Integrating Simulation in Organisational Design Studies

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Abstract

Designing organisational structures can be a complex and demanding task, one that can be greatly assisted by the use of carefully developed models. In this paper we investigate the efficacy of Business Process Simulation (BPS) in the context of the process paradigm of organisational design. The problem and its characteristics are presented, and BPS-specific issues and modelling considerations are discussed. Combined with generic simulation and change management theories, these issues are used to drive the development of a methodology for integrating simulation in organisational design studies. Additionally, we argue for the development of a design theory of Business Process Simulation to support the establishment and proliferation of this new and exciting research field.

Integrating Simulation in Organisational Design Studies

1. Introduction

The end of the millenium is being marked by the ongoing rise of a post-industrial *network society* (Castells 1996), characterized by a shift towards a global economy in which information and capital can flow almost instantaneously and where competition is not constrained by national or regional barriers. In order to survive and flourish in such a turbulent and complex environment (Scott-Morton 1991), organizations need to adapt themselves to new conditions.

Fueled by this need, the management of change has become an issue of paramount importance for contemporary firms. Business Process Re-engineering (BPR), Continuous Process Improvement (CPI), Total Quality Management (TQM), and other approaches have been developed to assist organizations in managing and implementing change. Many leading firms have been engaged in such programmes of change in order to improve productivity and gain competitive advantage (Jackson 1996). The increasing business and academic interest has resulted in a multitude of approaches, methodologies, and techniques to support organisational change management and implementation (for example, Wastell et al 1994, Harrison and Pratt 1993).

However, despite this support, the rate of failure in business change projects remains remarkably high (over 50% for BPR projects according to Hammer and Champy, 1993). Amongst the various explanations that have been offered for this phenomenon is a lack of tools for evaluating the effects of proposed changes before implementation (Paolucci et al 1997, Tumay 1995). Mistakes brought by business change can only be recognized once the redesigned processes are implemented, when it is usually difficult and costly to correct wrong decisions. There is a need for techniques and tools that will allow organisations to assess the impact of proposed changes on business performance *before* these changes are implemented in the workplace. Although the pre-implementation (*ex ante*) evaluation of alternative solutions is usually difficult, it is essential in order to reduce some of the risks associated with business change projects (Clemons 1995).

The emergence of the new field of Business Process Simulation (BPS) signals the increasing interest of the research community in the ways in which the technique of simulation can assist the process of modelling and analysing organisational structures. A number of recent publications, and even whole conferences and journal special issues (Scholtz-Reiter and Stickel 1996, Warren 1996, Blyth 1997), have been devoted to the field and researchers seem to agree on the potential of dynamic modelling to support business engineering (van Meel and Sol 1996). However, despite the existing application examples, BPS has not to date received the theoretical and methodological support needed to establish it as a separate research area.

This paper is an effort to address this gap by investigating the suitability of BPS in the context of *process-based* organizational analysis and design. We start by discussing how the *process paradigm* is related to traditional *simulation 'worldviews'*. We argue that organizational change is primarily a design problem and advocate the use of Business Process Simulation models as a mechanism that can efficiently address organizational design requirements. After presenting a number of existing BPS application examples, we discuss some important issues related to BPS application in practice. Drawing from these issues, as well as existing generic simulation and change management methods, we propose a specific methodology for incorporating simulation within the wider context of organizational design studies. Finally, we formulate an agenda for further research that will assist towards establishing the field of BPS within the Information Systems and Management Science research areas.

2. Process-based Organisational Analysis

A careful examination of the BPR literature reveals an interesting fact: although a 'business process' is the fundamental unit of analysis in BPR, there is no clear and unanimous definition of the term available. Table 1 classifies some definitions that have been given to business processes according to three variables: the fundamental unit of analysis of a process (the smallest identifiable and independent element within a process), the primary objectives anticipated by the process execution, and the mechanisms that the process uses to transform its inputs into meaningful outputs.

The aforementioned definitions of business processes can lead to some interesting observations:

a) There seems to be an agreement that business processes are decomposed into a number of more elementary steps (usually referred to as *tasks* or *activities*).
b) There is also some degree of agreement on what the focus of a business process should be. Most authors agree that processes have internal (i.e. within the organization) or external *customers*. A customer of a process can be either a person or another process. Processes should strive to satisfy the expectations of their customers so that they provide added value to the organization.
c) On the other hand, only a few authors seem to pay specific attention to the mechanisms which business processes utilize in order to attain their objectives. Even when mechanisms are mentioned, there seem to be widely diverse views on their nature and relative importance.

