PA, 19122
Phone: (215) 204-4573, Fax: (215) 204-3101, Email: kock@sbm.temple.ed

Frederic Murphy
Temple University
1810 North 13th Street, 111 Speakman Hall (006-00), Philadelphia, PA 19122
Phone: (215) 204-8189, Fax: (215) 204-5698, Email: fmurph@sbm.temple.edu

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Acknowledgements

In order to add theoretical rigor to the test of our main thesis, which is that communication flow-based approaches to process redesign are superior to their more widespread activity flow-based counterparts, we have decided to go beyond the original scope of our proposal and frame a set of hypotheses (which all follow from our main thesis) based on a theoretical framework. The theoretical framework, which we refer to as *communication flow optimization theory*, has been in part developed as an integral component of our research project and should be seen as a first step in the direction of a strong theoretical foundation for our main thesis. We hope the External Research Acquisition Program coordinators will appreciate this (perhaps bold) decision, which, we would like to stress, is a "first step" in a journey that will probably take us many years to complete.

We would like to thank the External Research Acquisition Program coordinators, particularly Dr. Ira Lewis, for their relentless and generous support. We would like to also thank the process redesign consultants, as well as employees and managers of the four organizations that participated in this study, for their time and support.

Abstract

It can be argued that process redesign has a long history, going as far back as Taylor's scientific management and reaching its peak in the 1990s with business process re-engineering. Throughout most of its history, operational-level approaches to process redesign maintained a focus on "workflows", or the chronological flows of activities in processes. It is argued in this report that while this makes some sense in materials-transformation processes, whose final product usually is a tangible manufactured item (e.g., a car engine), this orientation is fundamentally inconsistent with the communication-intensive nature of the vast majority of processes found in organizations today.

This report attempts to show that a focus on communication flow representations and methods is likely to lead to better process redesign outcomes than a focus on representations and methods in connection with "workflows". It does so by developing a set of hypotheses based on communication flow optimization theory, and testing those hypotheses in the context provided by four process redesign projects, conducted at four organizations from the private sector. The selection of target processes to be redesigned was based on an "activity group similarity approach", where similarity at the "activity group level" was sought against the Federal Acquisition Process (FAP). By following this approach we hope to have been able to cover a wider range of activities in the FAP than we would be able to if we had simply tried to target "pure" defense-purchasing processes. That is, given the complexity and variety of activities of the FAP, the use of the "activity group similarity approach" to select target processes ensured that the selected processes for redesign covered as many of the FAP activities as possible. Moreover, we also asked all of those involved in the four process redesign projects to carefully study a previous process redesign project that targeted a defense-related procurement and purchasing process (whereby the DoD procured and purchased software development services from major contractors) and report on possible differences between their projects and that previous project. The previous project that served as a basis for comparison had been conducted in 2000 though an earlier grant from the External Research Acquisition Program.

Overall, the results support our main thesis that communication flow-based approaches to process redesign are superior to their more widespread activity flow-based counterparts, and suggest that managers (in the defense sector and elsewhere) should strongly consider moving away from an activity flow-based focus and toward a focus on communication flows and related process redesign techniques.

Introduction

Organizational development approaches centered on business process redesign (or, simply, "process redesign") have become increasingly popular in contemporary management, particularly due to the emergence of business process re-engineering in the late 1980s and early 1990s (Hammer, 1996; Hunt, 1996). In spite of this research popularity, an argument can be made that process redesign is a much older approach than re-engineering; one that has probably influenced management thinking since management's emergence as a separate field of study and practice. According to this view, process redesign can be seen as dating back to the early 1900s, when Frederick Taylor (1911) published *The Principles of Scientific Management*. The scientific management movement strongly influenced organizational development ideas and approaches throughout the Second Industrial Revolution (1850-1950). During this period, process redesign was primarily concerned with productivity (i.e., efficiency) improvement in manufacturing plants, and was centered on the optimization of "times and motions" in situations of high work specialization and division of labor. For example, the Gilbreths developed diagrams to represent the actions taken in production processes to simplify the steps necessary to produce products. (see, e.g., Mundel, 1955.)

Taylor's scientific management led to what many believe to have been as a dehumanization of the workplace, which set the stage for more "humane" schools of management to emerge and flourish. The work of Elton Mayo in the early and mid-1900s (Mayo, 1945) and that of others such as McGregor, Maslow, and Herzberg represented the emergence of the "humanist" school of management (Clutterbuck and Crainer 1990; Herzberg et al., 1959; Maslow, 1954), which tried to shift the focus of organizational development from "processes" to "people". While these management thinkers, who were very successful during the mid 1900s, can be seen as having proposed ideas that minimized the importance of processes as competitiveness drivers in organizations, process redesign was far from "dead".

The work of the "humanists" set the stage for the emergence of what many saw as a more "humane" process redesign school of thought, generally known as total quality management (Walton, 1991), which have not only superceded scientific management as a process-based method for organizational development, but also represented a shift in focus from productivity to quality in the improvement of processes (Deming, 1986). While heavily based on statistical methods in its inception, this approach soon acquired a broader orientation (Deming, 1986; Ishikawa, 1986; Juran, 1989). Total quality management began in Japan after the World War II, largely due to the work of William Deming and Joseph Juran, and is widely credited as having propelled Japan to economic superpower status (Bergner, 1991; Chapman, 1991; Deming, 1986; Juran, 1989; Walton, 1989). In the 1980s, total quality management became widely practiced in the US and other Western capitalist countries (Deming, 1986; Juran, 1989; Walton, 1989; 1991). Similar to scientific management, its primary focus was the improvement of an organization's operations.

Business process re-engineering (Davenport, 1993; Hammer and Champy, 1993) re-emphasized process redesign in the early 1990s. Michael Hammer (together with James Champy) and Thomas Davenport independently developed business process re-engineering as, respectively, a better alternative (Hammer and Champy's version) and a complement (Davenport's version) to total quality management. Their work was based on the premise that the incremental gains in productivity obtained through the implementation of total quality management methods were insufficient for organizations to cope with the accelerated rate of change of the 1990s, brought about by new information technologies (Davenport, 1993;

1993a; Davenport and Short, 1990; Hammer, 1990; Hammer and Champy, 1993). As distinguished from scientific management and total quality management, business process re-engineering was presented as a method for the improvement of managerial and service as well as manufacturing operations.

In spite of being initially touted as a "new" idea, it became apparent that business process re-engineering had built on ideas and methods that were similar to those proposed by Taylor's scientific management (Earl, 1994; Waring, 1991). This is particularly true of "operational" versions of business process re-engineering (Hammer and Stanton, 1995; Hunt, 1996), which, unlike more strategic ones (Caron et al., 1994; Clemons et al., 1995), look into the inner workings of individual processes in order to improve them. In fact, throughout the history of process redesign, operational-level approaches to process redesign consistently maintained a focus on "workflows", or chronological flows of activities in processes (Kock and McQueen, 1996). It is argued in this report that while this orientation makes sense in materials-transformation processes, whose final product usually is a tangible manufactured item (e.g., a car engine), this orientation is fundamentally inconsistent with the communication-intensive nature of the vast majority of processes found in organizations today. In these processes, Kock and McQueen (1996) argue much more information (an intangible item) is handled than materials (or tangible items).

This report attempts to show that a focus on communication flow representations and methods is likely to lead to better process redesign outcomes than a focus on "workflows." It does so by developing a set of hypotheses based on communication flow optimization theory, and testing those hypotheses through an action research investigation of four process redesign projects, conducted at four organizations from the private sector. The selection of target processes to be redesigned was based on an “activity group similarity approach”, where similarity at the “activity group level” was sought against the Federal Acquisition Process (FAP). By following this approach we hope to have been able to cover a wider range of activities in the FAP than we would be able to if we had simply tried to target “pure” defense-purchasing processes. That is, given the complexity and variety of activities of the FAP, the use of the “activity group similarity approach” to select target processes ensured that the selected processes for redesign covered as many of the FAP activities as possible. Moreover, we also asked all of those involved in the four process redesign projects to carefully study a previous process redesign project that targeted a defense-related procurement and purchasing process (whereby the DoD procured and purchased software development services from major contractors) and report on possible differences between their projects and that previous project. The previous project that served as a basis for comparison had been conducted in 2000 though an earlier grant from the External Research Acquisition Program.

