A methodology for business process redesign: experiences and issues

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Abstract

Business process redesign (BPR) refers to the endeavour to augment organizational performance by improving the efficiency, effectiveness and adaptability of key business processes. This paper describes a flexible and extensible methodological framework (called PADM) for BPR which has been developed on the firm basis of several years of practical experience. PADM is an eclectic methodology. It has been strongly influenced by a number of methodological approaches, most notably soft systems methodology and sociotechnical systems design. The present paper outlines the main features of PADM and describes three recent case studies which show the range and variety of BPR initiatives. A number of issues are taken up in the discussion. The need for a flexible and adaptable methodology is stressed given the broad spread of studies subsumed under the BPR rubric. The dangers of process automation are illustrated and the need for a sociotechnical perspective is underlined. Business process redesign entails organization change. Many of our case studies fell short of their anticipated impact; various explanations are discussed (politics, culture, I.T. inertia). The paper concludes by outlining several fruitful areas for further research and describes a number of aspects of our current work.

Keywords: Business process redesign, soft systems methodology, sociotechnical design, process modelling, organizational change, information systems.

Introduction

In recent years, many an organization in Europe and North America has turned to the idea of redesigning its operational processes in order to sustain and improve its competitive position. Some firms have implemented far-reaching, top-down initiatives involving radical change, initiatives which have been acclaimed as yielding dramatic "order of magnitude" improvements in performance. Davenport uses the term process innovation to refer to such radical projects[1]; Hammer speaks of business process re-engineering[2]. Other companies have proceeded more cautiously, instigating smaller scale interventions aimed at bottom-up incremental improvements to existing processes (business process improvement[3]). As a generic label, we will use the term Business Process Redesign (BPR) to refer to initiatives, large and small, radical and conservative, whose common theme is the achievement of significant improvements in organizational performance by augmenting the efficiency and effectiveness of key business processes.

The most salient feature of business process redesign is the focus on "process", which is held by evangelists of BPR to reflect a paradigmatic change in the way in which organizations are conceived, a decisive movement away from the traditional functional concept, which stresses vertical differentiation and hierarchical control, to a view which emphasizes horizontal integration across functions[1,2,3]. From the process perspective, many of the ills of enterprises in North America and in Europe are attributed to the inefficiency and ineffectiveness of their business processes compared to their Japanese competitors[3]. Processes are argued to be inherently vulnerable because they flow horizontally, cutting across vertical functions. As a result, they are prone to atrophy due to departmental rivalries, lack of coordination across functions, bureaucratic cicatrice, loss of customer focus and so on.

From this perspective, the key to improving business performance is to revivify operational and administrative processes. Information technology is seen as a vital ingredient of this restorative. Hammer[2] comments: "We should re-engineer our businesses: use the power of modern information technology to radically redesign our businesses in order to achieve dramatic improvements in their performance". Traditionally, Hammer argues, I.T. has been used to mechanize and accelerate old ways of doing business. But if I.T. is to yield significant benefits, then the processes themselves must be carefully scrutinised and subjected to fundamental overhaul. The much vaunted case studies at Ford and Mutual Benefit Life are used by Hammer to show the power of I.T. systems coupled with fundamental process redesign to bring about radical improvements in business performance. Other pundits have proposed a similar agenda of process redesign through the deployment of information technology [4].

The Informatics Process Group at Manchester University has a number of years of experience in the area of business process redesign. The Group has two main interlinking interests in this field. The first is to develop a methodology for BPR through empirical research. To this end, we have undertaken a number of process design assignments for a wide range of companies. This diverse experience has led to the development of a methodological framework called PADM (Process Analysis and Design Methodology). The second area of interest concerns technological platforms based on the “process concept”. The Group has been involved, for instance, in the development of a process support technology which was known originally as IPSE 2.5 [5,6,7,8] and is now a commercial product.

Process technology will not be discussed in this paper. Our aim here is to focus on methodological and organizational issues in BPR.The goals of the paper are to outline our methodology, to illustrate its use in three recent case studies and to summarize the lessons learned. It is not our intention to provide full details of the methodology. The interested reader is referred to the relevant technical manuals which can be obtained from the authors [9,10]. The aim here is to outline the main features of our philosophy and method.

Methodology

PADM is not a tightly prescriptive methodology. It is better described as a contingency framework (much in the spirit of Wood-Harper, Antill and Avison's Multiview[11]) which provides a battery of tools and techniques to be deployed according to the circumstances of individual process redesign projects. The methodology has been inspired by several intellectual positions and draws on techniques from a number of different design philosophies. Soft systems methodology[12,13] and sociotechnical systems design[14,15] have been particularly influential. Before embarking on an overview of PADM, these two positions will be briefly described.

Soft systems methodology

Soft Systems Methodology (SSM) was developed at Lancaster University (U.K.) and is closely associated with the name of its originator, Peter Checkland[12]. SSM is, in essence, a technique for solving, or more aptly "structuring", complex unstructured problems. The technique is gaining wider and wider currency in many areas. It has attracted particular attention in the information systems field [11,13,16,17] as a means for exploring and defining user requirements. In brief, SSM works as follows. There are three main phases. In the first phase, the investigator forms a detailed understanding of the problem-situation, a so-called *rich picture.* The second phase*,* in contrast, involves disengagement from the real world into the realm of pure systems thinking. Conceptual models, not of how the world *is*, but of what it *could or ought to be* are constructed, based on a number of possible relevant perspectives. The final phase involves a comparison of these imaginary worlds with the actual problem situation in order to orchestrate constructive discussion, to throw light on what is wrong, and to suggest practical courses of action to improve the situation.