The aforementioned definitions imply a 'systemic' view of organizations, characterized by identifiable components with complex relationships between them. Organizations can be viewed as collections of entities, which interact between themselves and with their external environment in order to achieve specific objectives. This view is in line with Schmidt and Taylor's (1970) definition of a system and implies that the techniques of systems analysis and simulation have the (theoretical) potential to address the problems of organizational design and business change management. Before discussing the suitability of Business Process Simulation for this purpose, we will turn to a more detailed discussion of the *process paradigm* of organizational change. This discussion will reveal the role that simulation can play in process-based organizational design studies.

2.1. Organizational Change as a Design Problem

The process paradigm implies a new way of looking at organizations based on the processes they perform rather than the functional units, divisions or departments they are divided into. The perceived need for such a shift in organizational design stems from the fact that, despite the changes in contemporary economic and social environments, management values and principles from the industrial revolution still determine the organizational structure of many modern firms. This has resulted in companies being organized around functional units (departments or divisions), each with a highly specialized set of responsibilities. In such a form of vertical organization units become centers of expertise that build up considerable bodies of knowledge in their own subjects, but even the simplest business tasks tend to cross functional units and require the co-ordination and co-operation of different parts of the organization (Blacker 1995, Sadler 1995).

Process-based organizational analysis introduces an alternative way of looking into organizations (see Figure 1). It advocates the re-unification of separate business tasks so that they constitute a set of activities with clearly added value to their (internal or external) customers. It can be argued that process-based organizational analysis for the purpose of business change as defined above, is primarily a *design problem*. According to the long-established information processing (Tushman and Nadler 1978) and decision making (Huber and McDaniel 1986) paradigms of organizational design, processes can be viewed as collections of decision models each of which is identified by a type of decision and contains a sequence of information processing tasks (Moore and Whinston 1986). These tasks are the smallest identifiable units of analysis and their optimum arrangement is the critical design variable determining the efficiency of the resulting structures (Orman 1995).

Based on these theoretical foundations, techniques that allow for modelling business process components, experimenting with alternative configurations and process layouts, and comparing between diverse proposals for change, would be highly suitable for organisational design. We argue that BPS is well suited for this design purpose. In the following sections, we will discuss the suitability of simulation in more detail and present a methodology for employing simulation for Business Process Modeling (BPM).

3. Business Process Simulation (BPS)

Simon (1973) argues that one of the most important uses of computers is 'to model complex situations and to infer the consequences of alternative decisions to overcome bounded human rationality'. We argue that computer-based simulation models of business processes can help overcome the inherent complexities of studying and analyzing businesses as identified above, and therefore contribute to a higher level of understanding and designing organizational structures.

The basic idea behind simulation is simple (Doran and Gilbert 1994): We wish to acquire knowledge and reach some informed decisions regarding a real-world business system. But the system is not easy to study directly. We therefore proceed indirectly by creating and studying another entity (the simulation model), which is sufficiently similar to the real-world system that we are confident that some of what we learn about the model will also be true of the system.

In the context of business change management, simulation is attractive since it allows the studying of complex management systems before their implementation. Simulation can help to define deficiencies early in the design process when correction is easily and less expensively accomplished.

Simulation modeling techniques are by nature process-oriented. A process in simulation terminology is defined as a time-ordered sequence of interrelated events (*activities*) which describes the entire experience of an *entity* as it flows through a *system* (Law and Kelton 1991), a definition closely related to those of business processes presented earlier. Simulation terminology is similar to that used in organisational analysis, allowing for unambiguous communication and exchange of ideas between simulation experts and decision-makers.

A major advantage of simulation over other operational research techniques is that it allows for experimentation with any element of a business system. The behavior of both tangible (for example, material and machines) and intangible (for example, information, policies, roles) components of a business can be incorporated in a simulation model. Furthermore, simulation allows the decision-makers to obtain a ‘system-wide’ view of the effects of ‘local’ changes in a system and allows for the identification of implicit dependencies between parts of the system.

Moreover, especially when combined with graphical animation and interaction capabilities, simulation facilitates better understanding of a system’s behavior and of the impact of proposed changes, and allows for better communication of results. Managers and non-specialists can view a graphical layout of the proposed changes and understand the anticipated benefits more efficiently than would be possible with other modeling tools (for example, static flowchart models or spreadsheet financial analyses).

Finally, simulation encourages a cultural shift in the way modeling is perceived in an organization, by means of continuous measurement and evaluation of business activities. MacArthur et al (1994) have showed that once in use, simulation models encourage a culture of measurement that supports continuous process improvement within the business environment. Table 2 summarises the advantages of BPS for organisational design.