Research background

Much research on process redesign has been conducted in the 1990s, addressing important questions raised by re-engineering. Success factors and preconditions for effective process redesign have been identified (Bashein and Markus, 1994; Clemons et al., 1995), new methods and techniques for managing change in connection with process redesign have been proposed (Kettinger and Grover, 1995; Stoddard and Jarvenpaa, 1995), potentially damaging “myths” have been identified (Davenport and Stoddard, 1994), the role of information technology in process redesign efforts has been clarified (Venkatraman, 1994), new insights on the implementation of new process designs has been gained (Grover et al., 1995), and new methods and information technology tools to support process redesign have been proposed (Kock, 1999; Nissen, 1998).

One area that has received relatively little attention, however, is that of process representation frameworks and their impact on process redesign (Katzenstein and Lerch, 2000). This is an important area of research, because it addresses the way process redesign practitioners "look at" processes, or the representational "lens" through which they "see" a process, which is arguably likely to have a strong influence on how processes are redesigned (Hammer and Champy, 1993; Katzenstein and Lerch, 2000). For example, a focus on the flow of activities in a process (or "workflow") is likely to lead to changes in how *activities* flow in the process, whereas a focus on the flow of information in a process is likely to lead to changes in how *information* flows in the process (Davenport, 1993; Kock, 1999).

An analysis of process redesign practices throughout the 100-year period from the development of scientific management to the emergence of business process re-engineering suggests an interesting, perhaps cyclic, pattern. Even though business processes changed significantly since Frederick Taylor's times, the process redesign practices employed then seem very similar to those of the 1990s and beyond in terms of the focus of process redesign, which has consistently been the sequence of activities, or "workflow", of a process (Kock, 1999; Kock and McQueen, 1996; Waring, 1991).

The scientific management method (Taylor, 1911) consisted in breaking down a business process into component activities, for which a pictorial as well as a quantitative model was generated. The pictorial model depicted the flow of execution of the activities and the associated motions, whereas the quantitative model included information about physical distances associated with motions and the times needed to perform each of the activities. Taylor showed that managers could empirically devise optimal (or quasi-optimal) business process configurations that could then be standardized through financial incentives to workers (Taylor, 1885; 1911).

Many have argued that business process re-engineering is a “modernized” version of scientific management (Earl, 1994; Kock and McQueen, 1996; Rigby, 1993; Waring, 1991). Re-engineering’s popularity reached its peak by the mid 1990s and subsequently has declined due to a number of reported failures. James Champy, one of re-engineering’s pioneers, argued that 70% of all re-engineering projects failed to achieve their goals (Champy, 1995). In spite of this, re-engineering created renewed interest in process redesign, making it (i.e., process redesign) one the most widely practiced forms of organizational development today (Biggs, 2000; Davenport, 2000; Hammer, 2000). However, unlike during the “heyday” of scientific management, when business process improvement meant “materials flow” improvement, today most of what flows in business processes is information. As pointed out by Peter Drucker, already in the early 1990s: “In 1880, about nine out of 10 workers made and moved things; today, that is down to one out of five. The other four out of five are knowledge people or service workers” (Drucker, 1993, p. 50). A study by Kock and McQueen (1996) shows that, even in manufacturing organizations, approximately 80% of what flows in business processes is data (carrying information), while the other 20% is made up of materials (in service organizations, these proportions are usually very close to 100% and 0%, respectively). These figures seem to confirm the once thought to be visionary claims that “we are living in an information society” (Toffler, 1991) and that organizations have become “information organizations” (Drucker, 1989). The high proportion of information flow is also consistent with the widespread use of information technologies in organizations, and its increasing importance in the improvement of business processes.

In spite of the above, most process redesign practices today mirror Taylor's approaches of the early 1900s in one key respect – they appear to be tailored to the optimization of the flow of materials, which involves sequences of interrelated physical actions, and not the flow of information (Katzenstein and Lerch, 2000; Kock, 1999), which involves communication. This conclusion is reached based on the observation that most of today's process redesign practices focus on the analysis of business processes as sets of interrelated activities, and pay relatively little attention to the analysis of the communication flow in business processes (Archer and Bowker, 1995; Harrington et al., 1998; Kock and McQueen, 1996). Systems analysis and design methods (Davis, 1983; Dennis and Wixom, 2000), on the other hand, do address communication in processes, but they have traditionally been relegated to process *automation*, and had seldom been applied to process *redesign* (Harrington, 1991; Harrington et al., 1998; Kock and McQueen, 1996). More recently, object-oriented analysis and design methods have contributed a more communication-oriented view of processes, particularly those in connection with the unified modeling language (Booch et al., 1998; Rumbaugh et al., 1998), but they have also been faulted by what some see as an excessive activity orientation – see e.g., Chuang and Yadav (2000), who use this argument to explain the relative lack of success of object-oriented analysis and design methods in comparison with object-oriented programming methods.

A focus on the flow of activities makes particularly good sense in manufacturing process, e.g., assembly-line processes, because those processes usually involve sequential steps that add complexity and value to tangible items. Since manufacturing processes embody "action" in the physical sense, they can generally be easily represented as chronological sets of activities that bring tangible items together, such as car parts or chemical components, to produce other complex and value-added tangible items, such as a car engine or a complex chemical product. That is, it is natural to think of manufacturing processes as sequences of activities. However, this is not the case with non-manufacturing processes in general, where the output of the process is usually a service (which is usually consumed while it is produced) or an information product (e.g., a report or a computer program). It has been argued that in non-manufacturing processes in general, activity flow-based modeling attempts usually lead to overly complex and somewhat misleading representations, which are not useful for process redesign (Kock, 1999; Kock and McQueen, 1996).

Perhaps because until recently manufacturing processes played a key role in wealth creation, the most widely adopted normative approaches for process redesign embody general guidelines that place no special emphasis on the redesign of communication activities, thus arguably disregarding the information-intensive nature of business processes (Kock and McQueen, 1996). This is also true for the US Department of Defense and its contractors, where the IDEF0 approach for process redesign (Ang and Gay, 1993), an activity flow-based approach, has been chosen as the official process redesign approach and is by far the most widely used (Dean et al, 1995). One widely used activity flow-oriented approach proposed by Harrington (1991, p. 108), goes as far as stating that: “As a rule [information flow diagrams] are of more interest to computer programmers and automated systems analysts than to managers and employees charting business activities” (see also Harrington et al., 1998). While this opinion is obviously at odds with the notion that information processing is the main goal of business processes (Galbraith, 1977), it is in line with re-engineering’s original claims (Hammer and Champy, 1993) and most of the current process redesign practice.

Communication flow optimization theory (Kock, 1999; Kock and McQueen, 1996; Kock and Murphy, 2001; Kock, forthcoming; Kock et al., 1997) is an attempt to address the problems above from a theoretical perspective. The theory forms the basis from which the hypotheses of this study were derived, and is discussed in the section below.

Communication flow optimization theory

Communication flow optimization theory (Kock, 1999; Kock and McQueen, 1996; Kock and Murphy, 2001; Kock, forthcoming; Kock et al., 1997) was developed based on grounded-theory research (Glaser and Strauss, 1967; Strauss and Corbin, 1990; 1998). Given space limitations, the theory is only briefly summarized here – see particularly Kock (1999) and Kock and Murphy (2001) for more details. It emerged from real-world process redesign projects conducted over a period of 6 years. Evidence from those projects suggested that the flow of information could generally be seen as analogous to the flow of materials in processes, and that the former (i.e., the flow of information) could be subsumed by what is referred to as the "communication flow", or the web of communication interactions of a process. One of the key findings of those projects was that the communication flow structure of processes was a particularly strong determinant of most of the quality and productivity problems associated with processes, more so than either the activity flow or the material flow structure of the processes. Nevertheless, the evidence also suggested that, unlike in traditional systems analysis and design projects (Davis, 1983; Dennis and Wixom, 2000), rarely process redesign groups favored communication flow representations of processes over activity flow representations early on in their projects, because the former were seen as more difficult to generate, or "less natural" than the latter. The theory proposes that communication flow representations of processes are perceived as more difficult to be generated than activity flow representations because the latter are better aligned with the way humans are cognitively programmed to envision "action" in the physical sense. That is, processes, which essentially represent "action", are more naturally seen as a sequence of interconnected activities than communication interactions.