Sociotechnical system design

Sociotechnical systems design is founded on the idea that organizations are sociotechnical systems, i.e. that they have both a technical and a social dimension and that effective performance depends upon both these subsystems. The technical subsystem of an organization refer to its procedures and technology; the social subsystem denotes the people who work for the company and focuses on their "psychological need" for fulfilling and satisfying work. Sociotechnical systems design involves the joint design of the technical subsystem (optimized for efficiency) and the social subsystem (optimized for job satisfaction and motivation) in such a way that they support each other. The humanistic principles of participation, learning and empowerment are strongly emphasized in sociotechnical philosophy. Sociotechnical principles have been influential in the area of information systems development, where the work of Mumford on the ETHICS methodology[14] is well-known. Pava's [15] work has also been influential; both routine office work and professional "knowledge work" are dealt with in his framework.

Process analysis and design methodology (PADM)

The general structure of PADM is shown in figure 1. At the core of the framework is a four phase process for the definition, "capture", evaluation and redesign of business processes. The diagram makes it clear that BPR initiatives take place within a strategic business context. The input to the nucleus of the methodology is an organizational process that has been identified as a fruitful area for redesign. Process selection is a controversial area. It is well discussed by Davenport[1] and Harrington[3], who raise, amongst other issues, the question of what principles should guide the selection process. Harrington, for instance, identifies a range of criteria upon which selection can be based: business impact, customer problems, high cost, long cycle times, availability of new technology, ease and likely benefits of change. Process selection is not addressed in any detailed way in the current version of PADM. The methodology focuses on analysis and design once a process or general business area has been identified. The four phases will now be briefly described. The reader will appreciate that the neat separation of phases in figure 1 is, of course, a simplification. In practice the redesign process is a complex, dialectical activity in which the stages intermingle and reciprocally interact.

The first phase of PADM is *Process Definition*. This phase involves establishing the objectives of a given process, a definition of its boundaries and interfaces, its main inputs and outputs, those departments that are involved in executing the process, those "customers" that benefit from it (inside and outside the company) and those that provide input (suppliers). Without a clear definition of the goals of a process, any effort at improving it will be built on shifting ground. That much is a truism. But in practice a clear definition of objectives can be hard to crystallize. We will see this in at least one of the case studies presented below. In order to assist in process definition, PADM recommends the use of Soft Systems Methodology.

The second phase of PADM is *Baseline Process Capture and Representation*. Having selected a process for redesign and defined it in broad terms, it is then necessary to model the process in considerable detail. Modelling involves constructing a graphical representation of the process. The term "modelling" is an unfortunate one, however, as it fallaciously suggests the idea of literal description, that processes have a simple, objective existence and that they may be passively and directly portrayed much as an artist paints a bowl of fruit, or perhaps more aptly as a photographer takes a picture. In Checkland's terms, processes are "human activity systems"[12]. Human activity systems do not exist in the tangible, objective sense of a bowl of fruit. They are complex and often difficult to understand; moreover, they can be understood from several points of view.

Process modelling is a critical part of BPR as it is in systems analysis in general, where modelling techniques, such as the ubiquitous dataflow diagram, play a central role[17]. Process modelling is a complex hermeneutic process which involves talking to users, trying to understand their point of view, drawing pictures, checking, correcting, examining preconceptions and so on. It is a key activity and a considerable amount of our effort has been applied to the development of tools and techniques to support this phase (for example the person-centred process chart[9], a simple *pro forma* for codifying job descriptions in terms of tasks, tools, resources and products). The development of expressive and intelligible graphical notations has been an important part of our work. Standard techniques, such as the dataflow diagram (DFD), were found to be of limited value. DFDs focus exclusively on information flows and ignore, for example, the social organization of processes.

A simple technique, known as the Role Activity Diagram (RAD), has proved a popular and efficacious modelling device. RADs describe processes in an intuitively straightforward way as a network of activities carried out by agents. Related activities are grouped into so-called *roles* and the pattern of interactions between roles is also depicted on the diagram. Role activity diagramming is described in several publications[5,6,8]; figure 2 shows a simple example from one of the case studies described below. Another graphical tool, the object flow diagram, has also proved useful in our studies. These diagrams are used to track the passage of key objects through a process: an object is defined [9] as “anything that a user manipulates, uses or handles in the course of work”. Full details of these techniques are given in our technical manuals[9,10]. Other diagrammatic modelling languages have also been developed: e.g. the activity diagram[10] and the SARAD. The latter extends the RAD concept to incorporate modelling constructs based on language-action principles[7].

The third stage of PADM is *Process Evaluation*. This stage involves techniques and criteria for analyzing and assessing processes. The general aim of this stage is to look for weaknesses and problems in the process. In sociotechnical terms, deficiencies fall into two categories: technical and social. Typical social symptoms would include low job satisfaction and poor motivation. On the technical side, it is useful to distinguish two types of weakness: ineffectiveness and inefficiency. An ineffective process is one that fails in one way or another to satisfy customer requirements. In sociotechnical terminology, symptoms of ineffectiveness are known as “variances”. Typical variances could include: customer complaints, late or incomplete output, and the need to repeat work. Inefficiency, on the other hand, means that the process is wasteful of resources, although it may meet its operational goals.

Process evaluation is a quantitative activity. There is a strong emphasis on identifying and measuring key process performance indicators. What is measured in a particular study will, of course, depend on what is important in the study, which will in turn be related to the process definition. One of our studies, for example, took place in a user support organization. The process definition stressed quality of customer service and individual productivity and these were both established as key performance criteria. Customer service was operationalized as the latency between the original call from the customer and first contact by specialist staff. Productivity was measured in terms of a range of indicators, even down to the level of the number of data-entry key-presses involved in processing a customer problem!

The fourth phase, that of *Target Process Design*, involves the design of new processes for the organization, either by incremental improvement or radical change to the baseline processes. Again there is a need for a language in which to express the new process designs. The RAD has again proved of value here, as a means of improving the design of existing processes and as a basis for designing new processes *ab initio.*

Process redesign also involves both technical and social considerations. Technical improvement can take many forms. Process diagrams, such as RADs, very often reveal unnecessary organizational complexity: too many management levels, wasteful bureaucracy, duplicated work. Technical redesign involves stream-lining and rationalizing the process, aiming at reducing complexity, minimizing "non-value adding" activity, and eliminating or improving the control of variances. Identifying opportunities for process improvement by exploiting I.T. support is strongly emphasized in PADM. Process improvement from a social perspective involves changes to jobs and the social structure in order to increase motivation, to reduce stress and to improve performance by empowerment, i.e. giving people the skills, information and authority to take greater responsibility for their work.

