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Reengineering an Information System: A Case Study in Risk Reduction

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Abstract. Business-process reengineering (BPR), like computer information systems development (ISD), deals primarily with process and contains only weak facilities for addressing structure and culture. Manufacturing and ISD have strong roots in the functionalist traditions of natural science, and in a cultural environment their engineering stance deals poorly with obstacles to change. While the structured, or "hard," engineering approaches have given rise to successful developments, they have not always proved effective. In ISD, the hard engineering methods have a tendency to redefine information systems problems as problems of technical development, and similarly in engineering contexts, BPR risks becoming too focused on technical processes. However, failure to gain commitment and a sense of ownership in new processes is a cause of failure in both BPR and ISD. This article explores a case study where both technical and human issues must be addressed—the extension of student record processing within a university. In this study, the BPR requirement is seen to arise from the users of the information system rather than as an imposed managerial imperative. The use of total systems intervention (TSI) and interactive planning (IP) enabled the immediate technical problems to be separated from underlying BPR requirements and from the need to gain commitment to change. Thus, unnecessary technical effort and the risks of failure from resistance to change were avoided. From the findings of this intervention, it is argued that the wider application of TSI provides a framework within which managerially perceived needs can be translated into a grassroots commitment.

Key Words: BPR, human factors, information systems, risk reduction, total systems intervention

1. Introduction

The idea of business-process reengineering (BPR) is that organizations need to go back to the drawing board and consider what they want to achieve, how they are currently achieving it, and how it can be most efficiently organised. It is argued that there is often a gap between how things are currently done and how things should be done. In response, BPR offers a series of tools for identifying the necessary change and rebuilding the organization in a new image. However, it has little to say about human factors such as problems of conflicting values, coercion, and resistance (Oram and Wellins, 1995). Hammer and Champy (1995) go so far as to argue that the underlying reason for failure is invariably inadequate understanding or leadership from management. Even in this statement, the problem is reduced to a technical task that can only fail if there is poor workmanship on the part of managers.

Similar issues arise in information systems development (ISD). Here a common approach to developing systems is the redefinition of the users' needs and difficulties as a series of technical problems, followed by the application of project-management techniques to arrive at a solution. Repeated failures of this approach have led to the growth of soft methods that view ISD as a human-centred rather than a technical problem (Stowell and West, 1994; Walsham, 1993, 1995; Hirschheim, Klein, and Newman, 1991). Closely allied to this is the concept of viewing ISD from a holistic or systems-based perspective.

This article reports on such a holistic approach to the reengineering of an information system—the University of Luton Higher Education Management Information System (HEMIS). This is a computer-based information system designed to control student records and provide management information from those records. The driving force for its redevelopment was a management intent to provide for greater distributed accessibility by users of the system.

The purpose of the research presented here is to assess the use of total systems intervention (TSI) in such a scenario. To this end we outline and review the development of HEMIS to move it from a largely centralized management information system (MIS) to a more distributed system giving greater end-user access and control. The University of Luton applies the principles of total quality management (TQM), within which technical developments should be assured of success. This led the project to be dominated initially by the need to make software changes to provide the functionality required. However, the type of concrete problem definition needed to facilitate the technical design effort proved elusive as discussion continued.

It was at this impasse that the university sought alternative means of making progress and provided the opportunity to evaluate TSI in practice. The realization that conventional ISD methods were failing to solve the problem provided a climate in which the university management was willing to allow its own activities to become the subject of research. Thus it was possible to treat the records-system development as action research in which a body of evidence about the use of TSI could be accumulated, analyzed, and reported on as a live case study.

Intervention using TSI is not simply substituting one technical method of requirements analysis for another. In essence, the approach takes a critical look at the problem situation in an attempt to find a technique with the potential to break the logjam. It is, in this sense, a metamethodology aimed at reducing the risk of failure in BPR or ISD. Before looking at how the University of Luton's problem was resolved, the next section reviews soft systems approaches and describes the metamethodology of total systems intervention. In Section 3 this theoretical perspective is applied to development of the HEMIS system.

Finally, the research findings are reviewed and the conclusions for future ISD and BPR exercises are presented.

2. The total systems approach

Systems theory tells us that a system is a collection of objects, or subsystems, interacting to achieve some goal or purposive behavior. The initial task is to define those objects or subsystems that form the system in question and to determine the system boundary.

