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# Strategy Realisation Process: A Modelling Enabling Approach

By

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Doctoral Thesis

Submitted in partial fulfilment for the requirements for the award of

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To Isela, for always believing  
and Diego for his sole existence

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# ABSTRACT

Changing conditions within an organisation's environment necessitate enactment of the strategy realisation process to produce relevant coping strategic intents to successfully reconfigure current, or potential, process networks to better exploit potential opportunities or minimise impacts of a potential threats.

Literature regarding strategy realisation has not produced a coherent approach to describe and decompose the subprocesses of the strategy realisation, i.e., several different approaches have been taken to enact some components however there is no formal decomposition of such process. A revision of the strategy realisation literature was conducted and a formal decomposition model for the strategy realisation process was conceived.

Various modelling tools, methods and techniques were surveyed to enable the underpinning of the proposed strategy realisation conceptualisation. Utilising a combination of static, causal and simulation modelling methods and tools, a research methodology was proposed to underpin aspects of the enterprise which would facilitate the decision making process of the strategy realisation process.

Two case studies were identified in which the proposed methodology could be implemented. In the first case study, two differing strategic intents were analysed within the same organisation under opposing economic conditions. The second case study observed the implementation of a different system configuration to achieve a strategic intent. The strategy realisation process was studied using the described conceptualisation and the enterprise was modelled. Key variables, set by senior management were observed and quantitative analysis was undertaken and reported.

It was concluded that the use of modelling methods providing quantitative and qualitative analysis facilitated the decision process within an organisation. A new conceptualisation of the strategy realisation process and the integration of modelling methods, tools and techniques were devised.

***Keywords: Strategy, strategic planning, CIMOSA, Enterprise Modelling, Causal Loops, Simulation***

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# GLOSSARY

SR – Strategy Realisation

ME – Manufacturing Enterprise

MS – Manufacturing Systems

EM – Enterprise Modelling

CLD – Causal Loop Diagram

CIMOSA – Computer Integrated Manufacturing Open Systems Architecture

DP – Domain Process

BP – Business Process

EA – Enterprise Activity

FE – Functional Entity

FO – Functional Operation

GRAI – Graphic a Resultats et Activites Interlies

GIM – GRAI Integrated Methodology

IDEF – ICAM Definition Languages

CS – Continuous Simulation

DES – Discrete Event Simulation

# **CHAPTER 1 RESEARCH**

## **INTRODUCTION**

### **1.1 INTRODUCTION**

Organisations are a collection of process networks that interact with each other to successfully achieve the mission and objectives that such entities possess (Vernadat, 1996). Resources available, either human, technological or capital investment, enable the successful enactment of processes contained within those networks under parameters set by management (Mintzberg et al., 1998).

Political, economic, social and/or technological conditions generated externally or internally, necessitate an organisational change within current operations to better cope with evolving requirements posed by such conditions (Mintzberg, 1994). Shifting market requirements, global or local economic conditions, changes in the legal or political environment are among many factors which might lead an organisation to review relevant portions to reconfigure current process organisation so that it may effectively respond to external pressures or stimuli (O'Regan and Ghobardian, 2002). As such reconfigurations occur, potential opportunities can be identified and acted upon so that potential threats can be minimised.

Continuous challenges faced by the organisation necessitate configuration changes of current or potential resources and process networks to better cope with requirements posed. The strategy realisation process facilitates the creation, planning and implementation of potential position that enables the organisation to effectively address requirements posed by the environment (Porter, 1990).

### **1.2 STRATEGY REALISATION PROCESS OVERVIEW**

Organisations comprise a diverse array of finite resources that can be configured in multiple ways to achieve a specific task or goal set by the organisation within specific parameters of execution (Collins and Porras [CP2000]). Successful configuration of such resources can guarantee a survival for the organisation, especially within uncertain prospects or in the midst of severe competition for a niche market. The organisation's senior management are forever be presented with alternate configurations to effectively undertake the challenges present or perceived (Porter [P1990]). It is imperative that selection of a potential candidate configuration that deploys current or future envisaged resources of the organisation can address effectively and efficiently with the opportunity presented (Mintzberg et al., 1998).

There have been several approaches to the strategy realisation process (Mintzberg et al., 1998; Whittington, 1993). Such approaches have generally described the process in which strategy realisation is formed and provided various tools (Porter, 1990; Weirich, 1982; Mintzberg et al., 1998) to organise a proposed strategic intent and to communicate such intent within the organisation. However, most attempts utilising such tools and methods do not account for the organisation's unique configuration, leading to some strategic intents failing to be implemented or not achieving their overall intent (Mintzberg et al., 1998).

Given the cyclical nature of strategy realisation (Collins and Porras, 2000; Mintzberg et al., 1998; Porter, 1990), organisations necessitate to enact such process several times within their lifecycle (Mintzberg, M1994; Kaplan and Norton, 2000). The outcome of such cycles it is to better prepare the organisation for the prevailing conditions within the current constraints. It can be argued that predicting successfully the outcome of a particular strategic intent generated by the strategy realisation process would enable the organisation to better position itself against current or potential competitors. Therefore, an understanding of the current and potential process networks the enterprise comprises would benefit the strategy realisation process so that

potential strategic intents can be analysed before any resource allocation is made. Such understanding would additionally benefit the organisation so as to appreciate the necessary interfaces and potential impacts a proposed reconfiguration would have amongst relevant stakeholders throughout the organisation, enabling a coherent implementation rather than a fragmented approach of so called 'local optimums' [Womack and Jones,1997).

Therefore, it is necessary to consider an approach which would generate a formal representation of the actors, processes, interfaces, resources, etc. that comprise an enterprise so that any potential candidate strategic intent can be analysed before so that the strategist can observe the impact on such components of a proposed intent.

### **1.3 ORGANISATION MODELLING**

Several modelling tools and methods have been proposed to underpin an organisation process network; so as to gain further understandings about the organisations activities and resources (Vernadat [V1996], Forester [F1991]) The primary objective of these modelling approaches is to capture the state of current organisational process structures, resources and relations so as to generate potential candidate solutions that fulfil the organisation's need for change and reconfiguration. Such methods enable the analyst to comprehend aspects of the enterprise (Chen et al., 1997; Chatha et al., 2003; Vernadat, 1996; Kosanke, K1995).

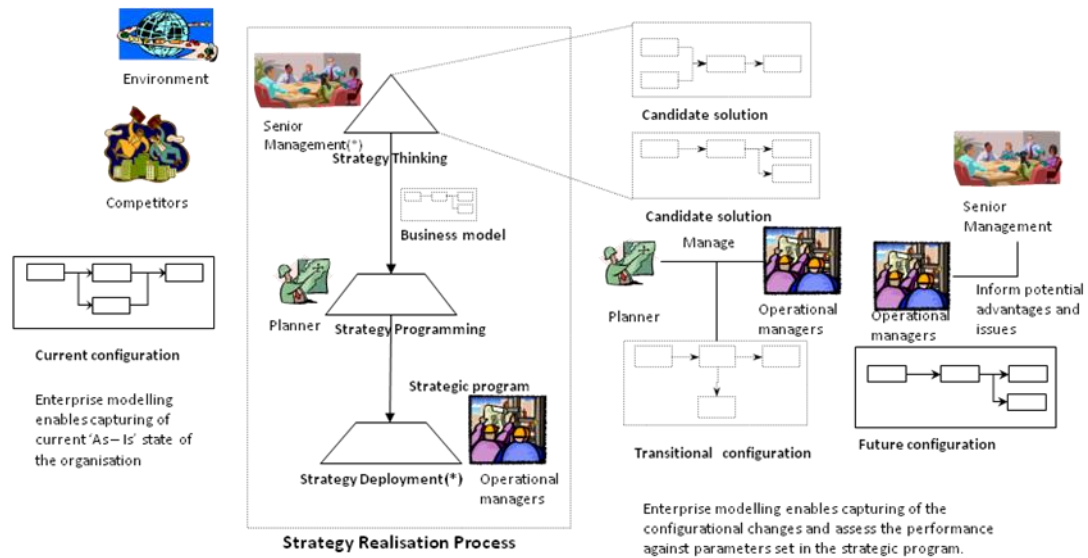
Additionally, various computer executable simulation software application have been utilised (Fowler, 2003; Pidd 2004) to observe behaviours of key variables within manufacturing systems to quantitatively analyse their performance under various scenarios. Such analysis provides a baseline for the decision making process of an organisation, however typically such attempts are done within a limited scope of the organisation, without considering the overall enterprise (Fowler, F2003).



#### **1.4 POTENTIAL USE OF ENTERPRISE MODELS WITHIN THE STRATEGY REALISATION PROCESS.**

From the ensuing discussion, it can be argued that there is a need for the strategy realisation process to consider potential impacts of a proposed strategic intent within an organisation. As the strategy realisation process affects multiple aspects of the organisation, an understanding of such aspects would enable a successful reconfiguration and deployment within the organisation of a proposed strategic intent.

Traditionally, models of the organisation used for analysing potential impacts of the proposed intent are 'detached' of the relations of the organisation. i.e., they are a generic model of an organisation with a generic business process network (Chandler, 1962; Mintzberg et al., 1998), resources and actors which may or may not be present at a particular organisation. By utilising a formal representation of a particular organisation undertaking the strategy realisation process, such representations would more adequately inform the strategy realisation process and indeed the decision-making process. Multiple aspects of the organisation and its inherent relations can be viewed utilising such modelling techniques as enterprise modelling, which would provide a static, i.e., relatively enduring, view of the process network. Additionally, causal relations between various key variables could enable the strategists to visualise impacts upon the current process relations, and simulation techniques would provide quantitative analysis to the time-dependent aspects. Models created of the organisation would serve as a 'baseline' for the organisation to consider various candidate reconfigurations and observe impacts on multiple areas of the organisation so that a potential reconfiguration would deliver the proposed benefits of the overall strategic intent considering the organisation's current and potential resources and interfaces.



(\*)Typically, senior management would be involved, yet this process can be done throughout the organisation

Fig. 1.1 Need of coherent set of models to deploy the strategy realisation process

## 1.5 SCOPE OF RESEARCH

Thus, the scope of the present research lies within the potential link between the strategy realisation process and static, i.e., relatively enduring aspects of the organisation such as process networks and dynamic modelling, i.e., time dependent. The present research investigates a suitable coherent set of subprocesses within the strategy realisation process to which aspects of enterprise and system dynamic models inform such sub-processes to provide quantitative analysis of impacts within current and potential candidate solutions as well as minimizing implementation risks associated with changing current topologies of processes within the organisation.

## 1.6 THESIS STRUCTURE

Chapter 2 presents a literature review of relevant aspects of the strategy realisation such as varying approaches to realisation and tools identified by multiple schools of thought. Various enterprise modelling tools and methods are discussed which enable the underpinning of multiple aspects of the enterprise and modelling methods and tools available.

Chapter 3 provides a brief gap analysis which had been identified from the literature and established relevant research methods that could have been used in the present research. The primary research hypothesis is stated along with research objectives.

In chapter 4 the strategy realisation process is analysed and a new characterisation, and potential interfaces between, components of this process is identified. The use of modelling constructs is discussed as an aide that will inform relevant aspects of strategy realisation.

Chapter 5 discusses the research methodology that will be applied in potential candidate case studies. A unified use of multiple modelling methods and technologies is proposed.

Chapter 6 presents the overview of an organisation selected together with the strategy realisation process described.

Chapter 7 further discusses a potential growth scenario that the organisation previously described intended and discusses relevant impacts within the organisation's production system and potential benefits of implementing such a strategic intent.

Chapter 8 discusses the situation where the previous organisation was faced with a decline in orders and a reversal of the growth pattern predicted in previous chapters. This chapter discusses impacts on the variables considered in the strategic intent.

Chapter 9 presents a new case study in which a similar sized organisation is faced with a manufacturing system reconfiguration strategic intent similar to that discussed in the previous chapters. A new technology is applied and the results are analysed and discussed both in terms of the case study and the strengths and weakness of the proposed methodology.

In chapter 10 both strengths and weaknesses of the present methodology are discussed. Reflections are made regarding the validity of the present research and contributions to knowledge are identified.

Figure 1.2 illustrates the thesis chapter structure utilising an IDEF0 model.

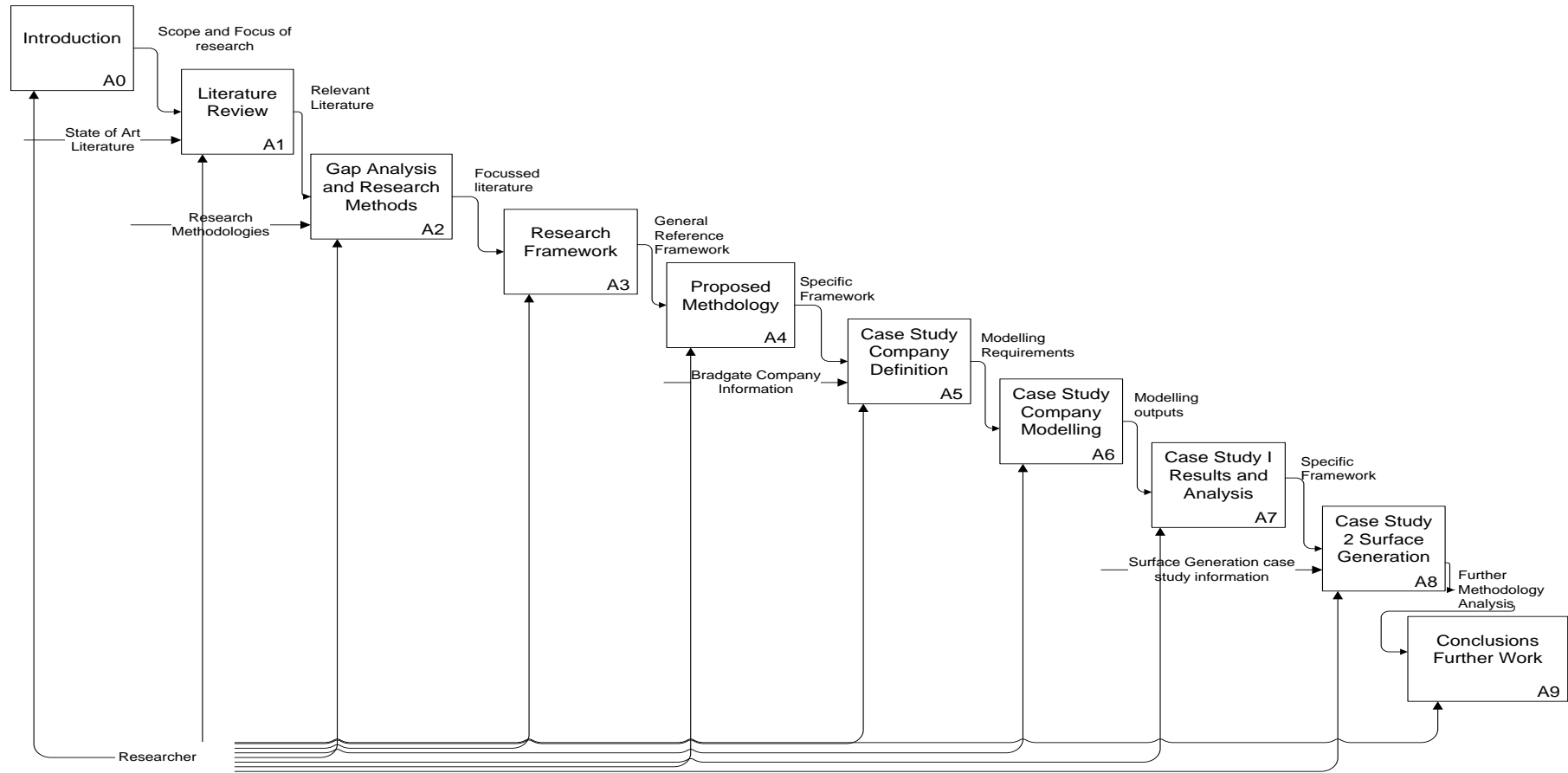


Fig 1.2 IDEF0 model of the structure of the thesis

# **CHAPTER 2 LITERATURE REVIEW**

## **2.1 INTRODUCTION**

The previous chapter delimited the scope and focus of the present research within the context of the general strategy realisation domain and the enterprise modelling (EM) domain. It has been observed that there is a need of a holistic view of the strategy realisation process. Therefore, a detailed surveying of the literature was considered necessary so as to gain an understanding of state of the art research previously developed.

The present chapter presents findings from current literature relevant to domains identified and provide an analysis which would enable the researcher to propose a methodology.

