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ABSTRACT

Business Process Redesign (BPR) and Information Architecture (IA) have been recognized as high organizational priority agenda items in the 1990s. This paper provides the premise for integrating these two critical issues. A model depicting the relationship between IA and BPR is presented. IA design and BPR share a common focus on business processes and, when properly conducted, IA design should produce a stable information architecture capable of supporting existing as well as improved business processes. Furthermore, selected IA methods and techniques are recommended for possible application in BPR. Future research is suggested concerning the need to validate this BPR and IA relationship and test the appropriateness of applying IA methodologies to BPR.

1. INTRODUCTION

Organizations are undergoing revolutionary changes in the way they function and compete. In popular business publications, article after article cites how corporations are embarking on campaigns to fundamentally rework how they do business. This business reengineering seeks to redesign internal work processes to enhance productivity and competitiveness. CSC Index Inc., a major consulting group, conducted a survey in 1991 of 444 senior information executives at U.S. and Canadian firms with at least $250 million in earnings to identify the critical Information Systems (IS) issues of the 1990s (McCormick 1991). "Reengineering business processes through IT" ranked a close second behind "aligning IS and business strategy." While it is clear from this survey that IS managers have recognized the importance of this activity, the impetus of Business Process Redesign (BPR) has thus far typically been outside the IS area, driven by such causes as downsizing, mergers, leveraged buyouts and acquisitions, productivity or quality improvement initiatives, and customer demands for product flexibility and innovation. In many instances, the IS area has been an afterthought as opposed to a leader in BPR (Hammer 1990).

Accompanying this recent IS focus on BPR has been a somewhat quieter, but equally significant, resurgence of thinking within the IS community on the importance of information as a strategic resource of the firm and the vital need to design a corporate "Information Architecture" (IA) to support dynamic competitive strategies and processes. The same CSC Index survey identified "creating an Information Architecture" as the third most critical issue in 1991. A recent Delphi study conducted among senior IS executives identified the "development of an Information Architecture" as the most critical issue facing IS managers in the 1990s (Niederman, Brancheau and Wetherbe 1991).

As we will demonstrate later in this paper, these two critical IS agenda items (BPR and IA) share a commonality in that their success hinges on the identification and design of efficient business processes. However, little research has been focused on this relationship nor has a clear conceptual framework been developed that integrates BPR and IA into existing scholarly thinking or practice in IS. For both the IS professional and academic, some simple but fundamental questions are in order. What is BPR? Is it different from what IS professionals have been saying and doing for some time? How do database technology and information architecture fit with BPR? What is the role of the IS department as the Information Architect during the business process redesign?

This paper will address the relationship between BPR and IA. It is hoped that our discussion will bring some synergy to methodologies used in each approach and begin to offer some guidelines in firms' efforts to redesign organizational processes to exploit the power of today's information technology (IT). We will first discuss the origins and current state of BPR and Information Architecture. We will then proceed to establish the conceptual relationship between IA and BPR, which will be validated by a case analysis at Ford Motor Company. Finally, we will conclude by drawing the synergy between these two concepts and highlight areas for future research.

2. BUSINESS PROCESS REDESIGN: ORIGINS AND PROGRESS

The current phenomenon we call "reengineering" has its roots in industrial engineering. With the rise of the industrial revolution, a field of engineering emerged concerned with the design of processes to achieve efficient production. One industrial engineering tenet was the division of labor into localized, specialized, and repeatable tasks. As might be expected, the same techniques that proved to be successful with line functions on the factory floor were mirrored in supporting business processes. The value chain of business information tasks was organized as a production line of employees who repeatedly applied their narrowly focused skill to stacks of paperwork. These same "scientific management" theories lie behind many of the business processes we have in place today.

As time progressed, technological developments were typically incrementally applied to business tasks with a narrow efficiency orientation. The idea was that in achieving maximum efficiency at each point in the value chain, the whole process would benefit. However, because today's businesses are changing so rapidly, this localized, incremental approach has created extremely complex process juggernauts which may contribute "clock-wise" efficiency to specific tasks, while allowing overall effectiveness of the process to suffer.