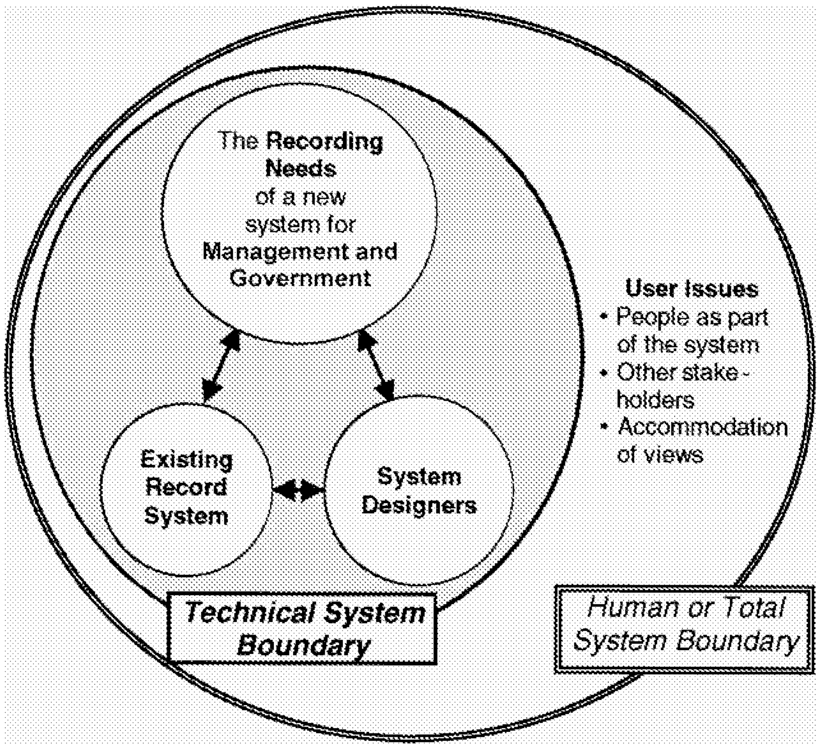

Figure 1. Choice of the system boundary (after Midgley et al., 1998).

Since engineering is a deliberate attempt to organize a system in a problem-free efficient and effective manner, engineers naturally focus on those objects whose behavior and interaction they can control. This leads them to define the system in terms of its technical boundary, as shown in Figure 1. Midgley (Midgley, Munlo, and Brown, 1998) criticizes this setting of the boundary and points to an alternative perception. This critical setting of the system boundary, determined by examining the viewpoints of stakeholder groups involved in the system, refocuses attention on human rather than technical issues and redirects the reengineering effort accordingly. Thus, people not only become part of the system but are the primary focus of study.

While it may be possible to engineer information technology (IT) or even the programs and procedures that may be seen as part of it, the human elements (or human activity system, HAS) are not susceptible to such directive manipulation. In these circumstances, reengineering must embrace both technical and human-centered issues within a framework that allows both to contribute.

The historic ISD methods have been seen as unable adequately to deal with such situations, and alternatives have been sought in soft (human-centered) methods, such as soft systems methodology (SSM) (Checkland, 1981, 1998). However, problems arise with this approach (Petheram, 1991; Mingers, 1984; Probert, 1994; Romm, 1994). These are perhaps best exemplified in Jackson's (1990) appraisal. He finds the recommendations of SSM too regulative and lacking in the kind of open participation that is essential for success in problem situations where there is conflict between powerful interest groups.

At a more fundamental level, there is a need to get beyond the polarization of hard versus soft issues. Flood and Carson (1993) argue that both schools are dominated by technique and operate with little or no reference to underlying theory at any level. Since real-world situations arguably involve both technical and human problems, adherence to a single methodology or paradigm (that is, hard or soft) cannot meet all these needs.

The human issues, unlike the technical problems, cannot be dealt with in a one-off problem-solving exercise. A business process or an information system is a dynamic entity where those involved in, or using, it continually seek to address new problems and meet new needs (Paul, 1993). Without a statement of user requirements, which is both fixed and agreed upon, a conventional problem-solving strategy cannot make progress. Yet in human systems this is possible only by ignoring the human (Paul, 1994). The human issues must remain predominant, without discarding the need to make progress with the technical elements of any new system. What is needed is an approach that combines methodologies from different paradigms in a wider systems context.