## **2.2 STRATEGIC REALISATION PROCESS**

The strategy realisation (SR) process enables the organisation to reconfigure itself to effectively and efficiently respond to opportunities and challenges, both present and foreseen in the environment. The main goal is to prepare ongoing SR processes to cope with the shifting in paradigms that the market, vendors, government, etc. dictate and to present a better solution than the enterprise's competitors. It follows that an enterprise needs to explicitly understand the strategic realisation process as effective attainment of SR should enable a sustainable advantage to be achieved over its competitors. O'Regan and Ghobadian (2002) have observed the development of dominant strategic realisation paradigms over the past four decades. This indicates that strategic realisation processes adopted by organisations have evolved over time. Mintzberg et al (1998) and Whittington (1993) have classified the current strategic realisation literature into 'schools of thought' that characterise the main content of that literature. Although it has been observed that there is no universally accepted definition of the term 'strategy' (O'Regan and Ghobadian, 2002; Mintzberg et al., 1998; Whittington, 1993), there is a consensus amongst them that the strategic realisation process can be further

decomposed. Mintzberg (1994) proposed a primary decomposition of the strategic planning into two sub-processes, i.e., strategic thinking and strategic programming. De Wit and Meyer (2004) expanded this decomposition by adding a third sub-process, strategic implementation yet they generally agree that the strategic process is normally centred on thinking, planning and implementation activity types (DeWit and Meyer (2004)). Ordered groupings of these activity types can be considered to comprise types of sub-process that concern a fundamentally important aspect (or view) of the strategic realisation process. Collectively these views enable the enterprise to determine and achieve intended purposes through its lifetime.

Therefore there is a significant body of opinion and backing evidence that the three main processes from which the strategic realisation process is constructed, are: *strategic thinking*, *strategic programming* (also known as planning or formulation) and *strategic deployment*<sup>1</sup>. Strategic thinking enables the senior management or strategist to identify relevant external and internal information that could potentially affect the current process network of an enterprise (Mintzberg et al., 1998; Magretta, 2002). Such subprocess produces a logical ‘business model’ that can be tested for logic validity and basic financial constraints (Magretta (2002)). Strategic programming enables the strategist to allocate resources, set key objectives, milestones and a timeframe for the activities necessary to enact the proposed strategic intent within an organisation (Harrison, 1995; Mintzberg, M1994). The objective of this subprocess is to present the organisation with an program of activities, metrics, resources needed to effectively implement the strategic intent (Mintzberg (1994)). Strategic deployment enables the organisation to monitor the performance of the activities described in a strategic plan and suggest potential corrective actions should there be a deviation with the original goals and objectives set (Freeman (2003)).

Previous authors (Mintzberg, 1994; De Wit and Meyer, 2004) have indicated that the strategy realisation process follows essentially a ‘sequential’ flow of

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<sup>1</sup> The term ‘strategic deployment’ will be utilised to avoid confusion with ‘strategic implementation’ because the latter is identified as an appendage of the strategic programming.

activities from thinking through programming to deployment, but that dependencies and constraints linking (the outcomes, resources, etc) of activities necessitates that the enactment process requires asynchronous and iterative follows between activities belonging to the three main processes. Typically, the strategic programming process is scheduled for a specific period of time (see Ansoff, 1965; Lorange and Vancil, 1997) but the strategic thinking and the strategic deployment are processes that run continuously in the organisation. A strategist (or a group of strategists) may regularly evaluate the current business model, enterprise structure and environment in search of potential opportunities or challenges. Also the strategic deployment process will normally realise an ongoing effort to enable the enterprise to achieve the proposed strategic intent, by suitably modifying the processes, structures and therefore configuration of the enterprise. Maintaining necessary (causal and temporal) dependencies between all enterprise processes is an essential ingredient of successful implementation of any strategic option for the enterprise. As such, direction setting inputs may impose constraints or offer opportunities to be explored by enterprise personnel within the context of sub-processes. Strategic programming typically takes the form of a scheduled process and normally occurs infrequently in the organisation, i.e., as an annual or biannual event or when the organisation faces a major challenge in which the variables and premises of the current strategic intent have been changed.

### *2.2.1 Strategic Thinking*

The strategic thinking process enables the recognition and encoding of relevant characteristics of the environment (or environments) within which the organisation needs to operate. It can also encode relevant organisational variables that are seen as presenting opportunities or challenges to the present or intended future courses of action of the enterprise. It enables enterprise strategists to assess properties of the organisational, internal and external, environment in search for conditions that could present an opportunity or a threat. Thereby strategists can propose intended courses of action to enable the enterprise to maximize perceived benefits while

minimizing potential damaging behaviours and conditions. It follows that strategy realisation processes normally need to constitute a collective and continuous process within the organisation, i.e., the holistic process is not a 'scheduled' event that should occur within a specific frame of time, even though some larger organisations set apart a period of time in which the main strategist of the organisation can meet and produce a strategic intent for the company (Eigeles (1997)).

Miles and Snow (1978) have pointed out two main strategy realisation approaches, namely proactive or reactive. The proactive approach is when the organisation is actively seeking to assess the environment as well as its internal structure in order to elicit potential ideas that might be considered to impinge on the strategic intent. The strategist proposes an intent that is designed to impact on the environment in a particular (and beneficial to the enterprise) manner. This could for example relate to the introduction of a product or service to the market. The reactive approach is that the organisation reacts upon market, competitors, government, etc. stimuli and addresses the present opportunity or challenge as part of its strategy realisation processes. Thus in reactive mode, the strategist observes the environment after a significant event has taken place that may disrupt the present enterprise configuration. The strategist reacts accordingly and proposes a reconfiguring of existing processes and structure in order to undertake the problematic situation. This could be the case when there is industry dominance or the level of uncertainty is high or a new product or technology has been introduced and directly affects the activities of the enterprise (Courtney et al. (1997)).

The literature also identifies three main sub-processes focused on informing strategy realisation, namely: (1) recollection, gathering and filtering of information (Corner et al., 1994; Huff, 1990), (2) creation and proposal of alternative ideas based on the information recollected (Brahm and Kleiner, 1996; Kay, 1995; Seaker and Wallace, 1996) and (3) evaluation, assessment of the viability of the proposed ideas (Magretta, 2002; Morris et al., 2005). The processing of information can enable strategists to discern between valuable



strategic information and 'noise', i.e., information that is not relevant for the organisation. Corner et al. (1994) described this decision making step as paying explicit 'attention' to what the information has to present, both to the organisation and to the individual. Huff (1990) and Senge (1990) established the concept of 'mental models' as the perception, i.e., images, assumptions, bias, etc., that an individual or an organisation has about the surrounding environment. They constitute the reference framework in which the enterprise takes its decisions, enacts its processes, etc. Eden and Ackerman (1998) have proposed strategic maps that provide a graphical representation of individual thinking in regard to strategic issues. This framework allows the 'thinking background' of the individual to be made explicit and to be explored and discussed when seeking the consensus the strategic team wants to achieve.

#### *2.2.1.1 Filtering*

Organisations and individuals deal with considerable amounts of information regarding the activities. Yet not all information presents an equal amount of relevance to the performance of the individual or the enterprise. Therefore, there is a need to filter the information that will be used during the performance of the activities. Huff (1990) has suggested that people utilise 'mental maps' in order to classify and decode the information presented. In an equal manner, when organisations are faced with information that pertains to their activities, it is necessary to classify it in terms of the relevance it presents. Mintzberg et al. (1998) suggest several concepts that organisations utilise in order to discard irrelevant information namely: organisational culture, organisational learning, personal and organisational mental maps, etc. Corner et al. (1994) suggest that organisations may engage in several ways in which the information is filtered, including a surveillance in which the organisation examine the environmental variables and elicit information from sources that create a 'disturbance', i.e., information that does not fit in the normal course of activities. The second method of filtering information is 'motivated search' in which the organisation actively searches for relevant information within a focused area of the organisation's domain.

### *2.2.1.2 Encoding*

Encoding of information enables the strategist to reference the information gathered from the filtering process into models that are understandable to individuals concerned. (Corner et al. (1994)). Information is categorised, related and interpreted so as to be usable for producing a strategic intent. The organisation encodes the information creating synergy between several strategists involved in the organisation, although this process also occurs within an individual.

Information storage occurs in various forms (Corner et al. (1994)). At the individual level, experience enables the strategist to use the mental models he has acquired in order to retrieve necessary information when a similar idea is presented. At the organisational level, storage can be done in several ways, including procedures, routines, databases, etc.

### *2.2.1.3 Analysis*

Thompson (1995) suggested three cardinal points for evaluation of a strategic idea, namely: (i) appropriateness, i.e. compatible with the current vision of the company, product portfolio, etc., (ii) feasibility of implementation and (iii) desirability. The three cardinalities should be met for an idea to be programmed and implemented.

Hamel and Prahalad (1994) have indicated that strategies must provide some thought as to the capabilities of the organisation, i.e., to potentially create the opportunity for a major change of configuration of resources, but at the same time consider the extent of what can be done with current or potential resources. Their appraisal for a strategy is the novelty and the surprise that this would have across the enterprise's industry.

To evaluate a strategy, senior management needs not only to consider the 'feasibility' or the 'numerical' results in order to assess their usefulness. Strategies are successful if they can be simple yet effective in achieving the

overall vision of the company and can successfully harness (properties and impacts from/to) the environment. Therefore, several subjective questions might be additionally posed to the idea to further validate its strength:

- What will be the 'To – Be' state that the enterprise will need to achieve?
- What will be our future competitive advantage over our competitors?
- What will be our competitive position, i.e., will we be able to increase our dominance over our current/proposed range of products?
- What will be suitable new enterprise configurations, i.e. business models, organisational structures, process network configurations and systems of human and technical resources? How flexible and reconfigurable will the new configurations need to be?

Collins and Porras (2000) establish that individual strategies must be in accordance with the company's vision. This is consistent with the writings of Hamel and Prahalad (1994) as the vision should be an abstraction of guiding principles and overall objectives of the organisation and therefore should be a key driving force in the creation of strategies.

#### *2.2.1.4 Business Model*

The term 'business model' has been discussed primarily in the literature in reference to the domain of electronic commerce (Chan and Chung, 2002; Magretta, 2002; Morris et al., 2005; Osterwalder and Pigneur, 2002). The main focus of the literature is to present the organisation the basic tenets of implementing a so called 'e-business model'. Unfortunately, the economic failure of so called 'dot com' industries has attenuated the subsequent attention given to business models. (Osterwalder and Pigneur, 2002; Magretta, 2002). Shafer et al. (2005) classified literature on business models and observed several characteristic aspects such as: supplier, customer, strategy, cash flow and implementation, among other aspects. Their definition of a business model is a representation of the organisation's strategic intent and business logic need to create value within an existing value chain. It has

been argued that there is a clear separation between the terms strategy and business model. Business models provide a 'blue print' for the strategic intent in the organisation (Shafer et al., 2005; Magretta, 2002). The utilisation of business models can benefit the strategic realisation process in that they might enable the capturing of initial configurations of the organisation and enable the proposition of alternate 'scenarios' in which differing strategic intents could be enacted. It is mentioned by the authors that such representations should not be considered to be a strategy, but could enable discussion about strategy. Magretta (2002) points out that a key element missing from a business model is the effect of competitors. However, the usage of business models can be used more generally to enable organisations to present aspects of their strategic intent in a coherent manner (Morris et al., 2003). Magretta (2002) has proposed a two-fold evaluation of ideas incorporated into business models. The first stage assessment concerns the 'logic' of the proposal, i.e., that the assumptions made in the model are congruent with the realities of the environment. The second evaluation aspect concerns numerical analysis; although this may be rather superficial in nature. Hence more detailed analysis would have to be done during the strategic programming process. That detailed analysis would typically inform decisions by senior management to commit resources to the proposed idea(s).

The output of the strategic thinking sub-process should therefore be a context-dependent model of the proposed ideas that the organisation will pursue in the following period of time. Though some viability analysis may be done, generally at this stage one would not expect this model to detail any resource allocations, neither is it likely to define necessary constraints when performing tasks. However this context-dependent model should provide an effective basis for performing 'strategic programming' (Mintzberg (1994)) or what more generally in industry is considered to be strategic planning.

### *2.2.2 Strategic Programming*

Strategic programming is therefore a complementary sub-process to that of the strategic thinking sub-process. Strategic programming should achieve necessary viability analysis, together with defining possible resource allocations, critical success factors and a set of performance measurements. The publication of 'Corporate Strategy' by H. I. Ansoff (Ansoff (1965)) initiated a school of thought based on the sequencing of enterprise activities according to a master plan, dictated by the mission, vision and general objectives of the organisation. Lorange and Vancil (1997) suggested that strategic planning is concerned with objectives, purposes of the organisation, goals and plans. The main objective of this process is to produce a formal document in which the enterprise's structure, resources, policies and procedures are aligned into the main mission and directives given by organisational leadership. It provides a decompositional approach, i.e., it leads to a division of the main tasks into smaller tasks until it can be manageable (Mintzberg et al., 1998; Molina et al. 1998) with given actions, objectives and milestones. The core of this process is to produce a framework of activities that the organisation can follow in order to implement a strategic intent. The plan produced by this process is essentially a configuration of the current resources, business processes, portfolio of products, etc. that the enterprise will require in order to achieve the goals set. Critics of the strategic planning process (see Mintzberg, 1994; Heracleous, 1998) have stressed the fact that strategic plans promote inflexibility in the organisation and might suffocate the reaction of the enterprise when presented with a learning opportunity to best tackle the present state. It is the present author's point of view that, whilst strategic plans or programs need to clearly delimit the activities needed to implement the strategic intent, it should be robust and provide the enterprise with options and exception handling. While certain structure must be maintained, the strategic program must be able to be reconfigured in cases where a minor disruption might affect the performance of its activities. The resulting plans are to be considered a general guideline in which the activities, resources and structure must evolve, yet at the same time, be capable of adjusting if conditions on the specific variables of the process change within a predetermined area of action. It follows to the reader that changes that

surpass those margins would require greater modification and could enable the strategic process to assess the extent of changes in the overall program.

To support the strategic process, several methodologies have been developed. Since the publication of Ansoff's work in 1965, there has been much development in the literature about methods and tools to implement this process in the enterprise, such as Scenario Planning (O'Brien, 2002; Courtney et al., 1997), Strategic Control (Harrison, 1995), Financial Control (Mintzberg et al., 1998; Molina et al., 1998). A key concept in the strategic programming process is to determine how to structure the organisation in accordance with defined objectives that the strategic thinking process has conceived. Mintzberg (1994) has proposed that the 'strategic programmer', derived from his classification of strategic programming, enables the strategic intent by presenting the necessary in depth analysis, i.e., present costs, necessary performance indicators, milestones, alternatives of action, etc. to the senior management in order that the strategic intent can be assessed more fully. Programming allows the organisation to do an in-depth analysis of the ideas presented, allocating resources, time constraints and performance indicators. The major goal of this process is to produce a 'robust' plan, i.e., a plan that may handle exceptions and suggest possible action courses to be followed. It provides a general framework with specific targets, objectives and goals that enable the organisation to attain the desired configuration specified in the strategic intent. This process provides the framework of action for the strategic deployment sub – process.

#### *2.2.2.1 Modularity in Strategic Programming*

Decomposition of objectives and goals enables the organisation to better implement the strategic intent (Ansoff (1965)) by layering different levels of hierarchy of budgets, resources and time constraints. Plans are decomposed into the corresponding areas in order to further decompose the activities pertaining a specific area until it is atomised in action lists presented for an individual department. Ansoff (1965) argues that such an approach facilitates the implementation of the strategic plan within the organisation as it assigns

resources, objectives and goals that can be measured at the various levels of organisational decomposition. Mintzberg (1994) argues that imposing a rigid framework upon the organisation might be unable to take the appropriate action should original assumptions for the strategic plan change. Lorange and Vancil (1997) have divided the strategic programming cycle into three cycles, being the first where a decomposition of the objectives is made in order to facilitate the detailed planning of the strategic intent. This is done by the middle and top managers in the general set of objectives and goals, yet when approached to the line managers and team leaders, a further decomposition will be done in order to communicate the strategic intent and to create the strategic implementation plan.

#### *2.2.2.2 Budgeting*

Budgeting enables the strategic program to allocate the necessary financial resources that are needed to enact the activities described in the strategic program. Ansoff and McDonnell (1990) recognise the existence of two main types of budgets, namely, strategic and operational. The first budget is characterised by the scope of its coverage, i.e., would typically include investments in current/expected areas of present/potential strategic business units (SBU's) and their geographical growth. A strategic budget is targeted at those activities that enable the organisation to expand or divest itself from present or potential activities. An operational budget is targeted at the present day operations of the enterprise and ways in which those activities may be more efficient. The scope of the operational budget would include the present value creating activities, potential expansion to those and the way to reduce present costs in the organisation. Lorange and Vancil (1977) characterise budget in accordance to their planning process, i.e., general, when the activities, objectives and goals are being agreed and discussed, and detailed, when the corporate managers have decided the activities to be programmed and implemented throughout the organisation. This characterisation and scope of the budgeting within the strategic programming process is consistent with Goold and Quinn (1990).