What reengineering offers is a way to regain control of seemingly untractable business processes by streamlining and simplifying how a company operates. Michael Hammer, a leading reengineering consultant, defines reengineering as "the fundamental analysis and radical redesign of business processes to achieve dramatic improvements in critical measures of performance" (Stewart 1992, p.95). The results of such reengineering efforts have already surfaced among firms in the 1990s. Ford Motor Company, Mutual Benefit Life Insurance, AT&T, and DEC report increases in productivity and decreases in staff by about 80 percent after business reengineering (Krass 1991). DEC was able to consolidate 55 accounting groups into five and was able to eliminate 450 jobs (Krass 1991). CIGNA RE Corporation saves $1.5 million each year in operations cost and has improved access to data due to a $3.2 million reengineering effort (Ryan 1991). Charles Schwab Corporation has adopted a Schwab Architecture and Migration Strategy (SAMS) model comprised of twenty-four business processes that will streamline their operation with the intent of a 20 percent revenue growth in the 1990s (Bartholomew 1991).

The tremendous growth in the number of firms undertaking such efforts provides insight as to how organizations will be designed in the 1990s. The organization of the future is envisioned to be networked across functions and will be designed around business processes rather than functional hierarchies (Rockart and Short 1989; Norton, Pollock and Ware 1989; Martin 1990). In essence, *reengineering business processes* has been suggested as a new paradigm of organizational change necessary in maintaining flexibility and competitiveness (Hammer 1990; Venkatraman 1991).

While business procedures can be reworked without IT, recent technological advances have placed greater importance on IT as an enabler of BPR. Increasingly, BPR is being deployed in tandem with the use of IT to revamp or overhaul existing business processes that limit the competitiveness, effectiveness and efficiency of the organization (Fried 1991; Senn 1991). Technologies such as Local Area Networks (LANs), client server architecture, Electronic Data Interchange (EDI) and Executive Information Systems (EIS) are some examples of IT which now allow firms to achieve performance gains in the communications dimensions of business processes. Emergence of other technologies such as video/teleconferencing, groupware and workflow technologies will also prove to be enablers of BPR by reducing or replacing several manual and/or communication tasks and roles currently existing in business processes (Huber 1990).

It is also important to point out that BPR is a continual process and that the critical business processes must be continually "redesigned, retooled and reorchestrated in the future" (Wilkinson 1991; Senn 1991). This continual change can be facilitated by an enterprise-wide IT platform. While the previously mentioned IT are important, database technology and information architecture (IA) may be the most critical IT enablers for BPR by allowing the development of an information platform or "information warehouse." One important factor that delineates IA from other IT enablers is the fact that IA is deeply rooted in the nature of the business at both the tactical and strategic level. As Michael Treacy, an IS consultant, stated, "systems already in place must be selectively destroyed and replaced by cross-functional systems that allow many departments to share a single 'information warehouse'" (Vowler 1991, p. 18).

To achieve this level of sophistication in information management, it will be crucial for firms to create an efficient information architecture that will provide access to information at all levels of the organization and also be able to accommodate continual process redesign in future reengineering efforts.

While the authors recognize that there are other important aspects of the architectural design, such as the overall technological (hardware) platform, which will be important IT components of BPR, we believe that the information architecture is fundamental to the BPR process. IA facilitates the BPR process because both BPR and IA design have the same process focus. The next section provides a detailed discussion on the rising importance of maintaining an enterprise IA and the assistance it can provide in supporting process redesign efforts.

3. INFORMATION ARCHITECTURE: ORIGINS AND PROGRESS

The development of modern computer-based information systems began with a file-oriented approach that had as its emphasis the "program" rather than "data." In fact, data was not even formally defined outside of the program. The resulting redundancy, inconsistency, and inflexibility led to the development of database management technology (Bachman 1969; CODASYL 1971) based on the three-schema architecture: external models (subschemas), conceptual model (schema), and internal model (ANSI 1975).