Thus, we need a continuous, iterative process (within which analysis may start or restart at any point in the cycle) rather than a problem-solving approach (which is largely perceived as a start-end activity). It must incorporate different methods, possibly with conflicting paradigmatic assumptions, for dealing systemically with both technical and human issues. Rather than another methodology, something like Boehm's meta-level spiral methodology (Boehm, 1989), which helps choose appropriate methods for tackling different elements of the problem situation, is required. It is our contention that in ISD, and by analogy BPR, total systems intervention satisfies these criteria.

2.1. Total systems intervention (TSI)

The full details of TSI have been presented by Flood and Jackson (1991a, 1991b, 1991c; Flood, 1995), but a brief description will now be presented. TSI consists of a cycle of three phases of activity: creativity, choice and implementation (as described below and in Figure 2). Further, this same basic cycle can operate in three distinct modes: problem solving, critical review, and critical reflection.

In a problem-solving mode, the activities in Figure 2 proceed in a clockwise direction, progressing through creativity, choice of method, and implementation of method. The objective here is to address the "mess" by creative thinking (to surface the issues to be managed), choice (to choose the methods best suited to managing the issues surfaced), and implementation (to implement the methods chosen). Clearly, such an approach treats the problem context as one for which any one method is unlikely to prove adequate and hence relies on multiple methods to address the issues raised. Critical review applies the process of TSI to reviewing the available methods and assessing their relevance. In effect, critical review follows the same process as problem solving, but instead of applying the approach to addressing the problem context encountered, it uses it to assess the various strengths of systems methods. Critical reflection follows Figure 2 in an anticlockwise direction,

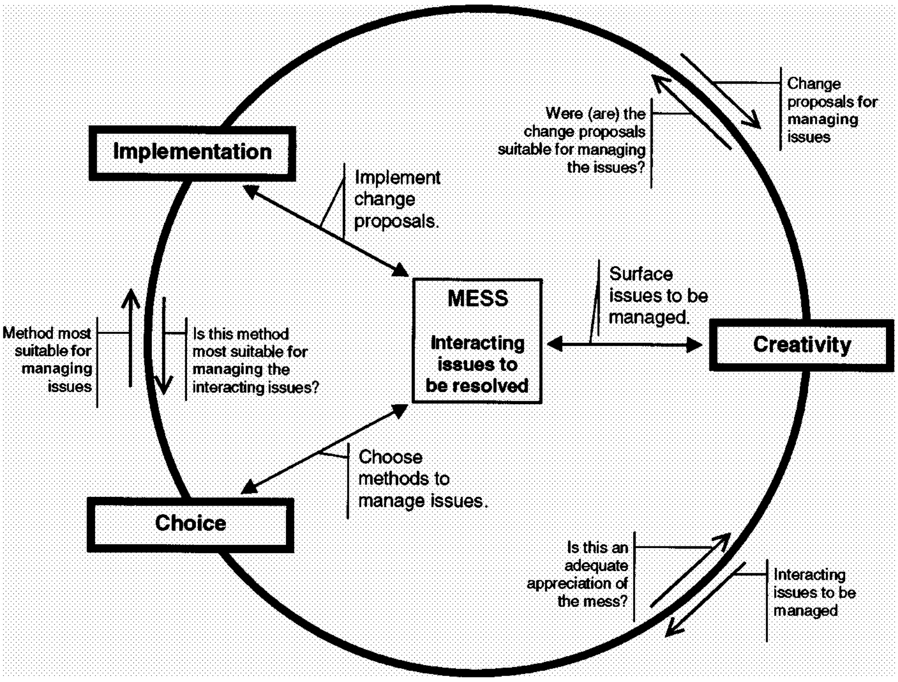

Figure 2. The process of total systems intervention (TSI) (from Flood, 1995).

reflecting at each phase on the outcome of the previous phase(s). The value of critical reflection should not be underestimated, since it is here that TSI explicitly applies critique to the intervention process. It accedes to the views of Ulrich (1983) that intervention should not be purely instrumental but should aim to surface the normative content and material conditions of any system.

TSI is not a methodology as such but rather is an approach to dealing with unstructured problem situations that aims to apply relevant methodologies where they can make a legitimate contribution. Nor does it simply solve "the problem." Rather, it recognizes that conflict and change are continuous by providing an iterative review and progressive mitigation of the problems. Its thrust is to enable methodologies from competing paradigms to be used together as and when appropriate (Jackson, 1990; Jackson and Keys, 1984; Mingers and Gill, 1997, pp. 243–440).