Budgeting has also proven to be effective in a small and medium enterprise context in that has enabled the management to decide between potential activities to be performed (Peel and Bridge (1998)). The authors state that the utilisation of a budgeting technique was influential in the level of detail in which the organisations made their strategic program. This resulted in a better level of achievement of the objectives and goals of the organisation.

#### *2.2.2.3 Resource Allocation*

As an extension of budgeting, Lorange and Vancil (1977) mention that resource allocation follows the assignment of budget to a strategic intent. However, the author mention that this process is usually done in an unsystematic and unstructured manner, which might create problems if the communication between corporate and unit manager is not good. Hamel and Prahalad (1994) have argued in favour of recognising the strategic need of configuring the organisation's intent around current and potentially acquirable resources, i.e. resources that could be obtained by the organisation that present a significant advantage. The allocation of resources turns crucial as a small company might be able to succeed in defending the market niche in which it is currently positioned.

#### *2.2.2.4 Time constraints*

As the objectives and goals are defined, it is important to define the necessary time constraints that would enable the organisation to achieve the proposed strategic intent. Harrison (1995) has proposed the concept of 'strategic maturities' as point in time in which an objective or an activity in the strategic realisation program should be accomplished. The measurement and progress of the strategic intent is a crucial part of the strategic program (Ansoff, 1965; Lorange and Vancil, 1977; Ansoff and McDonnell, 1990). Time constraints enable the organisation to assess the progress of the implementation of the strategic intent and help the organisation determine if there is a need of a



corrective action, in case the activity has not been completed or if there are foreseen problems with its completion.

#### *2.2.2.5 Strategic program*

The strategic program is normally a document in which the organisations states the intent of the strategy realisation process, provides the necessary resources, time constraints and configurational changes that will need to be enacted in order to implement the proposed strategic intent. It provides the organisation with a detailed analysis of the activities, performance indicators, portfolio of products, areas of investment, etc. that will be used in a specific timeframe. The program also addresses which resources will be allocated in the organisation, responsibilities and alternative courses of actions. It has been suggested by Weston (2000) that manufacturing organisations need to be 'change capable' in order to succeed in uncertain environments. Likewise, the strategic program needs to enables sufficient flexibility within the organisation so that for a set of possible scenarios of action be determined and necessary configurational change can be enacted readily and effectively. The strategic program should encode in a form suitable for use within the organisation, the intent of the business model should provide to the strategic thinking process with evidence about particular outcomes of an intended strategic intent.

#### *2.2.3 Strategic Deployment*

Strategic deployment, or implementation, manages the communication efforts between the strategic programming process and the related daily operations of the organisation. It constitutes a set of activities that are performed throughout the organisation in order to enact the proposed strategic intent. It manages transition form the current 'As – Is' state into the proposed 'To – Be' state by performing necessary configurational changes in the target processes by measuring their performance related to the expected one. Hammer and Champy (2001) propose a radical approach to redesigning

target processes, yet this focus is challenged by Quinn (Q1980) who favours an 'incremental' approach, i.e., 'small steps' towards achieving the proposed strategic intent. It should be noted that not all processes of the organisation are candidates if a given configurational change. For example, basic purchasing and accountancy will typically remain unchanged over several timeframes of other configurational changes. This researcher argues that strategic implementation can be a mixture various degrees of radicalism in that some processes can be changed faster and more radical than others. Yet a complete radical transformation of the organisation is not always desirable for practical and cultural reasons. Proposed changes to relevant processes need to be observed and monitored, so as to design appropriate measures to tackle any issues arising. This might be in the form of an adjustment to the configuration of the process or some key factor related to it. If the change of configuration affects several areas of the organisation, suitable interaction is required between the strategic deployment and the strategic programming teams, as premises for the original strategic plan may need to be modified as well as the objectives, timeframes, resource allocations, etc. envisioned in the strategic program. The strategic thinking process can be also affected by a major change in the configuration, as it might introduce new information that was not available when an earlier version of the strategic intent was developed. Although, the occurrence of such major changes may be infrequent and be triggered only by a major change in the organisational environment, such as new technology emergence, or the emergence of a significant competitor or a new governmental pressure. Should a major change occur, then there should be an effective and timely communication between the strategic programming team and the other teams (thinking or deployment teams) involved in order to assess the nature and extent of the necessary adjustment. Evidently therefore, strategic deployment provides feedback to both strategic programming and thinking. To the strategic programming process it provides information about the current state of enterprise processes and their competences an, capacities and so forth, and enables programmers to develop a 'realistic' view of the capabilities of the organisation. It has been mentioned earlier that the thinking, programming and deployment sub-processes provide a 'feedback loop' to each other.

Strategic deployment should analyse any need for change capability and compare this with existing change capabilities. Since deployment will in general cover the production areas of the enterprise, it is necessary that the personnel in those areas are involved in operationalising strategy deployment. Hamel (1996) even suggests that production personnel should be present during strategic thinking sessions, for this would reduce later implementation problems, i.e., lack of commitment, miscommunication, etc.

### *2.2.3.1 Strategic Issue Management*

Traditionally, strategic issue management is considered part of the strategic programming process (Mintzberg et al. (1998), yet it enables the management of those issues raised by the implementation of a strategic intent in an organisation. Muralidharan (1997) reviews several approaches to 'strategic control', from traditional control to periodic review, and concludes that when done periodically, strategic control enables the organisation to review the assumptions of strategic programming in order to make necessary adjustments to the program. The main focus of management control is to identify the strengths and weaknesses of the organisation as a strategic intent is implemented, monitor the impacts of the environment as to those issues previously identified and propose and enact the necessary changes that would enable the organisation deal effectively with the perceived threats. A similar conclusion is reached in the works of Ansoff and McDonnell (1990). The authors mention the utilisation of 'strategic issue management' enables the organisation to review the performance of its strategic program more frequently thus enabling necessary changes than the reviews that can be made by the strategic programming process. A major factor that contributes to the need for strategic issue management is a fast changing environment of the organisation

Ansoff and McDonnell (1990) have characterised 'strategic issue management' (SIM) as follows:

- Real time management

- Continuous surveillance of variables and assumptions in the environment.
- Cuts around organisational boundaries and hierarchies, usually a team manages the changes and reports to the senior management
- It supposes a management action, not a plan

The focus of SIM is to adapt the current strategic program to the performance and the environment of the company. When a major change is needed, a review of the strategic program should be done and the strategic programming process should be enacted. However, it should be noted that the SIM process may enable limited changes in order to adapt the strategic intent without a major change to the program itself.

#### *2.2.3.2 Implementation Plan*

The implementation plan defines necessary steps that enable each subset of the organisation to realise the premises of the strategic intent. It contains an operational description of the activities, resources, time constraints and performance indicators as well as the necessary process configuration changes that enable the organisation to implement the strategic intent. A basic premise of the strategic implementation plan is that it provides a route via which the organisation can transform itself from the present 'As – Is' state to the proposed 'To – Be' state, together with any need transitional configurations that are required to reach the proposed intent.

### **2.3 MODELLING TECHNIQUES THAT HAVE A POTENTIAL TO SUPPORT ASPECTS OF STRATEGY REALISATION**

Several modelling techniques have been surveyed in this thesis as potential candidate means of representing 'aspects' of the strategic realisation process. The following sub – sections provide a detailed description of the purpose, scope underlying concepts and evolving frameworks and modelling capacities related to those tools.

### *2.3.1 Enterprise modelling*

Enterprise modelling is the process of building models of whole or part of an enterprise from knowledge about the enterprise, previous models and/or reference models as well as domain ontologies and model representation languages (Vernadat (1996)). Amongst its main goals are: (1) support analysis of an enterprise, (2) model relevant business processes and enterprise objects concerned by business integration thus providing:

- better understanding and uniform representation of the enterprise
- support for designing new parts of the enterprise
- control and monitor model for enterprise operations

Several enterprise modelling approaches have been surveyed in the literature as candidate approaches to enable a representation of the business process network (Vernadat, 1996; Monfared M200)

#### *2.3.1.1 CIMOSA*

CIMOSA is the acronym for the Computer Integrated Manufacture Open System Architecture. CIMOSA was developed as the ESPRIT project by the AMICE consortium during the late 1980s to early 1990s. Its architects were Kosanke (1995), Zelm et al. (1995), Kosanke and Zelm (1999), Vernadat (1996) and Berio and Vernadat (1999). The main purpose of CIMOSA is to provide support for process oriented modelling in an enterprise by providing modelling concepts, modelling frameworks and modelling formalisms to explicitly decompose and describe its characteristic properties (Kosanke and Vernadat in Molina et al. (1998)). CIMOSA provides means of creating a 'holistic' view of organisations, and change projects carried out by organisations, by formally representing information regarding business processes and their related information, behaviour and activities. The modelling constructs provided allow the organisation to formally specify a consistent set of requirements and operation descriptions. Kosanke and Vernadat mention that CIMOSA enables the users to model "business

requirements, deriving enterprise system designs and support its maintenance and operation (Kosanke and Vernadat in Molina et al. (1998)).”

CIMOSA comprises three major components namely:

- CIMOSA system life cycle
- CIMOSA modelling framework
- CIMOSA integrating infrastructure

The CIMOSA system life cycle covers the phases of a system development project, from project conceptualisation to system dismantlement. These phases relate to the general development of large scale system engineering project, and cover general activities that should occur during the system design, implementation and subsequent release. According to Vernadat (1996) it comprises the following types of activity: master plan definition, requirements definition, system design, system build and release, system operation, system maintenance and change and system dismantlement. It should be noted that although system engineering activities may flow through these phases in an essentially sequential nature, these will normally be several iterations until a project is complete. Figure 2.1 illustrates amongst them, possibly flowing back to earlier phases relations between the three main components of CIMOSA

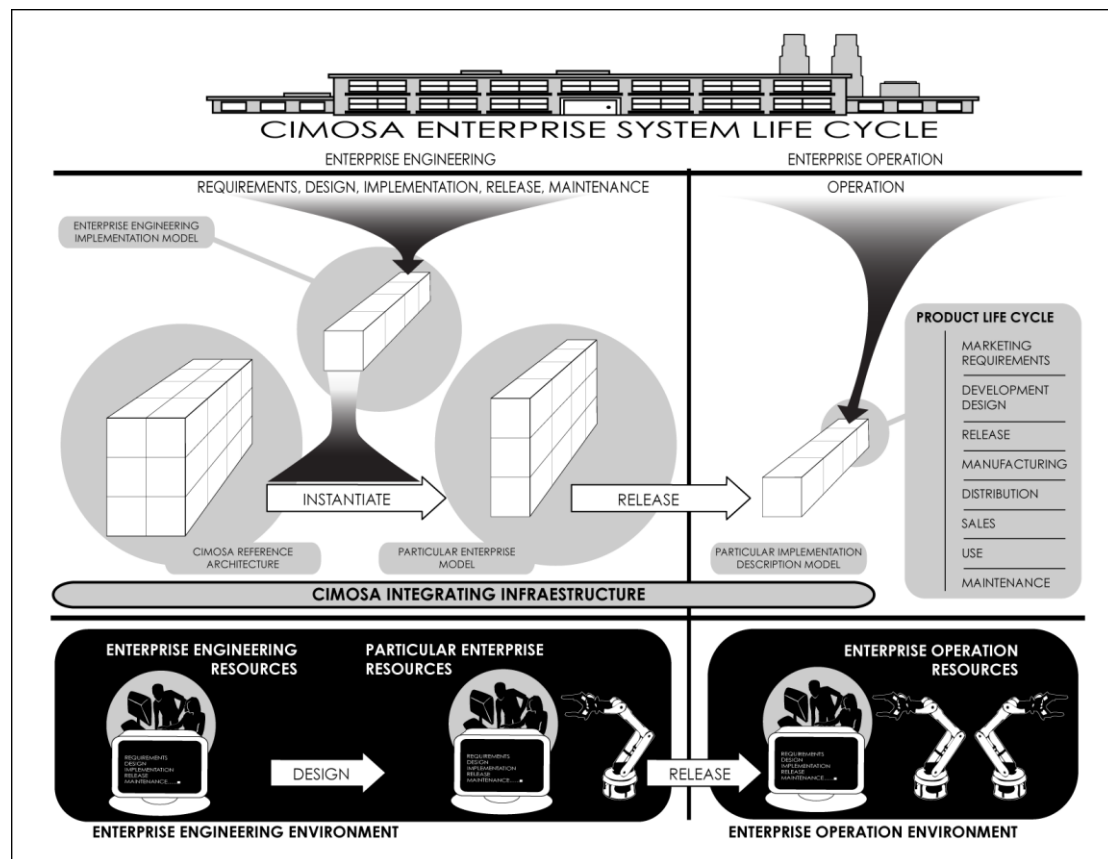


Fig 2.1 Relationship between Enterprise modelling and integration (developed from Kosanke and Vernadat in Molina et al. (1998))

CIMOSA also supports the representation of reference models) that may be utilised throughout the system life cycle. The level of abstraction presented in those models allows the modeller to effectively present the current state of the business process of the enterprise or possible future business process states. It is important that all CIMOSA models developed to describe an enterprise are validated and verified to ensure a greater level of success in the operation stage.

The CIMOSA Integrating Infrastructure (IIS) permits the modeller not only to represent the business processes of the enterprise, but to monitor and control the enactment of the models created for the organisation. The execution of the models may occur in a distributed and heterogeneous environment. The CIMOSA IIS will allow the model to be executed within the enterprise system, interacting with the enterprise resources and providing support for system,

application and business integration for all IT services in all the nodes of the organisation.

The CIMOSA modelling framework provide several views of the enterprise being modelled by decomposing high level, abstract models into more detailed and concise representations of focal concerns about business processes of an enterprise. For this purpose, three main modelling perspectives are defined by the CIMOSA specification as follows:

### *Derivation*

This perspective enables distinction to be drawn between major aspects of 'the system' life cycle namely:

- Requirement Specification: this stage provides the users of the system with the capacity to formally specify the requirements of the enterprise system.
- Design Specification: the enterprise system is formally designed and executable models are created.
- Implementation Description: this level provides a detailed documentation of the operation of the enterprise system, i.e., resources, exception handling, etc.

### *Instantiation*

This perspective is concerned with developing and deploying different levels of generality when representing enterprise models created. Three layers provided are:

- Generic: provides general structures, taxonomies and representations.
- Partial: models can be represented and stored in libraries that are relevant in the overall context of the enterprise, i.e., industry settings.



- Particular: represent a particular taxonomy and structure for the enterprise

### *Generation*

This principle decomposes enterprise into four main viewpoints, although it has been argued that several views can be added (Kosanke and Vernadat in Molina et al., 1998; Vernadat, 1996; Berio and Vernadat, 1999). The four viewpoints defined by the CIMOSA specifications are:

- Function: addresses the purpose and rules of behaviour of activities that a system is required to carry out.
- Information: defines the objects and flow of information in the enterprise
- Resource: describes the agents (human or technical) that will enact activities.
- Organisation: covers issues such as authority and responsibility, in the enterprise system.

Figure 2.2 illustrates the relationship between components of the CIMOSA Modelling Framework

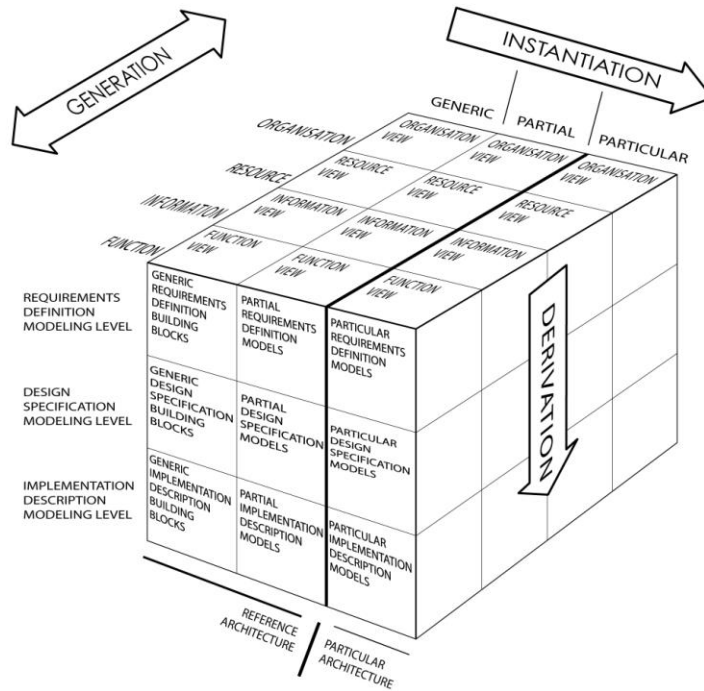


Fig. 2.2 CIMOSA Modelling Framework (From Vernadat (V1996))

The CIMOSA Modelling Framework provides modellers of organisations with a generic way of decomposing very complex systems, such as an enterprise and its environment. This decomposition covers recommended levels of abstraction and view points. It enables the organisation to reduce unnecessary complexity of modelled segments of the enterprise by creating coherent and consistently represented ‘sub-sets’ of the generic and partial models to be analysed. It also enables enterprise modelling using well defined blocks, avoiding overlapping of models and potential conflict in the assignment of resources and the way in which processes are organised.