The concept of data independence brought the realization that the center of the data processing universe was the data rather than the application program (Nolan 1973; Everest 1974). Through the conceptual model, the data independence concept calls for the design of a stable database structure that is capable of supporting several related applications, each with its own external view. To the extent that the conceptual model is properly designed, this goal of data independence is achievable even when some modifications to the external views become necessary. The methods for the logical design of shared databases have been greatly facilitated by the development of relational database theories and the accompanying normalization techniques (Codd 1971).

It soon became apparent that, if a particular subject database could provide stable data structure for a group of related applications, a set of such databases could support organization-wide processing requirements. This macro-level architectural approach to organize the entire organization's information resources was the major thrust of the BSP (Business Systems Planning) methodology developed by IBM Corporation in 1970. Referred to as "data classes," rather than the popular term "subject databases" (Martin 1982), a collection of these data classes may be systematically identified and configured to drive the entire organization's information needs (IBM 1984). The methodology consists of as many as thirteen formal steps and is very comprehensive, producing a large number of documents. The most significant of these is perhaps the process/data class matrix as shown in Figure 1.

While BSP has the advantage of comprehensiveness, the methodology has been criticized for requiring too many interviews, taking too long to complete, and often producing voluminous output without visible impacts (Rockart 1979; Goodhue, Quillard and Rockart 1988). Nevertheless, the methodology provides the conceptual foundation for many IS architectural planning methods introduced later. These later methods incorporate techniques such as Critical Success Factors and the Entity-Relationship approach to enterprise data modeling while maintaining the essential elements of BSP (Martin 1982; McFadden and Hoffer 1991). Normally, these later methods are more efficient to conduct and require less time and resources to complete.

Within BSP and other planning methods, the process/data class matrix is regarded as one of the basic blueprints for an organization's *information architecture*. It can be used as a basis for further analysis to determine process groups and data flow between these groups. The idea of information architecture has since attracted the attention of academic researchers (Wetherbe and Davis 1983; Brancheau and Wetherbe 1986). Brancheau and Wetherbe offer the following definition of information architecture: "An information architecture is a high-level map of the information requirements of an organization. It is a personnel-, organization-, and technology-independent profile of the major information categories used within an enterprise" (p. 453).

Everest and Kim (1989, p. 6.) describe information architecture as "blueprints or diagrams which reflect, satisfy, and adapt to the needs of business functions, operations, and decision making." Wardle (1984) identifies a broader concept of architecture when she identified the four components of an *information systems architecture*: data architecture, application architecture, communication architecture, and technology architecture. Therefore, it is important to make the distinction between information architecture and information systems architecture (Zachman 1987; Everest and Kim 1989). Perhaps because of this potential confusion, many authors use the term "data architecture" rather than information architecture. The concept of "information engineering" involves "the planning, designing, constructing, or managing" of information architecture using a methodology and a set of formal techniques (Everest and Kim 1989, p. 7).

Because it has its roots in data base technology, we define an information architecture as

> a high-level model of a set of databases configured to support the organization's value-adding business processes. The model may be portrayed in graphical, tabular, or narrative form and is independent of technology and current organizational structure.

We use the word "configure" because architecture is the outcome of a *purposeful design*. It is customary to present architecture in a graphical blueprint with supporting narrative description. The last part of our definition reaffirms the abstract nature of the design following the data independence principle. The database technology deployed may be relational today, but object-oriented tomorrow; the process to be supported now, may be reengineered in the future. Thus, the historical development of computer information systems has progressed from program-centered, file-oriented applications to isolated databases, to an enterprise-wide information architecture.

