CHANGING THE FOCUS OF BUSINESS PROCESS REDESIGN FROM ACTIVITY FLOWS TO INFORMATION FLOWS: *A DEFENSE ACQUISITION APPLICATION*

Ned Kock

Current business process redesign practices, in the defense sector as well as in business in general, are based on several assumptions inherited from Taylor's scientific management method, including the key assumption that activity-flow representations should provide the basis for business process redesign. While this assumption was probably correct for most organizations in the early 1900s, it is clearly inconsistent with the fact that, currently, "information" is what most flows in business processes, even in manufacturing organizations. The current focus of current business process redesign approaches should be on information flows rather than activity flows. (An action research study of a business process redesign project involving the U.S. Department of Defense (DoD) and Computer Sciences Corporation supports this hypothesis.)

Business processes are sets of interrelated activities that are performed to achieve a business goal. Business process redesign dates back to the early 1900s, when Frederick Taylor (1911) published "The Principles of Scientific Management." The scientific management movement strongly influenced process redesign ideas and approaches throughout the Second Industrial Revolution (1850–1950). During this period, business process redesign was primarily concerned with productivity (i.e., efficiency) improvement in manufacturing plants.

The work of Elton Mayo in the 1930s and others such as McGregor, Maslow, and Herzberg represented the emergence of the "humanist" school of management, which tried to shift the focus of organizational development from "business processes" to "people" (Mayo, 1945). While these management thinkers succeeded in accomplishing that shift during the mid-1900s, business process redesign was far from dead. Their work set the stage for the emergence of what many saw as a more humane business process redesign school of thought, generally known as total quality management, which not only succeeded scientific management as a business process-based method but also represented a shift in focus from productivity to quality in the improvement of business processes.

Total quality management began in Japan after 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 it became widely practiced in the United States and other Western capitalist countries. As with scientific management, its primary focus was the improvement of manufacturing operations.

In the early 1990s, business process reengineering replaced total quality management as the predominant school of thought regarding business process redesign. Michael Hammer and Thomas Davenport independently developed business process reengineering as, respectively, a better alternative (Hammer'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 (whose primary goal was quality, not productivity, improvement) was insufficient for organizations to cope with an accelerated rate of change fostered by information technologies (Davenport, 1993, 1993a; Davenport & Short, 1990; Hammer, 1990; Hammer & Champy, 1993). Differently from scientific management and total quality management, business process reengineering was presented as a method for the improvement of service as well as manufacturing operations.

Current Practices: A Rehash of Old Methods?

An analysis of the business process redesign practices throughout the 100-year period from the development of scientific management to the emergence of business process reengineering suggests an interesting, perhaps cyclic, pattern. Even though processes changed significantly since Frederick Taylor's time, the business process redesign practices used then seem very similar to those of the 1990s (Kock, 1999; Kock & McQueen, 1996; Waring, 1991).

The scientific management method consisted of 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).

The total quality management movement broke away from the productivity-only orientation of scientific management by emphasizing business process quality as the main goal of organizational development. One difficulty faced by the quality movement stems from the fact that "quality" is primarily a gauge of customer satisfaction and thus difficult to measure, which may perhaps explain a gradual but steady emphasis on quality "process" standardization (also known as quality "systems" standardization). Total quality management gradually became a movement dominated by quality process (or system) standards, such as the influential ISO 9000 set of quality standards (Arnold, 1994). As such, the view that "quality companies" were those that complied with quality process standards became increasingly widespread, which many view as having pushed total quality management in a wrong direction and in the hands of bureaucrats who specialized in quality standards implementation and certification.

The dissatisfaction created by the "bureaucratization" of total quality management and its alleged small and incremental impact on the bottom line of the companies that implemented it (Hammer & Champy, 1993) set the stage for the emergence of business process reengineering, which, many argue, is a modernized version of scientific management (Earl, 1994; Kock & McQueen, 1996; Rigby, 1993; Waring, 1991). Reengineering's popularity reached its peak by the mid-1990s and slumped since then, because of a number of reported failures. James Champy, one of reengineering's pioneers, argued that 70 percent of all reengineering projects failed to achieve their goals (Champy, 1995). In spite of this, reengineering created renewed interest in business process redesign, making it the most widely practiced form of organizational development in the year 2000. Business process redesign in the new millennium is usually conducted in conjunction with the implementation of enterprise systems and e-business applications (Biggs, 2000; Davenport, 2000; Hammer, 2000).

