Business Process Change: A Study of Methodologies, Techniques, and Tools*

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Abstract

Growth in Business Process Reengineering (BPR) consulting services has led to a proliferation of methods for conducting BPR. Sifting through vendor promotional hype and identifying a set of techniques and tools that best meets a particular projectÆs needs can be a daunting task. This article investigates BPR Methods, Techniques, and Tools (MTTs) and places them within an empirically derived reference framework. A comprehensive picture of BPR emerges that includes MTTs that help in reengineering strategy, people, management, structure, and technology dimensions of business processes. A BPR planning approach for customizing this framework based on unique project characteristics is then offered to assist in selecting those BPR project activities and techniques to be emphasized. This flexible framework and comprehensive survey of commonly used BPR techniques and tools forms a knowledge base to improve business process change practice and provides a basis for future BPR research.

Keywords: Business process redesign; reengineering; methodology; techniques; organizational process change; impact and socio-technical systems design; IS career development; software tools; qualitative and quantitative methods; strategy; quality

ISRL Categories: AI0102, DA01, DA06, DA08, EE0201, EH0208, FB03, FC07, FD08

Introduction

Over the past decade, firms have faced unprecedented change: globalization, political realignments, and the rapid advance of information technology. Against this backdrop the concept of Business Process Reengineering (BPR) quickly caught the imagination of corporate leaders. Early success stories pushed IS executives to take an active role in BPR projects. Fueled by the continuing demand for corporate transformation, there has been a flood of BPR consultants and a proliferation of methodologies, techniques, and tools (MTTs) for conducting business process change projects. Faced with this onslaught, BPR project planners are often confused as to which methods are best suited for the project at hand (Ives 1994). Adding to this

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confusion is a lack of consensus on what precisely makes up a prototypical BPR project.

Early consultants prescribed BPR "principles" that demanded *radical* change. For example, Hammer (1990) strongly advocated process "obliteration." His guiding concepts demanded strong top-down leadership, information technology (IT) enablement, parallel processing, and employee empowerment (Hammer and Champy 1993). With time, the "absoluteness" of these BPR principles was dispelled as "myth" (Davenport and Stoddard 1994) and alternative paths to business process change suggested. For example, Stoddard and Jarvenpaa (1995) found that Hammer-like "clean slate" BPR was not typically practiced. They indicate that BPR projects frequently attempt "revolutionary" (radical) change but because of political, organizational and resource constraints, take on "evolutionary" (incremental) implementations. Rather than following universal principles, it was found that consultants tend to tailor their BPR efforts to satisfy unique situational conditions faced by their clients. Research also indicates that inhouse BPR teams often modify their existing Total Quality Management (TQM) methods to accommodate more proactive business process change (Harkness, et al. 1996). With almost a decade of BPR practice, the area continues to evolve with more emphasis being placed on strategic linkage, smaller projects, fast-cycle methods, and active "bottom-up" participation (Davenport 1995). While this evolution adds new techniques and tools to the BPR arsenal, it has not, thus far, provided a BPR project planner with a universal method.

Rather than a "quick fix," BPR is increasingly recognized as a form of *organizational change* characterized by strategic transformation of interrelated organizational subsystems producing varied levels of impact. The unique contribution of BPR over past organizational change approaches is its primary focus on the *business process.* A *process* is "a lateral or horizontal organizational form, that encapsulates the interdependence of tasks, roles, people, departments and functions required to provide a customer with a product or service" (Earl 1994, p.13). As depicted in Figure 1, process change is portrayed as strategy driven based on an assessment of competitiveness factors (Kettinger and Grover 1995). BPR projects typically include attempts to transform the organizational subsystems of management (style, values, measures), people (jobs, skills, culture), information technology, and organizational structures, including team and coordination mechanisms. Changes to these subsystems are viewed through the analytic lens of the business process (intrafunctional, cross-functional, interorganizational). The goal of process transformation is improved process products and services measured in terms of cost, quality, customer satisfaction, or shareholder value.

Such an organizational change perspective recognizes that BPR is not a monolithic concept but rather a continuum of approaches to process change. And, while there is some commonality in how firms approach reengineering, BPR projects differ in the magnitude of planned change. Varying project characteristics call for differing methodological choices and emphasis of different techniques. To assist BPR project planners, the primary objective of this article is to empirically derive a BPR planning framework outlining the stages and activity of a BPR project archetype. This framework provides a point of comparison upon which contingent project approaches can be planned. Commonly used BPR techniques and tools are then mapped to this framework. Next, project characteristics that influence alternative configurations of this BPR project framework are identified. This discussion is followed with guidelines for selecting appropriate techniques. Finally, implications for practice, education, and research are drawn.

Methodologies, Techniques, and Tools: A Foundation for a BPR Project Framework

Like most new managerial innovations, reengineering experienced an initial period of chaotic "trial and error," with a lack of accepted methods. Once a critical mass of BPR projects was recognized, consultants quickly moved to fill this void, touting "proven" methods. However,

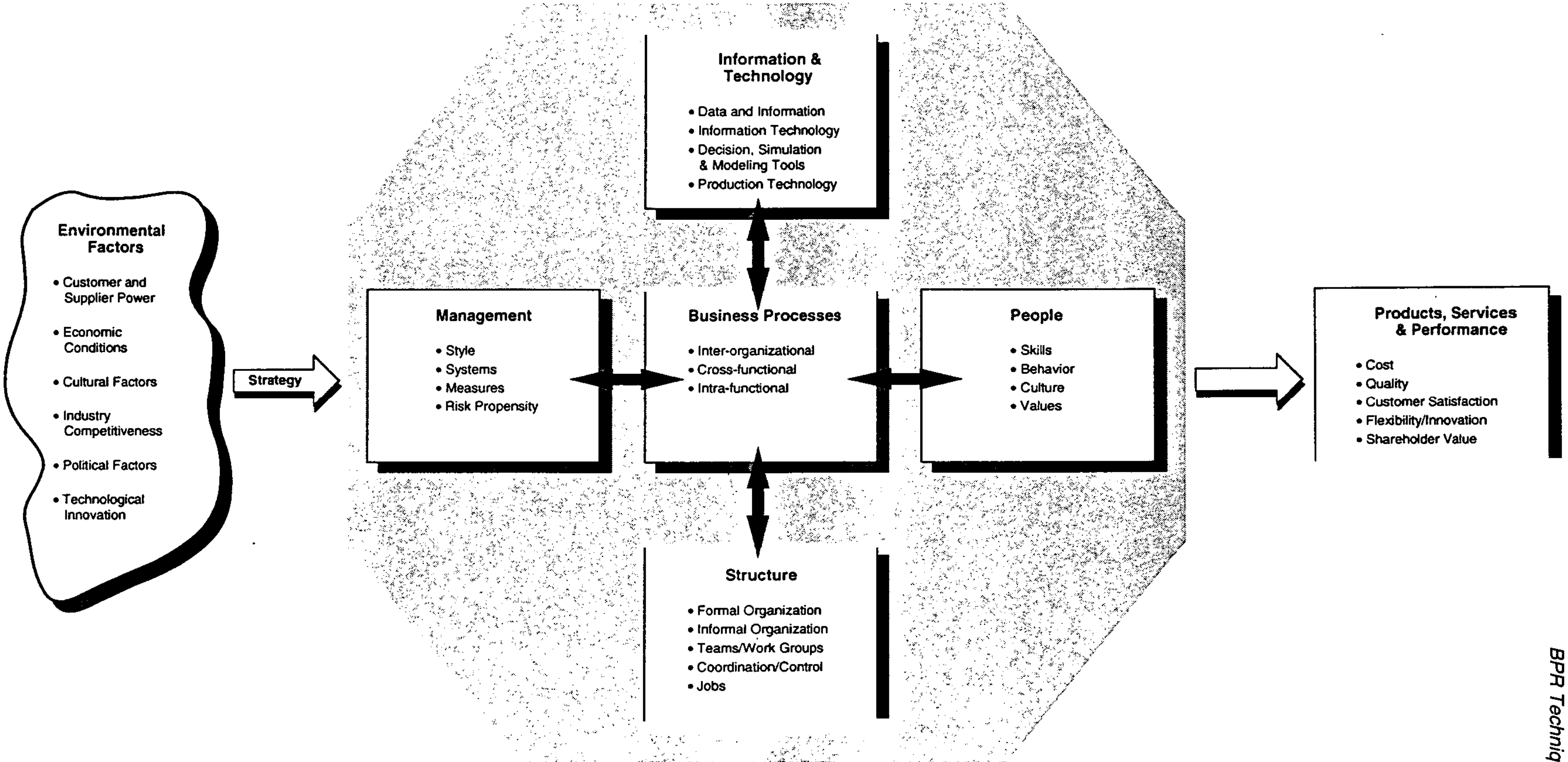


Figure 1. Business Process Change Model

(Adapted from Kettinger and Grover 1995) even given the plethora of BPR consulting services now available, there has not been a study placing these methodologies, techniques, and tools (MTTs) into a classification framework permitting project planners to assess the "fit" between their unique organizational problem situations and available MTTs. This study provides such a comprehensive and impartial survey by classifying BPR in terms of a method, techniques and tools scheme.