4. BUSINESS PROCESS REDESIGN AND INFORMATION ARCHITECTURE

4.1 The Role of Information Architecture in a Business Process Redesign Project

Traditionally, systems development has been targeted at particular operations within a specific functional area. The resulting "application system" would typically be lacking in its ability to adapt to changes in procedures and require-

Processes \ Data Classes	Objectives	Policies & Procedures	Organization Unit Desc	Product Forecasts	Bldg & Real Estate Reqt	Equipment Requirements	Organization Unit Budget	G/L Accounts Desc & Budget	Long Term Debt	Employee Requirements	Legal Requirements	Competitor	Marketplace	Product Description	Raw Material Description	Vendor Description	Buy Order	Product Warehouse Inventory	Shipment	Promotion	Customer Description	Customer Order	Seasonal Production Plan	Supplier Description	Purchase Order	Raw Material Inventory	Production Order	Equipment Description	Bldg & Real Estate Desc	Equipment Status	Accounts Receivable	Product Profitability	G/L Accounts Status	Accounts Payable	Employee Description	Employee Status
Establish Business Direction	C	C	C								U	U	U																			U	U			
Forecast Product Requirements	U			C															U			U														
Determine Facility & Eqt. Requests	U		U		C	C		U																				U	U	U						
Determine & Control Fin Requests	U		U				C	C	C																								U			
Determine Personnel Requests		U	U		U	U	U	U		C	U																									U
Comply with Legal Requests		U						U			C			U																					U	U
Analyze Marketplace	U											C	C						U																	
Design Product	U										U	U		C	C													U								
Buy Finished Goods				U										U		C	C																	U		
Control Product Inventory														U			U	C	U								U									
Ship Product																		U	C			U							U							
Advertise and Promote Product													U	U				U		C													U			
Market Product (Wholesale)												U	U	U						U	C	U														
Enter & Cntl Customer Order														U				U	U		U	C									U					
Plan Seasonal Production				U										U									C					U		U					U	U
Purchase Raw Materials															U								U	C	C	U								U		
Control Raw Materials Inventory															U										U	C	U									
Schedule & Control Production														U	U								U			U	C	U		U					U	U
Acquire & Dispose Fac & Eqt					U	U																						C	C							
Maintain Equipment																							U					U		C						U
Manage Facilities																													U							
Manage Cash Receipts																			U		U										C					
Determine Product Profitability								U						U	U				U													C	U		U	U
Manage Accounts									U									U								U	U				U		C	U		U
Manage Cash Disbursements									U							U	U		U							U								C	U	U
Hire & Terminate Personnel		U	U				U			U	U													U	U										C	U
Manage Personnel		U																																	U	C

Index: C: Create

U: Use

Figure 1. Information Architecture as Represented by a Process/Data Class Matrix (Adopted from IBM 1984, p. 40)

ments because of its parochial file-oriented design. In designing and establishing a common shared database for several related operations, the database approach breaks the barrier of structural boundaries between different functional areas. Herein lies the fundamental role of shared databases in business process redesign, with both IA and BPR striving to break the barriers between functional areas.

Let us consider a typical accounts payable system as outlined in Figure 2. A conventional system development project may merely seek to "automate" existing procedures which are represented by process boxes in Figure 2. Notice that the data flow diagram covers only the accounts payable function, rather than the entire *process* of paying vendors, which also involves the purchasing and receiving departments.

However, in adopting a database approach, the emphasis is on identifying the entities that are involved in the entire process. For the payable process, the two critical entities are *Supplier* and *Part*. A high level entity-relationship diagram for this process can be seen in Figure 3. In this diagram, neither existing nor improved operating procedures are modeled, which provides the flexibility to accommodate changing procedures.

The application of such a database approach in reengineering a payable process may be illustrated by a case example at Ford Motor Corporation as depicted in Figure 4. The "soul" of the newly reengineered accounts payable process at Ford Motor Company is a database shared by the purchasing, accounts payable, and receiving departments.