Each of the three modes of total systems intervention (TSI) (problem solving, critical review, and critical reflection) uses the three phases of creativity, choice, and implementation. Creativity is concerned with thinking creatively about the interacting issues to be managed, or "mess." Next choice seeks to choose a method or mix of methods to deal with the issues surfaced. Finally, in implementation, the chosen methods are used to change the existing "mess."

Creativity. The objective of the creativity phase is to generate the views of the problem situation that will inform choice of methodology, keeping in mind multiple viewpoints.

TSI uses techniques such as metaphors (Flood, 1995), the initial stages of soft systems methodology (SSM) (Checkland, 1998), or lateral thinking (de Bono, 1977).

Choice. The choice phase prioritizes the issues surfaced above and guides the choice of implementation methods. The technique used must reflect the need to manage interacting issues and will depend on the nature of the issues themselves. The choice of technique needs to focus on the type of method required (Flood, 1993):

- Design (or how-to) methods, where consensus already exists;
- Debating (or resolving-what-to-do) methods, where consensus is achievable; and
- Disimprisoning (or resolving-who-benefits and why-it-should-be-done) methods, where coercive influences are intervening to distort the problem situation.

Implementation. In this phase, the chosen methods are applied to change the problem situation. This is not always building the information system or reorganizing the business process. Implementation activities may involve debate and disimprisonment to prepare for a new creative activity at the start of another cycle.

2.2. TSI and BPR

Business-process reengineering (BPR) is a response to a perceived gap between how things are currently done and how things should be done. Although the perception might include some model of the alternative process, some study—analysis and design—is still required to determine what changes are feasible and desirable. Information systems change is often part of the perceived change, and moving straight to technical analysis and design gives only cursory treatment to the complexities and dilemmas associated with the reengineering of work processes (Willmott, 1994). Although technical ISD competence is important in BPR, significant risks arise from other areas (Teng, Fiedler, and Grover, 1998).

A significant number of stakeholders participate in most business processes, and one need will be to resolve the conflicting demands they make on the organization (Coakes and Elliman, 1997). Obtaining consensus and commitment is an important part of making headway within a BPR project (Oram and Wellins, 1995), and mechanisms for supporting this process need to be chosen with care.

Some resistance to consensus may be political rather than simply seeing the problem from different perspectives. This cannot necessarily be simplified through caricatures such as “resistance to change” or “labor’s resistance to management” but may need to be understood in terms of power and identity. Such politics are an inevitable part of organizational life, which render the outcomes of BPR uncertain and contested (Knights and McCabe, 1998).

The admission of these alternatives is the key to TSI’s ability to address the risks inherent in both ISD and BPR. TSI admits that problems can be mitigated but not solved and provides a means to make an informed choice of objectives and methodology within a problem situation.

3. Applying TSI at the University of Luton: A case study

This section describes the use of TSI to resolve the issues surfaced when attempting to define development of the University of Luton's Higher Education Management Information System (HEMIS) as a technical problem. Since this case study also formed a piece of action research, a brief review of the research methods employed to validate the following description and conclusions will be presented at the end of the section.

The key to making progress was in recognizing that the new system could not be clearly defined as a technical or organizational problem for which a solution could be designed. This points to a process problem and moves the project from the realm of simple ISD to one of process reenginering. Once the objective to give distributed access to the university's six faculties was accepted, the boundary was redrawn to identify a total system of student recording and monitoring (see Figure 1). It could no longer be turned into a "problem to be solved" but had to be viewed as a human activity supported by information technology (IT)—a classical BPR perspective (Kettinger, Teng, and Guha, 1996).

3.1. The creativity phase

Since the aim was to get participants to see the situation from different viewpoints, a brainstorming session (see de Bono, 1977) was set up. Important user groups were identified as management, faculty administration, academics, and students, and it was decided initially to focus on faculty administration. Each of the university's six faculties was invited to send two representatives to a meeting. At the meeting they formed two self-selected groups to address this question: "How can monitoring and recording of students at faculty level be better facilitated by information systems?"

This activity was organized by a facilitator who was not in the line of management and did not take on the role of IT or systems expert. The only additional guidance given was in the form of broad general questions to elicit how participants viewed the situation. The outcome of the two groups, together with some written responses received subsequently, was presented at a follow-up session that had this agenda: "To be agreed on the approach to be taken for the next stage of development." In the ensuing debate, the following issues were identified:

- A need for flexible systems;
- A need for consultation;
- The acknowledgment that problems arise when a bureaucratic, stable past sits uneasily facing a future of collaboratively organized responses to continuous change;
- The perception of the present as an uncomfortable transition that exhibits a mix of bureaucratic, collaborative, and internal political pressures.