According to the theory, optimal communication configurations can be obtained by redesigning the flow of communication in processes through the application of communication flow-oriented process redesign guidelines. It is hypothesized that the level of optimization of the communication configuration of a process will account for a substantial amount of the variation in quality and productivity achieved through the redesign. Process productivity is measured through the ratio of output capacity (e.g., the number *N* of complete insurance policies executed per month by an insurance underwriting process) versus costs (e.g., the direct and indirect costs associated with executing *N* insurance policies). Process quality is measured as the customer satisfaction in connection with the outputs of the process, where a customer can be internal (e.g., an insurance agent) or external to an organization (e.g., an insured corporation or individual).

While acknowledging differences between manufacturing and non-manufacturing processes, communication flow optimization theory argues that a focus on the flow of communication within a process will, on average and when applied to a number of processes, lead to better process redesign results than a focus on other elements, including activities and/or materials. The theory does not dismiss the usefulness of process redesign techniques based on operations research, linear programming, and other traditional assembly-line and factory design techniques (Buzacott, 1996; Childe et al., 1994; Maull et al., 1995; Misterek et al., 1992), whose focus on "times and motions" often leads to quantum-leap productivity gains. Nor does the theory dismiss the usefulness of methods that address coordination issues among processes. By expanding their scope beyond the individual process, such coordination improvement methods often require the consideration of process dimensions other than the communication flow dimension, including various socio-technical dimensions (Checkland and Scholes, 1990; Katzenstein and Lerch, 2000; Teng et al., 1998). Rather, communication flow optimization theory argues that at the individual process level, where redesign is usually done by looking at how elements (e.g., activities, materials, data etc.) flow within the process (Hunt, 1996; Ould, 1995), a focus on communication interactions is likely to yield results that are, on average, better than if other elements were targeted. The key reason for this is, according to the theory, the higher frequency of communication-intensive processes, whose quality and productivity are strongly determined by the flow of communication, in organizations today than non communication-intensive processes.

Even though its scope is relatively limited, communication flow optimization theory provides useful guidance for efforts that take a more operational approach to process redesign – rather than a more strategic one, where the focus may be on broad management strategies and not necessarily on how individual processes are executed (Champy, 1995; Hammer, 1996). Nevertheless, the theory addresses an important gap, since a large number of process redesign efforts are conducted at the operational and individual process levels, or at least start at those levels.

Hypotheses

This action research study tested a set of hypotheses derived from communication flow optimization theory within the context provided by four group-based process redesign projects facilitated in four different organizations. The first author of this report (referred to here as "the researcher") provided methodological facilitation to the groups. To foster a multiple-perspective view of the target processes as well as to avoid facilitation-induced bias, the researcher encouraged process redesign groups to generate both activity flow as well as communication flow representations of their target processes, and to consider both types of representations when redesigning the target processes.

Communication flow optimization theory argues that one of the key reasons why individuals prefer activity flow representations of processes over other types of representations, including communication flow representations, is because activity flow representations are better aligned with the way human beings envision "action". As such, activity flow representations should be seen, when compared with communication flow representations, as easier to generate and understand, as well as more accurate and complete representations of processes. These predictions are embodied in hypotheses **H1** to **H4** below.

> **H1**: *Process redesign group members will perceive communication flow representations of business processes as more difficult to generate than activity flow representations.*

H2: *Process redesign group members will perceive communication flow representations of business processes as less accurate than activity flow representations.*

H3: *Process redesign group members will perceive communication flow representations of business processes as more difficult to understand than activity flow representations.*

H4: *Process redesign group members will perceive communication flow representations of business processes as less complete than activity flow representations.*

It is important to test hypotheses **H1** to **H4** to assess communication flow optimization theory's claim (Kock and Murphy, 2001) that process redesign group members rarely think of processes in terms of communication interactions at the outset of their process redesign efforts, rather thinking of processes in terms of chronological sequences of interrelated activities, or activity flows, because the latter are better cognitively aligned with the way human beings think of "action". This claim provides an explanation for what seems to be a generalized preference for activity flow-based process redesign approaches today (Katzenstein and Lerch, 2000; Kock, 1999) and is thus central to communication flow optimization theory.

Nevertheless, the theory also predicts a "change of mind" after the beginning of a process redesign project, reflected in favorable perceptions toward, as well as preferences for, communication flow representations, as the project moves from process analysis to process redesign. According to the theory, this should be particularly noticeable in the redesign phase, where process redesign group members propose changes to a process they already selected and analyzed in some detail. Underlying this predicted preference for communication flow representations is the heavy role that information technologies are likely to play on process redesign implementations, and the consequent need to address the flow of communication in the processes targeted for redesign (Kock, 1999). This leads us to hypotheses **H5** to **H8** below.

> **H5**: *Process redesign group members will perceive communication flow representations of business processes as more useful in the identification of opportunities for improvement than activity flow representations.*

> **H6**: *Process redesign group members will perceive communication flow representations of business processes as more useful in the application of process redesign guidelines than activity flow representations.*

> **H7**: *Process redesign group members will perceive communication flow representations of business processes as more useful in the visualization of process changes than activity flow representations.*

> **H8**: *Process redesign group members will perceive communication flow representations of business processes as*

more useful in the development of generic information technology solutions than activity flow representations.

Hypotheses **H5** to **H8** assume that, when employing communication flow and activity flow representations during a process redesign project, the perception of process redesign group members about each type of representation will reflect a rational intention to achieve the best results possible. This can be seen as a reasonable assumption in connection with the group-based projects investigated here because those were "real" projects involving individuals who knew they were responsible for the outcomes of their projects, whether those outcomes were "good" or "bad".

Research method

Action research

The roots of organizational action research are in studies of social and work life issues (Fox, 1990; Lewin, 1946; Trist et al., 1970). Organizational action research is often uniquely identified by its dual goal of both improving the organization (or organizations) participating in the research study, and at the same time generating knowledge (Elden and Chisholm, 1993; Lau, 1997). A growing body of literature exists on the use of action research in organizational studies in general, as well as in the more specific context of information systems research (Avison et al., (1999) Baskerville, 1997; Baskerville, 1999; Baskerville and Wood-Harper, 1996; 1998; Myers, 1997; Olesen and Myers, 1999), where research on process redesign has flourished since 1990s. Due to space limitations, this literature is not reviewed here. The reader is referred to Lau (1997) for a seminal review of action research within the field of information systems research. Peters and Robinson (1984), as well as Elden and Chisholm (1993) provide more general and discipline-independent reviews of action research. For the purposes of this investigation, it suffices to highlight the fact that, in organizational action research, the action researcher is expected to apply positive intervention on the organization (Jonsonn, 1991), which is often realized by the researcher providing some form of service to the organization and its members.

By providing a service to a "client" organization, the action researcher fosters a sense of collaboration with his or her subjects, which characterizes most action research projects. This sense of collaboration is also believed to promote free information exchange and a general commitment from the researcher as well as the subjects toward both research quality and organizational development (Fox, 1990). One of the key reasons for the emergence and relative success of action research has been the recognition that the behavior of an organization, group, or individual, can be more deeply understood if the researcher collaborates with the subject or subjects being studied. In the case of an organization, this can be achieved when the researcher facilitates improvement-oriented change in the organization, which was the case in the investigation described in this report.

The role played by the researcher

The researcher provided process redesign training and facilitation to the members of four process redesign groups involving consultants, employees and management from four different organizations based in the US. The facilitation was solely methodological (e.g., no specific process redesign suggestions were offered), and also "methodologically neutral" so as not to bias the perceptions of the subjects about the redesign approaches used. The process redesign groups conducted their work independently from each other.

The process redesign groups

The research literature suggests successful process redesign projects are usually conducted by cross-departmental groups that are typically small in size (usually less than 15 members) and that have a short lifetime (from a few days to typically no more than a few months) during which its members define, analyze, and search for alternatives to improve one or a few organizational processes (Caron et al., 1994; Choi, 1995; Choi and Liker, 1995; Hammer and Stanton, 1995). The process redesign groups studied here presented these same general characteristics. They lasted approximately 3 months, had a "core" membership of 3 to 5 members (assigned nearly full-time to the process redesign projects), and had a "peripheral" membership of 5 to 10 members (which involved external advisors, consultants, and administrative support personnel assigned on a part-time basis to the process redesign projects). All of the groups were cross-departmental (i.e., they involved members from more than one department) and targeted cross-departmental processes (i.e., processes that involved more than one department in their execution). The term "departments" is used here to refer to organizational units that aggregate employees with expertise in related organizational functions, e.g., marketing department, computer support department, and quality control department.