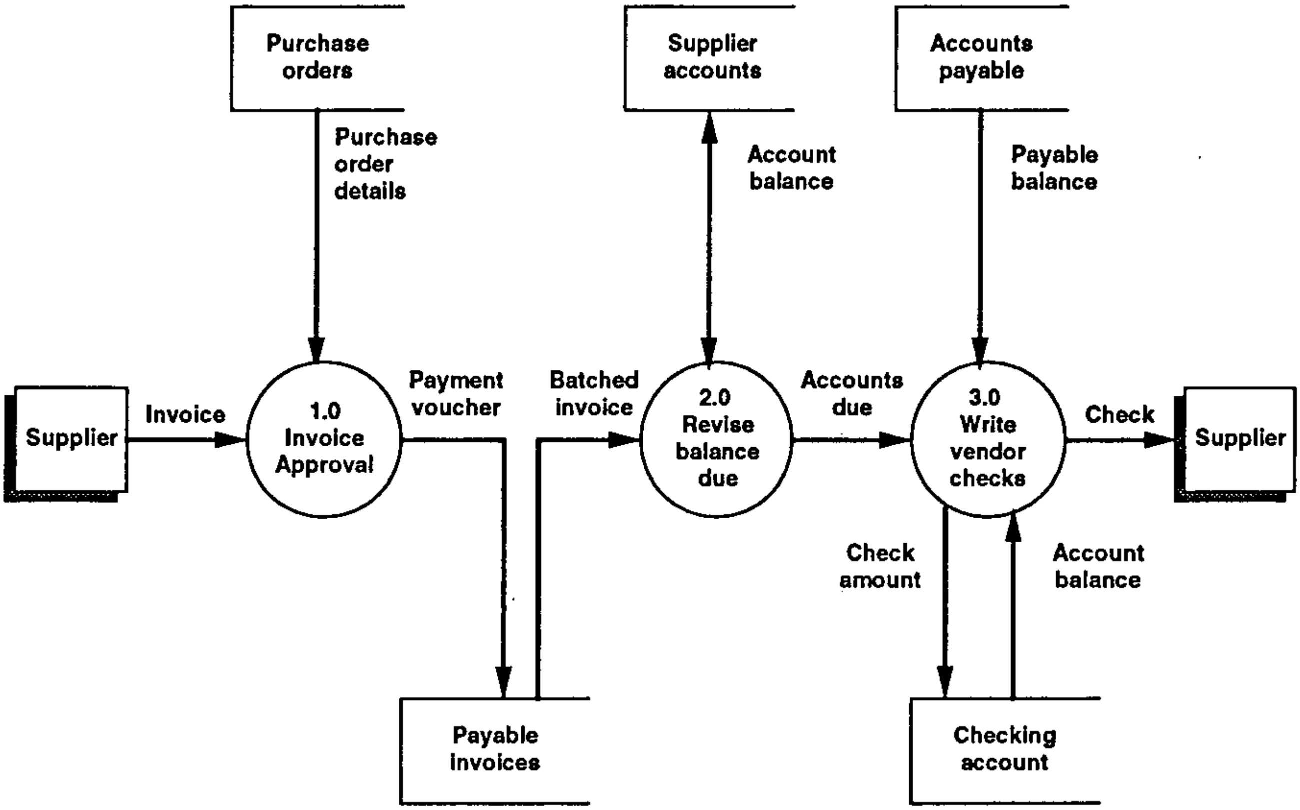

Figure 2. Data Flow Diagram for a Typical Accounts Payable System (Adapted from Senn 1984, p. 124)