4. BPS in Practice: Application Examples

Simulation models have been used in many practical business process modeling situations. For example, Nissen (1994) presents a small-scale simulation of business processes for selecting among alternative Information Technology investments. This approach emphasizes the modeling of, and experimentation with, alternative organizational processes for the purposes of redesign and re-engineering. Prospective Information Systems are then designed to suit the chosen process schema.

Lee and Elcan (1996) present a specific, real-life application of simulation for process re-engineering in the telecommunications industry (US West Communications). Simulation models are developed to help managers gain insight, identify opportunities for change, predict the quantitative impact of re-engineering efforts, and establish tangible management goals. In a similar application, Bruno et al (1995) present the development of an object-oriented simulation model that was applied for a real-life telecommunications project in Telecom Italy.

Hlupic and Robinson (1998) present two examples of business process simulation. The first example relates to a high level model of a manufacturing organisation, where models are used to predict the time from receipt of orders to completion of the final product. The second example presents a detailed model of an organisation that was used to predict the effects of product redesign on anticipated business profits.

Giaglis et al (1997) present a practical application of business process simulation in an inter-organisational process design setting, where more than one organisations initiated a joint effort to change their relationships and communication schemes within the pharmaceuticals industry. The authors discuss the unique characteristics and requirements associated with inter-organisational simulation modelling and argue for the need to develop special-purpose simulation environments that will address Business Process Simulation requirements.

Along the same lines, simulation models have been used (Mylonopoulos et al 1995a, 1995b, Giaglis 1996) to assess the expected benefits of inter-organisational changes made possible by the use of Information Technology. The authors have developed a model that simulates trading between a number of companies along a value chain, and they used it as a vehicle for assessing efficiency gains introduced by the use of Electronic Data Interchange applications in three different industry sectors (namely textile/clothing, pharmaceuticals, and supermarkets).

Ninios et al (1995) and Vlahos et al (1998) report on a similar setting and present the development of an object oriented modelling environment to facilitate the use of industry simulation models. The authors present an example of modelling the UK electricity industry and comment on the suitability of object orientation and Discrete Event System Specification (DEVS) for simulating industries.

In the social sciences area, the emergence of the new field of Computational and Mathematical Organizational Theory (CMOT) (Carley 1995) signals the growing interest of social scientists in the potential of simulation to assist organizational theory building. For example, Hyatt et al (1997) discuss *Blanche*, an object-oriented simulation environment designed and built to specifically support simulation of organizational networks. The authors describe how the tool can support the process of theory construction and present an empirical example to test the theoretical predictions of a network-based social influence model for the adoption of new communication technologies. The authors point to the need for model-building and simulation tools that are easily accessible and understood by organizational researchers who are not necessarily proficient in simulation.

The above examples show that simulation modeling has already been identified as a suitable tool for business process modeling and has been used successfully in individual business change studies. Despite the existence of these individual cases, a comprehensive methodology that uses simulation modeling to evaluate alternative redesign scenarios and capture business process performance has not yet been developed (MacArthur et al 1994). In the following sections, we discuss some issues pertinent to Business Process Simulation and introduce a methodology for integrating simulation in business change programmes.

5. Issues and Considerations in Business Process Simulation

Simulation model development can be a complex and laborious endeavour, especially for the, not necessarily technically proficient, typical business decision-maker. Table 3 summarises some important issues in BPS that require the attention of business modellers.

Definition and Scoping

Simulation models do not constitute an end in themselves. In the context of organisational design and change management, they should be viewed as means to support informed decision making by management. Therefore, it is of paramount importance that the model boundaries and level of detail are well defined and remain constantly aligned with the objectives of the wider business analysis project. Law and McComas (1989) warn about the danger of simulation studies to be treated as complicated exercises in computer programming rather than tools to support the job of business analysts. Giaglis and Paul (1996) also discuss the requirement for objective-driven BPS modelling.

Data Collection

Simulation involves the collection of sizeable amounts of quantitative data to specify operating parameters for the simulation models. Objective data collection may be very difficult to achieve and the modelers may be forced to trade off between the structure or scope of the simulation model and the availability of data. Furthermore, direct data collection is usually impossible when the real-world system does not yet exist (for example, when building a new business site). The modeler has then to proceed indirectly (for example by collecting data from similar systems) and make additional assumptions that add to the complexity of the simulation process.

Model Development

Decisions have to be made regarding the choice of the type of model to be developed (for example, discrete-event simulation or system dynamics), the simulation 'worldview' to adopt (for example, event-based, activity-based, or process-based), the choice of the modeling platform (generic purpose programming language, data-driven simulator), etc. An analysis of the various options for model development falls outside the scope of this paper. What is important for our analysis is that translating the business process modeling requirements into working computer programs can be a complex task that should be carefully managed within the overall organizational study.