*CIMOSA modelling constructs*

The operation in any enterprise can be described as a network of co-operating processes that share common resources. CIMOSA provides common modelling constructs to represent the main enterprise objects, such as: domains, events, business processes, enterprise activities, functional entities, etc. Figure 2.3 classify the modelling constructs defined by the CIMOSA specification.

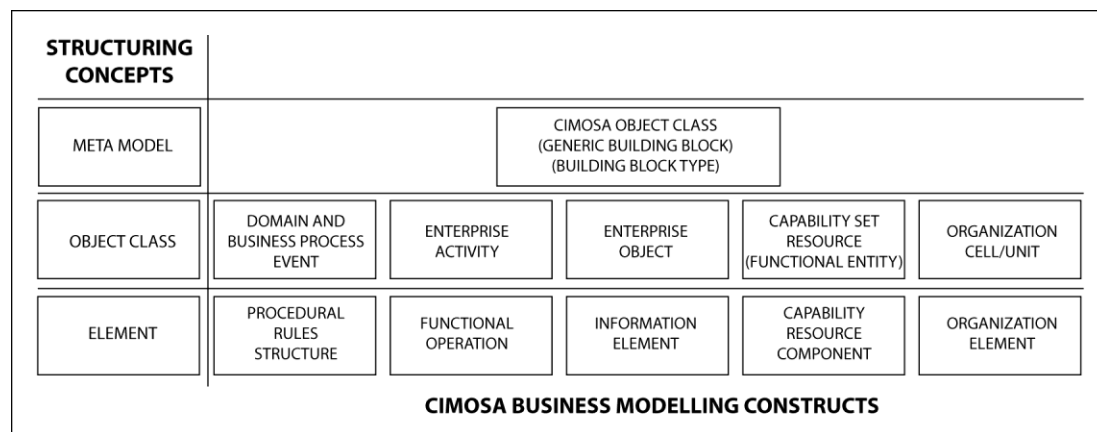


Fig. 2.3 CIMOSA Business Modelling Constructs (Kosanke in Molina et al. (1998))

### CIMOSA Object classes

The following object classes will have an instance in models created utilising CIMOSA. There is no formal graphical representation specified for each object class, but formal description of each element has been defined for tools that implant CIMOSA concepts, such as FIRST STEP and SEWOSA to graphically model characteristics such as: type, identifier, objectives, resource inputs, etc. (Vernadat (1996); Kosanke and Vernadat in Molina et al. (1998))

**Domain:** CIMOSA defines this as being a functional area of the enterprise that has a common organisational goal. A domain has several stand-alone processes, called ‘domain processes’ and is characterised by a name, scope, list of domain processes and relations with other domains.

**Event:** An event changes the status of one or more variables of modelled system. It may be generated by external or internal actors, i.e., from within enterprise domains or environmental domains. Each event is characterised by a name, source and process that enables or triggers a condition of existence.

**Domain processes:** These are set of end to end activities in an enterprise function that exists independently from other processes in an organisation,

i.e., they are so called 'stand – alone' processes. Each domain process is characterised by a name, a list of triggering events and its behavioural rules.

**Business Processes:** These are subsets of domain processes; they are enacted by a parent structure and not by an event.

**Enterprise Activities:** These are a set of ordered actions performed to achieve a specific goal. An activity transforms an object (whether physical or logical) from an initial to a final state. The following characterise an enterprise activity: name, inputs and outputs (functional, control and resources), status of termination, duration (minimum, maximum and average), and transformational function, i.e., what the activity does.

**Functional Operation:** This is an atomic task that is a part of an enterprise activity.

**Resource:** This is an entity, human or technological, needed for the execution of a given activity. Two conditions are needed for a resource to assist in an activity namely: that it is available and it has the necessary competencies, or the knowledge to perform the requirement of the activity, in order to function properly. Each resource is characterised by the following: an identification, capabilities, capacities, availability and components in the case of a component resource (Vernadat (1996)).

### *2.3.1.2 GRAI – GIM*

The GRAI methodology was developed at the LAP/ GRAI Laboratories at the University of Bordeaux. It has been described by Doumeingts et al., 1979; Doumeingts, 1985; Doumeingts et al., 1995; and Doumeingts, 1998. Its purpose is to provide a general description of Manufacturing Systems and their control components. An overall view of the system is decomposed into two main systems: Controlling system, which can be further divided into two

main 'sub-systems': Informational System and Decisional System and the so-called 'Controlled' or the Physical System.

Physical Systems comprise all the material and information flows that realise the transformation of raw material into physical goods. It comprises machines, humans, tools, etc.

An operational system is dedicated to the real – time control of the physical system.

Decision Systems comprise the decisions of the enterprise organised into a hierarchical structure comprising so-called 'decision centres'.

Information Systems provide a linkage between the physical and the decision systems. It processes and stores information generated. Figure 2.4 illustrates the division of different components comprising GRAI component system

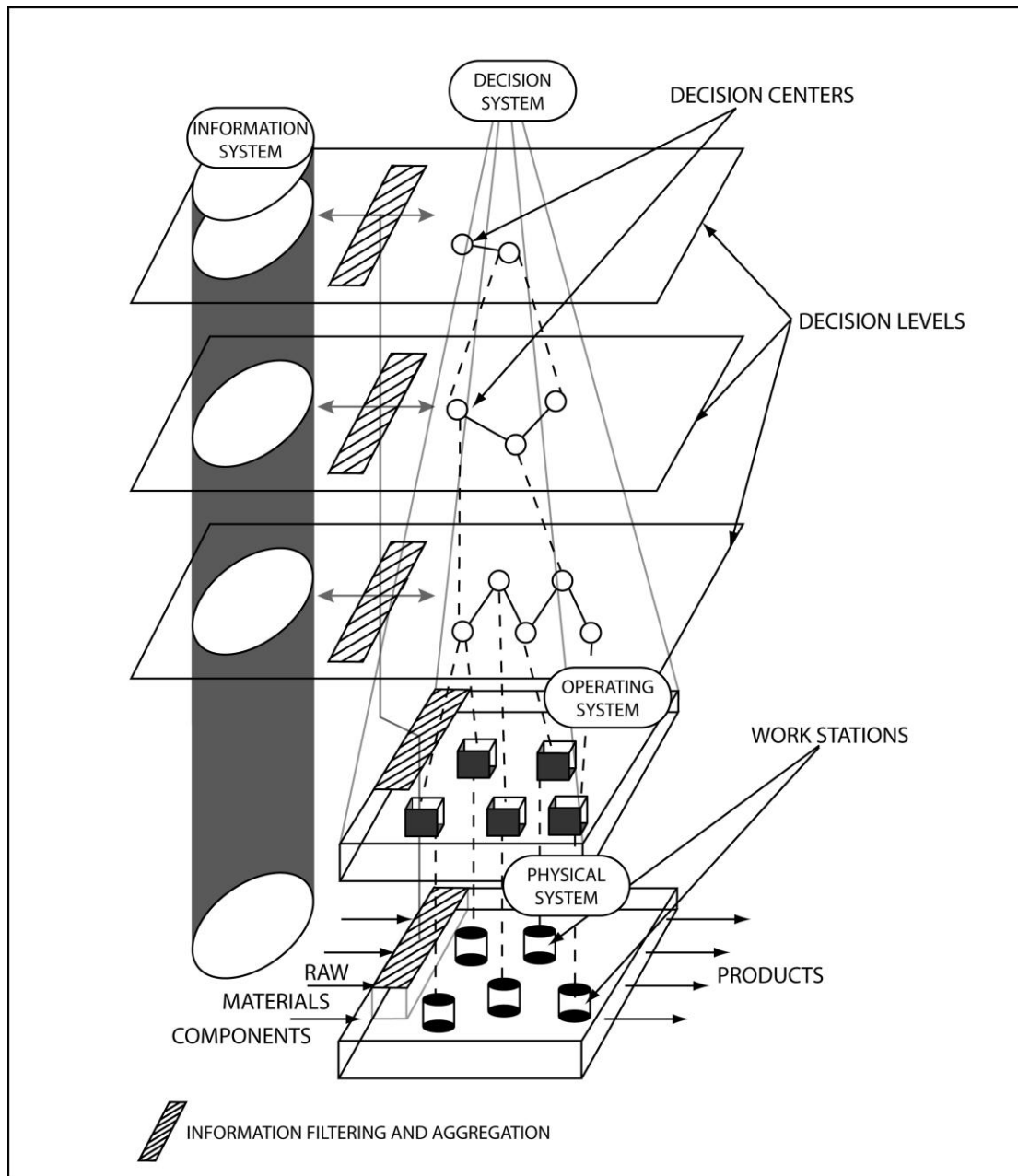


Fig 2.4 GRAI conceptual reference model (Doumeingts in Molina et al. (1998))

To manage complexity, two main criteria of decomposition are utilised as part of the GRAI methodology. The first criteria concern temporal aspects of decisions. Three main periods are utilised in this approach, namely strategic, tactical and operational, although enterprises may add more time divisions if it is considered necessary. The reach of each of these periods is defined for each specific enterprise case. Several concepts allow the enterprise to further decompose the nature of the decisions it makes, namely:

Horizon: period of time in which a decision or model remains valid

Period: temporary segment of time over which decisions are reconsidered.

Some heuristic rules have been defined in relation to GRAI decomposition principle between two consecutive decision levels. Among these are:

The maximum number of horizon considered for decomposition can be between six and twenty levels.

The temporal reach of the horizon of a lower level is half of the period from the immediate superior level.

The second principle of decomposition is based on functional activities performed in an enterprise based on selected production management theory. Three main activities are considered: product management; planning; and resource management. Product management activities are related to the rationale of the Manufacturing System, i.e., that it is needed to transform raw materials into finished products or services. Resource management activities are related to necessary entities (physical, human, economical, etc.) that enable material transformation via the Manufacturing System. Planning activities provide a coordination effort between the two former in order to achieve the goals of the organisation.

To further enable the communication between GRAI components, a model of feedback is established to enable the control and status of the system to be defined. A top-down approach is followed to coordinate the various hierarchical levels of the organisation thereby providing control and monitoring. A bottom-up approach facilitates an integration of data in the enterprise and reporting about the status of activities. Figure 4.5 illustrates GRAI principles of decomposition as well as its feedback information approach.

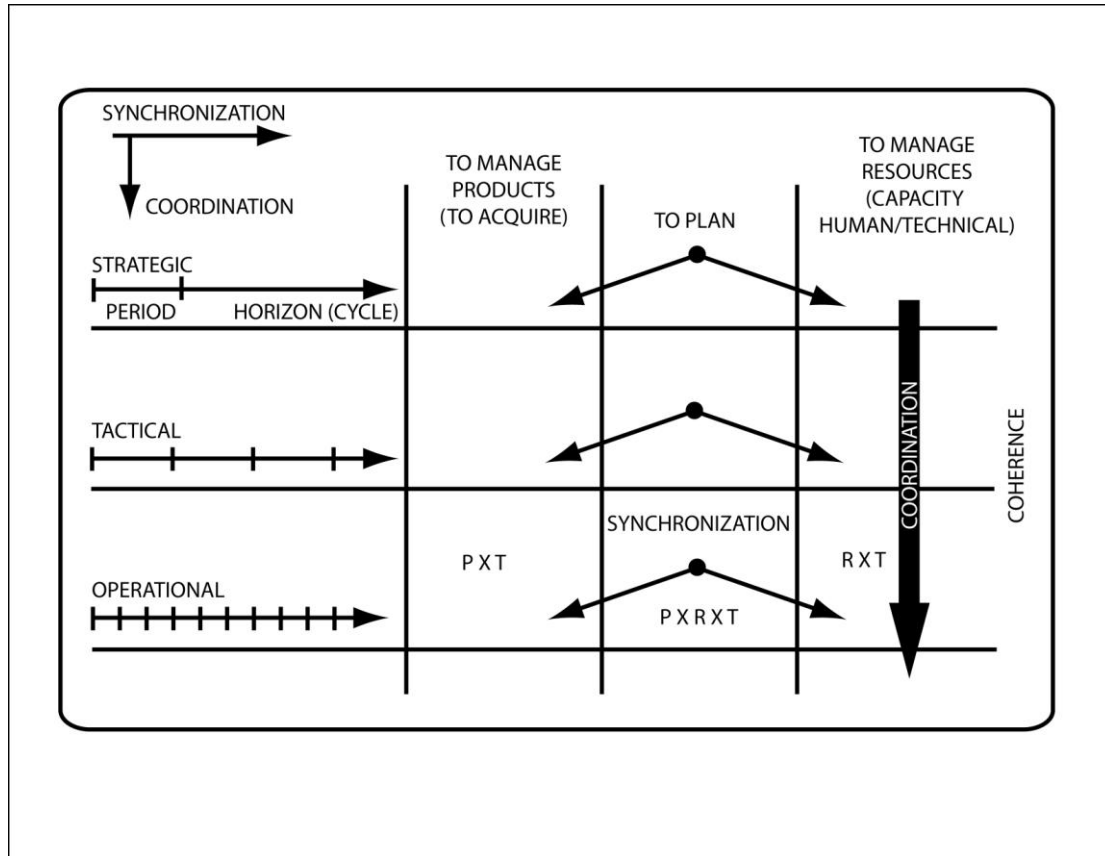


Fig. 2.5 Decomposition and feedback (Doumeingts in Molina et al. (1998))

### GRAI – GIM modelling constructs

The utilisation of IDEF0 modelling constructs by GRAI has resulted in the GIM (which stands for GRAI Integrated Methodology) to be utilised in the literature (Doumeingts (Molina et al., 1998)). As stated earlier, there are three main systems into which manufacturing systems are decomposed: physical, decisional and informational. Each view provides a specific perception of the enterprise and its relations. A fourth view is added to compliment the aforementioned perspectives namely: the functional view. This view presents the main functions carried out by the enterprise regardless of their location, i.e., where they are physically located in the organisation and how these functions are enacted.

To create a functional view of the enterprise, GIM utilises IDEF0 modelling constructs. These constructs enable modelling of inputs, controls, outputs and mechanisms (ICOM's) of functions under study. The IDEF0 methodology



(Vernadat, 1996; Knowledge Base Systems, 2004; Al-Ahmari and Ridgway, 1999; and Kim and Yang, 2002) allows decisions, actions and activities of the organisation to be modelled. IDEF0 analyses four different aspects. The first aspect concerns inputs to a function, i.e., materials, information, etc. The second aspect concerns controls which are conditions necessary to achieve enactment of the function. The third aspect concerns outputs, or the produced data or objects of that function. The fourth aspect concerns mechanisms which are the means with which the function enacts itself. Figure 2.6 shows the representation of a typical construct of the IDEF0 methodology.

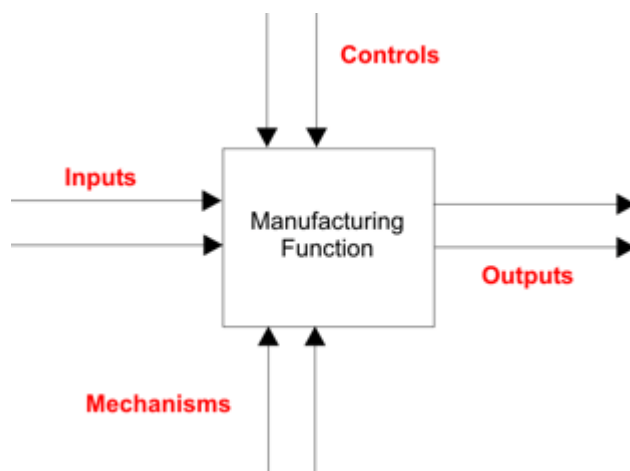


Fig. 2.6 IDEF0 construct (taken from Knowledge Base Systems, 2004)

Several formalisms are utilised to model the GRAI – GIM Physical system. These are used to construct an ‘holistic’ view of the system whilst coping with system complexity. The first step is to provide a static view of the main functions deployed in the enterprise. To aid in this purpose, the IDEF0 modelling framework is utilised to capture the functions of the enterprise and their static relation. Another level of modelling can be utilised by analysing the so called ‘stock – resource’ relations that enable an analysis of material management issues such: inventory levels and lead time. To provide a dynamical analysis of the Physical system, GRAI – GIM provides a modelling construct called GRAIC0. This construct enables synchronisation of several events that enable the enactment of a function under study.