Case studies

The *raison d'etre* of the Informatics Process Group is to develop a methodology for BPR through empirical research. In recent years, we have undertaken a large number of case studies across a wide range of companies. We have carried out assignments in the telecommunications sector, in the U.K. national health service, within the I.T. industry (on both the service and the manufacturing side), in central government, the financial services sector and in the nuclear industry. Three of more important and informative of these studies will now be briefly described. In order to protect confidences, the companies will be referred to using *noms de plumes*.

Bill Production at TelServ.

The first of the case studies was carried out for a provider of telecommunications services. The remit was to examine their bill production process. This was a fairly well-defined, well-understood process. However, as part of a manifesto of continuing improvement, the company were set on finding new ways of managing and supporting the process to make it more flexible and more effective. For example the company wanted to offer greater customer choice about the content, frequency and format of bills.

The case study began with a series of interviews. Managers were interviewed first. The aim was to get a good overall view of the billing process and of its constituent sub-processes. From these interviews a process definition was derived. The objective of the process was defined as follows: "to produce personal customer bills, to ensure these bills are accurate and to help ensure that they are paid". This definition succinctly captures the three key dimensions of the billing process: those of Issuing (getting bills to customers), Quality (ensuring the bills are accurate), and Revenue (making sure bills are paid). There were three main work-groups in the Billing department corresponding to these areas: invoice production, invoice control and credit limitation.

Stage 2 in PADM involves constructing detailed baseline models. Models for each of the three functional areas were developed. Staff members in each area were interviewed about what they did and why they did it. Information gleaned from individuals in the same group was cross-correlated. Any queries or inconsistencies were resolved by further discussion. From these discussions, person-centred process charts, RADs and object flow diagrams were constructed. These were validated by showing them to members of the billing department; they were revised and elaborated until they were felt to be accurate and complete.

Our analysis largely confirmed the high efficacy of the billing process. There were, however, a number of areas of weakness. It should be noted that much of the process was highly automated. Human intervention was only required to take care of "exceptions" that were thrown up by the I.T. system, such as a sudden increase in a bill (see figure 2). The process of handling these exceptions was slow and inefficient. Exception handling procedures were largely dictated by the design of the data processing system, which both created the inefficiencies and constrained the scope for process improvement. As an example, two operations were required to deal with errors. Possible errors were first investigated by a clerk. If a correction was required, it could not be effected immediately, only once the bill had been produced. At this stage, "flagged bills" were specially diverted for correction. Clearly these two stages should have been collapsed into a single stage. However, the rigidity of the I.T. system ruled out this simple rationalization.

Invoice production was another area where substantial improvements were identified. The RAD indicated that considerable consultation was necessary when exceptions arose (with engineers, credit control staff, supervisors). We recommended that invoice production staff be given greater discretion to deal with problems themselves. Six further proposals for process improvement were submitted to TelServ. Two are of note. One proposal was to make more use of expert systems for checking data validity. Expert systems were already in use and had proved their value in the Credit Limitation process. Another proposal was to improve the quality of the data used by Billing by taking a broader cross-functional view of the billing process. A number of functions, as well as the Billing department, were directly or indirectly involved in the process. For example, the computer centre produced the data used by the Billing department. Although they provided the data, the computer centre took limited responsibility for its validity. A more effective approach would have been to make the suppliers of the data responsible for its quality or to develop a more efficacious way of integrating these two functions as contributing to a single process. The importance of taking such a cross-functional view is, of course, at the heart of the whole BPR approach.

In addition to these specific areas of weakness, we expressed a general concern about the inflexibility of the current billing process. Harrington[3] stresses that "adaptability" is an important process quality, as important as effectiveness and efficiency: "we must design intelligence into processes so they will be able to accommodate special needs and expectations". Our report highlighted strong and imminent pressures for change coming from new market conditions, more demanding customer requirements and technological advances. As we have noted, the present billing process was difficult to change. The rigidity of the I.T. system was the main limiting factor. The system could be modified but this was done by a separate division of TelServ and typically even small changes took many months. This situation is typical of countless companies the world over. To a manager seeking the flexibility to cope with changing circumstances, or to innovate or respond to temporary problems, this sort of delay in today's conditions is intolerable.

The Outpatients process in Cardiology

The second study was based in the clinical department (of Cardiology) in a large teaching hospital. The aim of the project was to analyze current operational processes in the department and to put forward recommendations for I.T. based improvements. The main focus of the project was on the department's outpatients process as this was a source of many problems: e.g. patients being kept waiting because clinical notes could not be found, delays in correspondence between the hospital and the family doctor.

A baseline model of the outpatients process was constructed based on interviews, observation, questioning and the analysis of critical incidents. The outpatients process was highly complex; it involved the cooperative work of a diverse range of people: patients, doctors, nurses, secretaries, clerks, medical records staff, even porters who cart the notes around the hospital. The process is triggered by receipt of a letter from the patient's family doctor (GP) referring the patient to the hospital for expert cardiological assessment. An appointment is then made for the patient to see a specialist at a scheduled outpatients clinic. After the visit, further activities ensue (e.g. blood and exercise tests) before a letter from the hospital reports the specialist's expert assessment back to the family doctor.