According to the research and business literature, process redesign groups usually conduct their activities along three main conceptual stages: *definition*, *analysis*, and *redesign* (Davenport, 1993; Davenport and Short, 1990; Dennis et al., 1999; Hammer and Champy, 1993; Hammer and Stanton, 1997; Harrington, 1991; Harrington et al., 1998; Kock, 2001). In the definition stage, the process redesign group selects a process for redesign. In the analysis stage, the group studies the process in detail. Finally, in the redesign stage, the group proposes process design modifications. These stages are followed by the implementation of the modifications. The process redesign groups studied followed this general structure.

In the analysis stage, each process redesign group developed both activity flow and communication flow representations of their target processes. Activity flow representations followed the general format proposed by Harrington et al. (1998) for functional timeline flowcharts. While both types of representations contained different types of information, they generally embodied the same "amount" of information (i.e., neither was substantially more "information-rich" than the other). Communication flow representations were adaptations of data flow diagrams (Davis, 1983; Dennis and Wixom, 2000), and were generated following the modified format proposed by Kock (1999). See appendices A and B for examples of these representations.

In the redesign stage, each process redesign group independently proposed several major process changes. These changes were proposed without interference from the researcher. A list of generic process redesign guidelines, previously compiled by Kock (1999) based on a survey of the literature on process redesign, was provided to the groups to guide their work. To avoid biasing group member perceptions in favor of activity or communication flow representations, the guidelines were chosen so that: (a) three of the guidelines were more meaningful in the context of activity flow than communication flow representations, (b) three of the guidelines were more meaningful in the context of communication flow than activity flow representations, and (c) two of the guidelines could be can be applied in both contexts. See Appendix C for detailed descriptions of these guidelines.

Both activity flow and communication flow representations of the new processes, with major changes incorporated into them, were then generated. Following this, each process redesign group developed a "generic" information technology "solution" to implement the new process. These generic information technology solutions were essentially product-independent computer-based infrastructure and system specifications, and were illustrated through rich pictorial representations (Checkland, 1981; Checkland and Scholes, 1990; Kock, 1999; Kock and Murphy, 2001). The pictorial representations contained icons representing computers, databases and organizational functions responsible for executing individual activities of the new process. See Appendix D for an example of these representations.

The above stages were followed by the implementation of the recommended process changes, in most cases leading to changes in process-related procedures, reallocation of human and material resources, and use of new information technology solutions. Implementation took from four months to eight months. Process performance reviews were conducted approximately six months after the implementation of those changes. Those reviews were based primarily on unstructured interviews with managers and employees and aimed at assessing the bottom-line business impact of the process redesign projects. All of the four process redesign groups studied were generally successful in their projects, as the process changes recommended by them met the following success criteria – they were implemented fully or partially and led to positive observable results. These success criteria are consistent with those proposed in the process redesign literature (Burke and Peppard, 1995; Davenport, 1993; Hammer and Champy, 1993).

Data collection and analysis

Three main types of research data were collected and compiled in connection with the process redesign groups: *survey instrument answers* (Drew and Hardman, 1985; Sekaran, 1984), *participant observation notes* (Creswell, 1994; 1998; Sommer and Sommer, 1991), and *unstructured interview notes* (Patton, 1980; 1987). *Survey instrument answers* were obtained through a survey administered to the "core" members of each process redesign group (3 to 5 members) at the end of the work of each process redesign group. In total, 17 sets of answers were obtained based on the questionnaire available from Appendix E. *Participant observation notes* were generated based on direct observation of process redesign group members as well as other employees who were not directly involved with the process redesign groups yet observed or were affected by the work of the groups. *Unstructured interview notes* were obtained through interviews conducted with the "core" members of each process redesign group, as well as with other employees who were not directly involved in process redesign groups yet interacted with group members or were directly affected by the work of the groups. Over forty unstructured interviews were conducted in total.

The data analysis in connection with the hypotheses was focused on the search for "patterns". The identification of patterns in the survey instrument answers, which were obtained on a Likert-type scale, was conducted using paired-samples t tests (Green et al., 1997; Rosenthal and Rosnow, 1991) comparing the means for answers in connection with communication flow and activity flow representations. Patterns in participant observation and unstructured interview notes were identified either based on the observation that they occurred in the majority of the cases (Kock et al., 1997; Miles and Huberman, 1994), or, when the sample size for the unit of analysis under consideration permitted, based on the results of a Chi-square goodness-of-fit test comparing the observed distribution with the expected (or chance) distribution (Siegel and Castellan, 1998).

In order to increase the robustness of the data analysis, the three sources of research data – survey instrument answers, participant observation notes, and unstructured interview notes – were extensively triangulated (Jick, 1979; Maxwell, 1996; Yin, 1994). As recommended by Maxwell (1996) and Sommer and Sommer (1991), the data set was thoroughly examined for patterns of evidence in support of and against each of the hypotheses, and all the evidence obtained was carefully summarized, compared and double-checked for inconsistencies.

Results

As previously mentioned, unstructured interviews with managers and employees suggested that all of the four process redesign groups studied were generally successful in their projects. The process changes recommended by them were seen as revealing and useful by process owners, and seemed to have been implemented fully or partially, which in turn led to positive observable results – thus meeting general success criteria proposed in the process redesign literature (Burke and Peppard, 1995; Davenport, 1993; Hammer and Champy, 1993).

In this section, hypotheses-relevant results are grouped in three main categories, namely *survey instrument answers*, *participant observation notes*, and *unstructured interview notes*. Later in the section, the several hypotheses-relevant results, both in support and against the hypotheses, are summarized in a single table and compared against each other.

Survey instrument answers

Table 1 summarizes the results of a paired-samples *t* test applied on the survey instrument answers. In it, the "core" members of each process redesign group (3 to 5 members) answered the questions listed in Appendix E on a Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). The leftmost column of Table 1 lists 8 constructs associated with business process representations: *ease of generation* (EASYGEN); *accuracy* (ACCUR); *ease of understanding* (EASYUND); *completeness* (COMPLET); *usefulness in the identification of opportunities for improvement* (OPPORTU); *usefulness in the application of process redesign guidelines* (APLLIC); *usefulness in the visualization of process changes* (VISUAL); and *usefulness in the development of generic IT solutions* (ITSOLUT). The measures for these constructs (one per construct) are shown in Appendix E and reflect the constructs identified by Kock (1999) and Kock and Murphy (2001) based on grounded-theory research investigations (Glaser and Strauss, 1967; Strauss and Corbin, 1990; 1998).

	Mean - C	Std. deviation	Mean - A	Std. deviation	*t*	*p* (2-tailed)
EASYGEN	2.82	1.29	3.06	1.30	-0.61	0.55
ACCUR	4.18	0.88	3.12	1.50	2.20	< .05
EASYUND	4.18	1.07	3.82	0.81	0.92	0.37
COMPLET	3.35	1.37	2.59	1.23	2.02	0.06
OPPORTU	4.59	0.51	3.76	1.25	2.38	< .05
APPLIC	4.71	0.47	3.82	1.13	2.76	< .05
VISUAL	4.65	0.49	3.47	1.18	3.64	< .01
ITSOLUT	4.24	1.20	3.06	1.30	3.05	< .01

Table 1: Descriptive statistics and paired-samples *t* test results
(Quantitative data obtained from structured interview transcripts; range: 1 – 5)

Column "Mean – C" in Table 1 shows the means for answers referring to communication flow representations; column "Mean – A" refers to activity flow representations. On the right-hand sides of each of these columns are columns showing the standard deviations for each measure. The column "*t*" shows the *t* statistic for each pair of measures. Finally, the column "*p* (2-tailed)" shows the significance level for each *t* statistic based on a 2-tailed test.

The patterns of evidence listed below have been derived from Table 1. They are referred to by "SIA" (survey instrument answers) codes that are later used for data triangulation. The patterns of evidence SIA.$H1_0$, SIA.$H2_0$, SIA.$H3_0$ and SIA.$H4_0$ do not support hypotheses H1, H2, H3 and H4; that is they provide support for the null hypotheses $H1_0$, $H2_0$, $H3_0$ and $H4_0$, respectively. The patterns of evidence SIA.H5, SIA.H6, SIA.H7 and SIA.H8 provide support for the hypotheses H5, H6, H7 and H8, respectively.