CURRENT FOCUS ON ACTIVITY FLOWS AND ASSOCIATED PROBLEMS

Unlike in 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 Drucker (1993): "In 1880, about 9 out of 10 workers made and moved things; today, that is down to 1 out of 5 workers. The other 4 out of 5 are knowledge people or service workers." A study by Kock and McQueen (1996) shows that, even in manufacturing organizations, approximately 80 percent of what flows in business processes is information, while the other 20 percent is made up of materials (in service organizations, this ratio is usually very close to 100 percent versus 0 percent). These figures seem to confirm the once 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

> **"...today most of what flows in business processes is information."**

information flow is also consistent with the widespread use of information technologies in organizations, and its increasing importance in the improvement of business processes.

Paradoxically, though, most of today's business process redesign practices focus on the analysis of business processes as sets of interrelated activities, and pay little attention to the analysis of the information flow in business processes. The most widely adopted normative approaches for business process redesign embody general guidelines that place no special emphasis on the redesign of the information flow, thus disregarding the information-intensive nature of business processes (Kock & McQueen, 1996). This is also true for the DoD, where the IDEF0 approach for business process redesign (Ang & Gay, 1993), an activity-flow-based approach, has been chosen as the official business process redesign approach and is by far the most widely used (Dean, Lee, Orwig, & Vogel, 1995).

"... it is reasonable to expect that business process redesign approaches that focus on the flow of information will be more effective and thus preferred by practitioners over those based on the traditional activity-flow view of processes."

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, Esseling, & Van Nimwegen, 1998). While this opinion is obviously at odds with the notion that information processing is the main goal of business processes (Galbraith, 1977), the opinion is very much in line with reengineering's original claims (Hammer & Champy, 1993) and most of the current business process redesign practice.

Research Hypothesis and Its Negative Form

Given the discussion above, it is reasonable to expect that business process redesign approaches that focus on the flow of information will be more effective and thus preferred by practitioners over those based on the traditional activity-flow view of processes, for the simple reason that they will provide a better understanding of the business processes targeted and a clearer view of how process changes should be implemented. This expectation is formalized in the hypothesis H1a below (H1b is the negative form of H1a, developed for hypothesis testing purposes):

H1a: Business process redesign practitioners perceive approaches that focus on information flow as more useful than approaches that focus on activity flow.

H1b (negative form of H1a): Business process redesign practitioners perceive approaches that focus on information flow as either less effective than or presenting the same effectiveness as approaches that focus on activity flow.

The reason for the use of both positive and negative forms of the hypothesis is the use of Popper's (1992) "falsifiability criterion" for hypothesis corroboration in this study, which adds robustness to the study's findings. The falsifiability criterion is explained in more detail in the next section.

Hypothesis H1a above and its negative form H1b were tested through an action research study of a business process redesign project involving DoD and Computer Sciences Corporation, a leading software provider for the defense sector (the project also involved employees from Lockheed Martin, a regular business partner to Computer Sciences Corporation).

USING THE ACTION RESEARCH APPROACH

The research approach used was action research (Checkland, 1991; Rapoport, 1970; Susman & Evered, 1978; Winter, 1989), adapted for the specific context of business and information technology research (Baskerville, 1997; Lau, 1997; Wood-Harper, 1985). One of the main characteristics of organizational action research is that the researcher, or research team, applies "positive" intervention to the participating organization while collecting research data (Elden & Chisholm, 1993; Francis, 1991; Peters & Robinson, 1984). In this research project, the researcher provided business process improvement training and facilitation to the members of a business process redesign team involving employees from the DoD and Computer Sciences Corporation. 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.