Having specified the process, our attention moved to its evaluation, to the identification and analysis of variances, i.e. recurrent problems and breakdowns that have a major effect on performance especially from the customer's point of view (the patient). Many variances were identified: e.g. the inability to identify patients on the hospital's patient administrative system, missing clinical notes when the letter to the GP was to be written, and so on. A detailed social analysis was also undertaken as we were aware that there were endemic personnel problems. A psychological analysis of each job involved in the process was performed in terms of those job characteristics that are recognized[15] to impinge on job satisfaction and motivation (autonomy, skill variety, identity, pay etc.). In the present case, one job, that of the “notes clerk” was implicated in several key variances. Each clinical department in the hospital had such a clerk whose remit was to keep track of notes as they entered and left the department. The job was critical and required considerable informal knowledge as well as careful discipline, yet it was badly paid and suffered from high staff turnover. Poor performance of this job by unmotivated and inexperienced staff was the prime cause of one of the major variances afflicting the outpatients process, namely missing clinical notes.

Having completed our analysis, a new process design was elaborated which, following STSD precepts, attempted to optimize both technical (i.e. efficiency) and social (e.g. improved job satisfaction) objectives. It was proposed (in broad outline) that the hospital abolish its hitherto centralized outpatients bureaucracy, giving more authority to departments such as Cardiology to manage their own affairs. A number of specific I.T. based measures were also suggested. It was proposed that Cardiology develop a local management information system to underpin the new organizational arrangements. This would provide a database of critical administrative and clinical information and provide direct support for the outpatients process and other key activities. A network of external electronic links was also proposed, for example to the hospital laboratory for speeding up the reporting of blood test results. More controversially, we recommended electronic links to community health centres so that family doctors could book their own appointments and receive reports directly. On the social side, it was proposed that the notes clerk job be upgraded and training improved. A monthly "staff meeting" was also recommended to improve communication in the department between the different stakeholder groups: secretaries, clerks, nurses, technicians and the medical staff.

Many of these recommendations were accepted and implemented. Our proposals were made at a time when the hospital was actively considering the sort of decentralization that we had proposed. As a result of this reorganization, departments were given more autonomy and the central support departments were broken up. "Business managers" were appointed within departments and more administration was devolved with departments working more like independent business units. We assisted in the implementation of the new management arrangements in Cardiology and supervised the detailed design and implementation of a computer-based departmental information system. This system was used as a template for other departments in the hospital.

The Open Systems Centres at Pineapple Computers

The third study was commissioned by Pineapple Computers, a large manufacturer of computer systems, to analyze and redesign the key processes in the Systems Integration (SI) division of that company. The study took place shortly after a major re-organization in Pineapple, a re-organization which had led to the creation of a new division specifically concerned with formalizing the Company's approach to systems integration. This move was a key strategic change that was intended to lend credibility to the new image Pineapple was creating for itself, as a company that provided “total business solutions”, i.e. as a supplier of complex configurations made up of the Company's own products together with those supplied from other manufacturers.

The SI division comprised three main units. Two of these were known as Open Systems Centres. Their role was in the specific testing of particular configurations. One Centre was based in the North, the other in the South of England. They will be referred to as North and South. The third unit was known as the Process Engineering Group. Its role was to serve the two front-line centres: to coordinate their activities, to define a common approach, and to cultivate and codify Pineapple's experience in systems integration by developing a corporate “knowledge-base” of systems integration knowledge. The study was instigated by the Process Engineering Group.

The first two stages of PADM, of defining and modelling extant processes, proved highly problematic in a rather revealing way. At South, the exercise was a “primrose path”. A clear process explicitly existed. Marketeers would generate business scenarios. From these two “scripts” were developed. The *user script* encapsulated the user requirements for a hypothetical system; the *provider script* outlined the technical solution. A configuration would then be built from the provider script and tested against the user script. The lessons learned would then be written up in an evolving document known as “Guide to Systems Integration”. This was the process at South; expressing the process formally proved relatively straightforward.

The contrast at North was stark. One of the investigators commented:

> “At South the process was clear... here we found ourselves going round and round reading masses of paper, but it was all very high level mission statement stuff. We felt we were not getting at what people actually did. It was hard to understand what people actually did. They would say, well I am doing this but that's not really part of the

> process. More and more, people were saying we're not part of the process. I was trying to get at where the work was coming from but it became clear that not only were the outputs unclear the sources were unclear too.
>
> People were used to responding. People would say to them ‘would you test this’. The managers wanted to change all this- the new role was to produce what they called ‘nuggets of systems integration knowledge’ but there were just a lot of unanswered questions. Who were the systems integrators... what was the market? It was difficult to make any sense of... we were continually coming back to process definition. What was the process all about, what were its inputs and outputs? People just seemed to have ideas, to work on them and produce a report at the end....no passing on of information from group to group.
>
> We would show a diagram to a manager and ask ‘Is it like this?’ They'd say ‘yeah’. A week later we'd come back and show them something completely different. They'd say ‘yeah’ again!”

Eventually a high level process definition was produced for North. However:

> “when they saw the detailed activity diagrams we had produced for South they said ‘that's what we do’ even though it was completely different. They insisted throughout that they had a process, almost like a test of manhood. But we never in the end produced low level activity diagrams for North. We concluded that whatever they said, there wasn't a process at North.”

Thus at South, the process was clearly defined; at North it was not. This did not mean to say that the work done at North was inferior to that carried on in South. What appeared to have happened was that the history of the group at North had led to a highly informal way of working. They had been closely associated with Pineapple's main-frame division. When a salesman or software engineer wanted to test whether, say, a particular applications package worked with a particular version of the operating system, they simply got in contact directly with someone they knew could do the job. There was ample evidence that these informal networks worked effectively and that a useful service was provided. The process was simply invisible.

When a process is poorly defined in this way, PADM recommends the use of soft systems methods in order to help the clients and consultants construct models of what the process *ought* to look like. Towards the end of the project, several soft systems workshops were held which proved helpful. Preliminary root definitions were generated and some conceptual models sketched out. This work is now continuing in a follow-up project focusing exclusively on North.