Methodologies represent the highest level of abstraction for conceptualizing problem-solving methods. In this study, **methodology** is defined as *a collection of problem-solving methods governed by a set of principles and a common philosophy for solving targeted problems* (Checkland 1981). At the next level of abstraction, a technique is commonly understood to be a procedure or a set of specific steps for accomplishing a desired outcome (Hackathorn and Karimi 1988). The term **technique** is defined in this study as *a set of precisely described procedures for achieving a standard task.* At the lowest, most concrete level of our classification of development methods is a tool, which typically refers to instruments or certain tangible aids in performing a task (Hackathorn and Karimi 1988). In this study, **tool** is defined as *a computer software package to support one or more techniques* (Palvia and Nosek 1993).

To illustrate the three levels of abstraction of MTTs, consider the BPR methodology developed by Gateway, a consulting firm (Klein 1994). The Gateway methodology consists of six stages: Preparation, Identification, Vision, Solution: technical design, Solution: social design, and Transformation. Within each stage, there are many specific activities. As a part of the Vision stage, for instance, one of the activities is "identify value-adding activities." To accomplish this activity effectively, a technique called activity-based costing (ABC) (Tunney and Reeve 1992) can be used, and a software tool available to perform this technique is *Easy ABC-Plus* by Cost Technology Inc.

Research Approach

In this study, seven research steps were followed based on case- and field-study approaches suggested by Eisenhardt (1989). Figures, tables, and appendices associated with each research step are also listed in Table 1. A series of semistructured interviews with BPR experts and vendors were conducted to gain a systematic understanding of BPR MTTs. Interview notes were compiled to develop a database of summarized descriptions for each methodology, technique, and tool. Based on the descriptions of 25 BPR methodologies, a composite Stage-Activity (S-A) framework for reengineering (see Figure 2) was derived in Step 5 using an inductive process of pattern identification. The reliability of this framework was next examined (see Appendix 3). A further validation check was conducted at a number of actual reengineering field sites. In Step 7, the list of techniques compiled in Step 4 were mapped to the stages and activities in the framework (see Table 3). Similar mapping was accomplished for the tools (see Appendix 5). The result is a hierarchical MTT map that relates techniques to the BPR project stages and activities, and BPR software tools to techniques (see Appendix 6). A detailed description of the research methods can be found in the "MISQ Archivist."[1]

The BPR Project Stage-Activity Framework

In deriving the BPR project S-A framework, methodologies practiced by leading reengineering consulting firms, such as Gemini Consulting, Ernst & Young, ISS, DMR Group, Andersen Consulting, Nolan & Norton Inc., CSC/Index, McKinsey Co., D. Appleton Co. and Price Waterhouse were surveyed. These consulting houses make use of proprietary BPR methods embodying their own philosophical assumptions, and their consultants tailor their methods to fit clients' unique needs. It was also determined that many of the tools and technology vendors provide BPR services that are based on proprietary methodologies.

Table 1. Outline of Research Steps

	Research Step	Exhibits
Step 1	Literature review of BPR methodologies, techniques, and tools (MTT).	Appendix 1: Detailed description of the research methodology [see web address on p. 77]
Step 2	Collect service and product information from MTT consultants and vendors.	Appendix 2: Sources of research data [see web]
Step 3	Conduct semistructured onsite and telephone interviews of selected MTT consultants and vendors.	Appendix 1: Detailed description of the research methodology [see web]
Step 4	Establish research databases of reengineering MTTs for subsequent analysis.	Table 2: Representative surveyed methodologies Appendix 4: BPR techniques description and mapping [see web] Appendix 5: BPR tools description and mapping [see web]
Step 5	Analyze compiled methodologies and derive a composite BPR project planning framework	Figure 2: A state-activity framework for business process reengineering
Step 6	Examine reliability and validity of the S-A framework.	Appendix 3: Mapping and reliability of stages to BPR methodologies [see web]
Step 7	Map techniques and tools to the S-A framework.	Table 3: Mapping of techniques to stages and activities Appendix 6: Hierarchical mapping of techniques and tools to the stage-activity framework [see web]

Typical of the 25 BPR methodologies retained in the final study sample, Table 2 outlines a summarized description of three in terms of the stages and activities included.

Following a step-by-step inductive procedure as discussed in Appendix 1, a six-stage, 21-activity, composite S-A framework for BPR, as shown in Figure 2, was derived. Each stage in this framework was subdivided into major activities. For depiction purposes each activity has been coded as SiAj, where: Si= Stage number i; and, Aj= Activity j for Stage i. To further test the reliability of the S-A framework, a Q-sort was performed by a panel of judges who also categorized the stages and activities of the 25 methodologies. Results indicate a high degree of interjudge agreement, with reliability levels exceeding .80 for 130 among a total of 134 stages sorted (see Appendix 3). Validity checking at three actual BPR case sites also supported the composite S-A framework.

The six stages can be categorized as containing the following activities:

Envision (S_1)—This stage typically involves a BPR project champion engendering the support of top management. A task force, including senior executives and individuals knowledgeable about a firm's processes, is authorized to target a business process for improvement based on a review of business strategy and IT opportunities in the hope of improving the firmÆs overall performance.

Initiate (S_2)—This stage encompasses the assignment of a reengineering project team, setting of performance goals, project planning, and stakeholder/employee notification and "buy-in." This is frequently achieved by developing a business case for reengineering via

Table 2. Representative-Surveyed Methodologies, Stages, and Activities

Methodology Source	Stages and Activities				
International Systems & Services (ISS)	**Identify/ Categorize Targets**	**Assess Business Process**	**Design Business Process**	**Implement Business Process**	**Monitor Business Process**
	•Project scope •Review business strategy •CSFs and metrics •Preliminary evaluation of current business •Identify candidate process	•Analyze current business processes and quantify •Benchmark current processes •Define improvement objectives •Identify alternative solutions •Perform "what-if" analyses and determine preferred solutions •Analyze costs/benefits/risks	•Design new processes •Identify procedural requirements •Analyze technical alternatives •Define infrastructure requirements •Prototype restructured processes •Confirm performance objectives •Assess feasibility and impact •Develop implementation plan	•Establish control group •Develop procedures •Implement infrastructure changes •Develop IT applications •Roll out restructured processes	•Monitor and evaluate performance •Assess cost/benefit/ risk results •Conduct an audit of recently converted business processes •Institute a continuous improvement program
Texas Instrument	**Customer Engagement**	**Process Understanding**	**New Process Design**	**Process Change**	
	•Identify sponsor •Develop vision •Scope project •Create schedule & resources	•Form BPR team •Create high-level model •Identify critical processes •Identify redesign candidates	•Redesign process •Check for completeness •Develop prototype •Create technology, infrastructure, job-change plan	•Implement pilot •Fan-out business •Fine tune processes •Create improvement report	
Wang BPM 2000	**Define Business Goals**	**Analyze the Business Process**	**Redesign the Process**	**Implement the New Process**	**Measure the New Process**
	•Review customer objectives •Assess business conditions •Perform high-level process analysis •Evaluate technical environment •Define operational constraints •Document operating rules •Compare to industry and process standards	•Identify each job within each work unit •Analyze each process at the task level •Break down labor to the step level •Identify business information with labor/process •Break down business information into data elements •Break down products/ services into inputs/ outputs •Compare the baseline against "market leaders" goals •Identify changes required at the step level to meet goals •Establish an intervention matrix for people, process, and systems	•Simplify business rules by task and function •Create a new process model from the baseline •Transpose labor into the new process model •Identify non-technical interventions and procedural changes •Prototype the process and the supporting IS •Create a detailed design of the systems functions	•Inventory inputs/outputs and data elements to create a data model •Document data/procedural work flows •Document screen/report layouts •Produce database design specifications •Code and test programs •Document procedures, systems, and applications •Perform process and systems integration testing •Perform administrative and user training •Phase implementation of process and supporting systems •Manage production processing	•Perform variance and analysis from automated work mea-surement system •Review cost scheduling to objectives •Dynamically manage the work process to facilitate refinements to the new business process •Verify product cost schedules •Refine transaction cost analysis