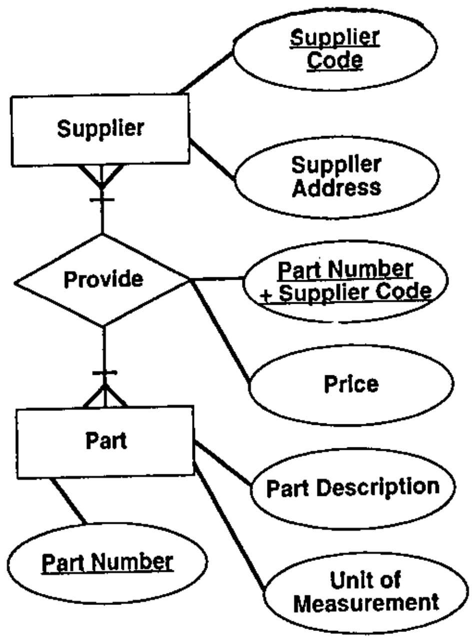

Figure 3. High-Level E-R Diagram for Accounts Payable Process

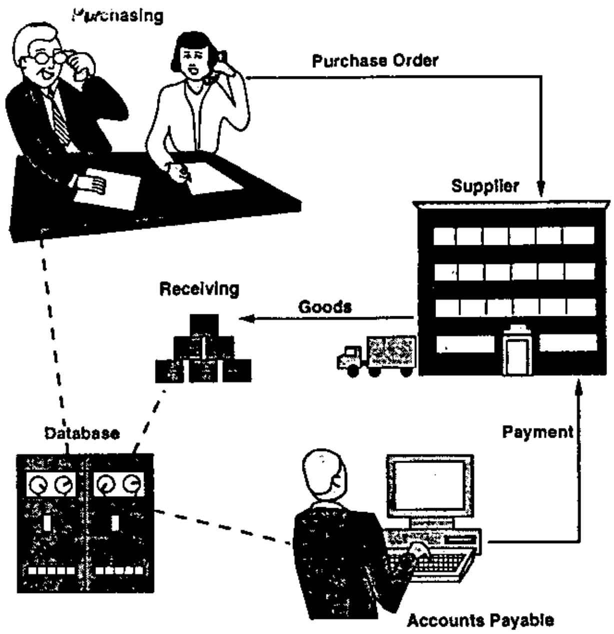

Figure 4. The Reengineered Accounts Payable Process at Ford Motor Company (Adapted from Hammer 1990, p. 107)

According to Hammer (1990), the purchasing department at Ford Motor Company no longer sends purchasing orders to accounts payable; instead it simply enters the order into the central database. When the goods arrive, the receiving clerk checks the database to see if an outstanding order corresponds to the arriving materials; if not, the materials are sent back to the supplier. Unlike the old system, which dictated that accounts payable clerks check fourteen data items when matching the purchase order, receipt record, and the invoice, the reengineered process requires the matching of only three data items: part number, supplier code, and the unit of measurement. This simplicity can be achieved because the database is normalized and based on the two *entities*, namely *Part* and *Supplier*, as shown in the high-level E-R diagram in Figure 3. The unified data base schema is capable of serving three different subschemas from the three different departments taking part in the same business process. In the future, if the payable function and the purchasing function are combined, the same data base schema will still be valid.

4.2 Information Architecture as a Facilitator for Business Process Redesign

The above example and discussion demonstrate that the design of information architecture, as manifested by the database structure, is supportive of reengineering. The database approach forces the designer to adopt a cross-functional process orientation that is not restricted by existing procedures. The most striking resemblance between information architectural design and BPR is the explicit focus on business process. Consider the following two definitions of a business process:

- Groups of logically related decisions and activities required to manage the resources of the business.

- A set of logically related tasks performed to achieve a defined business outcome.

The two definitions are certainly very similar. The first one is the BSP definition of a business process, which was one of the first techniques that included the basic elements necessary for IA design (IBM 1984, p. 29), while the second one was provided by Davenport and Short (1990, p. 12) in describing BPR. For the BSP approach,

> defining the organization's business processes is one of the most important parts of the methodology...no other activities during the study can be quite as overwhelming or as important. (IBM Corporation 1984, pp. 8, 10)

With a common focus on business process, the immediate question at hand is: *Does the pursuit of information architecture facilitate business process redesign?* To answer this question, Figure 5 shows the various relationships between IA and BPR. In an information architectural design, the objective is *to produce* an information architecture (Link 1 in Figure 5) that consists of a set of data classes *intended to support* a collection of existing business processes (Link 2). However, by supporting business processes through data classes, we strive to establish a more stable architectural foundation that may also be capable of supporting changes in business processes via data independence. Therefore, although the immediate benefit of IA design is to support existing processes (Link 2), the information architecture is in principle *capable of supporting* improved business processes as well (the dotted Link 3).