The Decisional system is modelled via the use of ‘GRAI grids’. These grids evolve after use of the two GRAI – GIM decomposition principles previously discussed, i.e., hierarchical and functional. They provide a ‘top – down’ analysis context for decisions and information flows within the enterprise. The columns presented describe the functions of the enterprise, described in terms of action verbs. They can be further decomposed into smaller grained functions, i.e., the function ‘To Acquire’ can be decomposed unto ‘To Purchase’ and ‘To Supply’. The rows represent the hierarchical levels at which decisions are analysed and are organised in chronological descending order, i.e., a level with the greatest horizon period will be positioned first, whilst a level with a shorter horizon will be defined last. This ensures a ‘top – down’ approach when analysing decisions. The intersection of a function and a hierarchical level is called ‘decision centre’. Each decision centre possesses: inputs, outputs, activities, decision variables and internal relations. Figure 2.7 illustrates the use of a GRAI grid.

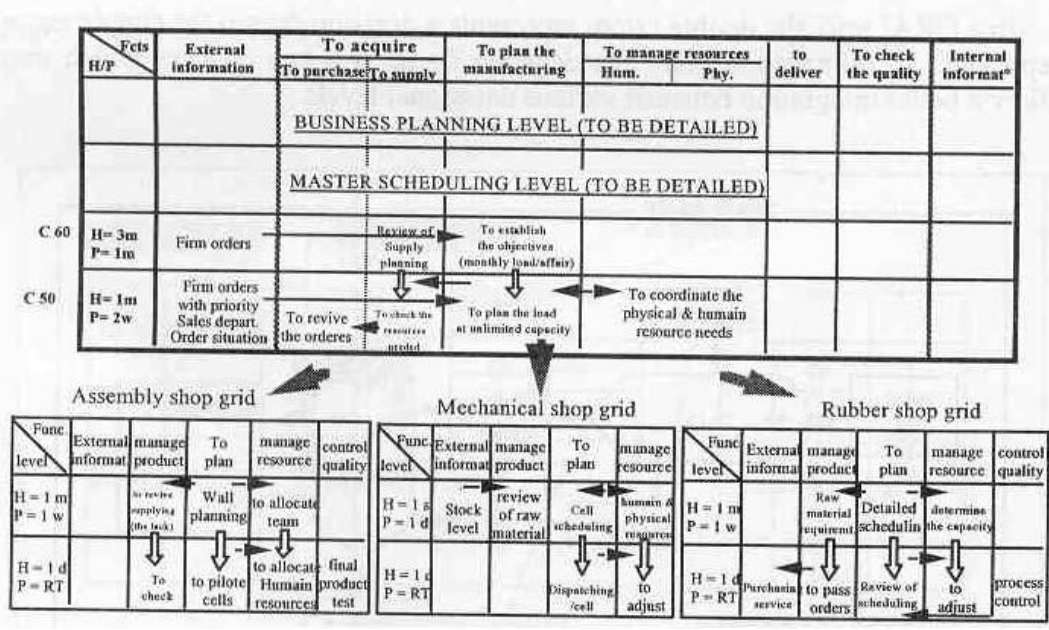


Fig. 2.7 An illustration of a GRAI grid (Doumeingts in (Molina et al. 1998))

To model internal relations of a decision centre, GRAI defines so called ‘GRAI nets’ graphical representations. GRAI nets provide the structure of the elements of the activities enacted by the decision centre and possess the following elements (Kosanke in Molina et al., 1998; Vernadat, 1996):

Activity which is the decision or main transformational action;

Support which is the necessary means that enable enactment and

State which represents the initial and final states of the decisional variables or actions needed for the process.

Figure 2.8 represents two examples of a GRAI net representation.

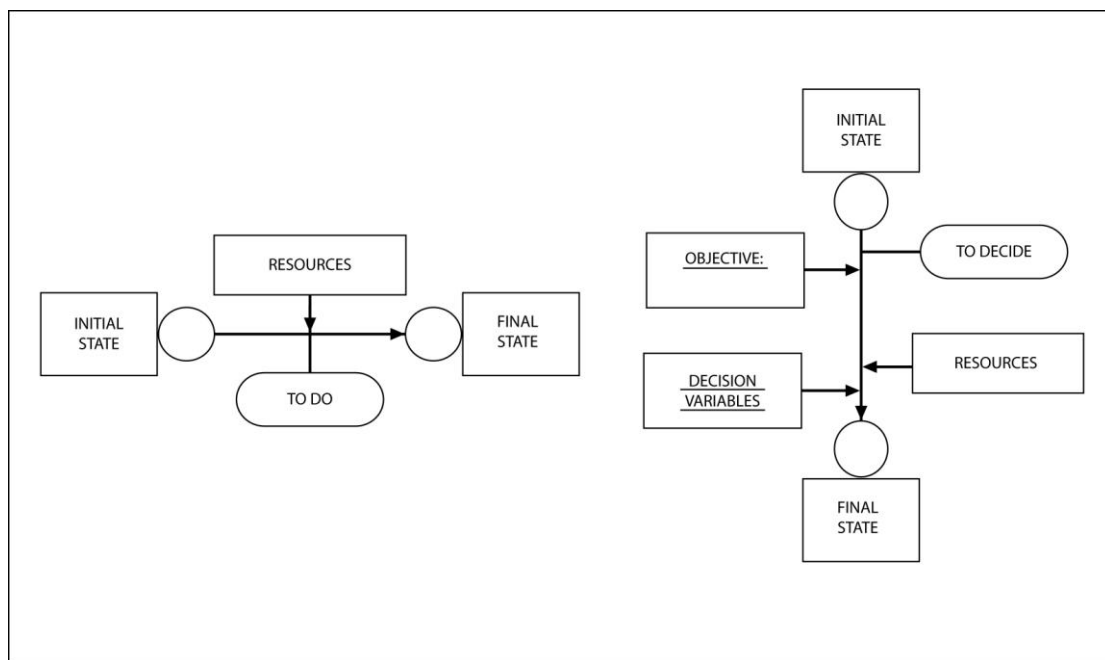


Fig. 2.8 GRAI net representation (Vernadat, 1996)

Although some elements of dynamism can be represented, GRAI nets do not encode the effect of time on the transformational process.

The Information system communicates and provides necessary data for any agent about resources, activities and objectives of the enterprise system. It processes and memorizes all the data produced by the Physical system in order to serve for the decision – making process. Doumeingts (in Molina et al. (1998)) considers two aspects of this system, namely: static and dynamic. The static aspect concerns the collection of the data produced as well as the constraints and rules used in its management. The dynamic aspect is concerned with the updating of information and changing the rules,

constraints and behaviour of the data especially when the external environment of the enterprise changes i.e., market analysis, regulations, etc.

This system is formally specified by the usage of ‘Entity – Relation’ diagrams to represent the information handled in the enterprise.

Figure 2.9 illustrates the various constructs utilised in the GRAI – GIM methodology for the several system views.

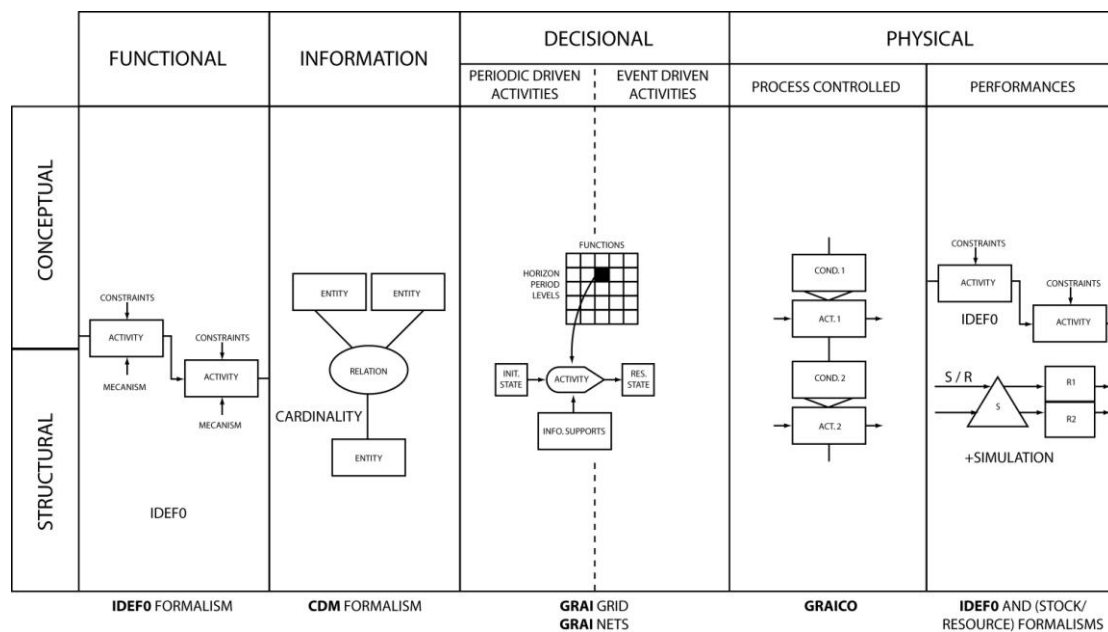


Fig. 2.9 GIM reference framework and modelling constructs utilised (Domeingts in (Molina et al., 1998))

### 2.3.1.3 PERA

This modelling framework was developed by Theodore Williams (1994) and his fellow researchers at Purdue University in the USA (Williams and Li (1997)). It stands for Purdue Enterprise Architecture Reference and its main focus is to present a formal description of the phases involved in the life cycle of an organisation. Several phases of systems can be represented from their conception to their dissolution. The model suggested by this methodology

provides a template for succeeding implementations of the system and throughout the life time of the enterprise.

Several sub-phases are defined by the PERA system life cycle. They comprise sets of activities that should be realised as the implementation of the enterprise system is carried out. The five main phases of the PERA lifecycle are as follows:

1. Concept region: Identification of the so-called 'Enterprise Business Entity', mission, vision and values. Also an identification of the major environmental factors, such as: government policies, competitors, etc.
2. Definition or Functional Analysis region: This sub – phase concerns: planning, operational policies, main function module definitions; and functional networks (both manufacturing and information flow) are defined.
3. Implementation region: This concerns the functional design of information systems, level of automation, plant design, software and hardware selection and detailed design of process components.
4. Installation and Construction region: This involves an integration of the previous designed and constructed components, i.e., the machines are installed and verified, software components are installed and tested.
5. Operation region: This concerns the operation and control of the system, deals with the necessity of training for human systems and continuous improvement of the system overall.

Figure 2.10 illustrates the system lifecycle and architectural reference that PERA provides for enterprise managers, designers and modellers:

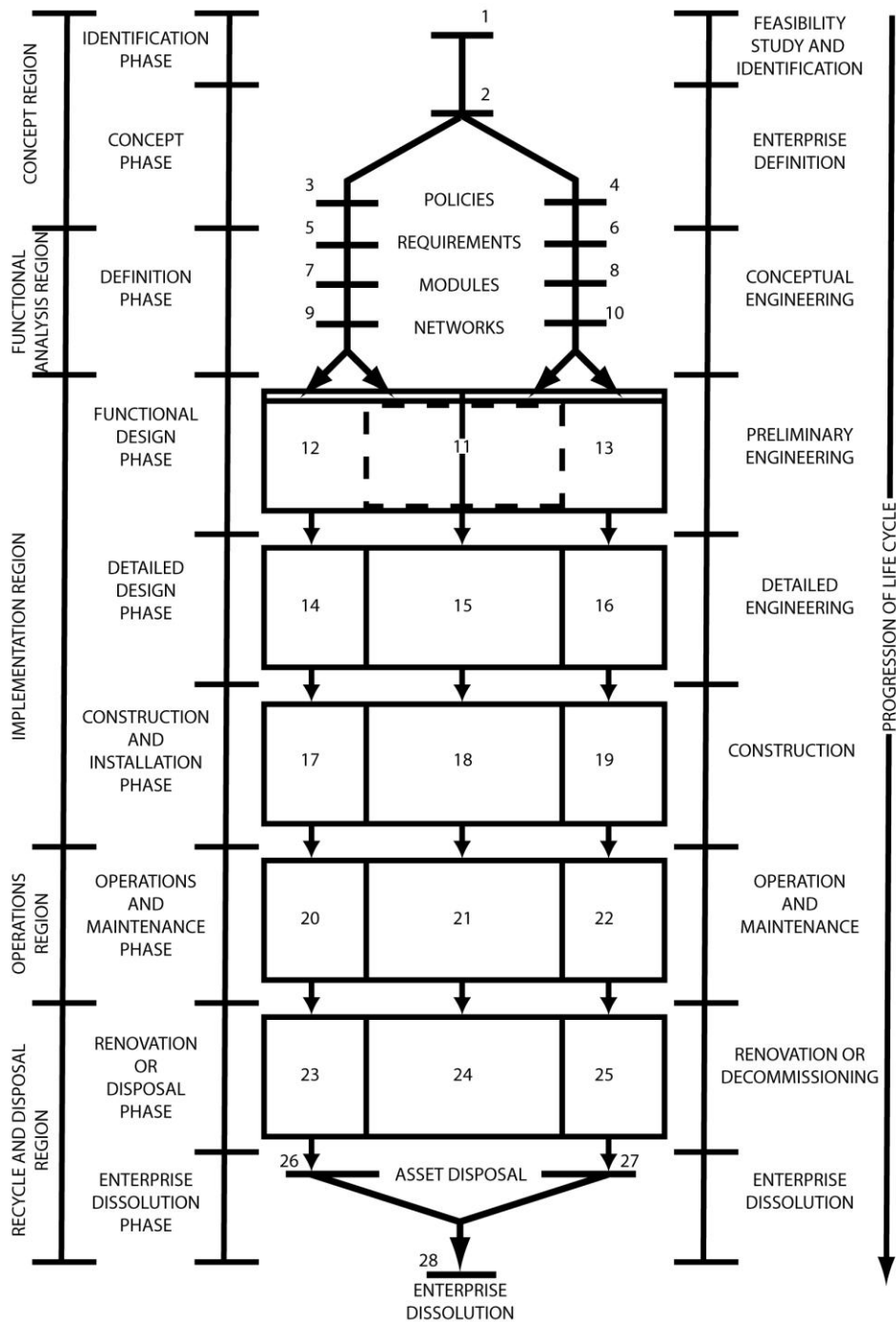


Fig. 2.10 PERA overall architecture diagram (From Williams in (Molina et al., 1998))

The first nodes of the lifecycle are where the enterprise strategy is conceived, planned and formalised and subsequent policies are defined for the enterprise to enact throughout its processes. PERA recognises two main categories of functions in the organisation, namely operational and information and control. Operational functions are designated to produce the customer's goods or

business services that enable the organisation to realise the constructs of its mission and objectives stated. Typical examples of these processes would include, but not be limited to: material transformation, storage of materials, semi-finished goods, etc.

Information and control functions involve the management of relevant information that aids in the operational functions and enables the organisation to perform in accordance to the established parameters in the production and provide a competitive advantage. Examples of these functions are planning, scheduling, data management, etc.

Therefore, two main architectures are specified in the functional design of the enterprise system: the Manufacturing Architecture, which would be enacted by the operational functions and the Information System Architecture, which is enacted by the information and control functions. A third architecture that provides a connection for the former architectures is the Human and Organisational Architecture. Figure 2.11 illustrates the connection between these architectures

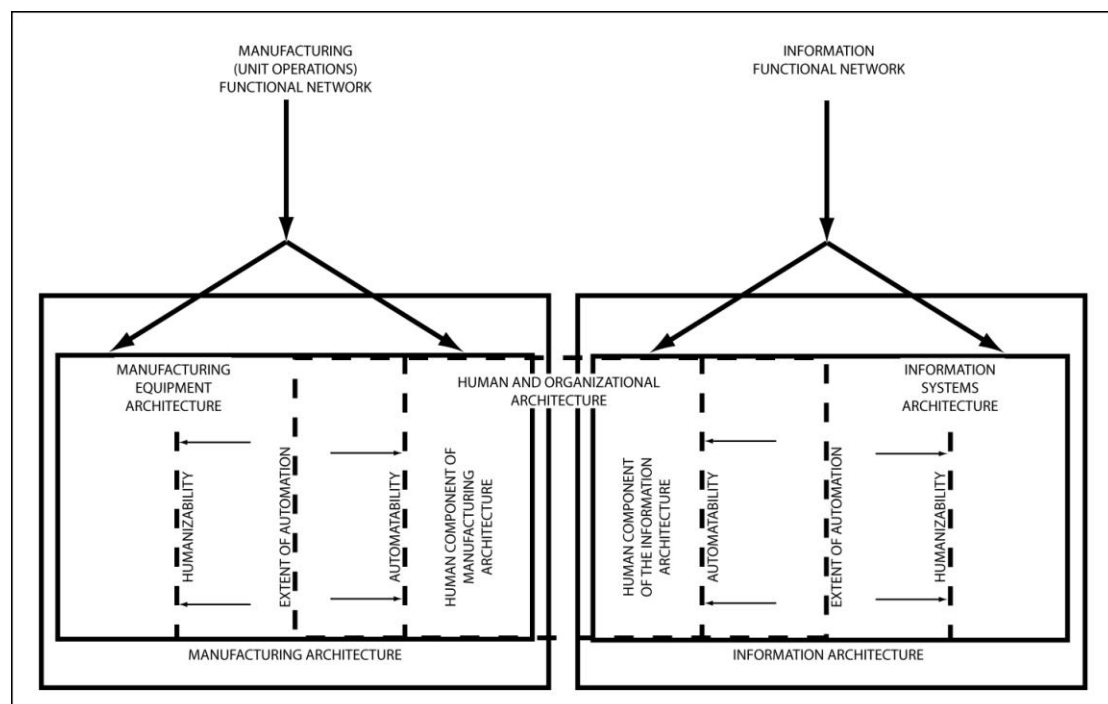


Fig. 2.11 Interaction between Manufacturing, Information System and Human and Organisational Architectures (Williams in (Molina et al., 1998))

Interfaces between components of the previously stated architectures are specified by the type of transfer that is been made, i.e., logical as in information to a machine or human or energy between a human and a machine. The Purdue methodology considers as well the so called 'internal interfaces' that occur between components.