Action research was used for two reasons. First, action research places the researcher in the middle of the action, allowing for close examination of real-world business situations in their full complexity, and thus is a particularly useful research approach for the study of new business topics and hypotheses such as those addressed by this research study. The second reason stems from the use of Popper's falsifiability criterion, which states that a researcher should prove a hypothesis not only by looking for evidence that supports it, but also by looking for evidence that suggests the existence of an exception to the hypothesis (or supporting evidence to the negative version of the original hypothesis; which is the reason why H1b was formulated based on the "negation" of H1a in the previous section). According to Popper's epistemology (i.e., Popper's accepted rules for creation of valid knowledge), the absence of contradictory evidence becomes a strong corroboration of the original hypothesis (Popper, 1992). Since in action research the researcher is an "insider," as opposed to a "removed observer," and thus has access to a broader body of evidence than in other research approaches (e.g., case research, survey research, and experimental research), action research is particularly

"The research approach used was action research adapted for the specific context of business and information technology research."

effective when used in combination with Popper's falsifiability criterion.

The business process redesign project focused on the Computer Sciences Corporation side of the software development procurement process, whereby the DoD purchased software from Computer Sciences Corporation, the 13th largest defense contractor in the United States, ranking 2nd in information technology contracts. The business process redesign team had nine members: six from Computer Sciences Corporation; and three from Lockheed Martin, a company that was a subcontractor for Computer Sciences Corporation in many software development projects (Lockheed Martin also regularly subcontracted Computer Science Corporation). DoD members also participated in the project as information providers, but not as members of the business process redesign team.

"The business process redesign team employed activity flow as well as information flow modeling tools."

Process Redesign Work and Information Flow Focus

An analysis conducted by the business process redesign team of the target process led to the identification of several problems, including:

- The work plan in the software development proposal developed for the DoD often did not include all the departments that participated in the actual work, which created internal budgeting difficulties.

- The justification of the items in the basis of estimates (BOEs) document, which forms the basis on which the budget is generated, often did not meet the needs of the DoD.

- Participating departments were not informed at the proper time about how much project funding was allocated to them, which often forced them to transfer initial overhead costs to other projects.

- There were no process metrics in place, which made it difficult for the contracts manager at Computer Sciences Corporation to manage the quality and productivity of their process.

- There had been incidents in which proposal data was lost, leading to many hours of wasted work. No disaster recovery procedure was in place.

The business process redesign team employed activity flow as well as information flow modeling tools. The activity-flow modeling tool used was the functional timeline flowchart, as proposed by Harrington (1991) and Harrington, Esseling, & Van Nimwegen (1998). It incorporated information about the organizational functions involved in the process (e.g., contracts manager, program manager, technical lead), the activities carried out by each organization function, the order of execution of each activity in relation to other activities, the "process time" for each activity (i.e., the amount of time required to perform each activity), and the "cycle time" for each activity (i.e., the elapsed time between the end of the activity and the end of the previous activity). See Appendix A for a sample functional time-line flowchart generated by the business process redesign team.

The information-flow modeling tool used was a modified version of the data flow diagram used in structured systems analysis and design (Davis, 1983; Dennis & Wixom, 2000), as proposed by Kock (1999). It incorporated information about the organizational functions involved in the process (e.g., contracts manager, program manager, technical lead), the activities carried out by each organization function, the information flows between organizational functions, and the information repositories in the business process. See Appendix A for a sample data flow diagram generated by the business process redesign team.

The redesign team independently proposed nine major business process changes, without interference from the facilitator. A content analysis of the descriptions of the proposed changes indicated the following breakdown according to their focuses:

- Eight focused only on the information flow of the target business process and led to changes in request for proposals (RFP) receipt and announcement, alpha negotiations, and receipt and announcement of project awards.

- One focused on both the activity and information flow of the target business process and led to the inclusion of activities related to the compilation and regular review of process metrics.

The team generated a functional time-line flowchart and a data flow diagram of the new process; both showed how the new process (i.e., with the proposed changes above included) would look. The team then developed a generic information technology solution (i.e., a product-independent computer-based infrastructure and system specification) to implement the new business process. The solution was illustrated through a rich pictorial representation with icons representing computers, databases, and organizational functions. The redesign team members saw this pictorial representation as an important aid for them to explain the new process to Computer Science Corporation employees and DoD representatives. The pictorial representation was generated entirely based on the information flow representation of the new process.