SIA.$H1_0$. On average, group members perceived communication flow representations as more difficult to generate than activity flow representations (see EASYGEN row in Table 1). The results of the paired samples *t* test ($t(16)=-.61$, $p=.55$) comparing perceptions for each representation were not statistically significant.

SIA.$H2_0$. On average, group members perceived communication flow representations as more accurate than activity flow representations (see ACCUR row in Table 1). The results of the paired samples *t* test ($t(16)=2.2$, $p<.05$) comparing perceptions for each representation were statistically significant.

SIA.$H3_0$. On average, group members perceived communication flow representations as easier to understand than activity flow representations (see EASYUND row in Table 1). The results of the paired samples *t* test ($t(16)=-.92$, $p=.37$) comparing perceptions for each representation were not statistically significant.

SIA.H4$_0$. On average, group members perceived communication flow representations as more complete than activity flow representations (see COMPLET row in Table 1). The results of the paired samples *t* test ($t(16)=2.02$, $p=.06$) comparing perceptions for each representation were not statistically significant.

SIA.H5. On average, group members perceived communication flow representations as more useful in the identification of opportunities for improvement than activity flow representations (see OPPORTU row in Table 1). The results of the paired samples *t* test ($t(16)=2.38$, $p<.05$) comparing perceptions for each representation were statistically significant.

SIA.H6. On average, group members perceived communication flow representations as more useful in the application of process redesign guidelines than activity flow representations (see APLLIC row in Table 1). The results of the paired samples *t* test ($t(16)=2.76$, $p<.05$) comparing perceptions for each representation were statistically significant.

SIA.H7. On average, group members perceived communication flow representations as more useful in the in the visualization of process changes than activity flow representations (see VISUAL row in Table 1). The results of the paired samples *t* test ($t(16)=3.64$, $p<.01$) comparing perceptions for each representation were statistically significant.

SIA.H8. On average, group members perceived communication flow representations as more useful in the development of generic information technology solutions than activity flow representations (see ITSOLUT row in Table 1). The results of the paired samples *t* test

($t(16)=3.05$, $p<.01$) comparing perceptions for each representation were statistically significant.

Participant observation notes

The patterns of evidence listed below have been derived from the participant observation notes generated based on direct observation of process redesign groups at work. They are referred to by "PON" (participant observation notes) codes that are later used for data triangulation. The patterns of evidence PON.H1, PON.H6 and PON.H8 provide support for the hypotheses H1, H6, and H8, respectively. These were the only patterns of evidence obtained from the analysis of participant observation notes that were relevant for testing the hypotheses – i.e., other patterns of evidence that emerged from the analysis but that were unrelated to the hypotheses are not listed below because they are not relevant for the study reported in this report.

PON.H1. All groups generated activity flow representations of their targeted processes before they generated communication flow representations. This is seen as supporting hypothesis H1 based on the assumption that process redesign groups would generate first the process representation that they perceived as the least difficult to generate.

PON.H6. Of all the 37 process redesign decisions made by the four groups as a whole, 23 process redesign decisions (62.16%) were entirely based on communication flow representations of their target processes. The other 14 process redesign decisions were distributed as follows: 4 (10.81%) were entirely based on activity flow representations of their target processes, and 10 (27.03%) were based on both types of representations. This is seen as supporting H6 because a Chi-square goodness-of-fit test of the distribution of process redesign decisions ($\chi^2(2, N=37)=15.3$, $p<.001$) suggests a statistically significant preference for the use of communication flow representations when applying process redesign guidelines.

PON.H8. All groups developed “generic” information technology “solutions” and respective rich pictorial representations entirely based on communication flow representations of their target processes. This is seen as supporting hypothesis H8 based on the assumption that process redesign groups would developed their “generic” information technology “solutions” and rich pictorial representations based on the process representation that they perceived as the most useful for those tasks.

Unstructured interview notes

The patterns of evidence listed below have been derived from the notes generated during unstructured interviews. They are referred to by “UIN” (unstructured interview notes) codes that are later used for data triangulation. The patterns of evidence UIN.$H1_0$, UIN.$H2_0$, UIN.$H3_0$, UIN.$H4_0$ and UIN.$H5_0$ do not support hypotheses H1, H2, H3, H4 and H5; that is, they provide support for the null hypotheses $H1_0$, $H2_0$, $H3_0$, $H4_0$ and $H5_0$ respectively. The patterns of evidence UIN.H6, UIN.H7 and UIN.H8 provide support for the hypotheses H6, H7 and H8, respectively.

UIN.$H1_0$. There was no clear majority perception as to whether communication flow representations were easier or more difficult to generate than activity flow representations.

UIN.H2$_0$. Most group members perceived communication flow representations as more accurate than activity flow representations. They generally explained their perception by pointing out that communication flow representations provided more accurate depictions of the elements that seemed to flow the most in their processes, which they often referred to as "data" or "information". The following quote illustrates this: "*For certain processes, both the workflow and data flow representations are accurate. However, they are not accurate for all processes. Our project consisted of movement of both work and data … the work flow diagram depicts the movement of material within different functions… they were depicted clearly and in the proper order with correct time frame by the functional time line. Our project also consisted of a variety of data movement[s] like writing the request mutually agreed specification, SOP, and generating the final report … the [communication] flow diagram by far more accurately depicted these data movement[s] than the functional time line.*"

UIN.H3$_0$. There was no clear majority perception as to whether communication flow representations were easier or more difficult to understand than activity flow representations.

UIN.H4$_0$. There was no clear majority perception as to whether communication flow representations were more or less complete than activity flow representations.

UIN.H5. Most group members perceived communication flow representations as more useful in the identification of opportunities for improvement than activity flow representations. They generally explained their perception by pointing out that communication flow representations had not "caged" them into thinking in an "artificially sequential" manner, which was necessary for the redesign of the flow of "data" or "information" within a process. The following quote provides an illustration of this: “*The [activity flow] diagram does not visibly show any wasted effort … Because the [communication flow diagram] does not show actual tasks it allows one to be more creative than being limited by a particular sequence. In the [communication flow diagram] sequences aren't greatly represented … so you do not get in the mindset of following a specific sequence. We can see what is needed, where to get information from, and it's up to us to define the sequence later.*”

UIN.H6. Most group members perceived communication flow representations as more useful in the application of process redesign guidelines than activity flow representations. They generally explained their perception by pointing out that communication flow representations were better visual aids in the identification of problems in connection with the flow of “data” or “information”, which were more frequently observed, and where process redesign guidelines could be easily applied. This is illustrated by the following quote: “*The workflow representation shows a chronological view. Thus, it is easier to conceptualize the process at first. This will give a quick picture in order to understand the process … [however] by utilizing the [communication] flow [representation], it was [easier] to see the excessive data flowing between the customer and the employees of ACD.*”

UIN.H7. Most group members perceived communication flow representations as more useful in the in the visualization of process changes than activity flow representations. They generally explained their perception in the same way as they explained their perception that communication flow representations were more useful in the application of process redesign guidelines, as the following quote suggests: “*It is easier to visualize the process changes using the data flow representations than the workflow representations. With the data flow, you see that different data stores are receiving data from the same functional unit and* *sending data to the same or different functions. Based upon the data flow representation, it is easy to determine that all of the data stores are not needed.*"

UIN.H8. Most group members perceived communication flow representations as more useful in the development of generic information technology solutions than activity flow representations. They generally explained their perception by pointing out that, since the generic information technology solution automated the flow of communication within a process, the communication flow representation was particularly well suited for its development. The following quote illustrates this: "*[Communication flow representations give] a much better guideline for development of generic IT solutions than workflow representations. In our case, we used the new [communication flow representation] and easily converted it to a generic IT solution. We had three main data stores. The first one was used for interaction between customer and ACD employees (in creation of RFS, MAS, SOP). This was easily changed to an asynchronous Web-based communication that was connected to a database management system. The second data store was used by the product technician for performing the test. This was replaced by the Automation system. The last data store stored manual results of lab which was replaced by the Lab Information Management System. This also provided the data needed for the Vice President to finalize the report for the customer and adhere to the ISO 9002 standard.*"

Summary of evidence in support and against the hypotheses

Table 2 summarizes evidence in connection with the hypotheses, showing individual patterns of evidence in support of and against the hypotheses. Evidenced against the hypotheses H1, H2 … is defined as evidence in support of the respective null hypotheses $H1_0$, $H2_0$ …

The evidence presented in Table 2 is grouped based on its source and indicated by specific acronyms that indicate the source of each piece of evidence – survey instrument answers (SIA), participant observation notes (PON), and unstructured interview notes (UIN). Empty cells indicate that a thorough search revealed the absence of patterns of evidence from a particular source in connection with the respective hypotheses.