### *PERA Modelling Constructs*

As it has been stated before, the Purdue methodology provides as reference architecture that enables the enterprise to construct its products within a system life cycle perspective (Vernadat, 1996)). Therefore, it does not provide formal modelling constructs to the analyst. It has been suggested that the same modelling constructs utilised for defining electronic data systems (EDS) can be utilised to 'model' the functionality needed. There are, however, some important contributions that PERA has made into the enterprise integration community. It presents a complete lifecycle of the enterprise integration, allows a more 'phased' approach in the construction of the enterprise system and provides an intuitive model that allows the integration of the project. Other contribution made is the inclusion of the human and organisational architecture.

### *2.3.2 System Dynamics*

System dynamics has enabled to capture the causal aspects of an organisation's policies (Forrester, 1992; Maani et al., 1998). Through the use of such methodology it has been possible to capture portions of policy, implement and simulate changes within the environment (Fowler, 2003). A graphical representation widely used is causal loop systems (Byer, 2004; Forrester, 1962).

#### *2.3.2.1 Causal Loop Diagrams*



Causal loop diagrams have been utilised in several environments such as production systems and organisation design (Jambekar and Nelson (1999)), strategy development and learning (Spector, Christensen and Sioutine (2001)) and health systems design (1998). The main focus is to identify the causes and effects within a particular domain. The diagrams presented are “graphical representations of our understanding of systemic structures (Kim and Anderson (1998)). This technique represents interactions between a cause and an effect. If the relation between the former on the latter is similar, i.e. it is intensified, then it is called a ‘reinforcing’ and it is presented by a positive sign (+). If the relation between the cause makes that the effect ‘diminishes’, it is represented by a negative sign (-). This does not qualify the relationship, only, shows the effects between the two factors (Kirkwood, 1998; Kim and Anderson, 1998). After a so called ‘loop’ or a circle of causes and effects has been identified, the occurrences of similar or positive signs and opposite or negative signs must be accounted. If a loop has the same amount of positive and negative signs, it is considered a ‘balancing loop’ (Fig 1). These types of loops have a ‘stabilising’ effect on the system, i. e.; it allows the system to maintain a desired condition.

If the number of negative signs is even or zero, then the loop is considered to be a regenerative loop. The effect of regenerative loops is that, over the time, it creates an exponential growth or decrease. If the number of negative signs in the loop is odd, then it will be considered a ‘balancing’ loop.

Figure 2.12 illustrates a generic example of ‘regenerative’ and ‘balancing’ loops.

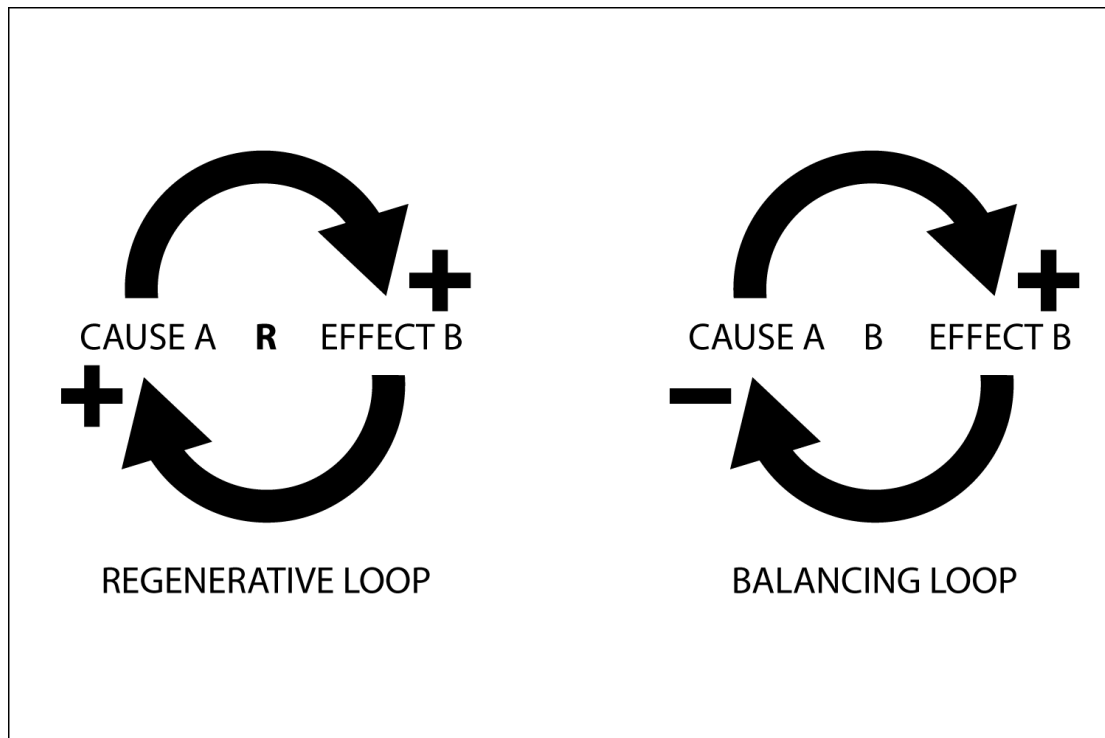


Fig. 2.12 Types of loops within a causal loop diagram

If the polished ideas and models that are produced within a brainstorming session during the strategic thinking process are to be combined, it would prove beneficial in the construction of a new model.

### 2.3.3 Discrete Event Simulation

Pidd (2004) and Fishman (2001) have stated that discrete event simulation (DES) modelling has been widely adopted by manufacturing industries. But in general DES application has been carried out in a piecemeal way, with a particular focus on some organisational segment and with some limited type of decision making support requirement in mind. The reason for this is that DES models are not readily scalable (Pidd (2004)) so that they can only either

- (1) Encode very abstract holistic models of ME systems behaviours, simply because invariably the reality being model is very complex. As a consequence DEs models can only have limited use in support of strategy realisation; or
- (2) Detailed models of ME realities must be heavily curtailed; so that they have a limited scope and or focus. Hence the current situation where

piecemeal models of ME realities do not share a common set of modelling ideas, nor an integrating framework, and therefore seldom can they be used synergistically.

On the other hand continuous simulation tools, based on the use of Numerical Integration techniques, have usefully supported thinking about big systems, including MEs. Furthermore the structure of continuous simulation models can be systematically derived from causal loop models. This kind of tool can lend some support to the conceptual design MEs, and their manufacturing systems; but this support is typically limited to testing ideas rather than detailing systems and programming system changes (Nidumolu et al. (1998).

## **2.4 LITERATURE ANALYSIS**

From the foregoing discussion it is clear to the reader that no coherent and explicit description of strategy realisation processes exists that managers of manufacturing enterprises can readily follow. Mintzberg (1994)) has argued that traditional views on strategic planning have impeded organisations to fully harness the creative potential within organisations. Whittington (1993) has further argued that differing schools of thought have not proposed a unified strategic process. DeWitt and Meyer (2004) have proposed the inclusion of an implementation process for the strategy realisation process, but as yet no explicit means of doing this has been proposed or provided.

Enterprise modelling methods can encode multiple aspects of an organisation (Vernadat (1996)) and provide a framework into which organisational knowledge and data about a specific ME can be positioned.

In principle two enterprise models can be used to detail needed organisational changes; and in this way they have potential to program a strategic intent. However, in respect to organisational design there has been limited industrial acceptance to date of Enterprise Modelling techniques; and where there has been acceptance generally this has centred on manufacturing systems engineering (Vernadat, (1996). Doumeingts et al. (2000) have argued that enterprise modelling methods can potentially enable many aspects of decision

making but little use of EM methods has been reported in the literature which is focussed on the various aspects of strategy realisation. Williams (Molina et al., (1998)) argued the need for modelling aspects of the strategy realisation process; however, his proposed methodology did not include modelling constraints or presented a coherent view of strategy realisation (Vernadat (1996)).

# CHAPTER 3 RESEARCH OBJECTIVES

## 3.1 INTRODUCTION

Chapters 1 and 2 have respectively set the focus of this research and reviewed relevant literature on the strategy realisation process, enterprise modelling and causal loop diagramming. A lack of coherence of the relevant literature of the strategy realisation process in terms of a holistic view or process derivation was discussed. Potential elements identified in the literature for subprocesses that comprise such process. Methodologies used to underpin the complex process networks within an organisation were also reviewed.

This chapter discussed the gap within the literature surveyed so as to identify potential candidate research aims and objectives and to formulate a research question which will be tested further on the present research

## 3.2 LITERATURE GAP ANALYSIS

Literature regarding the strategy realisation process was observed to be developed in a fragmented fashion, i.e., there is no widely accepted 'holistic' view of the strategic realisation process, literature concentrates on specific facets of it. A common underlying problem is that the term 'strategy' has been perceived and defined in a varied manner; therefore the literature surveyed presents findings about particular characterizations. Authors claim a series of 'best practices' based upon their definitions, usually neglecting or dismissing any other position that does not align with their view.

Organisations face an increased pressure to find the 'optimal configuration' that allows them to effectively realise and deliver their products or services with the minimum cost and at a maximum profit. The competition faced has increased as traditional industry boundaries have become blurred. Alliances

### *Chapter 3 – Research Objectives*

are common, small companies are forming networks to push their product with greater success across a contributing supply chain. A greater degree of uncertainty has meant that corporate horizons for planning have needed to be reduced, and reassessing objectives has become a more frequent activity in many organisations. Coordination between different parties in strategic alliances has become a critical success factor to ensure that equitable access to proposed benefits can be achieved. Technology has enhanced and enabled the production, distribution and control of the products and services offered simpler, yet it has posed additional issues such as obsolescence. With reference to this set of variables, companies have to reassess their resources, projects and organisational configuration such that they can effectively tackle their issues in a sustainable manner.

The development of enterprise modelling techniques and the current application of those techniques has focused mainly on the productive processes of enterprises. It has provided methodologies and tools that facilitate understanding, communication, analysis, simulation and reconfiguration of multiple perceptions about organisations such as about their prime product realising activities, functions and processes deployed within the organisation under study, as well as how current (and possible future) configurations of these multiple perceptions are (or could be) organised. The literature surveyed has explicitly described several methodologies that focus on different aspects of events, activities and sub processes in the organisation, e. g., GRAI – GIM focuses more on decisional aspect of activities whilst CIMOSA on a procedural view of activities. The main concern of enterprise modelling is to present to the user an abstraction of the portion of the organisation under study in order to enable analysis and the design of potentially better configurations that would lead to improved performance. By a process of ‘stepwise’ iteration, organisations are able to use enterprise models to specify more ‘effective’ and ‘robust’ processes, i.e., processes that are capable of competitively realise products for customers whilst enabling sufficient flexibility to handle exceptions to the norm with minimal disruption to expected outcomes.

Enterprise modellers have primarily considered strategy to be a business policy setting process (Vernadat, 1996)). Williams (in Molina et al. (1998)) has identified the strategic realisation process as the identification of the requirements and process, policies and modules of a given project. Doumeigns (in Molina et al. (1998)) has identified strategy as a decisional process. However, in their publications the extent of the strategic process has not been considered. Senge (1990) has proposed the use of causal loops to identify the 'learning' of the organisation and potentially to draw a conclusion to strategy making Senge's findings have been endorsed by Forrester (1991). With this background in mind, a second primary aim is to enhance the capability of state of the art enterprise modelling techniques by defining and evaluating the use of additional modelling concepts and modelling constructs that enable explicit modelling of the strategy realisation process. Such concepts and constructs would need to complement the use of existing enterprise modelling notions so as to explicitly encode understanding about the strategic intent of an organisation, together with the plans and the implementation efforts required to realise that intent. Because organisations are complex a decompositional approach will be needed to explicitly define interactions between the three strategic sub-processes, and the way in which strategic decision impact on the configuration and the performance of product realising processes.

### **3.3 RESEARCH AIM AND FOCUS**

The aim of the present research is to investigate potential use of enterprise modelling, systems thinking and simulation modelling to aide and support the strategy realisation process by providing a set of reusable models that facilitate analysis and implementation of the strategic intent in the organisation

Focus of the present research will be on the strategy realisation process in the context of a production system of a manufacturing enterprise to test the underlying methodology created in the present study. Therefore, the main concern will be the provision of a coherent set of models that can document,

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validate and simulate the proposed strategic intent within the context of a manufacturing enterprise.

It was considered necessary to establish research boundaries within the present research so as to focus findings and work to enable a meaningful contribution to knowledge. The present research will discuss the components of the strategy realisation process as applied within the context of a small business enterprise (SME) type of organisation and will consider the use of various enterprise modelling tools, methods and software capable of underpinning and simulating the relevant aspects of the organisation as it pertains to the proposed strategic intent.

A research hypothesis was formulated that the use of enterprise and simulation modelling tools and methods would enhance the decision making process of the strategy realisation and would inform the strategist within the organisation to potential behaviours of key variables within an organisation when a particular strategic intent would be deployed.

#### *3.3.1 Research Objectives and Benefits Expected*

The research focus has been determined with reference to the analysis of the literature presented in section 3.1. This has given rise to the following research objectives:

##### Objective 1

To characterise and formally define common elements and steps comprising the strategic realisation process such that the strategic intent of organisations can be created, programmed and implemented in a coherent way.

The developed reference model of the strategic process will enable:

- ❖ Characterisation of strategy realisation process in organisations in terms of corresponding steps and processes that are enacted in each sub process.



## *Chapter 3 – Research Objectives*

- ❖ Explicit and formal definition of interfaces that occur between components of the strategy realisation process.
- ❖ Reutilisation of the strategic realisation process across the organisation, and possibly between organisations, could be replicated with respect to some mechanistic decision process.
- ❖ Decompose the proposed strategy into a formal description of the corresponding units and their characteristic causal and temporal interrelations.

### Objective 2

To propose and partially test the use of a coherent set of modelling constructs that explicitly and formally define the strategic intent of manufacturing organisations and enables its representation throughout the strategic realisation process. Here the objective will be to explicitly describe reusable enterprise modelling methods that systemises the capture and re-use of models of strategic intent, and related model of organisation configurations and behaviour, within a specific organisational context.

The developed methodology should enable explicit representation, and deployment, of reusable models of the strategic intent, organisation configurations and organisation behaviours by facilitating:

- ❖ Characterisations of causal and temporal relations between factors identified by the strategic realisation process.
- ❖ Simulation of possible outcomes of the proposed intent with respect to the alteration of specific organisation's constraints.
- ❖ Operationalisation of the strategic intent, by simulating the behaviours of alternative candidate organisational configurations.
- ❖ Formalisation of the strategic intent, so that it can be communicated easily through the organisation.

## **3.4 RESEARCH METHODOLOGIES**

## *Chapter 3 – Research Objectives*

After the research objectives and expected benefits were identified, it was considered that the present research would benefit from various research methodologies, approaches and strategies. Research authors (Sekaran, 2003; Smith and Dainty, 1991; Thietart, 2001) have classified those elements that facilitate research and facilitate its completion. A subset of methodologies was selected on its potential use in the present study at its several stages.

### *3.4.1 Research Approaches*

Sekaran (2003) has identified two main types of approaches to do research namely: basic or pure research and applied research.

Basic or pure research generates a generic or detached body of literature to develop a basic discipline. The main aim of such research is to enhance the understanding of the environment or a particular discipline without a particular application in mind.

Applied research generates understanding of a particular problem within its environment with a specific subset of variables and constraints. Knowledge generated from such studies enhances the understanding within the particular environment in which the study is carried out and benefits mainly the sponsor of such research. However, generalisation of such research is possible and contributes to a more generic understanding of problems.