At South more palpable results were obtained. Because the process was tangible, it was possible to proceed further with PADM. The process was evaluated and some specific proposals for improvement were made. It is instructive to examine the nature of these proposals. The main recommendation was to improve links between the Centre and systems integrators in the field, i.e. the engineers responsible for installing and supporting systems on customer sites. Problems with this proposal were anticipated. Placing an onus on field engineers to report and share their knowledge would be an overhead on their time and require that they understood the broader need to accumulate systems integration knowledge systematically in the company. To overcome this problem, we suggested that the staff at South went into the field with the engineers. Greater participation in bid support was another measure we suggested along the same lines. It was also suggested that more configuration testing should be carried out on customer sites.

Discussion

Business process redesign is a broad generic banner subsuming many initiatives whose common aim is the radical improvement of cross-functional organizational processes. This paper has described a methodological framework (PADM) which we have developed for BPR and reports a selection of case studies that we have been involved in over the last few years. We will now attempt to abstract from our experience the themes and issues which seem to us to be of general significance.

Methodology: horses for courses

What is striking about the selection of case studies is their range and variety. In some of our projects there has been a strong focus on social system redesign, e.g. cardiology. In other studies, social factors have been less explicit. The projects also differed in their emphasis on I.T. In some cases, I.T. was prominent (TelServ, Cardiology). In others it was less so, e.g. Pineapple, where many of our redesign proposals were essentially organizational and cultural. At one extreme, we have been involved in projects calling for the relatively conservative improvement of well-established, mature processes (TelServ). Other projects have involved a greater degree of innovation. In a recent study, for instance, we were involved in the design of a user-centred software development process which would facilitate the collaboration of doctors and software engineers in the design of a medical workstation. Traditional software development approaches (e.g the waterfall model) were rejected as too conservative; what was needed was a radically new paradigm which would stimulate learning and sustain open and critical thinking. The process developed[18] was a sophisticated one involving two groups of users working with the software team in a complex formal structure involving two interdigitating cycles of development and evaluation.

The principal methodological implication of our work is thus the need to be flexible, to have a broad and adaptable methodological framework in which the right combination of techniques can be undogmatically tailored for each individual project. PADM is a versatile, eclectic and extensible methodology. It contains a number of specific techniques (e.g. RADs, object flow diagrams, soft systems) loosely assembled in a contingency framework which stresses the many and varied hues of BPR projects. This flexible, contingent character of PADM means it may be used for projects across the spectrum from incremental process improvement exercises to broad-scale innovation projects involving top-down organizational change.

It is important in a contingency framework to provide some guidance for users. One important variable in our contingency framework which bears on the choice of approach is process definition. Some processes are well defined, others as we have seen are less so. We have found soft systems techniques of great value in ill-defined situations such as Pineapple. SSM has been relevant, though, in all our work. Defining the perspective is always crucial. What is a teaching hospital, for instance? Should the emphasis be on clinical service, or teaching, or research? Modelling is a question of perspective and perception: what is "seen" by the modeler ineluctably depends on his/her vantage-point, or *weltanshauung* as Checkland[12] dubs it, the world-view that allows the interpreter to make sense of the "blooming, buzzing confusion" of organizational life.

It is important to understand business process redesign as organizational learning. We do not regard BPR as a closed, terminating process in which a process is redesigned and activity then stops. In many situations, especially those subject to rapid change, it is more appropriate to see process modelling as an open-ended learning process, a process of continuous improvement. Our philosophy is not so much to redesign a given process as a finite exercise but to attempt to implant process modelling methods into the studied organization, to provide our clients with a process redesign framework that they will be able to use for themselves as part of a long-term process of learning and self-improvement.

Information technology and process redesign

Information technology and business process redesign are intimately interlinked. Often I.T. provides the means through which radical process improvement can be achieved. For some advocates, I.T. is absolutely central to BPR[1,2] and indeed in PADM it has a special place. In the Cardiology study, a new information system was the centrepiece of our concept of devolved management. In TelServ, I.T. was featured explicitly in many of our proposals. The importance of I.T. to BPR can be seen in the recent appearance of software products built around the idea of providing direct support for the business process. Workflow automation and process support systems technologies embody this philosophy[5,6,7,8]. But whilst I.T. has a central role in BPR, we hope it is not too trite to stress that it is not indispensable. The redesign proposals at Pineapple, as we have said, were largely cultural and organizational.

Many authors have made the point that process automation in not a panacea. Indeed, automating an inefficient process will simply produce a “faster mess”[3]. We have been involved in several major studies which have involved the implementation of workflow automation systems. All have been fraught with difficulty. It is worthwhile briefly examining one of these experiences[†].

The project took place in the administrative division of a manufacturing company and involved the introduction of a workflow automation product which we will call, for reasons of commercial sensitivity, the Process Automation System, or PAS. The project focused on the User Support process. The role of this process was to help users encountering operational problems with the company’s products, by providing “over the phone” assistance and coordinating support from maintenance engineers. The business orientation of the project was strongly emphasized. It was hoped that the project would lead to measurable improvements in productivity as measured by revenue per head and increased profit levels. It was aimed to optimize the process by “eliminating unnecessary human activity”, to improve the quality of service to customers by “enforced conformance to process” and so on.

Our role in the project was to evaluate its outcome; we were not involved in the design process. The project was a challenging one. User Support was a substantial enterprise involving many staff and there was a well-defined, complex process for dealing with customer problems. The

†. The issues raised by this study are sensitive. The views expressed are essentially those of the first author.

key design task for the development team was to model this process, i.e. to capture the process in a formal representation much like a RAD. This model would then serve as a blueprint for the workflow system which, as it were, would "enact" the model, yielding an "active work environment" which automatically scheduled and coordinated the activities represented in the model. Work in User Support was governed by clear and detailed work instructions from which the process model was constructed. A process automation system based on that model was developed and piloted in one of the work-groups.