	Survey instrument answers	**Participant observation notes**	**Unstructured interview notes**
H1		PON.H1	
$H1_0$	$SIA.H1_0$		$UIN.H1_0$
H2			
$H2_0$	$SIA.H2_0$		$UIN.H2_0$
H3			
$H3_0$	$SIA.H3_0$		$UIN.H3_0$
H4			
$H4_0$	$SIA.H4_0$		$UIN.H4_0$
H5	SIA.H5		UIN.H5
$H5_0$			
H6	SIA.H6	PON.H6	UIN.H6
$H6_0$			
H7	SIA.H7		UIN.H7
$H7_0$			
H8	SIA.H8	PON.H8	UIN.H8
$H8_0$			

Table 2: Individual patterns of evidence in support of and against the hypotheses
(Evidence against H1, H2 … = Evidence in support of the null hypotheses $H1_0$, $H2_0$ …)

As previously mentioned, we also asked all of those involved in the four process redesign projects to carefully study a previous process redesign project that targeted a defense-related procurement and purchasing process (whereby the DoD procured and purchased software development services from major contractors) and report on possible differences between their projects and that previous project. Of the 17 respondents, fifteen stated that their answers would not have changed, and 2 that their answers would have changed slightly – with the following results of a related Chi-square goodness-of-fit test applied to this distribution of answers: $\chi^2(1, N=17)=9.9$, $p<.01$. This can be interpreted as suggesting that the answers provided by the respondents would not have changed substantially had their targeted processes been taken from the DoD, and thus that the findings of this study are likely to be valid from a defense acquisition perspective.

Discussion and conclusion

The patterns of evidence summarized in the previous section provide general support for hypotheses H5, H6, H7 and H8, weak support for hypothesis H1, and no support for hypotheses H2, H3 and H4. This is summarized in Table 3 for convenience. Since the hypotheses were developed based on communication flow optimization theory, we can conclude that the patterns of evidence also provide moderate support for the theory, reinforcing some elements the theory but not others.

Inconsistent with the theory's predictions, process redesign group members did not seem to perceive communication flow representations of processes as less accurate, more difficult to understand, and less complete than activity flow representations. In fact, evidence from both survey instrument answers (SIA.$H2_0$) and unstructured interview notes (UIN.$H2_0$) suggest that communication flow representations were perceived as significantly more accurate than activity flow representations.

Also inconsistent with the theory's predictions, process redesign group members did not seem to perceive communication flow representations of processes as more difficult to be generated than activity flow representations. Nevertheless, all groups generated activity flow representations of their targeted processes before they generated communication flow representations (PON.H1).

Hypothesis	Assessment
H5: Process redesign group members will perceive communication flow representations of business processes as more useful in the identification of opportunities for improvement than activity flow representations.	Supported
H6: Process redesign group members will perceive communication flow representations of business processes as more useful in the application of process redesign guidelines than activity flow representations.	Supported
H7: Process redesign group members will perceive communication flow representations of business processes as more useful in the visualization of process changes than activity flow representations.	Supported
H8: Process redesign group members will perceive communication flow representations of business processes as more useful in the development of generic information technology solutions than activity flow representations.	Supported
H1: Process redesign group members will perceive communication flow representations of business processes as more difficult to generate than activity flow representations.	Weak support
H2: Process redesign group members will perceive communication flow representations of business processes as less accurate than activity flow representations.	Not supported
H3: Process redesign group members will perceive communication flow representations of business processes as more difficult to understand than activity flow representations.	Not supported
H4: Process redesign group members will perceive communication flow representations of business processes as less complete than activity flow representations.	Not supported

Table 3: Assessment of the hypotheses

The above findings put into question communication flow optimization theory's assertion that activity flow representations are better aligned with the way humans are cognitively programmed to envision "action" in the physical sense, and its claim that such cognitive alignment is one of the reasons why activity flow representations and related process redesign guidelines are so widely used today.

On the other hand, consistent with communication flow optimization theory's predictions, process redesign group members perceived communication flow representations of business processes as more useful than activity flow representations in the following aspects: identification of opportunities for improvement, application of process redesign guidelines, visualization of process changes, and development of generic information technology solutions (SIA.H5, SIA.H6, SIA.H7, SIA.H8, UIN.H5, UIN.H6, UIN.H7, UIN.H8). Also consistent with communication flow optimization theory's predictions, the distribution of process redesign decisions suggested a statistically significant preference for the use of communication flow representations when applying process redesign guidelines (PON.H6), and all groups developed "generic" information technology "solutions" and respective rich pictorial representations entirely based on communication flow representations of their target processes (PON.H8).

The above findings support communication flow optimization theory's predictions that process redesign group members will prefer communication flow representations particularly as the project moves from process analysis to process redesign, arguably due to the heavy role that information technologies are likely to play on process redesign implementations, and the consequent need to address the flow of communication in the processes targeted for redesign.

It is clear that much more research is needed to further test and refine communication flow optimization theory. Notably, this study suggests that the widespread use of activity flow representations may be more due to current habits reinforced by consulting companies and management gurus, as argued by Kock and McQueen (1996), than to a cognitive predisposition toward those types of representations, as argued by communication flow optimization theory. This issue is addressed below in our discussion of implications for future research and practice.

Implications for research and practice

This research has key implications for managers involved in operational-level process redesign projects. One key implication is that those managers should carefully analyze the focus of their projects, especially when the goal is to obtain quality and productivity improvements through the redesign of individual processes. While a focus on activities and their flow may be advocated by proponents of popular activity flow-based methods such as large consulting companies and recognized management "gurus" such as Hammer (1996) and Harrington et al. (1998), this study suggests that such focus is likely to contribute to less than optimal outcomes. Managers should strongly consider moving away from that focus and toward a focus on communication flows and process redesign related techniques (such as those illustrated by the communication flow-oriented guidelines in Appendix C). This is particularly important in broad projects that target primarily service processes, where the flow of materials is minimal, such as the recent organization-wide initiatives by the US Department of Defense to improve acquisition practices (Graves, 2001). Even single-digit success rate increases can lead to savings in the range of millions of dollars in projects of such breadth and magnitude.

This study suggests one key area of future research in connection with communication flow optimization theory, which would be the investigation of the impact of using either communication flow or activity flow representations in process redesign projects, but not both (as in this study). This would provide the basis on which to more clearly assess the advantages and disadvantages of one type of representation over and against the other, as this research design would be less likely to be influenced by interaction effects in connection with repeated-measures research designs (Drew and Hardman, 1985; Rosenthal and Rosnow, 1991) such as the one employed in this study. It seems, from the findings of this study, that communication flow representations may provide a complete and advantageous alternative to activity flow representations.

Another area of future research relates to the development, refinement and investigation, based on the findings of this study, of methods and techniques that are related to but go beyond the scope of business process redesign. One area in which this line of inquiry may be fruitful is systems analysis and design (Dennis and Wixom, 2000), as there is research (see, e.g., Chuang and Yadav, 2000) suggesting that some new and increasingly popular systems analysis and design methods and techniques may suffer from the same problems associated with methods and techniques used in process redesign that rely too heavily on activity flow representations (and too lightly on communication flow representations).

One example of the above situation is the recent success of object-oriented programming, which has led to the emergence of object-oriented methods and techniques for systems analysis and design. In spite of much industry support, the scope of use of object-oriented methods and techniques in systems analysis and design is virtually insignificant when compared with that of object-oriented methods and techniques in programming. Chuang and Yadav (2000) argue that this is due to object-oriented analysis' excessive activity orientation, which they addressed by developing and validating, with positive conceptual results, a new methodology that applies modified object-oriented methods and techniques to the solution of systems analysis and design problems. This new methodology shifts the emphasis away from activities, as defined in this report, and onto how communication takes place in processes.