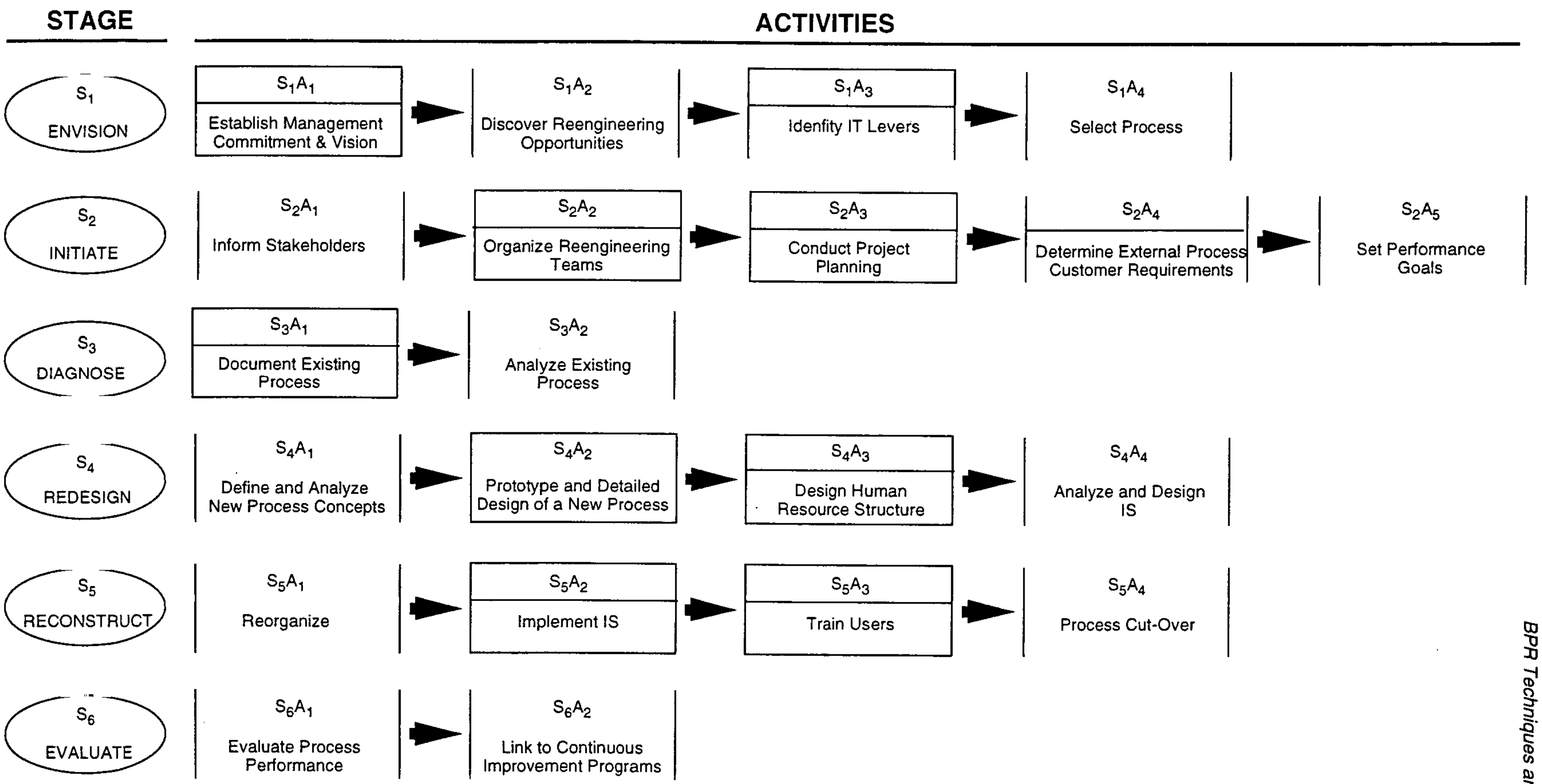


Figure 2. A Stage-Activity Framework for Business Process Reengineering

bench-marking, identifying external customer needs, and cost benefit analysis.

Diagnose (S_3)—This stage is classified as the documentation of the current process and subprocesses in terms of process attributes such as activities, resources, communication, roles, IT, and cost. In identifying process requirements and assigning customers value, root causes for problems are surfaced, and non-value-adding activities are identified.

Redesign (S_4)—In the redesign stage a new process design is developed. This is accomplished by devising process design alternatives through brainstorming and creativity techniques. The new design should meet strategic objectives and fit with the human resource and IT architectures. Documentation and prototyping of the new process is typically conducted, and a design of new information systems to support the new process is completed.

Reconstruct (S_5)—This stage relies heavily on change management techniques to ensure smooth migration to new process responsibilities and human resource roles. During this stage, the IT platform and systems are implemented, and the users go through training and transition.

Evaluate (S_6)—The last stage of a BPR methodology requires monitoring of the new process to determine if it met its goals and often involves linkage to a firm's total quality programs.

It was found that, while BPR methodologies may vary based on philosophical differences, there is enough commonality among the practiced approaches to generally describe a prototypical BPR effort. In fact, in a majority of cases (19 out of 25) the original sequencing of stages within the methodologies before mapping (indicated by alphabets in front of the stage names in Appendix 3) is consistent with that of the BPR project S-A framework.

The key activities of the BPR project S-A framework correspond closely to the various subsystems of the Business Process Change Model, as outlined in Figure 1. Surveyed methodologies tend to be strategy driven, with top management interpreting environmental and competitive factors. Most methodologies attempt to challenge existing assumptions concerning organizational systems. They generally recognize resistance to change and attempt to minimize this through an assessment of cultural readiness and through activities to establish project buy-in. Methodologies generally focus on cross-functional and interorganizational processes. They take the customer view and leverage IT's coordination and processing capabilities. Methods include activities that empower individuals and teams and accommodate measurement of performance gains particularly as they relate to customer satisfaction and profitability. In summary, the BPR project S-A framework portrays the essence of a BPR project as a set of coordinated efforts to modify various organizational subsystems through business process change. Practitioners may use the derived framework as a starting point in understanding "ingredients" descriptive of BPR and as a basis for evaluating alternatives to project approaches.

Survey of BPR Techniques and Tools

Survey and interview results indicate that at least 72 techniques are used to accomplish activities associated with BPR projects. Analysis of the surveyed BPR techniques show that consultants and vendors are using techniques developed in other problem-solving contexts and applying them to BPR. For example, adapted techniques include: quality function deployment, (for customer requirements determination); process modeling techniques (e.g., IDEF, role activity diagramming); simulation; rules specification and database design techniques (Appleton 1995); and process measurement techniques (e.g., customer value analysis (Kanevsky and Housel 1995)). From the Japanese quality movement, BPR has benefited from techniques for well-defined processes (e.g., seven quality control tools) as well as techniques to represent concepts (e.g., seven management and planning tools (Mizuno 1988)). Augmenting these techniques are a set of employee practices regarding individual and team work design (e.g., Hackman and Oldham 1979) and levels of participation in decisionmaking (Pava 1983). In this regard, BPR overlaps with socio-technical design (Cherns 1976) and its later derivations such as soft systems methodology (Checkland 1981) and promotes the understanding the total work system's technical and social boundaries by employing analysis of social systems boundaries, values, formal and informal information flows, and employees' skill levels.