The attempts to introduce PAS in User Support met with fierce opposition. The reasons were not hard to find. The system was simply too prescriptive, it attempted to impose a straitjacket on the users. "Your system has been designed to be idiotproof, the trouble is we're not idiots...", as one user drolly put it. Our evaluation revealed that, although many months had been spent developing the system, very little time had actually been spent talking to end-users, watching and assessing what they really did. The process model at the core of the system had been based largely on the work instructions set down in the procedure manual. These bore an indirect relation to what the users actually did, faced with day-to-day exigencies. By basing the system design on the procedure manual rather than real practice, the designers had attempted, as Sheil has pithily put it, "to automate a fiction"[19]. Although procedures certainly existed in User Support, they did not determine the work that was done; applying the procedures involved considerable judgement, flexibility and inventiveness. In part, the motive to "control the process" was a deliberate intention. One of the managers observed that he had wanted to tie his staff down, "to pin them to the floor". Flexibility and initiative were, however, the key to efficient and effective performance not slavish conformance to process. Version one of PAS was rejected and was withdrawn. A less prescriptive version was developed with more user involvement. This version proved to be more acceptable but the project was subsequently discontinued.

Models and Reality: the representation problem

Processes are conventionally portrayed as sequences of routine, recurrent activities that take inputs and produce outputs in a largely mechanical way[1,2]. This simple, deterministic view of processes is reinforced by their depiction in formal representations, which as Suchman argues, implies that they are specifications for action[20], i.e. that they represent "pre-existing specifications of the courses of action that people are supposed to engage in by using them"[17]. This suggests workers follow procedures akin to the way a computer executes a formal algorithm[19,21]. Our studies acutely show up the naivety of this view. A poignant example is the User Support study where a system built to "execute" the formal model ran into serious difficulties.

In general, our studies have confirmed the findings of ethnographic studies[20,22,23] in revealing that routine work, which appears on the surface to be mundane and procedural, involves a considerable amount of extemporization and problem-solving which is rendered invisible in procedural specifications and formal process models. This hidden work has been referred to as "articulation"[24,25].

> "Standardized representations of office work and it's products, as captured in forms, diagrams, databases, or narrative text, are the result of articulation, the local adjustments that make the work possible in practice...When the articulation of the work is deleted in representations of that work, the resulting task descriptions can only be uneasily superimposed on the flow of work"[24].

Formal representations such as dataflow diagrams are best regarded normative idealizations. They hide what is most interesting and significant about routine work, namely its contingent problem-solving character and the interpretive work that is required to put procedures into action. Formal descriptions fail to do full justice to the true character of apparently routine work. The Customer Services fiasco is a cautionary tale; its moral is not to take the formal process model too literally.

The need for a sociotechnical perspective

There are two strong arguments for taking a sociotechnical perspective in BPR. The first argument is the conventional one which is advanced by sociotechnical advocates in information systems design, that organizations are sociotechnical systems and that social factors must be taken into account in designing new systems[14,15]. This view is echoed in the writings of BPR theorists such as Davenport[1] who contends that "for every example of I.T. as an enabler of new process redesigns, there is almost invariably an accompanying change in organizational or human resource type... creating a more empowered work force, creating self-managing work teams, combining jobs and upgrading skills".

The second strong argument for the sociotechnical approach, which is often overlooked, derives from its view of organizations as open systems. STSD, by stressing the concept of variance, emphatically reminds us that real processes are not the closed, idealized worlds depicted in the formal process model. Things go wrong and problem-solving activity is necessary to put matters right. This hidden activity is not abstracted away; it is brought into the foreground of the analysis in STSD. It is through improving “variance control” that STSD seeks to improve the performance of the technical system. This open systems view strongly resonates with our Suchmanesque view of routine work as problem-solving.

The are various practical ways in which sociotechnical principles are reflected in our approach. The analysis of social structure and job satisfaction was a central theme in the Cardiology case study where there was an explicit focus on creating more rewarding and motivating jobs. The use of variance analysis gives practical effect to our view of routine office work as skilled problem-solving. Variance analysis brings out this fundamental characteristic that is otherwise glossed over in conventional modelling techniques. RADs are also capable of modelling, at a surface level, problem-solving activities. This is most clearly seen in the Telserv study where the main focus of the analysis was on exception handling procedures.

BPR and organisational change

Business process design is about organizational change, whether in the large or in the small. Change though in organizations is often resisted. It means upheaval and the rupturing of familiar social structures and entrenched practices[26]. Change requires the mobilization of effort and if there is insufficient “energy” in the organization then it will not happen[27]. I.T. has long been regarded as an enabler of change[28], yet we know that attempts to introduce new information systems often meet resistance precisely because they threaten the *status quo*[29,30,31,32]. Davenport[1] trumpets process innovation as being about major, large scale organizational change. Yet he concedes that “despite its promise of radical competitive benefit, process innovation is still a rare phenomenon in the corporate world”. Other writers[33] have observed that BPR initiatives have typically achieved much less than they promised. The BPR projects we have been involved in have entailed change yet what has ultimately been achieved has again often fallen far short of what was envisaged. It is instructive to examine some of the sources of resistance in our projects.

One important source of resistance ironically comes from the I.T. infrastructure. Davenport[1] champions I.T. as an enabler of change but is shrewd enough to see it as a potential constraint on process redesign, although he only gives the subject three pages in his proselytizing book. Other writers have made similar points[28]. Most firms have made a very significant investment over many years in I.T. It is simply too facile to expect this infrastructure to be “wished away”. The restraints imposed by existing I.T. arrangements have been a feature of many of our studies. The phenomenon is most clearly seen in TelServ where a whole range of rationalizations were precluded by the rigidity of a traditional batch processing approach.

Organizational culture and politics can also facilitate or impede change. In the Cardiology study, change ensued following our study. This was not simply because our clients were convinced by our proposals. The timing of the study was crucial. Our proposals for change were made at a time when there was a general move in the health service away from centralized service departments to provider units set up with much greater control over their affairs; i.e. we had proposed the right sort of organizational changes at the right time. New process designs, because they are sociotechnical entities, intrinsically have a cultural dimension. If the cultural hue of the new design clashes with the prevailing organizational culture, then there will be resistance. Davenport[1] makes a useful distinction between two cultures, of empowerment and control. A BPR project aimed at strengthening control structures in a professional milieu that emphasizes individual responsibility and empowerment is likely to lead to trouble, and indeed *vice versa*. This was certainly an important aspect of the User Support study, where the new process support system strongly constrained the latitude of workers who had been used to a high degree of discretion.