In terms of the applicable metaphors, the organization was changing from mechanistic to sociocultural, with sociopolitical influences, suggesting that the main concern was the question of what should be done (debate). There were also indications of a lesser need to consider *how* to do things (design) and to address some questions of *why* they should be done or whose interests would be served (liberation or disimprisonment).

Table 1. The complementarist framework (Flood, 1995, p. 183).

Designing	Debating	Disimprisoning
Machine	Sociocultural	Sociopolitical
Organic		
Neurocybernetic		

The conclusion drawn during the creativity phase was that the main requirement was to debate the important human and technical issues and to decide what to do about them. The perception of a desired future was clearly expressed, and the idea emerged that two futures might reasonably be assessed—one rooted in maintaining past views (undesired) and one taken from future views (desired). The first, short-term view was expressed mostly as a need to assess the present management information system and seek improvements. The second was, by contrast, a long-term view with clear strategic importance.

3.2. The choice phase

In the choice phase selection of method can be based on Flood's (1993) "complementarist framework," which he presents as a tabular categorization of methods (Table 1). Since the need for debate was prime, the indicated choice was a debating methodology, and ultimately the three prime candidates to emerge were strategic assumption surfacing and testing (SAST: Mason and Mitroff, 1981), soft systems methodology (SSM) (Checkland, 1998), and interactive planning (Ackoff, 1981).

Much of SSM is concerned with finding out about problem situations, and certainly stages one to five were considered as relevant. In contrast SAST addresses pluralistic, adversarial debate and so was not seen to address directly the present concerns, which were not of an adversarial nature. Interactive planning (IP) seemed to have much to offer, in particular the ideas of means and ends planning and of idealized design were directly relevant to the view developed of the system. Thus, it was chosen as the dominant methodology. However, the need to address the mechanistic and sociopolitical dimensions was not forgotten. Systems-development life-cycle (SDLC) approaches were selected for the former, commencing with an audit of existing information systems. Finally, the political dimension was to be monitored, and elements of critical systems heuristics (Ulrich, 1983) were applied where needed.

The initial phases of TSI had led to the selection of several activities for the implementation phase. We now look at the most important of these in operation.

3.3. Interactive planning: Developing a long-term strategy

This article concentrates on what became the most difficult area—that of the long-term strategic matters that surfaced in Section 3.1. Here the important problems became determining what needed doing and building commitment toward the vision that developed.

Having decided that consensus was achievable, the objective became charting a vision of the system needed and a route to its achievement. The planning process was not yet ready to deal with the technical issues of design and programming but only attempted to frame the broad outline of requirements for such a task. The need, at this stage, was to develop these with a commitment to the future shape of the business process to be supported.

A notion of "mess" is central to TSI (Figure 2) and also lies at the core of the interactive planning (IP) approach (Ackoff, 1981). It is useful to perceive such a mess as the incipient seeds of destruction implied by the current behavior of an organization and its environment. Thus, the purpose of formulating this mess is to identify the nature of these concealed threats and to suggest changes that can increase the ability to survive. The following focuses on those elements in IP that are of particular benefit to ISD and BPR. Since we are dealing with lack of consensus, the required process is one that will help participants understand different views of the system and find a common way forward. The following elements of IP help these objectives:

- An obstruction analysis that examines organizational ends, means, resources, structure, management, and stakeholders;
- A reference scenario that determines what the outcome would be if the university system maintained its present development path;
- An idealized design for the current environment that is technologically feasible, operationally viable, and capable of rapid learning and adaptation (this lies at the heart of interactive planning);
- A constrained idealized design that identifies and takes into account anticipated constraints on the system.

The lack of consensus in the student record-system requirement pointed to a potential process reengineering risk—namely, that by not meeting the perceived needs of stakeholders they would adopt informal and alternative means of working that would undermine the benefits of a reengineered system. By addressing perceived constraints on the reengineered system, IP addresses this risk. It deals with constraints by preparing two idealized designs: the one prepared first ignores any constraints, and the second takes known constraints of the environment into account but proposes no changes to the environment. In defining the unconstrained system, the changes it assumes it would need in the environment must be made explicit.