BPR tool vendors were also surveyed, and a set of 102 tools were compiled. Analysis shows few tools for conducting front-end BPR activities including process planning, competitive analysis, and creative thinking. A lack of tools also exists in the tasks of capturing process communication channels. Given the high participation of non-technical personnel on BPR teams, there is a need for more user-friendly and "media-rich" process capture and simulation packages allowing team members easy visualization and participation in process modeling. Needed multimedia-based tools may prove particularly beneficial in prototyping, accelerating process conceptualization, and avoiding time-consuming trial and error. Several vendors provide integrated BPR tool sets that span most of a BPR project's life cycle. BPR tool sets with a repository typically provide graphic interfaces, menus, templates, and data indexing to facilitate collective knowledge sharing and directly translate process requirements into information requirements. In sumary, the tools survey indicates that an expanding suite of tools are being used to provide structure and information management capability in conducting BPR techniques and possess the potential to accelerate BPR projects.

Mapping of BPR Techniques and Tools to the S-A Framework

Given page limitations, it is not possible to discuss in detail all the BPR techniques and tools identified. A complete description of the 72 techniques and 102 tools can be found in the "MISQ Archivist," as mentioned previously. (see "BPR Techniques Description and Mapping," Appendix 4 and "BPR Tools Description," Appendix - 5). Based on the analysis of how the surveyed techniques are used in BPR projects, each BPR technique was mapped to the derived BPR S-A framework, as listed in Table 3. Figure 3 illustrates a sample of prominent techniques from each stage of the S-A framework to demonstrate how techniques and tools are employed in conducting BPR.

An assessment of each BPR tool was also made to determine how they implement various problem-solving techniques. Based on this analysis, tools were mapped to techniques. This provided a completed hierarchy relating techniques to BPR project activities, and BPR tools to techniques. A complete listing of these relationships can be seen in Appendix 6.

Representative techniques used in the envision stage

Search conference, used in the envision stage to establish commitment (S1A1), brings stakeholders together to participate in defining both the need for change and how changes should be achieved (Pasmore 1994). All levels and functions related to a process are typically represented including customers, shareholders, and suppliers. The power of the search conference is that it brings together an array of resources in an active, real time dialogue in one location where understanding is sought by "seeing the big picture," and commitment to change is nurtured by active participation.

The IT/process analysis technique is used to match IT capabilities to a candidate's process requirements (S1A3). Guidelines for conducting this analysis, which are based on the work of Davenport and Short (1990), are provided in Appendix 7. Employing this technique, candidate processes are classified into different types based on dimensions of entities (interorganizational, interfunctional, or interpersonal), objects (physical or informational), and activi-

Table 3. Mapping of Techniques to Stages and Activities

Stage 1: ENVISION		
Establish Management Commitment & Vision—S_1A_1		
• Fast Cycle Full Participation Change Methods	• Search Conference	• Visioning
	• Persuasion Technique	
Discover Reengineering Opportunities—S_1A_2		
• Assumption Surfacing	• Core Process Analysis	• Force Field Analysis
• Brainstorming	• Critical Success Factors	• Nominal Group Technique
• Business Systems Planning	• Cultural Assessment Analysis	• Out-of-the-Box Thinking
• Competitive Analysis	• Delphi Technique	• Value-Chain Analysis
Identify IT Levers—S_1A_1		
• Brainstorming	• Business Systems Planning	• Information Technology Analysis
Select Process—S_1S_4		
• Analytical Hierarchy Process	• Critical Success Factors	• Process Prioritization Matrix
• Cost/Benefit/Risk Analysis		
Stage 2: INITIATE		
Inform Stakeholders—S_2A_2		
• Fast Cycle Full Participation Change Method	• Persuasion Technique	• Search Conference
	• Reframing	
Organize Reengineering Teams—S_2A_2		
• Team-Building Techniques		
Conduct Project Planning—S_2A_3		
• Budgeting	• Project Scheduling Techniques	
Determine External Process Customer Requirements—S_2A_4		
• Benchmarking	• Quality Function Deployment	• Survey
• Focus Group	• Structured Interview	
Set Performance Goals—S_2A_5		
• Benchmarking	• Critical Success Factors	• 10X Technique
• Cost/Benefit/Risk Analysis	• Out-of-the-Box Thinking	
Stage 3: DIAGNOSE		
Document Existing Process—S_3A_1		
• Activity-Based Costing	• Hierarchical Colored Petri Nets	• Role Activity Diagramming
• Computer-Aided Software Engineering	• Information Control Net	• Speech Interaction Modeling
• Data Flow Diagramming	• $IDEF_{0,3}$	• Structured Interview
• Employee and Team Attitude Assessment	• Job Analysis	• Survey
	• Process Flowcharting	• Time Motion Study
Analyze Existing Process—S_3A_2		
• Activity-Based Costing	• Fishbone Analysis	• Pareto Diagramming
• Benchmarking	• Hierarchical Colored Petri Nets	• Quality Function Deployment
• Cognitive Mapping	• $IDEF_{0,3}$	• Statistical Process Control
• Computer-Aided Software Engineering	• Information Control Net	• Value Analysis
Stage 4: REDESIGN		
Define and Analyze New Process Concepts—S_4A_1		
• Affinity Diagramming	• Force Field Analysis	• Role Activity Digramming
• Assumption Surfacing	• Hierarchical Colored Petri Nets	• Simulation
• Brainstorming	• $IDEF_{0,3}$	• Socio-Tech System Design
• Cognitive Mapping	• $IDEF_2$	• Soft System Method
• Computer-Aided Software Engineering	• Job Design	• Speech Interaction Modeling
		• Visioning

Table 3. Continued

• Cost/Benefit/Risk Analysis • Data Flow Diagramming • Delphi Technique • Fast-Cycle Full Participation Change Method	• Nominal Group Technique • Out-of-the-Box Thinking • Process Flowcharting	• Workflow Design
Prototype and Detailed Design of a New Process—S_4A_2		
• Activity-Based Costing • Data Flow Diagramming • Hierarchical Colored Petri Nets	• $IDEF_{0,2,3}$ • Process Flowcharting • Simulation	• Role Playing
Design Human Resource Structure—S_4A_3		
• Brainstorming • Critical Incident Technique • Cultural Assessment Analysis • Employee and Team Attitude Assessment • Information Control Net	• Fast-Cycle Full Participation Change Method • Job Analysis • Job Design • Out-of-the-Box Thinking • Socio-Technical Design	• Skills Inventory Analysis • Soft System Method • Speech Interaction Modeling • Team-Based Organizational Design
Analyze and Design IS—S_4A_4		
• Computer-Aided Software Engineering • Database Design • Data Flow Diagramming • $IDEF_{1,1x,4,5,6}$	• Information Engineering • IS Prototyping • IS Systems Walkthrough • Joint Application Development/ Rapid Application Development	• Software Reengineering • Speech Interaction Modeling • Workflow Design
Stage 5: RECONSTRUCT		
Reorganize—S_5A_1		
• Assumption Surfacing • Benchmarking • Force Field Analysis	• Reframing • Role Playing • Skill Inventory Analysis	• Socio-Technical System Design • Team Building Techniques • Team-Based Organizational Design
Implement IS—S_5A_2		
• System Testing Techniques		
Train Users—S_5A_3		
• Behavioral Modeling Training Method • Exploratory Training Method	• Instruction-Based Training • Role Playing	
Process Cut-Over—S_5A_4		
• Conversion Techniques		
STAGE 6: EVALUATE		
Evaluate Process Performance—S_6A_1		
• Activity-Based Costing • Auditing • Employee and Team Attitude Assessment • Fishbone Analysis	• Focus Group • Pareto Diagramming • Quality Function Deployment • Statistical Process Control • Structured Interview	• Survey • Time Motion Study • Value Analysis
Link to Continuous Improvement Programs—S_6A_2		
• Total Quality Management Programs		

Envision Stage

Critical Success Factors*

Business Processes	C_1	C_2	C_3	C_4	C_5	C_6	Total
P_1		E		D			3
P_2			E		D	D	4
P_3	E	D		D		D	5
P_4				E			2
P_5			D				1
P_6		E	D		E	E	7
P_7	D	E		E		D	6
P_8	D		E	E			5

*E = Essential (2 points) D = Desirable (1 point)