In Pineapple SI, the problems in getting BPR underway were partly political and partly cultural. The client for this project, it will be remembered, was the Process Engineering Group. But the process owners were the Open Systems Centres. Some of the problems we experienced at North were undoubtedly due to a perceived clash of interests between a new Group looking for a role (PEG) and an established group defending its territory. Clearly-defined roles and relationships are important in any change project. Davenport[1] has identified four roles that must be filled by the correct people: the change advocate, the sponsor, the target and the agent. In the new phase of the Pineapple study, the PEG will play a less prominent role and it is hoped that this will simplify the project dynamics. Politics were not the whole story though; there were cultural issues too. North had been used to a very informal way of working. They were naturally troubled by the appearance of an initiative which had as its central principle the idea of making processes explicit. Workers in North found the idea of BPR professionally threatening and intellectually alien.

Concluding comments and future research

Business process redesign, as we have said, is a very broad generic label which subsumes a wide range of diverse activities. Accordingly, we have stressed the need for a flexible, contingency approach and PADM has been developed very much in this spirit. To conclude the paper we will briefly identify some research directions that we believe to be of importance and summaries some of the main areas of our current activity.

An important area of our present work is the development of an overall conceptual framework for BPR which will help to bring some intellectual structure to a disjointed field. The conceptual framework[34] deals with a number of key issues. The development of a detailed taxonomy of different types of BPR initiative is one important concern. Having such a taxonomy will provide a principled basis for configuring PADM to meet the requirements of a given class of project. A second important goal is to attempt to codify the profusion of BPR techniques, particularly in the area of process modelling, in terms of their role in BPR and the type of information that they provide. Processes can be viewed, indeed need to be viewed, from several different points of view. We have found it helpful to distinguish between the following perspectives: functional/behavioural (describing what activities take place and when), informational (the data entities that are involved) and organizational (the resources, human and otherwise, that are involved in the process). This scheme provides a useful basis for classifying process modelling techniques. Another issue addressed in the framework is the relationship between BPR and information systems development as BPR can be seen as transcending and absorbing the traditional concerns of IS methodologies. A fourth area concerns process support technologies (such as workflow automation and “Group-ware”) in which, as has been mentioned, we have a particular interest. What is the role of such support systems? How should their design be integrated in the wider BPR process?

If they are to be used effectively, methodologies need good tool support. Another important area of our work is the development of a set of tools to support PADM. This toolset is known as PMW, the Process Modelling Workbench, and includes tools which allow the creation and editing of our main modelling notations (e.g. RADs and activity diagrams). PMW includes some support for quantitative process analysis, using simulation techniques to identify critical paths, cycle times, work flow-rates, bottlenecks etc. The toolset will also allow processes to be viewed at different levels of abstraction and from different user (senior manager, line manager, the “shop floor”) and process perspectives (functional, informational etc.).

The vicissitudes of process automation projects, such as the User Support project, are not untypical of attempts to introduce I.T. systems into the workplace. Even in highly technical environments, such as air traffic control[35], new systems have foundered because designers have underestimated the complexity of cooperative working practices. Hoped-for benefits have failed to materialize because of the lack of “resonance”, as Harper *et al.* [35] put it, between the I.T. system and the social organization of work. As a further area for research, we see a need for more ethnographic studies of routine and professional work (addressing issues such as articulation, coordination etc.) teasing out implications for methodology and for the design of appropriate process technologies.

Business process redesign inherently entails organizational change and we have discussed how BPR initiatives often deliver much less than they promise. Why change is resisted and how we can improve the management of change are thus key issues for BPR. Our recent work has explored resistance to change from a “stress perspective”[31]. The basis of this approach is the argument that organizational change is a highly threatening and stressful experience for many participants and that high levels of stress can have a pernicious effect on individuals, group processes and organizational learning. Resistance to change can be seen from this viewpoint as a defence mechanism, as a coping strategy for dealing with high stress levels. The stress perspective is helpful in that it suggests a number of ways in which stress can be ameliorated (e.g. open communication) with the aim of facilitating change.

References

1) Davenport, T.H. *Process innovation: reengineering work through information technology*. Harvard Business Press, Boston (1992).

2) Hammer, M. Reengineering Work: Don't Automate, Obliterate. *Harvard Business Review*, (July - Aug 1990), pp 104-112.

3) Harrington, H.J. *Business Process Improvement: the breakthrough strategy for total quality, productivity and effectiveness*. MacGraw-Hill, New York (1991).

4) Venkatraman, N. IT induced business reconfiguration. In M.S. Scott-Morton (ed.), *The Corporation of the 1990s: information technology and organizational transformation*. Oxford University Press, Oxford (1991).

5) Wastell D.G. and Maresh, J. Process modelling and CSCW: an application of IPSE technology to medical office work. In D. Diaper, G. Gilmore, G. Cockton, and B. Shackel (eds.), *Human Computer Interaction: Proceedings of INTERACT 90*. North Holland, Amsterdam, pp 849-852.

6) White, P. and Wastell, D.G. IPSE technology as a basic for implementing CSCW systems. In: H.J. Bullinger (ed.), *Human aspects in computing*. Elsevier, Amsterdam (1991), pp 1103-1107.

7) Wastell, D.G. Process support technology, cooperative work and information systems development. In: J. DeGross, I Benbasat, G. DeSanctis and C. Beath (eds.), *Proceedings of the 11th International Conference on Information Systems*. ACM, New York (1991), pp 93-100.

8) Wastell, D.G. and White, P. Using process technology to support cooperative work: prospects and design issues. In: D. Diaper and C. Sanger (Eds.), *CSCW in practice: an introduction and case studies*. Springer-Verlag, London (1993), pp 106-126.

9) Kawalek, P. *The Process Modelling Cookbook*. IPG Internal report, Computer Science, University of Manchester (1991).