Verification and Validation

Before subjected to experimentation and analysis, a simulation model should be verified and validated. Verification is substantiating that the computer simulation program correctly represents the conceptual model of its developers. Validation is substantiating that the conceptual model correctly models the real-world system it is supposed to represent (Carson 1986, Sargent 1994). If a simulation model is not an adequate approximation of the actual system being studied, then any conclusions derived from the model will be of doubtful value.

Experimental Design

Experimentation and what-if analysis is the essence of simulation (Pidd 1992). Experiments must be carefully planned so that alternative process structures are identified and properly modelled. Because the process of generating alternative process structures is the essence of business change as well, business process modelers must pay special attention in ensuring that experiments are planned so that both simulation experimental design rules are not violated, and business requirements and goals are also taken into account.

Output Analysis

Simulation models typically generate huge numbers of numerical results that have to be carefully organized and examined. Although there are special-purpose techniques available to assist and guide simulation output analysis, the correct interpretation of results and derivation of useful recommendations, will necessarily depend on the ability of the modelers and decision makers to make informed judgments based on the output of the model runs. Gladwin and Tumay (1994) have shown that output analysis of BPS models should be different than other types of systems (for example, manufacturing). Business models should be studied in transient behaviour, as opposed to traditional simulation steady-state behaviour analyses. Also, maximum statistics may be more important than averages due to the 'burst' mode in queues.

Polymorphic Modelling

A certain proposed business change may impact the organisation on many levels, including the processes, the people, the organisational structure, the informational requirements, and so on. A well-designed organisational study should present a thorough business case identifying all possible implications of changes so that no 'unchartered' territories are left. Liles and Presley (1996) present a five-view enterprise reference architecture distinguishing between the process view, the activity view, the organisation view, the resource view, and the business rule view of an organisation. The authors argue that unless all views are included, a comprehensive enterprise model cannot be developed. The implication for BPS models is that they need to be polymorphic, in the sense that they should allow for different organisational perspectives to be modelled and analysed in an integrated and consistent manner.

Modular Model Analysis and Design

A BPS model will usually depict one or more business processes. A process typically requires co-ordination and synchronisation of the activities of different parts of the organisation (for example, different departments). BPS models should allow for defining sub-models that will clearly indicate the ‘decision territories’ of organisational parts to enable them assess the impact of changes on their own performance. Of course, at the same time, modellers should keep an eye on the influence of ‘local’ changes on ‘global’ performance. There is a need for modelling conventions that will allow for modular model implementation and for experimentation with selected sub-models. Although simulation as a technique can theoretically be used for modular model development and use, the majority of existing simulation packages do not generally include such characteristics.

Model Decomposition and Integration

Implementation of modular models should be achievable even if this is not the initial target of the modelling exercise. For example, two firms might develop models independently of each other and at a later stage wish to link these models into a inter-organisational model. To enhance model reusability, individual models should be easy to link, without extensive modifications. In the same way, a single model might need to be decomposed to sub-models, when for example departments of an organisation need to assess their individual performance. Perhaps the only way to achieve problem-free model decomposition and integration, is by defining standard interfaces between models. At the current status of non-existence of industrial standards to define the interconnectivity issues between simulation model components, this requirement cannot be easily satisfied.

Multilevel Analysis

An issue related specifically to Business Process Simulation concerns the multiplicity of analysis levels within a BPS study. Seror (1994) argues that organizational models may require different levels of analysis according to the objectives of the modeling study and the level of decision making. Such levels of analysis include the individual, the group, the process, the organization, the industry sector, the national economy, the society, etc. For example, modeling the effects of a certain change in government policy will naturally require different types of analysis than modeling the introduction of a new Information Technology application in the production facility of a single organization. Such differences in scope of the organizational analysis study have certain implications both for the development of the model and the data that should be collected and analyzed. It is therefore imperative that Business Process Simulation is well targeted and planned to match the decision-making requirements and the objectives of the study.

6. A Methodology for Business Process Simulation

BPS has up to date received limited theoretical support, despite the need for such a support to ensure that a minimum level of rigor is maintained within a new research area. The development of methodologies is the first step towards establishing the field of BPS, as they can facilitate structuring, planning, and monitoring, and help towards the codification of experience and ideas (van Meel and Sol 1996).

In this section we will combine generic simulation methodologies on the one hand with generic approaches to business change management on the other, to develop a specific methodology for BPS. This methodology should explicitly address the issues identified above to ensure that they are properly managed within an organisational design study.