Process/CSF Matrix

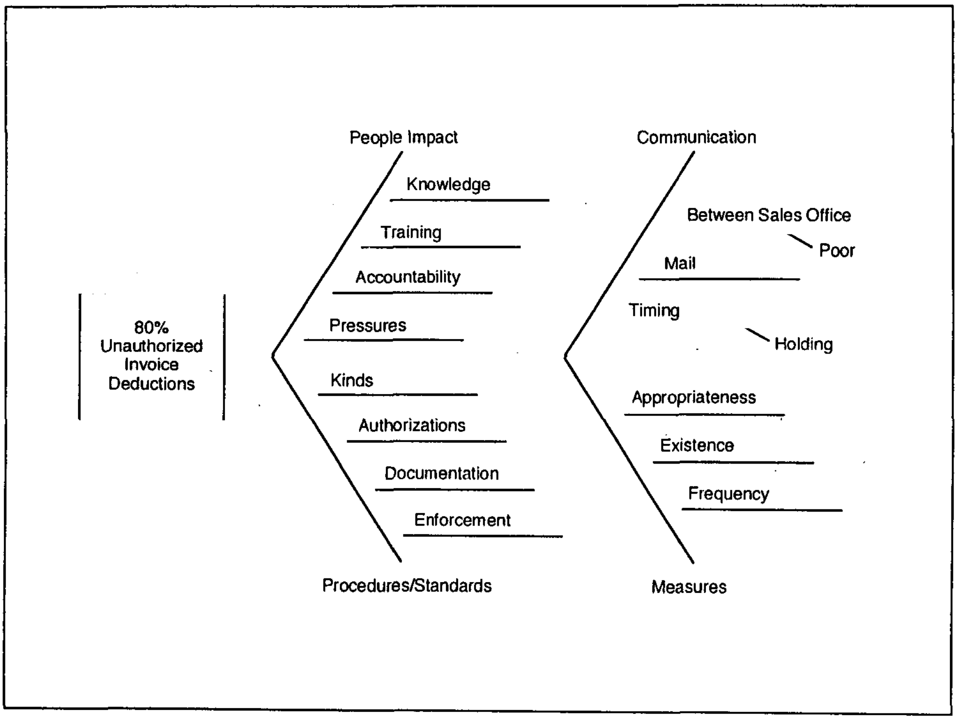
Initiate Stage

Classification/Division: 1st level deployment	2nd level deployment	3rd level deployment	4th level deployment	Degree of importance		Quality Characteristics – Service – Availability of goods (stock) classification: # incidents where availability classification not clear	Immediate response rate	Rate of missing books	Degree of satisfaction in availability	Degree of satisfaction in classification	Degree of filing books	Reception & response to customers: Degree of satisfaction of service	Waiting time at checkout counter	Rate of product knowledge	Evaluation of reception to customers
Demanded Quality Deployment: Fast	Information	Information for getting books	Can tell if book is in stock or not	-0.29	○	◎	◎		◎						
			Can tell why not in stock	0.60	◎	◎		◎							
			Can tell if book is available or not			○									
			Can give date of availability	0.01	○	○								○	
		Search	Can tell name of publisher, author, title											◎	○
			Can find related books	-0.18										◎	○
			Offer information on the contents & give advice											◎	○
			Information lists of published books available									○		○	

Quality Function Deployment

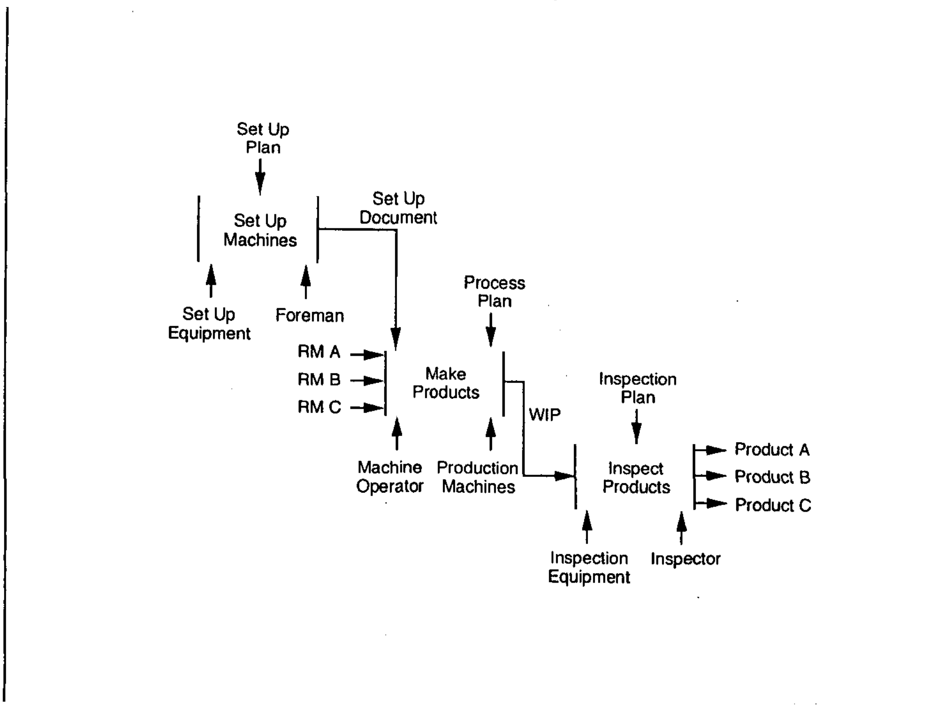
Figure 3. Representative Techniques for Each Stage