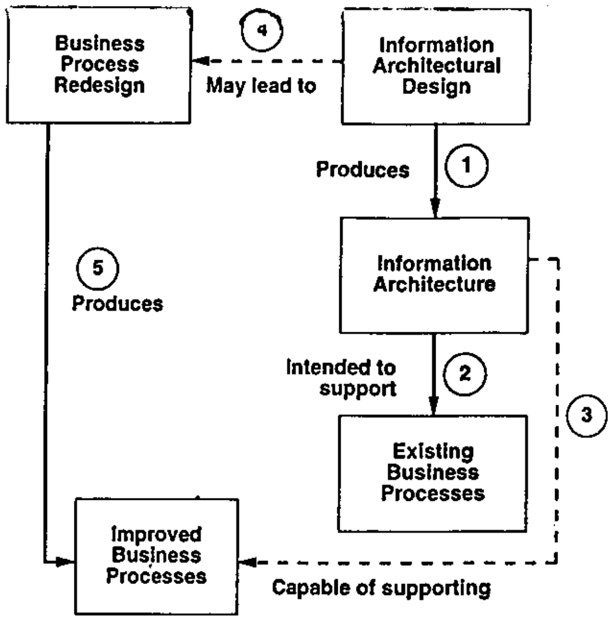

Figure 5. IA as a Facilitator of BPR: Motives and Outcomes

The exciting potential outlined in Link 3 has come to the attention of IS architects. This view point can be characterized in the following remark:

> When we first started this, we thought this was a technique for examining existing procedures. We discovered, a step at a time, that it's much more than that. First, we found that the existing procedures had been horrifyingly duplicated....You had numerous different forms where one computerized form would suffice....The procedures and the flow of work had anomalies...the management structure itself was wrong. It needed a thorough reorganization of the departments and even divisions in order to get tight control and high administrative productivity. (Martin 1982, pp. 141-142)

This recognition suggests that efforts to build shared databases and an information architecture to support cross-functional business processes *may lead to* business process redesign (the dotted Link 4). A case in point occurred at Syntex Corporation, a pharmaceutical manufacturer. Moad (1989) reported that the firm started to build a cross-functional IS using the relational database technology to track the full life cycle of its products but encountered severe user resistance from the affected functions. Eventually, the project team began to use "structured dataflow and organizational analysis to determine exactly how work got done in the business unit" and "discovered that between 30% and 50% of the tasks people were doing were redundant" (Moad 1989, p. 74). With top management endorsement, the team began to redesign certain aspects of the process to take full advantage of the shared data base environment.

5. STRIVING FOR SYNERGY BETWEEN IA DESIGN AND BUSINESS PROCESS REDESIGN

We have shown that IA design and BPR have a common focus on business processes and, when properly conducted, IA design should produce a stable information architecture capable of supporting existing as well as improved business processes. Further, the IA design has actually led some firms to embark on BPR unintentionally. As shown in Figure 5, these curious patterns of relationships not only clearly indicate that IA design is the precursor to the current movement toward IT-enabled BPR, but also strongly suggests that we should be able to take advantage of IA design methods in BPR and strive for synergy between the two methods.

Our first recommendation is to include Information Architects as vital members of a BPR team. These architects will be responsible for designing a shared database for reengineering any cross-functional business process. The immediate enabling and performance-enhancing considerations aside, this approach would lay the information architectural foundation for the process to ensure its long-term viability. An accounts payable process may undergo additional changes in the future, but there will always be a supplier entity and a part entity for the process. While changes in process and procedures will occur, data entities will last as long as the firm remains in the same business. As the competitive environment changes and the business adapts, the process may have to be reengineered again; however, this solid information architectural foundation will remain basically intact.

Some organizations may prefer a targeted approach to BPR and focus on a specific critical process. The advantages of such an approach may be a quick payoff, less risk, and timeliness of project completion. While the information architecture for a particular cross-functional process can greatly facilitate BPR efforts *at the individual process level,* methods and techniques for designing enterprise-wide information architecture can also be incorporated into the BPR effort at the *overall organizational level.* While such enterprise-wide efforts present greater risks, they also offer the potential of significant pay-off as the scope of the BPR effort more closely reflects overall corporate strategy. In addition, because the IA provides a blueprint of the information needs of the organization as a whole, benefits of cross-functional, intra- and inter-firm systems integration can be realized.