Figure 2 illustrates a generic approach to simulation model development advocated by Law and Kelton (1991). The methodology consists of ten steps and focuses on aspects of model development, validation, and statistical control of simulation experiments.

Although these aspects are clearly important for ensuring that simulation model development and analysis are performed correctly, it is equally important that the specific requirements of process change management are also captured in a specific BPS methodology. Figure 3 illustrates a generic approach to process redesign advocated by Davenport (1993). This methodology emphasises the process of aligning process redesign with strategic business goals and capturing the essence of process analysis. However, it does not provide guidance as to how the steps identified can be actually carried out or how can each step be supported by modelling techniques and tools.

Drawing on these two methodologies, we present the ISEC methodology for incorporating Business Process Simulation in a process change study (Table 4). The methodology that we propose consists of four main phases (Initiative, Simulate, Experiment, Conclude) that can be further decomposed into a number of more detailed steps.

Phase 1: Initiate

This phase is concerned with 'preparing the ground' for the use of simulation in an organizational design project. As mentioned above, it is important that the scope and objectives of the overall organizational design study and the (more detailed) sub-objectives of the simulation exercise are well defined and remain aligned throughout the study duration. The definition of objectives will influence the choice of the modeling methods used, the definition of the model boundaries, and the identification of the desired properties of the simulation models (for example, modeling paradigm used, choice of computer simulation environments). Furthermore, the key performance indicators (KPIs) should be defined as early as possible in the study. KPIs are the critical business variables that will later be used as criteria for defining the acceptability of alternative process designs. KPIs may refer to cost indicators, cycle time data, throughput metrics, quality measures, and so on. KPIs must be use to define the levels of analysis that should be performed in the simulation models and any requirements for decomposition and/or integration of models.

Phase 2: Simulate

The actual procedure of building the simulation models starts by collecting data from the existing system (or by making substantiated assumptions to accommodate the lack of such data). The simulation model itself can then be implemented. Specific attention must be paid to ensure that all relevant organisational perspectives are taken into account and integrated when developing the AS-IS model(s). The study objectives and levels of analysis (articulated in Phase 1) should be used to decide on the perspectives that need to be modelled for a given study (degree of model polymorhism). After the AS-IS model(s) have been developed, they should be verified (i.e. check that the model was built right) and validated (i.e. check that the right model was built).

Phase 3: Experiment

After a valid and credible model has been built, the actual process of using the model for experimentation, 'what-if' analyses, and decision making can proceed. This phase is concerned with running the AS-IS model(s) and obtaining data to determine the problems faced and opportunities for process change. After new process structures and simulation experiments have been designed, the respective TO-BE simulation models should be developed and run. The aim is to identify an acceptable organization of activities within the processes so that the decision-makers are satisfied with the (simulated) performance of the new process designs. The analysis should be performed in all the levels of analysis identified in Phase 1. The Experimentation Phase will necessarily involve changes (which may be substantial) in the initial simulation model(s). It is therefore most likely that an iterative cycle of Phases 2 and 3 will be initiated in order for alternative simulation models to be developed and experimented upon.

Phase 4: Conclude

The final part of the organizational design study is to use the simulation results in order to reach informed decisions about changes and to identify the business requirements of introducing these changes in the organization. This may involve cost-benefit analyses of the respective investments (or any other means of deciding upon the feasibility and justifiability of changes), migration plans for introducing the changes in the workplace, and so on. Once the redesign processes are introduced, the simulation models can be continuously used to monitor business performance and initiate new cycles of changes if and when required.

It must be noted that the ISEC methodology is not a sequential process. It should rather be viewed as an iterative, spiral framework whereby the user may need to repeat previous steps until satisfactory results are achieved. For example, if the modeler or the decision maker is not satisfied with the validation of the initial model, they may wish to go back and initiate a new ISEC cycle in order to include additional or modified model properties and/or to collect additional data on the existing system.

Each step of the iteration builds upon the previous models and analyses and incorporates additional requirements.

7. Conclusions: The Road Ahead

We argued that the analysis and design of organizational processes can be assisted by the development of business process simulation models. Simulation can provide a valuable mechanism for addressing the problem of quantitative and qualitative evaluation of prospective designs of business processes. Furthermore, simulation can facilitate experimentation with and study of multiple perspectives of organizations, thus contributing towards a holistic view of enterprises and, ideally, towards increasing the quality of change decisions.

However, the road to successfully applying simulation in business process design is not trouble-free. Organizations and organizational processes are sufficiently complex systems so that their analysis presents a number of difficulties and particular issues that should be addressed. Problems related to data collection, experimental design, and multi-perspective model analysis, are only some of the issues that have been identified in this paper.