Smith and Dainty (1991) confirm differences between the previously described approaches and further classify basic or pure research into objective research. Such research tackles a problem which can occur in a particular problem domain but it is not constrained to a particular application therefore facilitating knowledge dissemination in the academic and practitioner spheres.

The author of the present research considers that the approach undertaken in this study can be positioned closer to the applied research domains as it aims to gain a better understanding of implementation tools within a particular

## *Chapter 3 – Research Objectives*

organisation. Although the research problem was set in an academic setting, its application was observed under an industrial setting so that benefits could be relevant over a considerable period of time.

### *3.4.2 Methods of reasoning*

Two basic approaches can be undertaken when designing a research problem, namely;

#### *3.4.2.1 Deductive*

Knowledge generated under such an approach tends to consider previous premises or knowledge commonly regarded as fact to analyse the current problem and generate new understandings. This method involves reasoning from general principles to particular. A particular application of this method of reasoning is syllogisms. This particular method of reasoning is helpful when identifying potential causal effects in the variables of the problem domain under study.

Sekaran (2003) has proposed seven steps to effectively utilise this method of reasoning, namely:

- Observation
- Preliminary information gathering
- Theory formulation
- Further scientific data collection
- Data Analysis
- Deduction

#### *3.4.2.2 Inductive*

This method consists of several observations of phenomena associated with several instances of the research problem domain to develop new

## *Chapter 3 – Research Objectives*

understandings. This method of reasoning tends to gather information at a particular level of understanding and through a relational analysis develop new generic understandings. Smith and Dainty (1991) have observed three necessary conditions for effective observations utilising this particular method of reasoning:

- Correctly and accurately performed and recorded
- Cover a representative portion of the potential research population
- Conclusions should be drawn from statements substantiated directly from observations.

During the present study, both methods of reasoning have been utilised at various stages of the study progression. In the first stages, a deductive approach was utilised to generate potential partial knowledge that would benefit the methodology developed throughout the present research. In particular, how the use of enterprise modelling and simulation modelling methods and tools would enhance the strategy realisation process by providing reusable models in which a quantitative analysis could be realised to further study potential implications of a new strategic intent. Inductive reasoning was then utilised when individual observations were realised to confirm and validate the methodology proposed.

### *3.4.3 Research strategies*

A research strategy provides a general framework in which the researcher can collect, analyse and synthesise observations into reusable knowledge components (Smith and Dainty, 1991)). Various research strategies reported in Sekaran (2003) and Smith and Dainty (1991) are considered in the present section.

#### *3.4.3.1 Literature survey*

Generally this involves a documentation of previous published or unpublished research into the problem domain in which a particular study is positioned, in

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order to provide a theoretical framework to conduct and focus subsequent experiments, interviews, etc.

### *3.4.3.2 Experiment*

Experiments are the most utilised in scientific research to generate knowledge. A hypothesis and an alternative hypothesis are formulated to generate understandings of a particular problem domain. A subset of potential variables is controlled in order to enable the researcher to observe a particular variable, or set of variables, to analyse results. Sekaran (2003) argues that although experiments can be conducted in the laboratory, in a managerial or social science experiments can be conducted in a non-controlled environment. The researcher must ponder which set of variables can be controlled.

### *3.4.3.3 Case Studies*

Case studies provide an in depth analysis of a particular problem within a contained unit, be it an individual, a group of persons or an organisation within a specific context (Smith and Dainty, 1991). Case studies provide an enhanced historical perspective on a particular hypothesis under study in an organisation thus facilitating generation of a generic understanding of the problem domain within the constraints specified. It should be noted, however, that in several cases data elicited and discussed in a case study can be subject to confidentiality issues. However, the researcher can generalise from such studies to provide a theoretical and practical framework to a particular study (Sekaran, 2003).

### *3.4.3.4 Surveys*

Surveys are utilised primarily in social sciences and management research to obtain large amount of information of a statistically significant portion of a subset of persons or elements within the problem domain under study; to predict potential outcomes under semi-controlled environments. Data elicited

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with such methods of research will necessitate some form of statistical analysis to validate selection of elements and realised results (Smith and Dainty, 1991).

#### *3.4.3.5 Action Research*

Mainly undertaken by management consultants, this type of methodology involves changing current process networks in the organisation under study. A previously identified problem is researched by gathering relevant data and proposing and assessing potential candidate solutions and implementing the most viable one. Effects are measured and follow-up/corrective actions are determined if a problem persists or if a new problem has arisen (Sekaran, 2003)).

Several research strategies were deployed during the present research. Literature survey was employed in the earlier stages to collect relevant literature on the strategy realisation process and enterprise modelling to define the research problem domain; in middle stages, it was utilised to support the methodology proposed in the present study. A case study approach was utilised to provide a testing framework for the proposed methodology within a selected organisation. After several models were created of this organisation, an experimentation approach was considered to further test the methodology and to obtain data that could support the hypothesis of the present study.

#### *3.4.4 Purpose of Study*

Research studies may be classified by their purpose and the general manner in which they are conducted into three main categories namely: exploratory, descriptive and explanatory. These categories are aimed at the nature of the research, i.e., how the study is conducted and will depend greatly by the level of advancement in a particular problem domain. These methods are complimentary and can be present in a research study.

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### *3.4.4.1 Exploratory research*

This type of research is undertaken when there is little or no previous knowledge of the problem understudied. Exploratory studies are realised to gain a better understanding of the nature of the problem. Studies are normally conducted utilising interviews, questionnaires, etc. and the data collected is essentially explorative in nature. Such studies are particularly useful when developing a potential candidate research framework (Sekaran, 2003)). Realisation of this type of studies facilitates understanding of the phenomena understudy.

### *3.4.4.2 Descriptive*

Considered to be the most basic level of research (Smith and Dainty (1991)), this type of research provides a description of selected characteristics of the variables of the phenomena understudy. Descriptive studies are normally undertaken to describe characteristics of a group of individuals within an organisation and responses present under particular conditions. The main objective of deploying such studies is to present to the observer relevant aspects of the problem instance understudy from an organisational perspective (Sekaran, 2003)).

### *3.4.3.3 Explanatory*

Based on previously collected data, explanatory research aims to understand the reasons behind the occurrence of a particular characteristic within the system. The main aim of conducting such type of research is to gain new understandings behind the phenomena observed and potentially categorise and classify such findings within existing body of knowledge.

The present study benefited from a combination of the abovementioned research purposes. By describing the characteristics observed within the organisation selected, new understandings of the strategy realisation process and how enterprise and simulation modelling can enhance and support it. An

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explanatory approach was utilised when summarising and understanding potential implications of the present research for both academic and industrial settings.

#### *3.4.5 Research Reliability*

Research findings need to provide a foundational block to further research. As such, there is a need for validation of such results so that they can be reutilised (Sekaran, 2003). Particular attention needs to be considered with the following:

Construct validity – Validates the concepts and the interpretation of research results obtained from the research study are consistent with the theoretical framework from which they were derived from.

Content validity – Assures that a sufficient subset of elements that can properly characterise the problem domain under study

Internal validity – Assures the pertinence and coherence of reported results. It also observes the correlation between independent variables present in the research study.

External validity – Measures the level of generalisation the reported results may have in the potential parent population, i.e., results obtained from a survey study being generic enough as to represent the majority of the universe population.

Reliability – Assures that a research study performed under similar conditions, parameters, population, problem domain, etc. potentially can present similar results and conclusions to those of the original study.

Construct and internal validity were of primary concern to the researcher. Review of current literature enabled the researcher to gain confidence in the theoretical constructs thus facilitating the correlation between the proposed



approach and what current literature provides. Results were validated against the organisation and the body of literature and were found to be consistent. Regarding the present study’s reliability, it is the author’s conviction that utilising the same theoretical framework and tools and methods deployed, similar conclusions can be achieved.

### 3.5 RESEARCH METHODOLOGIES SELECTED

Several methodologies discussed in the previous section were selected to achieve the objectives of the present study. Table 3.1 summarises the methodologies selected during several stages of the research. Overall, it was considered that the present research would be an applied research, utilising case study strategy, with both inductive and deductive forms.

| Research phase | Description   | Methodologies selected   |
|----------------|---|--|
| Phase I        | Review of current literature of research’s problem domain   | Literature review,<br>Exploratory                              |
| Phase II       | Literature critique<br>Development of methodology   | Exploratory  |
| Phase III      | Application of research methodology in an organisation<br>Develop coherent models of organisation | Experimentation (simulation)<br>Case study<br>Applied research |
| Phase IV       | Analysis of results<br>Critique of results and further development to methodology                 | Descriptive<br>Exploratory<br>Applied research                 |

Table 3.1 Research methodologies selected for each study phase

# CHAPTER 4 RESEARCH FRAMEWORK

## 4.1 INTRODUCTION

Chapter 2 and chapter 3 have considered state of the art literature, research objectives regarding the present research. Two major research domains were identified and reviewed, namely: (1) strategy realisation and (2) enterprise modelling. From the literature review it was observed that there is a lack of a coherent 'model' of the strategy realisation process. Tools described in the strategy realisation literature have traditionally mapped the potential strategic intent and some key milestones; however, there is no reported approach to modelling the organisation in which such intent is to be deployed or to become positioned to quantify potential benefit that would arise from reconfiguration.

Additionally, organisational modelling literature tends to focus on the manufacturing systems of an organisation with no connection to the potential candidate strategic intent. The use of decomposition has been traditionally conceived to depict a production system. A need for a holistic view of the strategy realisation process was observed. Also observed was a need for enhanced enterprise modelling techniques that enable a better characterisation of the causal and temporal relations that impact on the strategy realisation process.

With the purpose in mind of addressing strategy realisation and enterprise modelling related needs, the following research assumptions have been made in this thesis:

- The 'strategy realisation process' is a generic process, in the sense that it embeds similar sub processes namely: thinking, programming and deployment, regardless of the size of the organisation

- Individual organisations adapt their deployment of these similar sub processes and their related concepts, to match their own circumstances
- instances of the strategy realisation process can be executed within different 'layers' (e.g., hierarchical levels, with associated 'phase', 'scope', 'focus' and 'time frame' of concern with respect to the several strategy realisation processes) of an organisation
- various modelling techniques, centred on enterprise modelling can be wed coherently to explicitly externalise enterprise understandings knowledge and data (normally distributed amongst distributed knowledge holders) such that it can support various kinds of decision making and action taking necessary to mature and realise strategies appropriate to different type of organisations

The validity or invalidity of these assumptions is considered in subsequent chapters of this thesis. In this chapter a detailed review and analysis of previous literature on strategy realisation and enterprise modelling is included to lay underpinning ground work for the assumption testing.

Key aspects of the research framework are graphically illustrated in figure 4.1. The main users, or roles, within the strategy realisation process are identified. Modelling methodologies are covered which enable the organisation to underpin various aspects of the strategy realisation process and intent within an organisation. A general overview of a potential methodology is discussed.

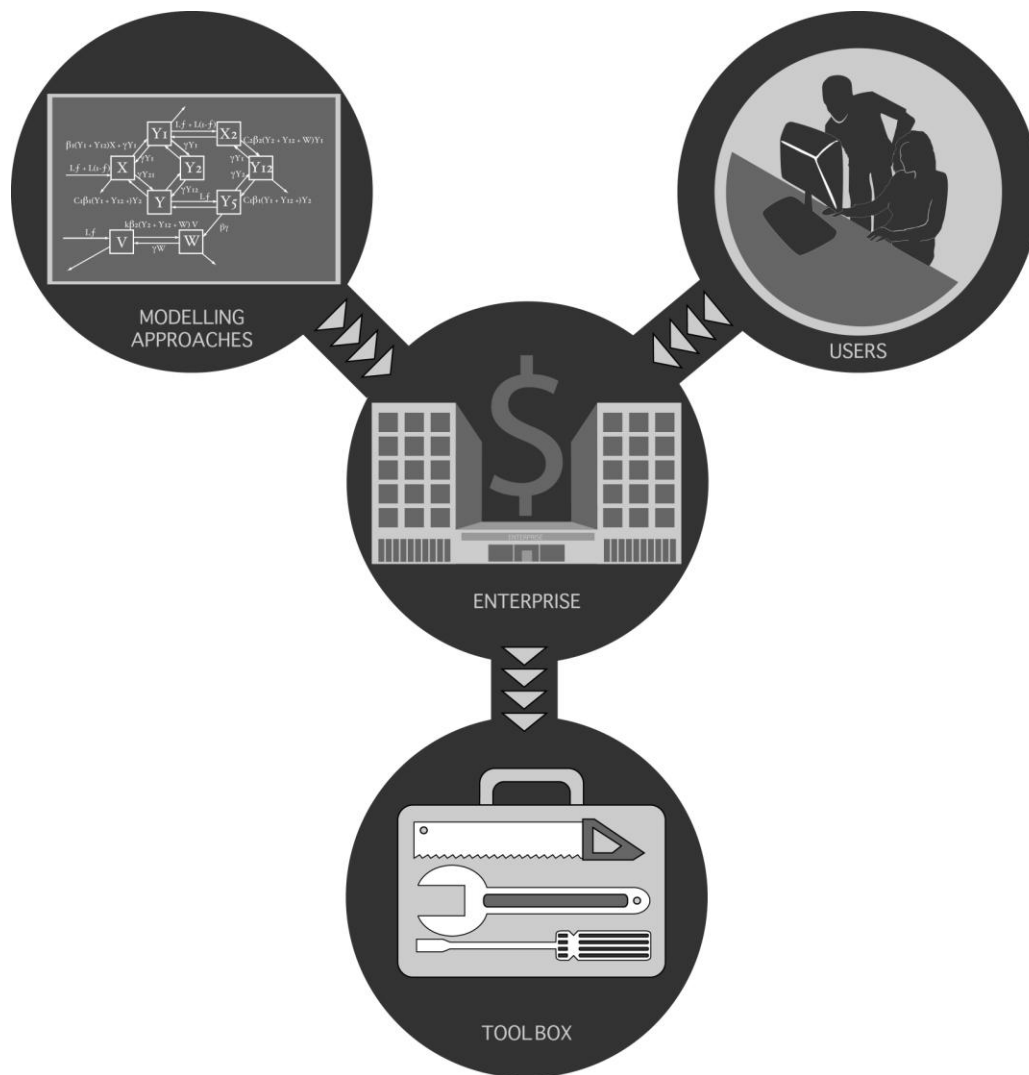


Fig 4.1 Research framework components

## 4.2 PROCESS CLASSIFICATION

Industry at large is reported to have shown increasing interest in ‘process modelling’; as a means of formally defining and explicitly representing current and potential future configurations i.e., changing interrelations between actors, activities and workflows in any organisation. Vernadat has defined a process as “a characteristic model or abstract representation “of the flow of control of things happening in the enterprise” (Vernadat, 1996). Vernadat goes on to say that “processes whose enactment depends on a particular set of events would produce a determined quantifiable result.” Also he states that ‘processes’ interconnect throughout the organisation accommodating several

activities such as: manufacturing and, engineering to conform the process network of an enterprise<sup>1</sup>.

Two main approaches to process modelling have been distinguished (Chatha et al., 2006). The first approach is to elicit and define enterprise requirements and the proposed underlying systems requirements. This viewpoint centres the models in an interrelation in the flow of activities and is enriched by decision making support, control and information flows. This approach to model conceptualisation enables the practitioner to separate current process relations, i.e., current process logic and relations, away from the conceptualisation and/or description of potential candidate system solutions that process abilities needed to realise the current processes within specified cost and timeframe constraints, and within specified qualities and quantities outputs. Indeed this separation is considered to be desirable by systems engineers because typical ‘process requirements’ of an enterprise will change at a different rate to changes in the human a technical resource systems (i.e. actors) used to realise those process requirements. For example, change in customer orders may result daily leading to changes in the number of instances (or occurrences) of a process. Whereas the process itself (i.e., the ordered set of activities required may change episodically (only when new products are introduced or when process improvement processes are invoked), whilst various forms of resources system change may occur monthly, weekly or daily as the nature of workloads change when resource availability change.