"The redesign team independently proposed nine major business process changes, without interference from the facilitator."

A focus group discussion was conducted with the members of the business process redesign team immediately after the above tasks had been completed. In this discussion the members unanimously indicated that, based on their experience in the project, a focus on the information flow of a business process was more likely to lead to successful redesign outcomes than a focus on the activity flow of the business process. However, there was no consensus on the reason for this. Some suggested that information-flow representations were easier to generate than activity-flow representations of business processes. Others disagreed, arguing that while information-flow representations were more difficult to generate, they made it easier to spot business process improvement opportunities.

All of the process changes proposed by the redesign team were approved and subsequently implemented, through modifications in the computer system used by the DoD for procurement, known as joint computer-aided acquisition and logistics support (JCALS), which had originally been developed by Computer Sciences Corporation. A process performance review conducted approximately 6 months after the implementation of the changes indicated that the business process redesign outcomes had led to productivity and quality gains.

"All of the process changes proposed by the redesign team were approved and subsequently implemented...."

Discussion and Conclusion

The evidence from the business process redesign project provides support to hypothesis H1a and, more importantly, fails to support H1b, which is the negative form of H1a. The most relevant pieces of evidence are briefly discussed below.

H1a states that: "Business process redesign practitioners perceive approaches that focus on information flow as more useful than approaches that focus on activity flow." Key pieces of evidence support this hypothesis:

- The business process redesign team used only the information flow representation to develop almost all (8 out of 9, or 88.89 percent) of their change recommendations. The remaining change recommendation was also based on the information flow representation, although not exclusively.

- The pictorial representation of the generic information technology solution was generated entirely based on the information flow representation of the new process.

- In the focus group discussion conducted with the members of the business process redesign team immediately after it completed the redesign of the process, they unanimously indicated that a focus on the information flow of a business process was more likely to lead to successful redesign outcomes than a focus on the activity flow of the business process.

H1b, which is the negation of H1a, states that: "Business process redesign practitioners perceive approaches that focus on information flow as either less effective than or presenting the same effectiveness as approaches that focus on activity flow." The following items suggest a lack of evidence in support of this hypothesis:

- The business process redesign team favored the information flow representation even though it had generated both activity flow and information flow representations of the business process. Given that the team was familiar with both representations, it is likely that, if it had perceived both types of representation as equivalent in terms of effectiveness, the team would not have favored one or another. If they had perceived the activity-flow representation as superior, they would likely have favored it over the information flow representation.

- Even though the business process redesign team had generated both activity flow and information-flow representations of the new business process, i.e., the business process resulting from the change recommendations, the pictorial representation of the generic information technology solution was based only on the information flow representation of the new process. Given that the members of the redesign team had both representations available to them, it is likely that, if they had perceived both types of representation as equivalent in terms of effectiveness, they would not have chosen one and referred to that type of representation as more likely to lead to successful results, as they did, in the focus group discussion. If they had perceived the activity-flow representation as superior, they would likely have favored it over the information-flow representation.

- One might argue that the team perceived the pictorial representation as of little importance. Otherwise they might have used the activity-flow representation as a basis. Yet, it is clear from the evidence that the pictorial representation was seen as very important by the redesign team, as it illustrated how information technology would enable the new process. Also, the team saw the pictorial representation as an important aid for explaining the new process to Computer Science Corporation employees and DoD representatives.

Given the above, it can be argued that, based on the evidence of this study, business process redesign practitioners perceive approaches that focus on information flow as more useful than approaches that focus on activity flow.

The evidence also suggests that the perceptions above are warranted; that is, business process redesign approaches that focus on information flow may actually be more effective (i.e., not only perceived as more effective) than the more pervasive activity-flow-based approaches. The key reason for this is that the business process redesign project studied was a successful one. If the business process redesign project had been unsuccessful, the fact that practitioners favored one approach over another would be less meaningful.