Creative development of change proposals. Figure 3 shows the use of IP to generate process changes to which the participants are committed. The use of IP, as a creative process, will have given rise to a view both of the current situation (the reference scenario) and of a possible future (the idealized design). These are then compared to the reference scenario to determine a way forward. By studying the gap between these views, participants can select and evaluate different development paths, taking into account the potential obstructions that were identified. The smaller the gap, the more straightforward the eventual implementation processes.

If the difference between the two idealized systems is small, then the organization's future is in its own hands. Further, when the constraints are made explicit, areas that need further work to address the human issues in BPR will become evident.

Obstruction analysis. In this case study it was seen that, in terms of organizational ends, the university has committed itself to wide choice and flexibility in its courses. Any MIS

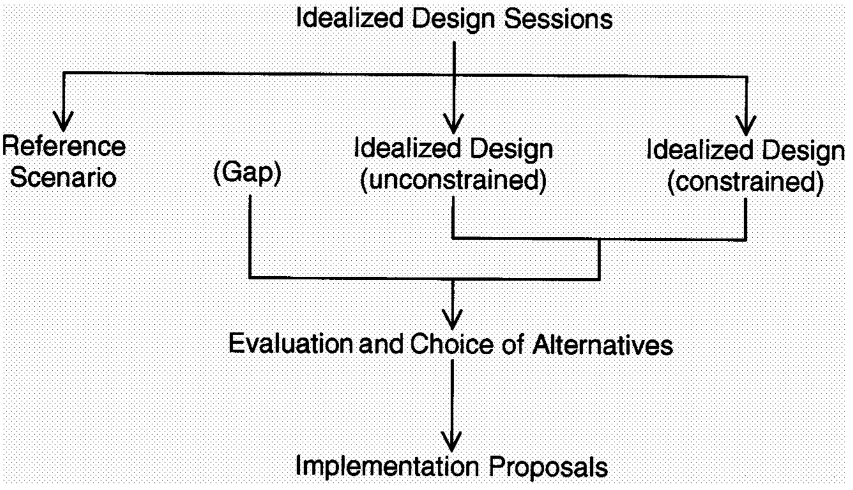

Figure 3. Development of proposals using interactive planning.

to support these course offerings must be able to support a flexible mix of information to students, academic staff, administrative staff, and management. In so far as this is achieved, the system's ends and the organization's ends will not be in conflict.

In Ackoff's terms (1981, p. 88) organizational means relate primarily to personnel issues. He argues that, in general, opinions vary widely about the following:

- What corporate personnel believe they do;
- What corporate personnel actually do;
- What others believe them to do;
- What they are supposed to do.

Such differences may be essential for corporate survival and must be explicitly recognized and allowed for in BPR project methodologies. The culture of the university is one of giving employees the freedom to make their own decisions about day-to-day work practices. This runs the risk of conflicting with the approach of management services that, as with many computer-based departments, primarily focuses on setting up systems and then seeking to ensure that participants use them as instructed.

It would be unrealistic to suggest that the bureaucratic management required only five or so years ago has been entirely replaced by a more relaxed form needed under the present university regime (Clarke and Lehaney, 1995). However, systems designed *now* must look to support an adhocracy and yet still supply information required in largely bureaucratic forms (such as the reporting requirements requested by the central government). There is a perception of a need to supply central government agencies ahead of all others because government is the university's key stakeholder. This has the appearance of placing the needs of internal participants lower down the order of priorities. In practice the pattern of stakeholders with an interest in a university's information systems has much more complex internal and external links. Balancing the needs of internal users against external stakeholders who are dependent on the system but represented only by proxy within the planning process is a major problem in its own right (Coakes and Elliman, 1999).

The reference scenario. The reference scenario aimed to determine what the outcome would be if the university system for recording student data maintained its present development path, assuming no environmental change. It is essentially a prediction of the likely future of the organization if no changes are made to the current approaches.

The present development path concentrated on the short-term enhancement of current systems identified as an issue in Section 3.1. This development was of a mainly centralized system based on VAX/Alpha computers. It was projected that faculty use of the system would be achieved by modifications and extensions to the input and output routines. However, it would remain essentially as a consolidated central repository for student record data with the primary purpose of serving external agencies or the university generally rather than faculties specifically. Lack of adaptability would continue to be a problem. The central system is ill equipped to deal with the changing demands of the developing modular and nonmodular courses within the university.

In this scenario, poor provision for distributed faculty requirements is to be anticipated, and other problems would develop around such issues as the difficulties of servicing nonmodular and nonsemesterized courses. Faculties would still need to adapt to the central system, but it would become increasingly out of touch with their operational needs. Faculty-based personal information systems would continue to be used, and coordination between these and the central system would generate the already identified difficulties of duplication and error checking.