Diagnose Stage



Fishbone Diagram

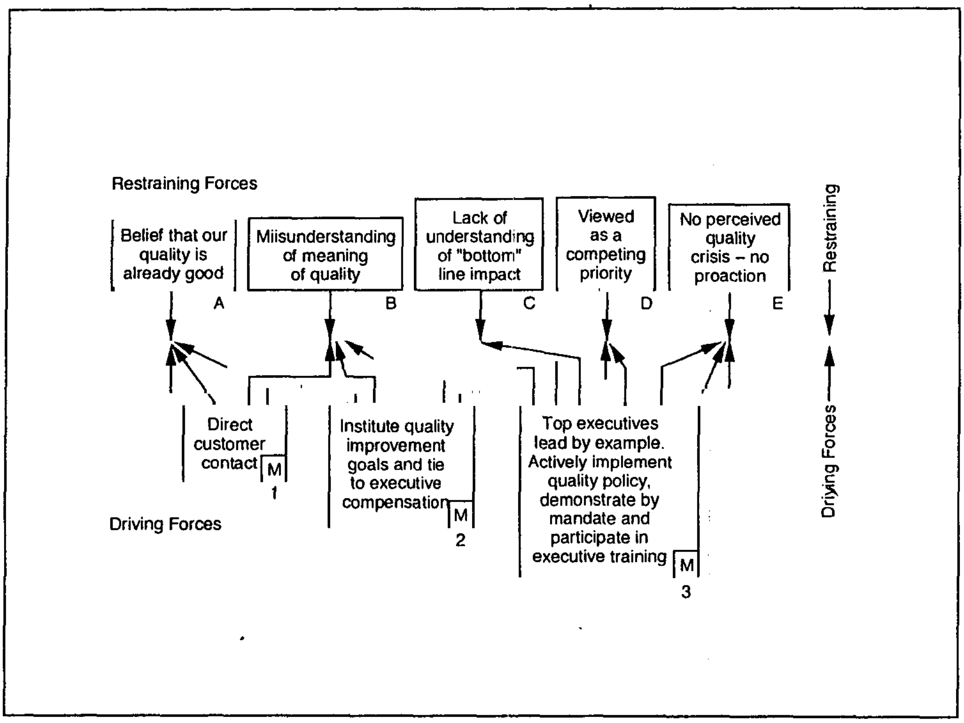
Redesign Stage



IDEF

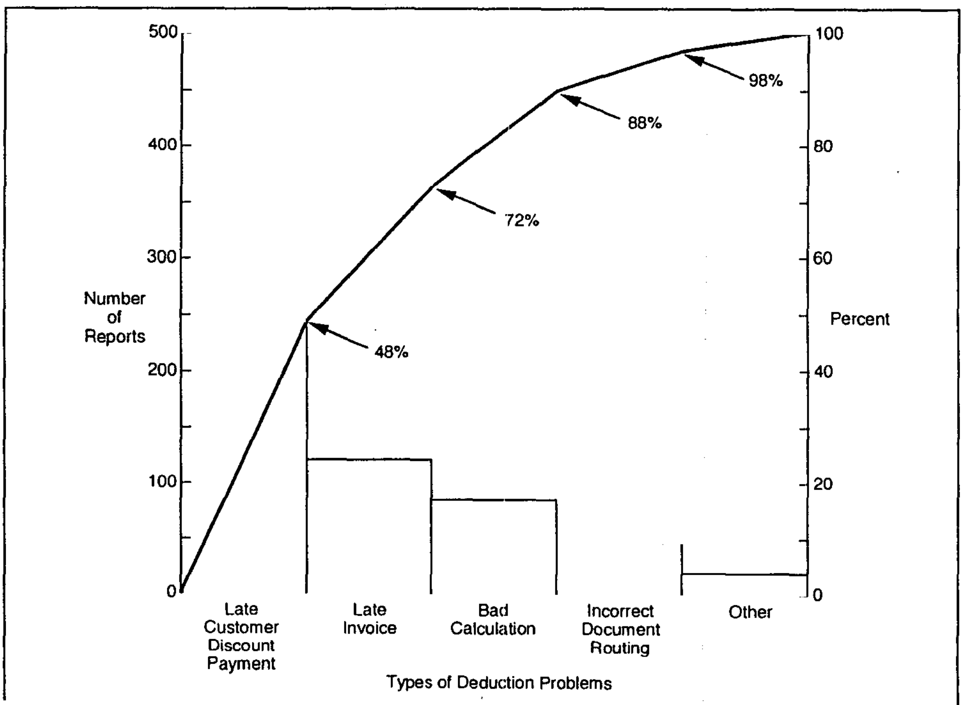
Figure 3. Continued

Reconstruct Stage



Force Field Analysis

Evaluate Stage



Pareto Diagram

Figure 3. Continued

ties (operational or managerial). Requirements associated with each process type are briefly described (e.g., allowing detailed tracking of a purchase order's status), and capabilities of available IT that meet these requirement are identified (e.g., workflow and imaging technologies that provide a detailed transaction trail).

The process prioritization matrix is used in process selection (S1A4) (Kettinger, et al. 1996). As shown in Figure 3, a matrix can be prepared after top executives establish a firm's critical success factors (CSF) and identify those processes that are essential (cells marked by the letter E) or desirable (cells marked by the letter D) to achieve the organization's CSFs. While selection criteria may differ by organization, one approach is to assign a value of 2 to "E" and a value of 1 to "D." The resulting row totals reflect the overall strategic relevance of the process to the various critical success factors, with highest row totals receiving top priority in project selection. Considered in conjunction with cost/risk factors, this analysis should lead to the final selection of a process to be reengineered.

Representative technique used in the initiate stage

Quality function deployment (QFD) structures translation of customer needs to process/product characteristics (see Figure 3). Team members prioritize a set of customer needs and relate them to process characteristics (S2A1) benchmarked on "world-class" processes (Akao 1990). The QFD approach contributes to BPR in three ways: (1) the "house of quality" is an effective way to identify those business subprocesses that are responsible for customer dissatisfaction; (2) QFD demands close collaboration between different functions involved in the same business process; (3) individual "houses" correspond to a subprocess in a larger business process, and the metrics and standards developed can be used as performance measures for these subprocesses and for bench-marking.

Representative techniques used in the diagnose stage

Process mapping techniques assists project teams in "documenting the existing processes" (S3A1). Consultants sometimes use simple depiction techniques such as process flowcharts or more structured techniques such as role activity diagramming (Huckvale and Ould 1995) and workflow modeling. Speech interaction modeling analyzes communication and information flows using the metaphor of speech-action (Scherr 1993; Winograd and Flores 1986). Instead of viewing coordination as information flow between tasks, it is defined by the language acts through which people coordinate. Workflow automation tools offered by several companies make use of this technique.

Fishbone analysis: Once a process is documented, identifying the problems and the root-causes (S3A2) is a prestep to redesign. Several root-cause analysis techniques such as pareto diagramming and fishbone analysis are employed to assess the pathologies within a process and determine which areas need to be improved. The fishbone technique (see Figure 3) represents the relationship between a given effect and its potential causes (AT&T 1989). Several consultants indicated that they use simple graphic packages to construct and display these cause/effect interactions among factors and problems affecting a process.

Representative techniques used in the redesign stage

Creativity techniques and IDEF: In the "define and analyze the new process concepts" activity (S4A1), creativity techniques such as brainstorming, "out-of-the-box" thinking, nominal group, and visioning are employed. In addition to capturing the existing process, the IDEF technique (see Figure 3) can also be used to model a new process design (S4A1). IDEF models contain task inputs and outputs, resources, and controls and their interrelationships. They also seek to provide a systematic family of techniques for capturing, simulating, and building processes (Mayer, et al. 1995).

Process simulation techniques: Once new process alternatives are documented, simulation allows dynamic modeling to assess process design options (S4A1) (van Meel, et al. 1995). In simulation, process variables such as cycle time, queuing times, inputs/outputs, and resources may be manipulated to provide quantitative analysis of process design scenarios in real-time. Simulation modules are being integrated with process capture tools and sold as a complete BPR tool sets. However, many of these tools require special design skills and operations management background.

Data modeling techniques are essential precursors to systems development, and they utilize the output of process mapping to provide the basis for the data architecture of the new process (S4A4). These techniques can be supported by tools ranging from the I-CASE that have data flow diagramming capabilities to IDEF tools that use the IDEF1X data modeling technique. CASE-based information engineering tools allow the systems analyst to model the data requirements of the redesigned process. Available tools facilitate reverse engineering of legacy code to new systems design specifications.

Representative techniques used in the reconstruct stage

Force field analysis (see Figure 3) assists the BPR team in identifying forces resisting the new process' implementation (S5A1). A number of communication-based "persuasion" techniques also have proven effective in supporting change management (Melone 1995). The lack of effective human resource techniques to assist changes in compensation, career paths, and work-role rotation, as a consequence of new designs, is a major constraint to BPR (Davenport 1993). While this area has received less interest by vendors, some tools to assist in these activities are beginning to emerge.

Representative techniques used in the evaluate stage

Activity-based costing (ABC) and pareto diagramming are techniques that allowed reengineering teams to assign process activities to cost centers and quantify process performance (S5A1). Survey results indicate that the ABC technique is incorporated into many of the integrated BPR tools. For mechanistic and structured processes, tools for monitoring process performance through statistical process control are available. Pareto diagrams (see Figure 3) are particularly valuable in graphically ordering problem causes from the most to least significant (AT&T 1989).

BPR Project Planning: Devising a Contingency Approach

The BPR project S-A framework provides project planners with a BPR methodological archetype. However, no two BPR projects are exactly alike. Because of the unique characteristics of the project and the amount of change sought in the organizational subsystems of the Business Process Change Model (Figure 1), the apportionment of effort dedicated to specific BPR project stages and activities should be adjusted to maximize effectiveness. Field study interviews of BPR experts indicate they consider four major project characteristics in BPR planning: (1) project radicalness, (2) process structuredness, (3) customer focus, and (4) the potential for IT enablement.

Most prominent among the four project characteristics, the degree of radicalness of change is crucial in customizing the S-A methodology framework. For instance, if radical reengineering strategy is adopted, the diagnose stage (S3) (see Figure 2), which involves documenting and analyzing the existing process (S3A1 and S3A2), requires less attention than activities such as designing the new process and the associated human resource architecture (S4A1 and S4A3). External customers have direct competitive significance to the firm, and processes interfacing with them warrant more intensive *customer focus* (Ives and Mason 1990). Therefore, those projects that directly involve external customers require increased emphasis on customer requirements determination. *Process structuredness* is important in adjusting the project S-A framework, since more structured processes can be more easily understood, analyzed, modeled, and redesigned (Earl 1994). The *extent of IT enablement* varies from project to project. Some projects require emerging technologies such as the Internet-based electronic commerce, imaging, workflow, and groupware, while others involve adaptation of existing IT such as shared databases and expert systems.

This section develops a contingency approach to BPR project planning based on these four project characteristics. As it is more difficult to determine project radicalness than other characteristics, a method for assessing this crucial characteristic is first presented. Next, an approach to customize the BPR project S-A methodology based on all four project characteristics is discussed. This is followed by recommendations for selecting techniques that are most applicable for a specific project.