Business Process Simulation is still at an embryonic level of study, despite the widespread use of simulation as a modeling technique in various other application areas. There is ample space for further research that will identify further issues and propose remedies for problems relating to the application of simulation in organizational design. Future research can be concerned with developing simulation theories, methods, and software tools that will directly address the problem of process-based organizational design. One aim could be to develop a comprehensive, prescriptive *design theory of Business Process Simulation* that will generalize on the distinct problems and modeling requirements of this application area. This theory could drive the development of special-purpose simulation software packages that will assist organizations in employing simulation in organizational studies. Other related areas of research are concerned with the application of simulation for Information Systems modeling or with the special requirements of modeling human behavior as part of the business environment. These areas relate primarily to the need identified above for aligning multiple perspectives of analysis in business process simulation studies (polymorphism).

The convergence of the aforementioned research directions could lead to the development of integrated computer-supported environments to support the process of organizational design. We envisage the development of an '*organizational design workbench*' that will build upon a simulation environment and complement it with a number of other computer-supported tools to assist the various phases of design identified in the ISEC methodology. Such tools may include:

1. Tools that capture data from the actual organizational processes to facilitate design and population of simulation models (*data collectors and analyzers*).
2. Tools that support the development of modular, polymorphic business simulation models consistent with the BPS theoretical propositions (*BPS Simulators*).
3. Tools that support experimentation with and analysis of simulation output results in order to assist decision-making (e.g. special-purpose *Decision Support Systems* and *Knowledge based software tools*).
4. Tools that will support the actual implementation and monitoring of the everyday operation of redesigned business processes and collect data about actual process performance (e.g. *workflow management environments*). These tools could provide input to the data collectors above and be the starting point of new organizational design projects.

Finally, an issue of practical importance relates to the level of simulation awareness in industry. Hollocks (1992) reports on the findings of a study commissioned by DTI (the UK Department of Trade and Industry) and points to the remarkably low level of simulation awareness within the manufacturing sector. Despite the huge benefits claimed by those practitioners that were aware of and had used simulation, the industry as a whole remained largely ignorant of the real potential of the technique, resulted in an estimated annual loss of £300 million in UK alone (in the form of missed benefits). If awareness of the technology is low in the manufacturing industry where simulation has been used for over thirty years, one can safely assume that BPS awareness will be much lower in the service sector. Focused and applied BPS research, combined with wider dissemination of results and better simulation education of future managers, are needed in order to ensure that similar benefits are not missed by contemporary organisations, especially in the face of today's competitive business environment.

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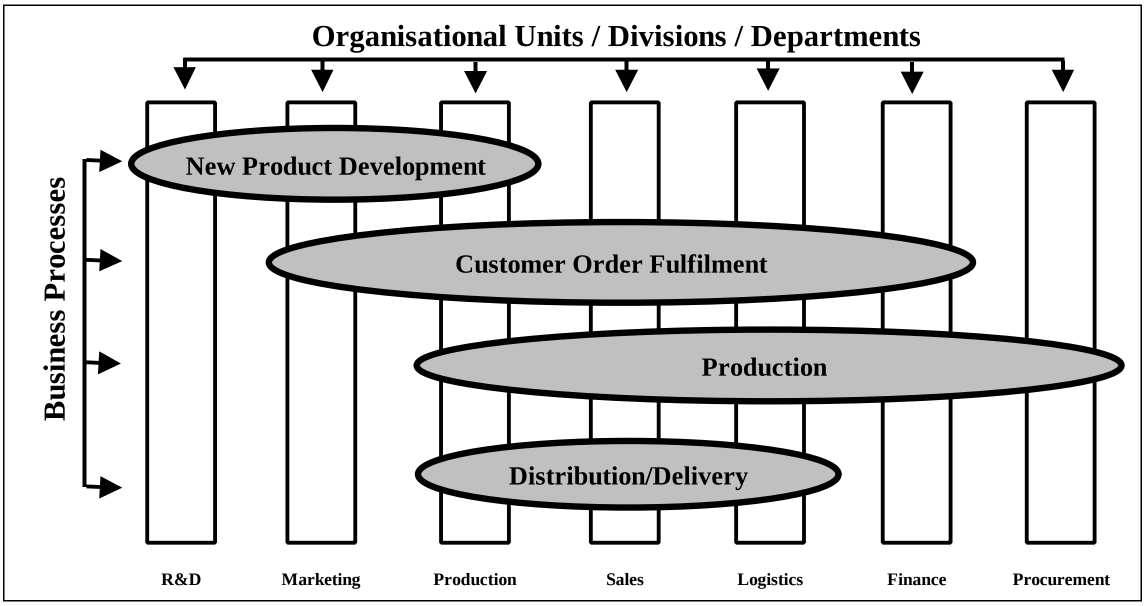