Operational access to the central system would be infrequent, and the faculties would not rely on it as an accurate source of student data. This existence of different systems containing the same data would be a major quality issue and give rise to complex administrative procedures. Lack of participation in central systems would continue to prejudice the system performance and accuracy, in both perception and reality. Pressures from outside agencies would emphasize HEMIS's objective as being the provision of management information. The conflict between central and local information systems, supplying data for use centrally, locally and externally, would remain unresolved. With central resource for operational problems being in short supply, the central systems risk becoming overloaded.

Idealized design. The process now turns to an idealized design of the student-record computer-based information system. Idealized design is a design not for some future projected environment but for the current environment. Its requirements are that it be technologically feasible, operationally viable, and capable of rapid learning and adaptation. The process of idealized design involves four steps: selecting a mission, specifying the desired properties of the design, designing the system, and determining constraints. The university statement of mission commits the organization to the provision of a wide range of courses. Operationally this translates to a complex offering of modules within a modular teaching scheme, which the student-record systems have to support.

Creating idealized design at the University of Luton. To achieve an idealized design at the University of Luton, four idealized design sessions, each lasting for two hours, were held over a four-month period. Idealized design aims not to determine detailed (software) designs, but soft, or architectural, designs of the system of concern. Sixty- eight participants, representing all of the identified stakeholder groups in the university student-record systems, attended these sessions.

To aid the creativity process, at each idealized design session Figure 1 was given to participants indicating what was to be considered as part of the system. It was made clear that the system was to be seen as the whole system of student data recording and control and not simply the Higher Education Management Information System (HEMIS) or some other administrative system in current use. Participants were invited to specify their ideal properties of the system. A number of headings, which were open to debate and change, were suggested for this specification. No other output was sought from this meeting. Using the findings drawn from each participant group, alternative scenarios were prepared to inform the way forward. Subsequently, the findings of the four participant groups were combined. There was little disagreement about the ideals, but the consensus was fed back to all participants, who were invited to comment on any misunderstandings or misrepresentations. Once this was received, it was incorporated into the results before forming the necessary scenarios.

These findings are drawn together below as the unconstrained idealized design. This shows the likely changes, assuming no constraints in the environment, if the findings of this idealized design are followed. The likely constraints and the constrained idealized design shows the changes needed if the idealized design is followed, but the assumed constraints are realized.

The unconstrained idealized design. The system needs to be adaptable. Modular, nonstandard modular (for example, different end dates or progression not at year-ends), and nonmodular courses all need to be monitored. Tools that provide ad hoc reporting are needed.

The system must recognize that accurate information on student monitoring comes from the faculties. In a student's progress everything that happens after enrollment and module choice needs to be monitored at a faculty level. The Higher Education Management Information System (HEMIS) needs to be constrained to supplying a clearly determined set of information, and its development thereby restricted to that of being the central repository for universitywide data. The design of faculty-specific systems, which supply information directly to the central system, is required. In this way, information will be recorded and controlled at its point of generation, and consistency of information will be more easily assured.

In any links from local to central systems, the integrity of the central system must be maintained, and the validity of faculty-generated data verified. The tasks assigned to central and faculty systems need to be clearly defined, but some major issues have already been identified. Among these is the need for assessment to be dealt with at a faculty level. In effect, this is already done, but the systems used are neither common, consistent with the central system, or, in many cases, even recognized. By contrast, it is likely that, with some work on the user interface, HEMIS will prove to be the correct system for controlling enrollment details, albeit modifiable from faculties.

In stark comparison to the reference scenario, there is here a clear way forward where the faculties gain real benefit from the system without significantly affecting the central need to assemble aggregate information. There are local operational benefits, which in turn lead to more accurate information held centrally on HEMIS. Thus, the ideal design has the faculties committing themselves to accuracy and integrity of data, whereas the earlier technical solution failed to gain their commitment. The shift of development effort to faculty systems, may represent a higher resource demand, but it does not appear excessive given the gains that might be achieved.