5.1 The Identification of a List of Business Processes

A number of organizations have adopted this approach to BPR. For example, Rank Xerox U.K. began the BPR process by uncovering eighteen "macro" business processes and 143 "micro" processes (Davenport and Short 1990). Charles Schwab Corporation's BPR team spent five months to build a global business model which encompasses twenty-four business processes (Bartholomew 1991). Methods for IA design can be readily utilized for this difficult task. For example, BSP as a tool for developing IA identifies business processes as the first critical task. This approach takes each product, service, and support resource through the four stages of their life cycle: requirements, acquisition, stewardship, and disposition. One advantage for adopting the IA approach to process identification is that these processes are not just uncovered in isolation, they are identified *in relation* to data classes, data entities, functional departments, and application systems, etc. The resulting analysis will greatly facilitate actual development and implementation of systems, especially with respect to shared data bases to support reengineered processes.

5.2 Enterprise Data Modeling

Another important tool for IA design is enterprise data modeling, which is typically accomplished via high-level E-R models for the organization under study. The model reveals data entities, data classes, and how they are related to each other. At Pillsbury U.S. Foods, for example, the enterprise data model was presented on twenty-one pages with two levels of details (Brancheau, Schuster and March 1989). Conducted in conjunction with the identification of business processes, enterprise data modeling produces a map for actual database development for a sequence of BPR projects that will eventually cover all business processes.

5.3 Prioritizing Development Projects

Faced with a list of business processes, how does one choose a particular process to begin the first BPR project? This same question confronts IA designers, who have used methods such as Critical Success Factor (CSF) to prioritize the development of systems and subject data bases (Brancheau and Wetherbe 1986; McFadden and Hoffer 1991). We recommend a similar approach to the prioritization of BPR projects based on CSF in the context of corporate strategic objectives.

5.4 Establishing Process Performance Measures

A critical step in BPR is to understand and measure the process (Davenport and Short 1990). Hammer (1990, p. 108) emphasizes this point in stating the importance to "organize around outcome, not tasks." To ensure that the outcome of a process is successful, it is necessary to establish criteria for effectiveness. Further, we must also be concerned with the efficiency of the process to minimize the resources needed to produce the outcome. To address these important questions in BPR, the Ends/Means (E/M) Analysis method developed for IA design (Wetherbe and Davis 1983) may prove to be helpful. Grounded in general systems theory, E/M Analysis calls for the examination of two critical questions:

- One concerning *effectiveness*: What makes goods or services provided by this process *effective* to users or customers? What *information or measures* are needed to ensure that it is being effective at providing these goods or services?
- The other concerning *efficiency*: How do you define *efficiency* in providing goods or services by this process? What *information or measures* are needed to evaluate its efficiency?

It is important to realize that these questions are directed to the overall goals and objectives of the process rather than the current operating procedures. Applying these questions to a process forces the BPR analyst to design a process that can meet the efficiency and effectiveness requirements without being blinded by existing procedures or operations. We strongly recommend this IA method be considered as a BPR tool.

6. CONCLUSION

Business Process Redesign and Information Architecture have been recognized as high priority agenda items in organizations in the 1990s. This paper provides the premise for integrating these two critical issues. In a synergistic relationship, IA may not only facilitate BPR, but many IA methods and techniques may be applied to BPR. IA may provide a solid conceptual grounding for corporate and IS planners who in the past ventured into business reengineering only on a "leap of faith." Through IA, a solid base can be built in designing processes around stable entities.

Further research is recommended to validate the link between BPR and IA. It would be interesting to analyze the process and outcome differences between cases of reengineering that implemented enterprise-wide IA as a part of their BPR strategy and those that did not. Another pertinent issue that needs to be addressed is the differences in scope of reengineering efforts as well as the scope of IA design to complement the BPR task. The appropriateness of application of IA methodologies to facilitate BPR is another area that needs to be addressed.

If BPR proves to be the paradigm for organizational change that will maintain an organization's flexibility and competitiveness in the 1990s, it is incumbent that the best approaches be applied. IA offers powerful and proven techniques and methods for analyzing business processes. We believe the incorporation of these methods and techniques in BPR warrants further attention and research.

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