"... business process redesign practitioners perceive approaches that focus on information flow as more useful than approaches that focus on activity flow."

This study suggests the need for a change of focus in business process redesign in the defense sector (and possibly elsewhere), from activity flow to information-flow-based approaches. Given the widespread use of activity-flow-based approaches today, and their high rate of failure (Champy, 1995; Nissen, 1998), such change of focus may have a dramatic impact on future business process redesign practices and bottom-line business impact.

REFERENCES

Ang, C. L., & Gay, R. K. L. (1993). IDEF0 modeling for project risk assessment. *Computers in Industry, 22*(1), 31–46.

Arnold, K. L. (1994). *The manager's guide to ISO 9000*. New York: The Free Press.

Baskerville, R. L. (1997). Distinguishing action research from participative case studies. *Journal of Systems and Information Technology, 1*(1), 25–45.

Bergner, J. T. (1991). *The new superpowers: Germany, Japan, the U.S., and the new world order*. New York: St. Martin's Press.

Biggs, M. (2000). Enabling a successful e-business strategy requires a detailed business process map, *InfoWorld, 22*(10), 64.

Champy, J. (1995). *Reengineering management.* New York: Harper Business.

Chapman, W. (1991). *Inventing Japan: The making of a postwar civilization*. New York: Prentice Hall.

Checkland, P. (1991). From framework through experience to learning: The essential nature of action research. In H. Nissen, H. K. Klein, & R. Hirschheim (Eds.), *Information systems research: Contemporary approaches and emergent traditions* (pp. 397–403). New York: North-Holland.

Davenport, T. H. (1993). *Process innovation*. Boston: Harvard Business Press.

Davenport, T. H. (1993a). Need radical innovation and continuous improvement? Integrate process re-engineering and total quality management. *Planning Review, 21*(3), 6–12.

Davenport, T. (2000). *Mission critical: realizing the promise of enterprise systems*. Boston: Harvard Business School Press.

Davenport, T. H., & Short, J. E. (1990). The new industrial engineering: information technology and business process redesign. *Sloan Management Review, 31*(4), 11–27.

Davis, W. S. (1983). *System analysis and design: A structured approach*. Reading, MA: Addison-Wesley.

Dean, D. L., Lee, J. D., Orwig, R. E., & Vogel, D. R. (1995). Technological support for group process modeling. *Journal of Management Information Systems, 11*(3), 42–63.

Deming, W. E. (1986). *Out of the crisis*. Cambridge, MA: Center for Advanced Engineering Study, Massachusetts Institute of Technology.

Dennis, A., & Wixom, B. H. (2000). *Systems analysis and design: An applied approach*. New York: John Wiley & Sons.

Drucker, P. F. (1989). *The new realities*. New York: Harper & Row.

Drucker, P. F. (1993). Professional's productivity. *Across the Board, 30*(9), 50.

Earl, M. J. (1994). The new and the old of business process redesign. *Journal of Strategic Information Systems, 3*(1), 5–22.

Elden, M., & Chisholm, R. F. (1993). Emerging varieties of action research *Human Relations, 46*(2), 121–141.

Francis, D. (1991). Moving from non-interventionist research to participatory action. In C. Collins, C., & P. Chippendale (Eds.), *Proceedings of the First World Congress on Action Research, 2*, (pp. 31–42). Sunnybank Hills, Queensland, Australia: Acorn.

Galbraith, J. (1977). *Organizational design*. Reading, MA: Addison-Wesley.

Hammer, M. (1990). Reengineering work: Don't automate, obliterate. *Harvard Business Review*, *68*(4), 104–114.

Hammer, M. (2000). Reengineering redux. *CIO Magazine, 13*(10), 143–156.

Hammer, M., & Champy, J. (1993). *Reengineering the corporation*. New York: Harper Business.

Harrington, J. H. (1991). *Business process improvement*. New York: McGraw-Hill.

Harrington, J. H., Esseling, E. K. C., & Van Nimwegen, H. (1998). *Business process improvement workbook: Documentation, analysis, design, and management of business Process Improvement*, New York: McGraw-Hill.

Juran, J. (1989). *Juran on leadership for quality*. New York: The Free Press.