Assessing project radicalness

To help BPR practitioners in this assessment, a "project radicalness planning worksheet" has been developed. As shown in Figure 4, a set of 11 contingency factors pertinent in BPR project planning are included. For each factor, a score between 1 and 5 may be assigned in reference to the descriptive anchors at the two poles. A lower score would pull the strategy toward the process improvement end of the continuum; a higher score, the radical reengineering end. A score of 3 would favor a moderate process redesign option, which represents the neutral point. For example, the first factor, strategic centrality, pertains to how important the targeted process is to the firm's strategic goals and objectives, ranging from tangential (1) to integral (5). To illustrate how the worksheet may be used, scoring is shown in Figure 4 for the planning of a reengineering project of a hypothetical customer service process.

If each factor is weighted equally, as illustrated by the example shown in Figure 4, the average score for the 11 factors (3.36 in this case) may be used as a basic indicator of the advisability for radical process change. If the decision maker judges some criteria as more significant than others, unequal weights may be used. As indicated at the bottom of the worksheet, the basic advisability index should be filtered by the decision makers' risk-taking propensity. Similar to past portfolio approaches (McFarlan 1981), this risk-taking index, which was rated from 1 (risk averse) to 5 (risk taking), can be used to modify the basic index through an averaging procedure. This would push up or pull down the basic index depending on whether the risk-taking index is higher than, the same as, or lower than the basic index. In this case example involving a customer service process, the risk-taking index is 4, which is higher than the basic index of 3.36, yielding a final strategy index of 3.68. This suggests a project strategy involving substantial change to the existing process, but not so radical as to start a completely new design from a clean slate.

Though derived from the field, each of the 11 contingency factors can be related to the subsystems in the Business Process Change (BPC) Model (Figure 1) indicating the underlying conceptual basis for process change. For example, the first factor, strategic centrality, is related to the strategy component of the BPC model. If the process is integral to the firm's strategy, then breakthrough performance gains from radical reengineering might be required to support desired strategic objectives. Other factors relate to the various process change components as follows: environmental factors (value chain target), management factors (senior management commitment, performance measurement criteria, project resource availability, and management's willingness to impact people), business process factors (process breadth, process functionality), information and technology factors (feasibility of IT to change process), structure factors (structural flexibility), and people factors (cultural

Factor	Question	Process Improvement	Process Redesign	Radical Reengineering
Strategic centrality	Is the targeted process merely tangential (1) or integral (5) to the firm's strategic goals and objectives?	1 — 2 Tangential	3	**4** 5 Integral
Feasibility of IT to change process	Does IT enable only incidental change (1) or fundamental process change (5)?	1 — 2 Incidental	3	**4** 5 Fundamental
Process breadth	Is the scope of the process intra-functional (1) or interorganizational (5)?	1 — 2 Intra-functional	3	**4** 5 Inter-organizational
Senior management commitment	Is the senior management visibly removed (1) or actively involved (5) in the BPR efforts?	1 — 2 Removed	3	4 **5** Involved
Performance measurement criteria	Are the preferred performance measurement criteria effiency based (1) or effectiveness based (5)?	1 — 2 Efficiency Based	**3**	4 5 Effectiveness Based
Process functionality	Is the process functioning marginally (1) or is the process not functioning well at all (5)?	1 — 2 Higher Functionality	3	**4** 5 Lower Functionality
Project resource availability	Are only minimal resources (1) available to support the process change or are resources abundant (5)?	1 — 2 Scarce	3	**4** 5 Abundant
Structural flexibility	Is the organizational structure rigid (1) or is it flexibly conducive (5) to change and learning?	1 — **2** Rigid	3	4 — 5 Flexible
Cultural capacity for change	Does the culture support the status quo (1) or actively seek participatory change (5)?	1 — **2** Status Quo	3	4 — 5 Adaptable
Management's willingness to impact people	Are only modest impacts on people tolerable (1) or is management willing to deal with the consequences of disruptive impacts (5)?	1 — **2** Modest	3	4 — 5 Disruptive
Value chain target	Is the BPR effort targeted at an internal support process (1) or a core process (5)?	1 — 2 Support	**3**	4 — 5 Core
Propensity for Risk		1 2 Very Risk Averse	3	**4** 5 High Risk Taking

Process Change Strategy= (Avg. Score of Contingency Factors + Risk Propensity)/2 = (3.36 +4)/2 = 3.68 → (Substantial Process Redesign '+')

Figure 4. Project Radicalness Planning Worksheet

capacity for change and management's willingness to impact people). Thus, project radicalness, a major consideration in customizing the BPR S-A methodology, is rooted in the various components of business process change.

Customizing the S-A methodology

Once project radicalness has been determined, it should be assessed along with the three other critical project characteristics (process structuredness, customer focus, and IT enablement) to customizing a methodology for the project at hand. The objective is to identify stages and activities (see Figure 2) to be emphasized in response to the following four questions:

1. **How radical is the project?** If radicalness is *high,* emphasize activities aimed at change management and new process formulation including:

   - Establish management commitment and vision (S_1A_1)
   - Inform stakeholders (S_2A_1)
   - Define and analyze new process concepts (S_4A_1)
   - Prototype and detailed design of a new process (S_4A_2)
   - Design human resource structure (S_4A_3)
   - Reorganize (S_5A_1)

   If radicalness is *low,* emphasize those activities that are important to incremental improvements of existing processes:

   - Document existing processes (S_3A_1)
   - Analyze existing processes (S_3A_2)

2. **How structured is the process?** The more a process is structured, the greater the emphasis should be placed on the following activities in process capture and modeling:

   - For projects higher in radicalness
     - Define and analyze new process design (S_4A_1)
     - Prototype and detailed design of a new process (S_4A_2)
   - For projects lower in radicalness
     - Document existing process (S_3A_1)
     - Analyze existing process (S_3A_2)

3. **Does the process have high customer focus?** If so, emphasize activities that determine external process customer requirements (S_2A_4).

4. **Does the process require high levels of IT enablement?** If so, emphasize activities that are devoted to developing IT enablers for the process change:

   - Analysis and design of IS (S_4A_4)
   - Implement IS (S_5A_2)

In the case of the customer service process example introduced earlier in the project radicalness planning worksheet (Figure 4), answers to the four questions might be: the project is moderately radical, and the process is substantially structured, has very high customer focus and requires high IT enablement. Other BPR project activities (e.g., discovering reengineering opportunities, organizing the reengineering team, and evaluating process performance) are not particularly effected by varying project characteristics and in this example, as in all projects, should receive constant attention.

Selecting reengineering techniques

A serious problem for conventional BPR methods is the cycle time for delivering results, with even the most aggressive projects typically requiring six months to reach new designs and over a year to implement (Davenport 1995). As in the example outlined above, BPR project planners can gain efficiency by customizing their methodology and selectively emphasizing pertinent project activities. Once a customized methodology has been determined, a second important project planning decision must be made in choosing between the many techniques available to support the emphasized project activities.

To develop a basis for techniques selection, techniques are grouped in terms of the reasoning process and the object of their application. Eleven categories of BPR techniques were identified by the researchers through an iterative process of literature research, classification, and Q-sort. These categories can be used as a "primary index" (with the activity each supports being the basis for a "secondary index") in understanding and learning reengineering techniques. For example, the "creative thinking" category contains techniques such as brainstorming, nominal group technique, out-of-the-box thinking, and force field analysis, all of which encourage unrestrained development of ideas aimed at identifying alternatives in problem formulation and problem solving. Many techniques belong to a single category, while others are assigned to more than one category. These categories and typical techniques are listed below and illustrate each category's objectives. A full listing of technique groupings is available in Appendix 8.

1. Project management: budgeting, project scheduling (PERT, CPM, Gantt), etc.

2. Problem solving and diagnosis: fishbone diagramming, pareto diagramming, cognitive mapping, etc.

3. Customer requirement analysis: QFD, benchmarking, focus group, etc.

4. Process capture and modeling: process flowcharting, IDEF, role activity diagramming, speech interaction modeling, etc.

5. Process measurement: activity-based costing, statistical process control, time motion study, etc.

6. Process prototyping and simulation: hierarchical colored petri net, role playing, simulation techniques, etc.

7. IS systems analysis and design: software reengineering, CASE, JAD/RAD, etc.

8. Business planning: critical success factors, value chain analysis, core process analysis, etc.

9. Creative thinking: visioning, out-of-box-thinking, affinity diagramming, Delphi method, etc.

10. Organizational analysis and design: employee and team attitude opinion assessment, job design, team building techniques, etc.