10) White, P.R. *Report On A Process Analysis And Design Method*. IPG Internal report, Computer Science, University of Manchester (1993).

11) Wood-Harper, A.T., Antill, L. and Avison, D. *Information systems definition: the multiview approach*. Blackwell, Oxford (1985).

12) Checkland, P. *Systems Thinking Systems Practice*. Wiley, New York (1981).

13) Checkland, P. and Scholes J. *Soft Systems Methodology In Action*. Wiley, New York (1990).

14) Mumford, E. *Designing participatively*. Manchester Business School Press, Manchester (1983).

15) Pava, C. *Managing new office technology: an organizational strategy*. Free Press, New York (1983).

16) Lyytinen, K. Stakeholders, information system failures and soft systems methodology: an assessment. *J. of Applied Systems Analysis*, vol 18 (1988), pp 61-81.

17) Flynn, D.J. *Information system requirements: determination and analysis.* McGraw-Hill, Maidenhead (1992).

18) Rector, A., Horan, B., Fitter, M., Kay, S., Newton, P., Nowlan, W.A., Robinson, D. and Wilson, A. *User centred development of a general practice medical workstation: the PEN&PAD experience*. Proceedings of CHI'92 (1992).

19) Sheil, B. Coping with complexity. *Office: technology and people*, vol 1 (1983), pp 295-320.

20) Suchman, L Office procedures as practical action. *ACM transactions on office information systems*, vol 1 (1983), pp 320-328.

21) Fikes, R.E. A commitment-based framework for describing informal cooperative work. *Cognitive Science*, vol 6 (1982), pp 331-347.

22) Wynne, E. *Office conversation as an information medium*. PhD. thesis, University of California at Berkeley (1979).

23) Suchman, L. and Wynne, E. Procedures and problems in the office. *Office: technology and people*, vol 2 (1984), pp 133-154.

24) Gerson, E.M. and Star, S.L. Analyzing due process in the workplace. *ACM trans. on Office Information Systems*, vol 4 (1986), pp 257-270.

25) Gasser, L. The integration of computing and routine work. *ACM transactions on office information systems*, vol 4 (1986), pp 205-225.

26) Huczynski, A. and Buchanan, D. *Organizational behavior*. Prentice-Hall, New York, (1991).

27) Beckhard, R. and Harris, R. *Organizational transitions: managing complex change*. Addison-Wesley, Reading (1987).

28) Benjamin, R. Managing information technology enabled change. In Avison, D., Kendall, J. and DeGross, J. (Eds), *Human, organizational and social dimensions of information systems development*. North Holland, Amsterdam (1993), pp 381-398.

29) Markus, L. Power, politics and MIS implementation. *Comms. of the ACM*, vol 26 (1983), pp 430-444.

30) Eason, K *Information Technology And Organizational Change*.Taylor and Francis, London (1990).

31) Wastell, D.G. and Newman, N. The behavioral dynamics of information system development: a stress perspective. *Accounting, management and information technology*, vol 3 (1993), pp 121-148.

32) Wastell D.G. The politics of systems development: conflict, stress and user resistance. In: S. Easterbrook (Ed.), *CSCW: cooperation or conflict?* Springer-Verlag, London (1993).

33) Short, J.E and Venkatraman, N. Beyond business process redesign: redefining Baxter's business network. *Sloan Management Review,* (Fall 1992), pp 7-21.

34) White, P. and Kawalek, P. (1993). *A framework for business process management.* IPG Internal Report, Computer Science, University of Manchester.

35) Harper, R., Hughes, J. and Shapiro. Harmonious working and CSCW: computer technology and air traffic control. In Bowers, J. and Benford, S (Eds.), *Studies in computer supported cooperative work*. North Holland, Amsterdam (1991), pp 225-234.

Figure 2. An example role activity diagram (RAD) from the TelServ case study. The RAD depicts part of the exception handling process for suspect bills. The key idea in the RAD formalism is that of a role, which refers to a logical group of related activities. Two separate roles are shown in the diagram: the billing clerk and the billing supervisor. The individual activities constituting a role are shown as black boxes; white boxes indicate points at which two roles interact, e.g. to exchange information. The RAD indicates that when a suspect bill is detected, first the billing clerk checks to see whether the amount charged and the calls made are in agreement. If they are not then the clerk assesses the discrepancy. As the clerk does not have the authority to amend bills, the information is then handed over to the supervisor who makes the necessary amendment.

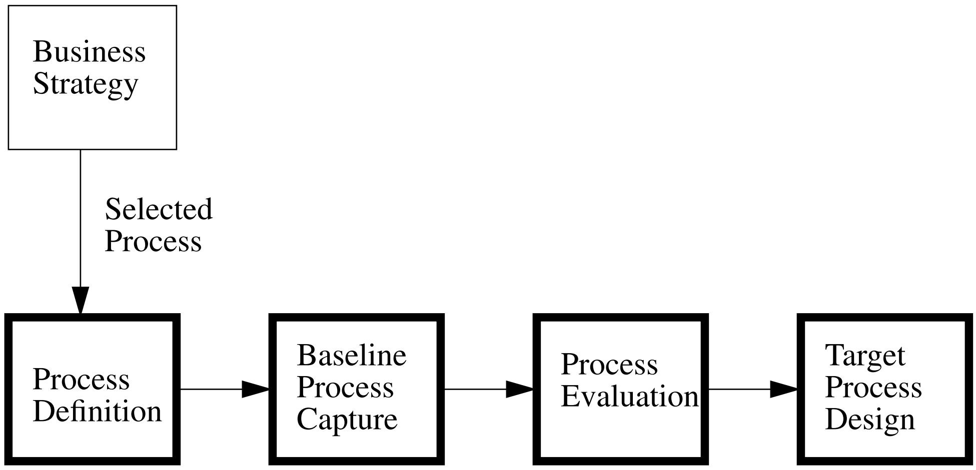

Figure 1. The PADM framework.