Kock, N. (1995). *Process reengineering, PROI: A practical methodology*. Sao Paulo, Brazil: Editora Vozes (in Portuguese).

Kock, N. (1999). *Process improvement and organizational learning: The role of collaboration technologies*. Hershey, PA: Idea Group Publishing.

Kock, N., & McQueen, R. J. (1996). Product flow, breadth and complexity of business processes: An empirical study of fifteen business processes in three organizations. *Business Process Re-engineering & Management, 2*(2), 8–22.

Lau, F. (1997). A review on the use of action research in information systems studies. In A. S. Lee, J. Liebenau, & J. I. DeGross (Eds.). *Information systems and qualitative research* (pp. 31–68). London: Chapman & Hall.

Mayo, E. (1945). *The social problems of an industrial civilization*. New York: Macmillan.

Nissen, M. E. (1998). Redesigning reengineering through measurement-driven inference. *MIS Quarterly, 22*(4), 509–534.

Peters, M., & Robinson, V. (1984). The origins and status of action research. *The Journal of Applied Behavioral Science, 20*(2), 113–124.

Popper, K. R. (1992). *Logic of scientific discovery*. New York: Routledge.

Rapoport, R. N. (1970). Three dilemmas in action research. *Human Relations, 23*(6), 499–513.

Rigby, D. (1993, March/April). The secret history of process reengineering. *Planning Review, 21*(2), 24–27.

Susman, G. I., & Evered, R. D. (1978, December 23). An assessment of the scientific merits of action research. *Administrative Science Quarterly,* 582–603.

Taylor, F. W. (1885). *A piece rate system*. New York: McGraw-Hill.

Taylor, F. W. (1911). *The principles of scientific management*. New York: Norton & Company.

Toffler, A. (1991). *Powershift*. New York: Bantam Books.

Walton, M. (1989). *The Deming management method*. London: Mercury.

Waring, S. P. (1991). *Taylorism transformed*. Chapel Hill, NC: The University of North Carolina Press.

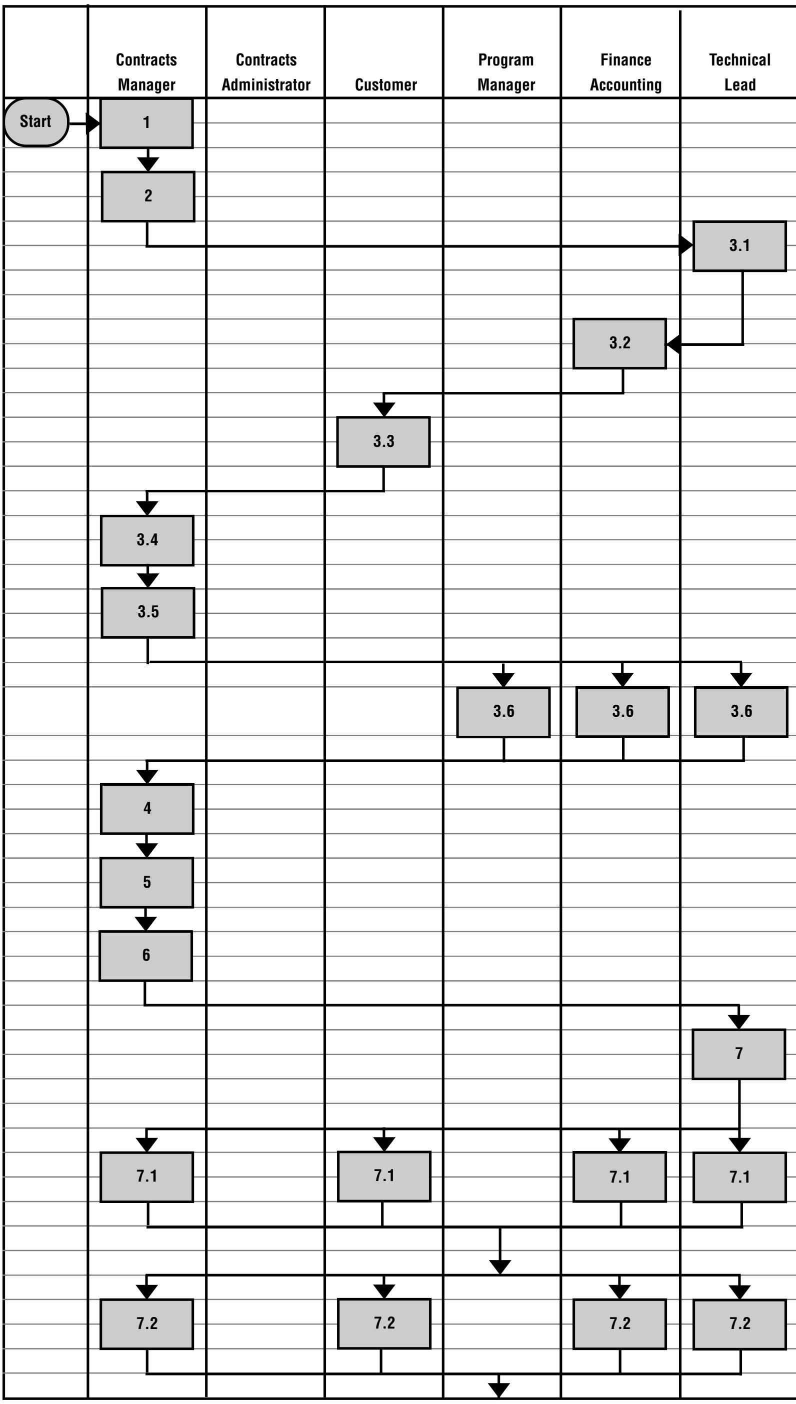
Winter, R. (1989). *Learning from experience: Principles and practice in action-research*. New York: The Falmer Press.