The constrained idealized design. The investigations surfaced relatively few real constraints to the proposed development, although some perceived constraints were put forward, the main one being HEMIS itself. The management reports, which are required for external as well as internal purposes, are built into HEMIS, and it is unreasonable to expect that the university will be allowed to change them in the short term. Indeed, the recommendation from this study is that any such change would be too high a risk to take in the short to medium term. For the foreseeable future, therefore, HEMIS needs to retain the information necessary for these reports. Allied to this has been the change of responsibility for producing this information from local (faculties and departments) to central officers. The knock-on effect of this has been to put a strain on the resources allocated to these tasks. The culture of the university is also a constraining factor. The current computer systems require that end users work to time-scales that serve the center but offer little local operational benefit. However, faculties and departments are relatively autonomous and often fail to provide the necessary services to the center in a timely fashion. Either the systems must change to serve the adhocratic nature of the organization, or the organization must change to serve the systems.

The constrained idealized design is little different from the unconstrained design. The constraints in the environment require HEMIS to be at the center, but show it to be lacking adaptability and having limited availability of development resources. However, the suggestion to develop faculty systems, which link to a frozen HEMIS system, at once creates a structure with the adaptability required. It also offers resources in the form of faculty personnel, very willing to be involved in such a development, and begins to overcome the cultural problems by gaining commitment to the faculty systems.

The small gap between the constrained and unconstrained idealized designs indicates that future development is controllable within the institution. Clearly, further detailed work is needed to determine the specific objectives and goals to be pursued, but the exercise to date has developed a group enthusiastic to tackle the task.

3.4. Validation of the case-study findings

In the first instance, the conduct of the intervention and the practical sessions were reviewed reflectively to answer the following questions:

- To what extent are the principles of critical systems thinking (CST)—the basis for TSI—seen within the practical intervention?

- Taking each of the commitments of TSI in turn, how could they have been achieved without using an explicitly critical framework?

Second, throughout the case study detailed records of the activities were maintained for subsequent analysis and evaluation. To ground this analysis the content of the documents was divided into some 3267 text units that were tagged with issues and themes relevant to the research using the computer package NUD-IST. This qualitative catalogue was then used to identify patterns and interpretations supported by the record (Dey, 1993; Jones, 1985).

Although a broader approach going beyond the technical might have eventually emerged by accident, the use of TSI led to a breaking of the original deadlock. The principles of CST are evident in the choice and application of Ackoff's IP, and the data analysis shows clear changes of perception and attitude on the part of participants over the period in question. The key elements here appear to have been generating the creative environment to break out of the functionalist paradigm. TSI's power to deal with emancipatory and political issues was not tested as they were unnecessary in the current environment.

All the evidence suggests that had TSI not been used, little progress would have been made beyond, perhaps, the implementation of an unsatisfactory solution.

4. Conclusions

Of necessity, this article has reported only a part of the application of TSI to resolving business process problems within a university setting. The intervention is ongoing but has already yielded significant benefits. The analysis showed that there were significantly different views of the proposed change and, with the cultural overtones identified, a real risk of polarization between the main groups of users. By treating it as a problem situation and choosing methods that focused participants on the total system and did not impose a technical solution, the risks were avoided.

As a meta-level approach behind the management of change in human systems, TSI has parallels in other approaches. The processes of formalizing the mess and finding a route forward with interactive planning (as described above) are a sort of mini-TSI cycle within the implementation stage of a larger cycle. The iterative evaluation of risk and selection of appropriate methods for each cycle is also the basis of Boehm's (1989) spiral software engineering (or ISD) life cycle.

The value of TSI lies in it not being a methodology as such. In this type of intervention, adherence to one methodology would be clearly inadequate in dealing with the range of issues surfaced at the outset. However, the informed choice flowing from TSI allowed the use of different methodologies where each had a legitimate contribution to make. In addition the use of TSI promoted a view of problems as ongoing "messes" to be improved, and within the iterative process the need for continued critical reflection keeps creativity, choice, and implementation under review at all times.

Once the need for change has been recognized, senior management may perceive all delays as loss making. However, this risk must be set against the alternative of catastrophic business failure. Examples particularly seen as relevant to this study include the London

Ambulance Service (LAS) despatch system (Binder Hamlyn, 1993) and a major systems failure in a U.S. university (Davis et al., 1992). Subsequent experience in the LAS has shown that resisting pressures to act and focusing on the human issues can produce success despite the initial delays. TSI provides a principled foundation for managing and mitigating such risks, even in a situation of conflict.

BPR involves changing human-activity systems no matter how engineering oriented the business is. The lessons learned from TSI in ISD have clear parallels in manufacturing process changes and should be applicable to reduce risks in such ventures.

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