Figure 1. Vertical vs. Horizontal Organisational Design

	UNIT OF ANALYSIS	OBJECTIVES	MECHANISMS
Pall (1987)	Work Activity	Produce a specified end result (work product)	People, materials, energy, equipment, procedures
Davenport & Short (1990)	Task	Achieve a defined business outcome	*Not specified*
Davenport (1993)	Activity	Produce a specified output for a particular customer or market	*Not specified*
Hammer & Champy (1993)	Activity	Produce value to the customer	*Not specified*
Talwar (1993)	Activity	Achieve a pre-specified type or range of outcomes	*Not specified*
Earl (1994)	*Not specified*	Provide a product or service to a customer	Tasks, roles, people, departments, functions
Omrani (1994)	Activity	Achieve a business objective	*Not specified*
Ferrie (1995)	Activity	Satisfy an agreed customer need	*Not specified*
Ould (1995)	*Not specified*	Achieve a specific goal	People, machines
Alter (1996)	Step or Activity	Create value for internal or external customers	People, information and other resources
Saxena (1996)	Work activity	Produce specific outputs	*Not specified*

Table 1. Business Process Definitions

Simulation can be used to model Complex Management Systems that cannot be analytically studied (Law and Kelton 1991).
Simulation allows for replicable experimentation and answering ‘what-if’ type questions.
Experimentation with both technical and social elements of businesses is possible (Giaglis and Paul 1996).
Process deficiencies and bottlenecks can be identified without disrupting the actual business operations by prototyping or implementation.
Simulation terminology and ‘worldviews’ are related to the process organisational analysis paradigm.
Simulation can quantify the intangible costs and benefits associated with a proposed investment decision (Giaglis et al 1997).
Graphical representation, animation and interaction allow for better understanding, idea generation, and communication between users.
BPS encourages a shift in organisational culture towards continuous measurement and improvement (MacArthur et al 1994).

Table 2. Advantages of Simulation for Organisational Design

Generic Issues	*BPS-Specific Issues*
Definition and Scoping	Polymorphic Modelling
Data Collection	Modular Model Design and Analysis
Model Development	Model Decomposition and Integration
Verification and Validation	Multilevel Analysis
Experimental Design	
Output Analysis	