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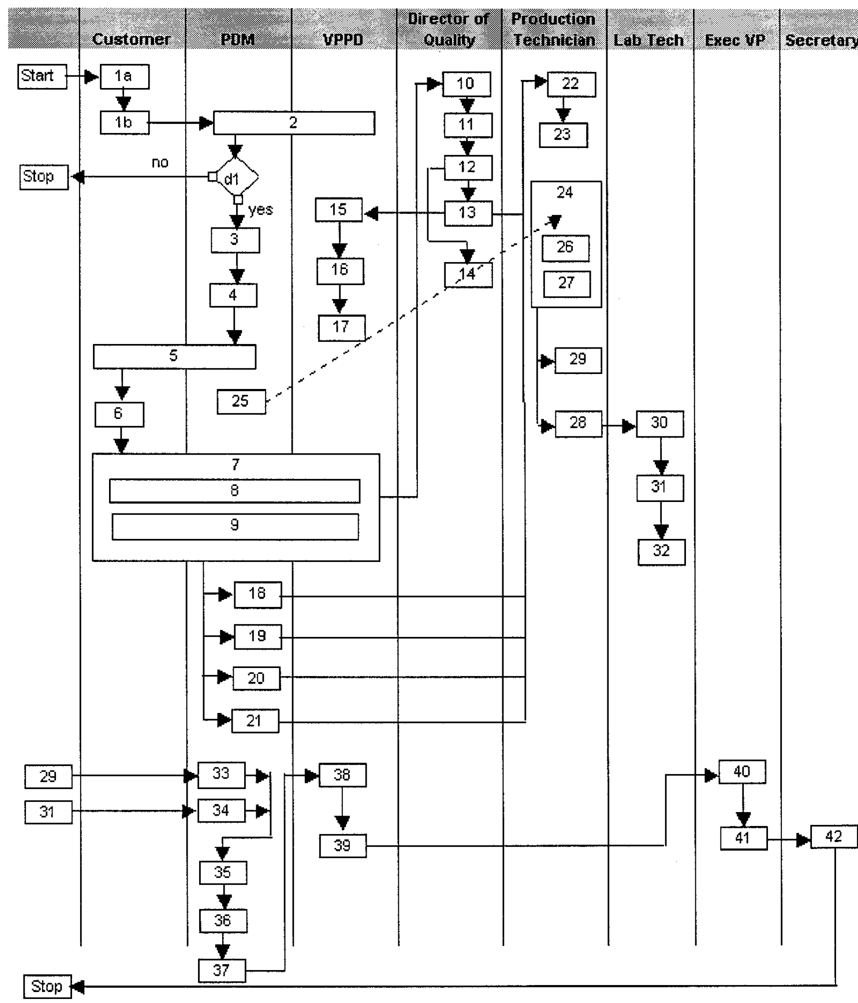
Appendix A: Activity flow representation used

The partial functional timeline flowchart (Harrington, 1991; Harrington et al., 1998) below, generated by one of the groups, illustrates the activity flow representations used by the process redesign groups. Activity names were listed next to the representations.

A FUNCTIONAL TIME-LINE FLOWCHART OF THE PROCESS

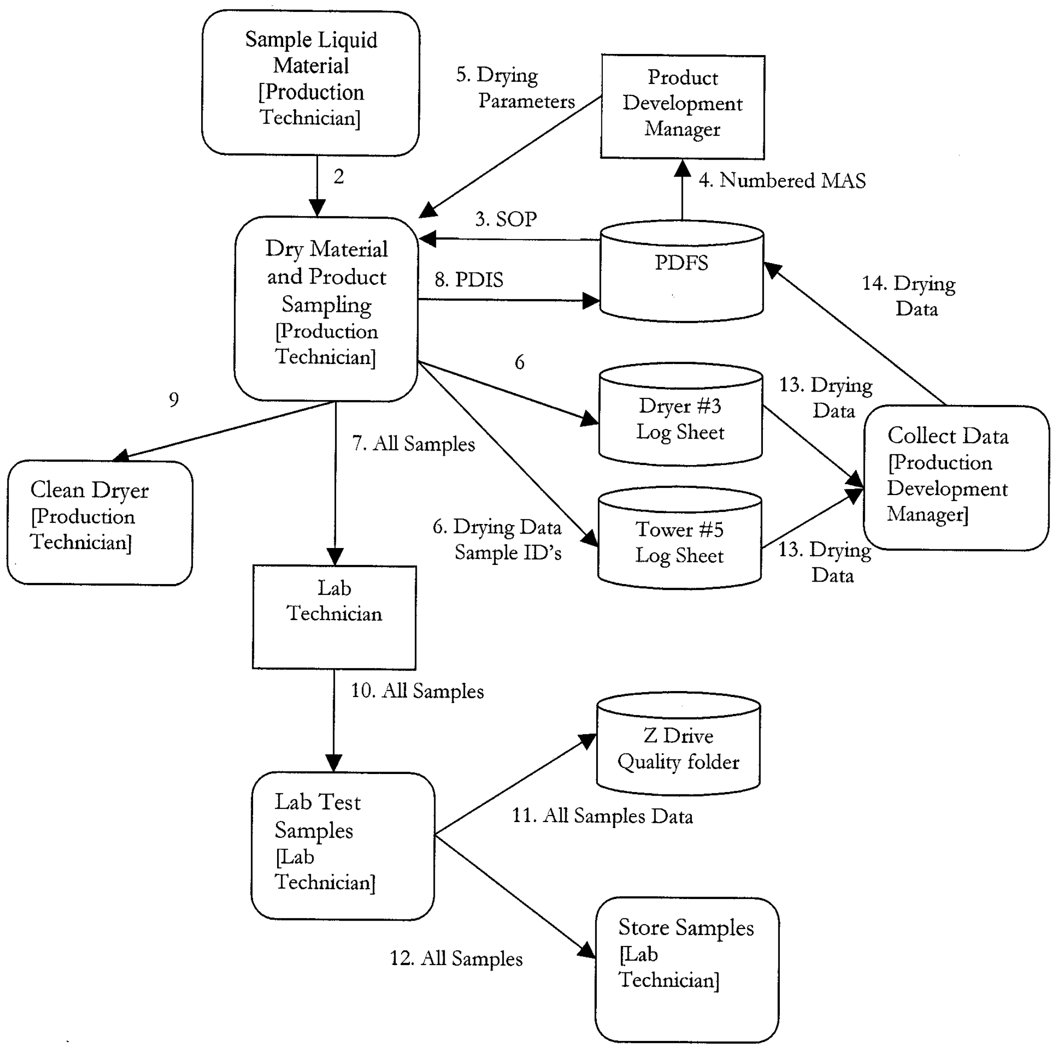


Activity	Process Time	Cycle Time
1a	30m	2d
1b	1m	5m
2	15m	1d
3	5m	4h
4	10m	2h
5	30m	3d
6	1m	5m
7*	2h	2h
8	0	0
9	0	0
10	5m	2h
11	5m	1d
12	30m	30m
13	20m	20m
14	1m	1m
15	1m	30m
16	4h	2d
17	5m	5m
18	?	?
19	30m	30m
20	30m	30m
21*	30m	30m
22	15m	15m
23	5m	5m
24	1-5 days	1-5 days
25	5m	5m
26	1m/time	1m/time
27	2m/time	2m/time
28	15m	15m
29	4+h	4+h
30	1+d	1+d
31	10m	10m
32	15m	2h
33	1h	1d
34	30m	1h
35	2h	2d
36	1h	1h
37	1m	2h
38	15m	1d
39	2m	2h
40	10m	1d
41	1m	15m
41	30m	4h
Total	7d	25d
%	28%	100%

*	Items are scheduled weeks later
dotted line	The dotted line points to where the task resides
1a	Fill oout CDR
1b	Submit CDR
d1	Can the product be dried

Appendix B: Communication flow representation used

The partial communication flow diagram (Kock, 1999; Kock and Murphy, 2001) below, generated by one of the groups, illustrates the communication flow representations used by the process redesign groups.



Appendix C: Process redesign guidelines used

The process redesign groups used the following guidelines, which have been compiled from a large body of literature on process redesign, and are discussed in more detail by Kock (1999). In the list below, each guideline is followed by a brief description of why it may lead to process improvement, using generally the same language and rationale as those presented to the participants.

In order to provide a balanced set of guidelines for the participants and avoid biasing their preferences, the guidelines were distributed as follows regarding the most natural context of application. Guidelines 1–3 are more meaningful in the context of communication flow than activity flow representations. Guidelines 4–5 can be applied in both contexts. Guidelines 6–8 are more meaningful in the context of activity flow than communication flow representations.