11. Change management: search conference, assumption surfacing, persuasion techniques, etc.

As outlined in Table 4, contingent upon the project characteristics, some categories of techniques are more applicable than others for a unique project. For example, the importance of customer requirement analysis techniques are grater when a project is more customer focused. The radicalness of the project, as indicated in the last row of the Table 4, has significant implications for the applicability of a number of important technique categories. For example, more radical projects typically have greater strategic ramifications for the firm in terms of performance breakthrough and should be consistent with the firm's business strategy (Mitchell and Zmud 1995). Application of planning techniques such as critical success factors and value chain analysis would help to ensure such prodigious undertakings. Creative thinking techniques also become more important in radical projects because unconventional approaches to business processes are often needed to achieve dramatic performance gains. Recent research findings reveal that the success of radical BPR projects are highly dependent on effective change management (Grover, et al. 1995). This places particular pressure on BPR project planners to effectively integrate techniques for organizational design and change into their customized

Table 4. BPR Techniques Applicability Guide

Project Characteristics	Applicability	Technique Category
All projects	.... require .... need	project management. problem solving and diagnosis.
The more customer focused	.... the more important is	customer requirements analysis.
The more structured the process	.... the more useful is .... the more feasible is .... the more applicable is	process capture and modeling. process prototyping and simulation. process measurement.
The more IT enables process change	.... the more relevant is	IS systems analysis and design.
The more radical the project	.... the greater the reliance on .... the higher the demand for .... the more essential the .... the greater the criticality of	business planning. creative thinking. organizational analysis & design. change management.

approaches. Techniques for project management and problem solving & diagnosis are essential for basic problem analysis regardless of the project characteristics.

Implications of the Study

The study has generated results with significant implications for practice, education, and research.

Implications for practice

For practice, this study provides these observations:

Planning can be greatly facilitated by developing a customized BPR project S-A methodology and selecting techniques that fit the unique characteristics of the project. Guidelines presented in this article may be used by practitioners in devising a contingency approach to planning process change projects. Understanding the appropriate emphasis to be placed on various BPR project activities is not only useful in planning in-house BPR projects but also allows firms to be better educated consumers of BPR consulting services. For example, in choosing between BPR consultants, practitioners would be prudent to gather as much information as possible concerning specific stages and activities included in each consultant's methodology. For example, this study's findings indicate that some methodologies may not be placing enough emphasis on preparing the organization for the change ahead (Initiate stage) and in "institutionalizing" the changes on a long-term basis (Evaluate stage). While some consultants recognized the need to monitor a redesigned process and link it to continuous improvement programs, many methods studied did not reflect the recognition of these needs. Some methodologies also do not clearly include activities for determining human communication patterns, the development of a human resource architecture, and/or benchmarking. These, however, were considered important facilitators for BPR success by such consultants as ISS and EDS, and field research confirms their critical importance (Grover, et al. 1995).

IS professionals can make immediate and important contributions to reengineering projects. Using the 11 categories of techniques as an indicator of needed BPR project skills, IS professionals have the requisite expertise to make major contributions in a number of critical BPR project activities. IS knowledge of project management is well honed through many years of experience in managing IS projects. IS professionals have also developed needed skills in soliciting end-user systems requirements, which may be redeployed in assessing internal and external customer requirements. In process capture and modeling and process prototyping and simulation, BPR projects can benefit from IS skills in structured analysis, design, modeling, and programming. IS experience in rapid application development and systems prototyping brings important expertise needed in process prototyping. While IS professionals typically have little experience in such process measurement and problem-solving techniques as activity-based costing, benchmarking, statistical process control, and pareto diagramming, their technical systems skills in feasibility and variance analysis is valuable in assessing project costs/benefits/risks and the quantification of process metrics. IS executives may also gain creditability in business planning by capitalizing on their experience in IT/business strategy alignment and their use of IT for competitive advantage. In identifying process and technical opportunities, well-known IS techniques such as scenario analysis and CSF should make valued contributions. Undoubtedly, IS professionals can make their greatest immediate contribution to BPR projects in information systems analysis and design.

BPR teams can benefit from multidisciplinary knowledge and experience. In this study, an understanding of the underlying components of a BPR project was developed. The multifaceted nature of reengineering was demonstrated by the variety of BPR techniques compiled. It was found that BPR synthesizes existing techniques from industrial engineering, TQM, creativity, organizational behavior, human resource management, and information systems analysis and design. In addition to the multidisciplinary knowledge gained by technique sharing, BPR team members join a small learning environment drawing together many strange bedfellows that can, for at least a brief moment of organizational life, gain new understanding of how others view them and the rest of the world. To maximize the value of this learning, projects should be structured to benefit from cross fertilization and encourage the carry-back of skills and ideas to respective functional areas once a project is completed.

Implications for IS education

For reengineering education, the study offers a number of contributions:

Providing a knowledge base of BPR methods. The detailed compilation of MTTs in numerous tables, figures, and appendices (including those in the "MISQ Archivist") should provide a valuable knowledge base on BPR techniques and tools. University faculty can make good use of this knowledge base in teaching business process reengineering in their classes.

Pointing to the need for additional IS education. Results of this study point to specific areas where additional education is needed to help IS professionals become more productive contributors in reengineering projects. Using the derived technique categories as indicators of needed BPR project skills, we observed that IS professionals may fall short in such categories as creative thinking, organizational analysis and design, and change management. Professional education in creativity techniques such as force field analysis and nominal group may prove particularly helpful (Couger, et al. 1993). Since many general managers perceive IS as less adept in the behavioral elements of BPR, it is probably unlikely that IS professionals will be immediately called on for their expertise in change management, organizational analysis and design, or the human resource side of BPR (Davenport and Stoddard 1994). To make gains in this regard, IS education should place greater focus on socio-technical systems design and techniques that prepare IS professionals for the softer side of business process change.

Implications for research

Given this study's findings, there are many opportunities for future BPR scholarship. Research is recommended to further validate the six-stage BPR project S-A framework. This may include empirical analysis with a survey of a broader sample of BPR projects, allowing the conduct of statistical procedures to cluster stages and activities. In this vein, a study is recommended that would further validate the grouping of techniques into common BPR technique classes. This analysis may be supplemented by empirically determining BPR skill requirements as they relate to BPR techniques. Classification of tool usage, based on actual reengineering cases, may reveal patterns of use as they relate to organizational forms and/or project scope. This type of classificatory model would provide insight in selection of tools for particular organizational situations. A study relating the effectiveness of tool usage to project success would also be interesting. Further research is also recommended in understanding the extent of education and skills improvement needed by BPR practitioners and IS professionals. A final, and probably most important, research endeavor is the empirical development of a contingent model predicting project success and the inclusion/exclusion of stages, activities, techniques, and tools.

Concluding Remarks

While the proliferation of BPR methodologies introduced by leading consultants has done much to advance practice, there have been relatively few published works analyzing BPR methods. Unlike other BPR studies where the unit of analysis is the organization, this inquiry is centered on the BPR project, which is of more immediate relevance to IS professionals. In the tradition of past IS research, this study adds to our understanding by describing and analyzing the major stages and activities conducted in reengineering. Further, the relationships between the key activities of the BPR project stage-activity framework and the subsystems of the business process change model (Figure 1) were observed, revealing the underlying components of a BPR project. This framework was then mapped with commonly used BPR techniques and tools, and guidance was given to BPR project planners as to how they could customize methodology and select techniques. Given the rate of change in the BPR industry, this MTT framework must be viewed as representative rather than all inclusive. However, as a planning tool with demonstrable relationships to the underlying process change subsystems, the conceptual basis for the framework and associated techniques should provide enduring applicability to practice and research.

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Endnotes

[1]To keep this article within acceptable MISQ publication length, certain valuable reference documents (designated as Appendices 1–8) have been placed with the "MISQ Archivist" and can be accessed through MISQ Central (http://www.misq.org/archivist/appendices/article1.html).

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Appendices

MISQ Archivist for Business Process Change: A Study of Methodologies, Techniques, and Tools

By

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A total of eight appendices (Appendix 1 through Appendix 8) are associated with this paper. Because of their length, a web site has been established on the "MISQ Archivist" homepage to view them. The address is http://www.misq.org/archivist/appendices/article1.html. In addition, there is currently a search engine located at http://theweb.badm.sc.edu/bpr/index.htm to assist users in identifying BPR techniques and tools.

List of Appendices 1–8
(contained in "MISQ Archivist")