Wood-Harper, A. T. (1985). Research methods in information systems: Using action research. In E. Mumford, R. Hirschheim, G. Fitzgerald, & A. T. Wood-Harper, (Eds.), *Research methods in information systems* (pp. 169–191). Amsterdam, The Netherlands: North-Holland.

Ned Kock is CIGNA Research Fellow in the Fox School of Business and Management, Temple University. He holds a B.E.E. degree in electronics engineering, an M.S. degree in computer science, and a Ph.D. degree in information systems. Kock has written more than 80 academic papers and three books, including the best-selling "Process Improvement and Organizational Learning: The Role of Collaboration Technologies."

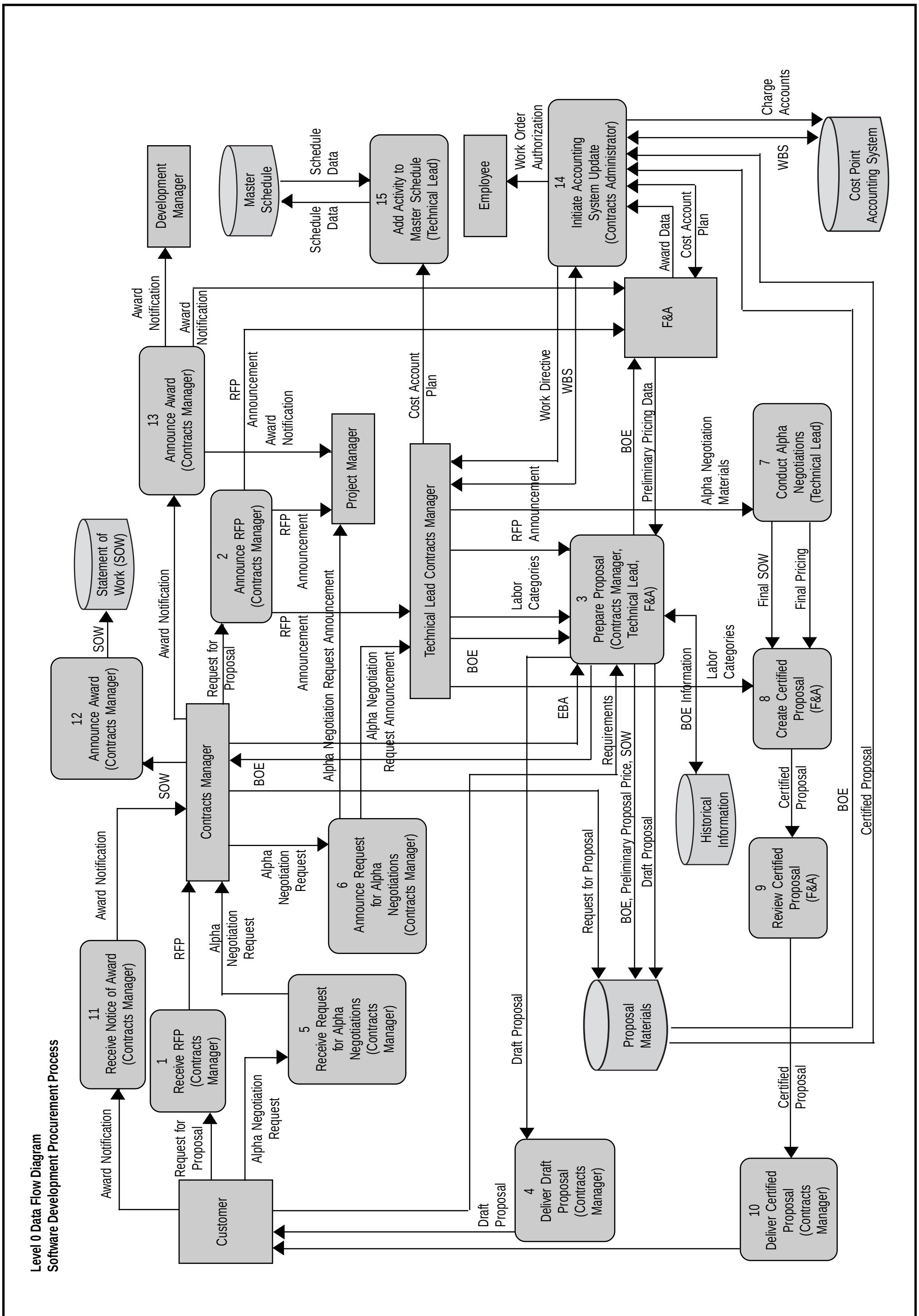
(Kock@sbm.temple.edu)

Appendix A: Activity Flow and Data Flow Diagrams Used



Activity	Processing Time (Days)	Cycle Time (Days)
1	1	1
2	1	1
3.1	1	1
3.2	5	10
3.3	1	1
3.4	5	10
3.5	7.5	20
3.6	3	5
4	1	1
5	0.5	2
6	3	5
7	5	10
7.1	3	5
7.2	3	5
8	1	2
9	2.5	5
10	3	5
11	1	1
12	1	1
13	1	3
14	3	5
14.1	1	1
14.2	1	1
14.3	2	4
14.3.1	2	5
14.3.3	1	1
14.4	1	1
15	1	1
	62.5	114

Sample Functional Timeline Flowchart
Generated by the Redesign Team
(Activity Names Were Listed Next to the Diagram)



Sample data flow diagram generated by the redesign team

APPENDIX B: BUSINESS PROCESS REDESIGN GUIDELINES USED

The business process redesign team used the following guidelines, which have been compiled from a large body of literature on business process redesign and discussed in more detail by Kock (1999). In the list below, the name of the technique is followed by a brief description of why the technique may lead to business process improvement.

- **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 time waste (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.

- **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 inconsistencies, which may have a negative impact on productivity and quality. Kock (1995) describes a situation where a large automaker'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 more than 400 parts suppliers.

- **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.

- **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 group committed.

- **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.

- **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 sped up the assembly of certain car models.

- **Group interrelated activities.** Closely interrelated activities should be grouped in time and space. Activities that use the same resources, that is, 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 sent its internal team first. Should this team find no internal connection problem, the external team would then be dispatched to 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. When complaints were categorized and counted, it was found that most of the problems were external.

- **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 subprocesses: organization of exhibitions, conferences, and exhibitor 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, because with simpler processes, one person could perform functions in various processes at the same time.