1. *Foster asynchronous communication*. When people exchange information they can do it synchronously, i.e., interacting at the same time, or asynchronously, i.e., interacting at different times. One example of synchronous communication is a telephone conversation. If the conversation takes place via e-mail, it then becomes an example of asynchronous communication. It has been observed, especially in formal business interaction, that, almost always, asynchronous communication is more efficient. For example, synchronous communication often leads to wasted time (e.g., waiting for the other person to be found) and communication tends to be less objective. Asynchronous communication can be implemented with simple artifacts such as in-and out-boxes, fax trays, and billboards. These artifacts work as dynamic information repositories.

2. *Eliminate duplication of information*. Static repositories, as opposed to dynamic repositories, hold information in a more permanent basis. A student file maintained by a primary school, for example, is a static repository of information. Conversely, the data entry form used to temporary stored information

about a student that will be entered into the student file is not a static repository. Duplication of information in different static repositories often creates inconsistency problems, which may have a negative impact on productivity and quality. Kock (1995) describes a situation where a large auto maker's purchasing division tried to keep two supplier databases updated; one manually and the other through a computer system. Two databases were being kept because the computer database had presented some problems and therefore was deemed unreliable. This, in turn, was causing a large number of inconsistencies between the two databases. Each database stored data about over four hundred parts suppliers.

3. *Reduce information flow*. Excessive information flow is often caused by an over-commitment to efficiency to the detriment of effectiveness. Information is perceived as an important component of processes, which drives people to an unhealthy information hunger. This causes information overload and the creation of unnecessary information processing functions within the organization. Information overload leads to stress and, often, the creation of information filtering roles. These roles are normally those of aides or middle managers, who are responsible for filtering in the important bit from the information coming from the bottom of, and from outside, the organization. Conversely, excessive information flowing top-down forces middle managers to become messengers, to the damage of more important roles. Information flow can be reduced by selecting the information that is important in processes and eliminating the rest, and by effectively using group support and database management systems.

4. *Reduce control*. Control activities do not normally add value to customers. They are often designed to prevent problems from happening as a result of human mistakes. In several cases, however, control itself fosters neglect, with a negative impact on productivity. For example, a worker may not be careful enough when performing a process activity because he knows that there will be some kind of control to catch his mistakes. Additionally, some types of control, such as those aimed at preventing fraud, may prove to be more costly than no control at all. Some car insurance companies, for example, have found out that the cost of accident inspections, for a large group of customers, was much more expensive than the average cost of frauds that that group committed.

5. *Reduce the number of contact points*. Contact points can be defined as points where there is interaction between two or more people, both within the process and outside. This involves contacts between functions, and between functions and customers. Contact points generate delays and inconsistencies and, when in excess, lead to customer perplexity and dissatisfaction. In self-service restaurants and warehouses, for example, the points of contact were successfully reduced to a minimum. Additionally, it is much easier to monitor customer perceptions in situations where there are a small number of contact points. This makes it easier to improve process quality.

6. *Execute activities concurrently*. Activities are often executed in sequence, even when they could be done concurrently. This has a negative impact primarily on productivity, and is easier to spot on process flowcharts than in data flow diagrams. In a car assembly process, for example, the doors and other body parts can be assembled concurrently with some engine parts. This has been noted by several automakers, which, by redesigning their processes accordingly, significantly speeded up the assembly of certain car models.

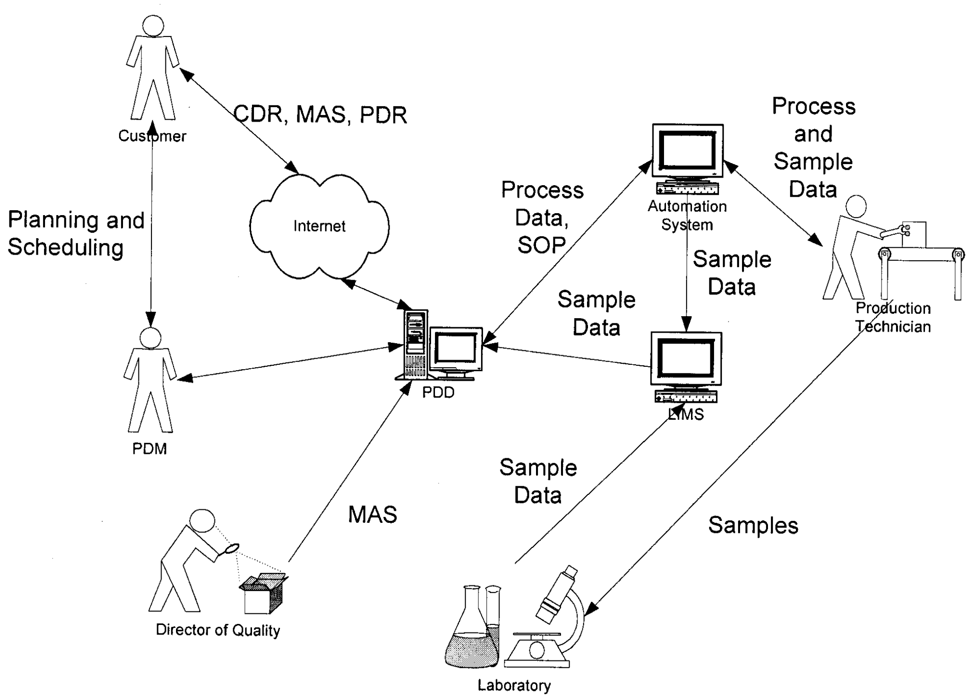
7. *Group interrelated activities*. Closely interrelated activities should be grouped in time and space. Activities that use the same resources, i.e. artifacts or functions, may be carried out at the same location and, in some cases, at the same time. Kock (1999) illustrates this point using the case of a telephone company that repaired external and internal house telephone connections. This company had two teams, one team for internal and another for external repairs. An internal repair occurs, by definition, within the boundaries of a commercial building or residence; external repairs involve problems outside these boundaries. Whenever the telephone company received a customer complaint, it used to send first its internal team. Should this team find no internal connection problem, the external team would then be dispatched check the problem. It took a process improvement group to show the company that it was wasting thousands of dollars a year, and upsetting customers due to repair delays, by not combining the two teams into a single repair team. This was because, when complaints were categorized and counted, it was found out that most of the problems were external.

8. *Break complex processes into simpler ones*. Complex processes with dozens (hundreds in some cases) of activities and decision points should be "broken" into simpler ones. It is often much simpler to train

workers to execute several simple processes, than one complex process. It is also easier to avoid mistakes in this way, as simple processes are easy to understand and coordinate. In support of this point, Kock (1999) discusses the case of an international events organizer, which was structured around two main processes: organization of national and international events. After a detailed analysis of these two processes, which embodied over a hundred activities each, it was found that they both could be split into three simpler sub-processes: organization of exhibitions, conferences, and exhibitors participation. This simplification improved the learning curve for the processes, as well as reducing the occurrence of mistakes. It did not, however, lead to an increase in the number of employees needed. The reason is because, with simpler processes, one person could perform functions in various processes at the same time.

Appendix D: Rich pictorial representation used

The partial rich pictorial representation (Checkland, 1981; Checkland and Scholes, 1990; Kock, 1999; Kock and Murphy, 2001) below, generated by one of the groups, illustrates the pictorial representations used by the process redesign groups to show how a new process would be generally implemented with information technologies.



Appendix E: Survey instrument

The statements below were used for the "questions" in the survey instrument, which were answered on a Likert-type scale going from "strongly disagree" to "strongly agree" (range: 1 to 5).

1. Activity flow representations are easy to generate.
2. Communication flow representations are easy to generate.
3. Activity flow representations are accurate representations of processes.
4. Communication flow representations are accurate representations of processes.
5. Activity flow representations are easy to understand.
6. Communication flow representations are easy to understand.
7. Activity flow representations provide a complete view of the process.
8. Communication flow representations provide a complete view of the process.
9. Activity flow representations are useful in the identification of opportunities for improvement.
10. Communication flow representations are useful in the identification of opportunities for improvement.
11. Activity flow representations are useful in the application of process redesign guidelines.
12. Communication flow representations are useful in the application of process redesign guidelines.
13. Activity flow representations are useful in the visualization of process changes.
14. Communication flow representations are useful in the visualization of process changes.
15. Activity flow representations are useful in the development of generic IT solutions.
16. Communication flow representations are useful in the development of generic IT solutions.