Table 3. Issues in Business Process Simulation

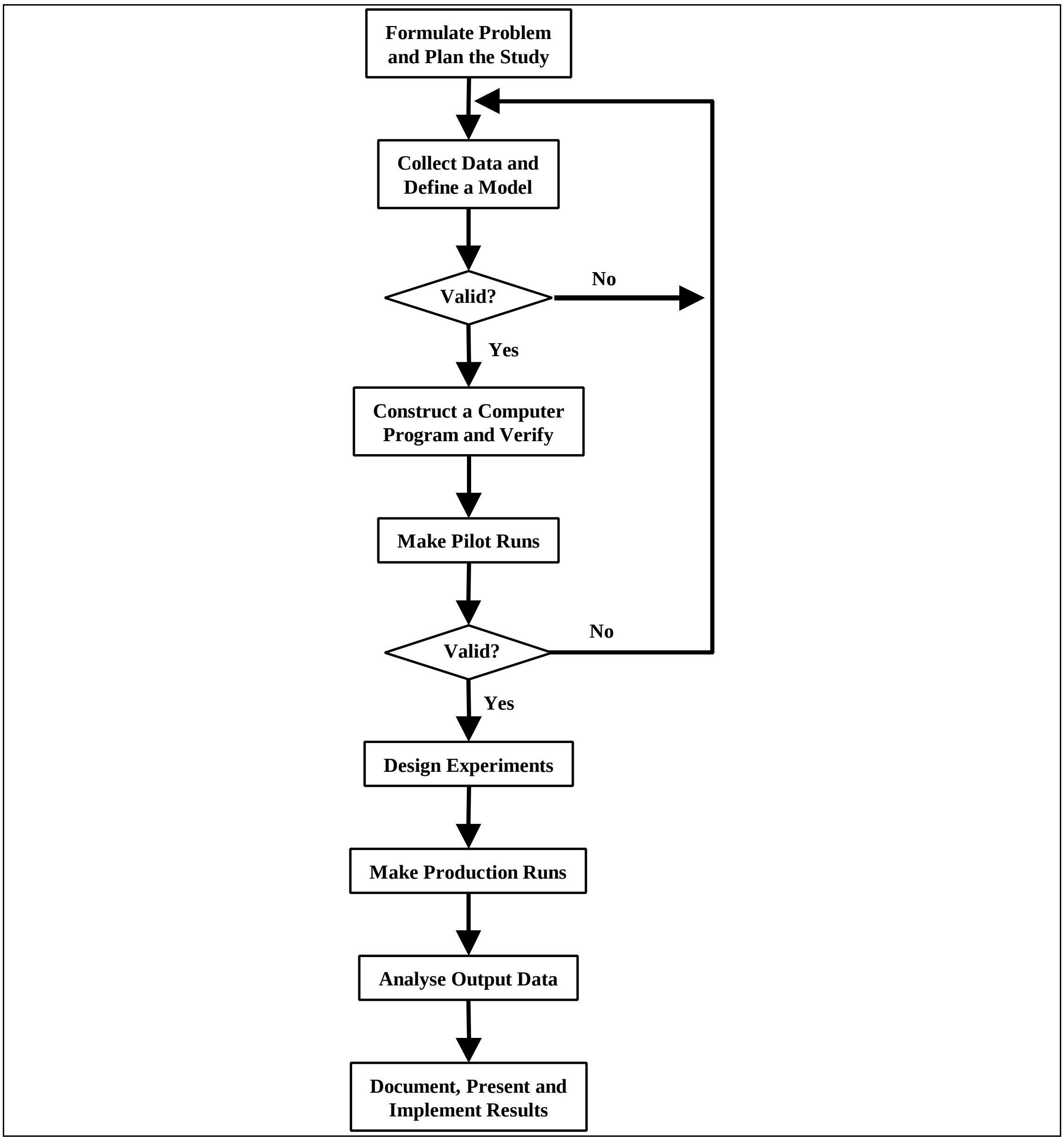

Figure 2. Steps in a Generic Simulation Study (Law and Kelton 1991)

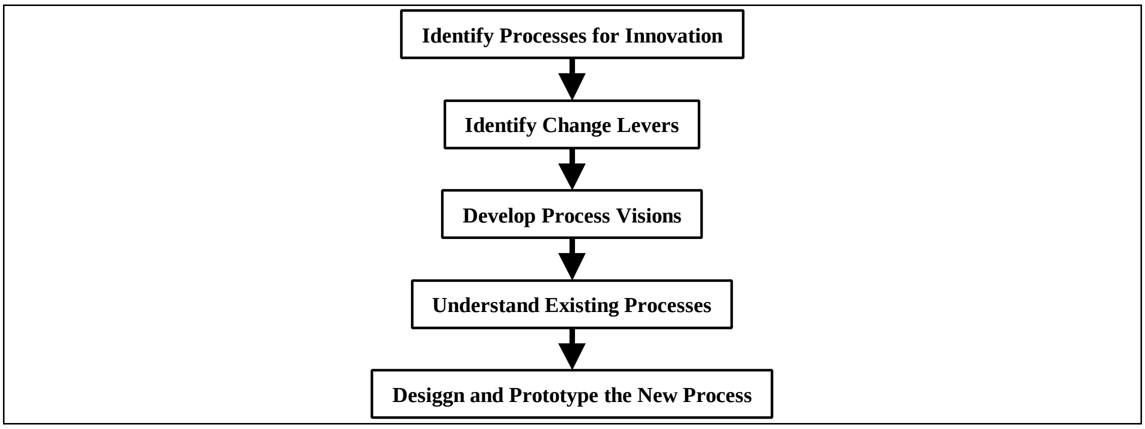

Figure 3. A Generic Business Redesign methodology (Davenport 1993)

Initiate	Step 1.a:	Define Scope and Objectives of the Organizational Design Study
	Step 1.b:	Define Scope and Objectives of the Simulation
	Step 1.c:	Define Business Key Performance Indicators
	Step 1.d:	Identify Levels of Simulation Analysis and Model Decomposition/Integration Requirements
Simulate	Step 2.a:	Collect Data
	Step 2.b:	Develop (Polymorphic) AS-IS Simulation Model(s)
	Step 2.c:	Verify Model(s)
	Step 2.d:	Validate Model(s)
Experiment	Step 3.a:	Run AS-IS Model(s) and Analyse Results
	Step 3.b:	Design New Proposed Processes, Design Experiments
	Step 3.c:	Develop (Polymorphic) TO-BE models
	Step 3.d:	Run TO-BE models, Analyze and Compare Results
Conclude	Step 4.a:	Decide on Proposed Changes
	Step 4.b:	Develop Migration Plan
	Step 4.c:	Implement Changes
	Step 4.d:	Monitor Performance

Table 4: The ISEC Methodology for Business Process Simulation