#### *4.2.1 Pandya Classification*

Several process classifications have enabled enterprises to be characterised in terms of their composed types of process (or business processes) and the relations between the processes therein. For example, Pandya et al. (1997) observed twelve general process types that can be present in an organisation where they grouped three main categories namely: Generic Management

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<sup>1</sup> The term ‘enterprise’ is utilised as a collection of processes and a part of the organisation that is under study (Vernadat, 1996)

Process, Generic Operate Process and Generic Support Process. Instances of processes within these categories typically traverse throughout the organisation boundaries, e.g., between companies, business units, departments, sections shops and cells, and it should not be inferred that their enactment is constrained to a particular segment of the organisation. Pandaya states that the 'Generic Management Process' determines and enables the realisation of structures that are overlaid onto the processes (or business processes) of an enterprise so that their operation runs smoothly with respect to other processes (internal or external) to the enterprise). The 'Generic Management Process' was decomposed by Pandaya et al. into three main processes: 'direction setting', 'business planning' and 'direct business'. Conversely the 'Generic Support Process' provides support (services) to the operational and management processes of the organisation, in order to enable them to achieve their specific targets. The 'Generic Support Process' category is typically decomposed into the following process types: 'human resource management', 'financial management', 'information management', 'marketing management' and 'technology management'. The 'Generic Operate Process' enables the transformation of requirements into products or services that are meaningful to the customers of the organisation and by so doing should realise value for enterprise stakeholders. The 'Generic Operate Process' is typically decomposed in to the following processes: 'obtain order', 'product and service development', 'fulfil order' and 'support fulfilment'.

Figure 4.2 illustrates the process classification identified by Pandya et al. (1997) and common process types within each class in common use by enterprises of various types and sizes.

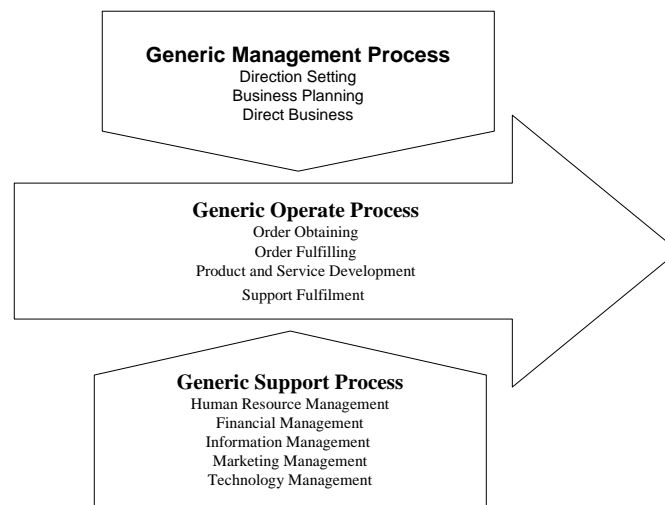


Figure 4.2 Process classification of generic business process in an organisation (Source: Pandya et al., 1997)

### 4.3 STRATEGY REALISATION PROCESS

As discussed in chapter 2, the strategy realisation (SR) process is used by any organisation to renew itself (i.e. recompose or reconfigure itself) to effectively and efficiently respond to opportunities and challenges, both present and foreseen in the environment; so that the organisation remains useful and competitive throughout its lifetime. A main goal of any organisation is to prepare ongoing strategy realisation processes to cope with the shifting in paradigms that the market, vendors, government, etc. dictate and to present a better solution than the enterprise's competitors. It follows that the enterprise needs to explicitly understand the strategic realisation process, as the effective attainment of SR should enable a sustainable advantage to be achieved relative to its competitors. O'Regan and Ghobadian (2002) have observed the development of dominant strategic realisation paradigms over the past four decades. This implicitly means that strategic realisation processes adopted by organisations have evolved over time. Mintzberg et al (1998) and Whittington (1993) have classified the current strategic realisation

literature into ‘schools of thought’ that characterise the main content of cognate literature. Although it has been observed that there is no universally accepted definition of the term ‘strategy’ (O’Regan and Ghobadian, 2002; Mintzberg et al., 1998; Whittington, 1993)], there is a consensus amongst the above listed authors that the strategic realisation process can be further decomposed. Mintzberg (1994) proposed the initial classification into two main sub-processes, i.e., strategic thinking and strategic programming. De Wit and Meyer (DM2004) expanded this decomposition by identifying a third sub-process, strategic implementation. Yet generally these authors agree that the strategic process is normally centred on thinking, planning and implementation activity types (De Wit and Meyer, 2004) These sub processes have also been more in deeply discussed in the literature (Freedman, 20003; Gundy, 1998; Gunasekaran and Cecile, 1998; Lorange, 1996; Noble, 1999) yet normally, these three sub processes have been studied in an isolated way.

Based on discussions and division observed in this strategy realisation literature, the present author has made a research assumption (that is particularly tested by the research study reported in this thesis), namely that organised groupings of these activity types can be considered to comprise types of sub-process that concern a fundamentally important aspect (or view) of the strategic realisation process. Also that by understanding characteristics and developing these views an enterprise better determines and achieves intended purposes through its lifetime.

Indeed there is a significant body of opinion and backing evidence that the three main processes from which the strategic realisation process is constructed, are: *strategic thinking*, *strategic programming* (also known as planning or formulation) and *strategic deployment*<sup>2</sup>. The previous authors point out that strategy realisation is essentially a sequential flow of activities from thinking through programming to deployment, but that dependencies and constraints linking (the outcomes, resources, etc) of activities necessitates

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<sup>2</sup> The term ‘strategic deployment’ will be utilised to avoid confusion with ‘strategic implementation’ because the latter is commonly identified as an appendage of the strategic programming.



that the enactment process requires asynchronous and iterative flows between activities belonging to the three main processes. Typically, the strategic programming process is scheduled for a specific period of time (see Ansoff, 1965; Lorange and Vancil, 1997) but the strategic thinking and the strategic deployment are processes that run continuously in the organisation. A strategist (or a group of strategists) may regularly evaluate the current business model, enterprise structure and environment in search of potential opportunities or challenges. Also the strategic deployment process will normally realise an ongoing effort to enable the enterprise to achieve the proposed strategic intent, by suitably modifying the processes, structures and therefore configuration of the enterprise. Maintaining necessary (causal and temporal) dependencies between all enterprise processes is an essential ingredient of successful implementation of any strategic option for the enterprise. As such, direction setting inputs may impose constraints or offer opportunities to be explored by enterprise personnel within the context of sub-processes. Strategic programming typically takes the form of a scheduled process and normally occurs infrequently in the organisation, i.e., as an annual or biannual event or when the organisation faces a major challenge in which the variables and premises of the current strategic intent have been changed.

#### *4.3.1 Strategic Thinking*

Mintzberg (1994) has argued that organisations cannot directly implement a strategic plan without considering the environment in which they are positioned. To effectively analyse the events, stimuli and information that the external and internal organisational environment generate, it is necessary to filter the relevant information through the 'strategic thinking process' Potential courses of action are chartered and ideas are explored within the organisation to better cope with changing demands. Corner et al. (1994) argues that such decoding of information enables recognition and encoding of relevant characteristics of the environment (or environments) within which the organisation needs to operate. It follows that strategy realisation processes normally need to constitute a collective and continuous process within the

organisation, i.e., the holistic process is not a 'scheduled' event that should occur within a specific frame of time, even though some larger organisations set apart a period of time in which the main strategist of the organisation can meet and produce a strategic intent for the company (Eigeles, 1997).

The literature also identifies four main sub-processes focused on informing strategy realisation, namely: (1) recollection, gathering and filtering of information (Corner et al., 1994; Huff, 1990), (2) encoding of potential ideas based on the information filtered (Brahm and Kleiner, 1996; Kay, 1995; Seaker and Wallace, 1996), (3) evaluation, assessment of the viability of the proposed ideas (Magretta, 2002; Morris et al., 2005) and (4) a potential candidate model of the organisation (Magretta, 2002). The processing of information can enable strategists to discern between valuable strategic information and 'noise', i.e., information that is not relevant for the organisation. Corner et al. (1994) described this decision making step as paying explicit 'attention' to what the information has to present, both to the organisation and to the individual. Huff (1990) and Senge (1990) established the concept of 'mental models' as the perception, i.e., images, assumptions, bias, etc., that an individual or an organisation has about the surrounding environment.

#### *4.3.1.1 Filtering*

Organisations and individuals deal with considerable amounts of information from multiple sources that inform the relevant activities. However, given the potential overflow of such information it is necessary to assess the relevance for the particular set of environmental conditions for a particular section of the enterprise. Therefore, there is a need to filter the information that will be used during the performance of the activities. Huff (1990) has suggested that people utilise 'mental maps' in order to classify and decode the information presented. In an equal manner, when organisations are faced with information that pertains to their activities, it is necessary to classify it in terms of the relevance it presents. Mintzberg et al. (1998) suggest several concepts that organisations utilise in order to discard irrelevant information namely:

organisational culture, organisational learning, personal and organisational mental maps, etc. Corner et al. (1994) suggest that organisations may engage in several ways in which the information is filtered, including a surveillance in which the organisation examines the environmental variables and elicits information from sources that create a 'disturbance', i.e., information that does not fit in the normal course of activities. A second method of filtering information is 'motivated search' in which the organisation actively searches for relevant information within a focused area of the organisation's domain.

#### *4.3.1.2 Encoding*

Encoding of information enables the strategist to reference the information gathered from the filtering process into models that are understandable to all individuals concerned (Corner et al., 1994). Information is categorised, related and interpreted so as to be usable for producing a strategic intent. The organisation encodes the information creating synergy between several strategists involved in the organisation, although this process also occurs within an individual.

Information storage occurs in various forms (Corner et al., 1994). At the individual level, experience enables the strategist to use the mental models he has acquired in order to retrieve necessary information when a similar idea is presented. At the organisational level, storage can be done in several ways, including procedures, routines, databases, etc.

#### *4.3.1.3 Analysis*

Thompson (1995) suggested three cardinal points for evaluation of a strategic idea, namely: (i) appropriateness, i.e. compatible with the current vision of the company, product portfolio, etc., (ii) feasibility of implementation and (iii) desirability. These three cardinalities should be met for an idea to be programmed and implemented.

To evaluate a strategy, senior management needs not only to consider the 'feasibility' or the 'numerical' results in order to assess their usefulness. Strategies are successful if they can be simple yet effective in achieving the overall vision of the company and can successfully harness (properties and impacts from/on) the environment. Therefore, three main questions would serve as a guiding principle for the analysis (Hamel and Prahalad, 1994), namely: (a) what is the competitive advantage needed, (b) will the organisation observe a dominance in a particular scenario and (c) what is the optimum configuration of the manufacturing system.

Collins and Porras (2000) established that individual strategies must be in accordance with the company's vision. This is consistent with the writings of Hamel and Prahalad (1994) as the vision should be an abstraction of guiding principles and overall objectives of the organisation and therefore should be a key driving force in the creation of strategies.

#### *4.3.1.4 Business model*

The term 'business model' has been discussed primarily in the literature with reference to the domain of electronic commerce (Chan and Chung, 2002; Magretta, 2002; Morris et al., 2005, Osterwalder and Pigneur, 2002) or the logic behind a proposed strategic intent (Varum and Melo, 2009). Shafer et al. (2005) classified literature on business models and observed several characteristic aspects such as: supplier, customer, strategy, cash flow and implementation, among other aspects. Their definition of a business model is a representation of the organisation's strategic intent and business logic needed to create value within an existing value chain. It has been argued that there is a clear separation between the terms strategy and business model. Business models provide a 'blue print' for the strategic intent in the organisation (Shafer et al., 2005; Magretta, 2002). The utilisation of business models can benefit the strategic realisation process in that they might help structure the capturing of initial configurations of the organisation and enable the proposition of alternate 'scenarios' in which differing strategic intents could be enacted. It is mentioned by the authors that such representations should

not be considered to be a strategy, but could enable discussion about strategy.

The output of the strategic thinking sub-process should therefore be a context-dependent model of the proposed ideas that the organisation will pursue in the following period of time. Though some viability analysis may be done, generally at this stage one would not expect this model to detail any resource allocations, neither is it likely to define necessary constraints when performing tasks. However this context-dependent model should provide an effective basis for performing 'strategic programming' (Mintzberg, 1994) or what more generally in industry is considered to be strategic planning.

#### *4.3.2 Strategic Programming*

Strategic programming is therefore a complementary sub-process to that of the strategic thinking sub-process. Strategic programming should achieve necessary viability analysis, together with defining possible resource allocations, critical success factors and a set of performance measurements. The publication of 'Corporate Strategy' by H. I. Ansoff (1965) initiated a school of thought based on the sequencing of enterprise activities according to a master plan, dictated by the mission, vision and general objectives of the organisation. Lorange and Vancil (1997) suggested that strategic planning is concerned with objectives, purposes of the organisation, goals and plans. The main objective of this process is to produce a formal document in which the enterprise's structure, resources, policies and procedures are aligned into the main mission and directives given by organisational leadership. It provides a decompositional approach, i.e., it leads to a division of the main tasks into smaller tasks until those tasks are manageable (Mintzberg et al., 1998) with necessary actions, objectives and milestones defined. The core of this process is to produce a framework of activities that the organisation can follow in order to implement a strategic intent. The plan produced by this process is essentially a configuration of the current resources, business processes, portfolio of products, etc. that the enterprise will require in order to achieve the goals set. Critics of the strategic planning process (see Mintzberg, 1994;

Heracleous, 1998) have stressed the fact that strategic plans promote inflexibility in the organisation and might suffocate the reaction of the enterprise when presented with a learning opportunity to best tackle the present state. It is the present author's point of view that, whilst strategic plans or programs need to clearly delimit the activities needed to implement the strategic intent, it should be robust and provide the enterprise with options and exception handling. While certain structure must be maintained, the strategic program must be able to be reconfigured in cases where a minor disruption might affect the performance of its activities. The resulting plans are to be considered a general guideline in which the activities, resources and structure must evolve, yet at the same time, be capable of adjusting if conditions on the specific variables of the process change within a predetermined area of action. It follows to the reader that changes that surpass those margins would require greater modification and could enable the strategic process to assess the extent of changes in the overall program.

To support the strategic process, several methodologies have been developed. Since the publication of Ansoff's work in 1965, there has been much development in the literature about methods and tools to implement this process in the enterprise, such as Scenario Planning (O'Brien, 2002; Courtney et al., 1997), Strategic Control (Harrison, 1995), Financial Control (Mintzberg et al., 1998). A key concept in the strategic programming process is to determine how to structure the organisation in accordance with defined objectives that the strategic thinking process has conceived. Mintzberg (1994) has proposed that the 'strategic programmer', derived from his classification of strategic programming, enables the strategic intent by presenting the necessary in depth analysis, i.e., present costs, necessary performance indicators, milestones, alternatives of action, etc. to the senior management in order that the strategic intent can be assessed more fully. Programming allows the organisation to do an in-depth analysis of the ideas presented, allocating resources, time constraints and performance indicators. The major goal of this process is to produce a 'robust' plan, i.e., that may handle exceptions and suggest possible action courses to be followed. It provides a general framework with specific targets, objectives and goals that enable the

organisation to attain the desired configuration specified in the strategic intent. This process provides the framework of action for the strategic deployment sub – process.

#### *4.3.2.1 Modularity in Strategic Programming*

Decomposition of objectives and goals enables the organisation to better implement the strategic intent (Ansoff, 1965) by layering different levels of hierarchy of budgets, resources and time constraints. Plans are decomposed into the corresponding areas in order to further decompose the activities pertaining to a specific area until it is atomised in action lists presented for an individual department. Lorange and Vancil (1997) have divided the strategic programming cycle into three cycles, being the first where a decomposition of the objectives is made in order to facilitate the detailed planning of the strategic intent. This is done by the middle and top managers in the general set of objectives and goals, yet when approached to the line managers and team leaders, a further decomposition will be done in order to communicate the strategic intent and to create the strategic implementation plan.

#### *4.3.2.2 Budgeting*

Budgeting enables the strategic program to allocate the necessary financial resources that are needed to enact the activities described in the strategic program. Ansoff and McDonnell (1990) recognise the existence of two main types of budgets, namely, strategic and operational. The first budget is characterised by the scope of its coverage, i.e., would typically include investments in current/expected areas of present/potential strategic business units (SBU's) and their geographical growth. A strategic budget is targeted at those activities that enable the organisation to expand or divest itself from present or potential activities. An operational budget is targeted at the present day operations of the enterprise and ways in which those activities may be more efficient. The scope of the operational budget would include the present value creating activities, potential expansion to those and the way to reduce present costs in the organisation. Lorange and Vancil (1977) characterise

budgets in accordance to their planning process, i.e., general, when the activities, objectives and goals are being agreed and discussed, and detailed, when the corporate managers have decided the activities to be programmed and implemented throughout the organisation. This characterisation and scope of the budgeting within the strategic programming process is consistent with Goold and Quinn (1990).

Budgeting has also proven to be effective in a small and medium enterprise context in that has enabled the management to decide between potential activities to be performed (Peel and Bridge, 1998). The authors state that the utilisation of a budgeting technique was influential in the level of detail in which the organisations made their strategic program. This resulted in a better level of achievement of the objectives and goals of the organisation.

#### *4.3.2.3 Resource Allocation*

As an extension of budgeting, Lorange and Vancil (1977) mention that resource allocation follows the assignment of budgets to a strategic intent. However, the author mention that this process is usually done in an unsystematic and unstructured manner, which might create problems if the communication between corporate and unit manager is not good. Hamel and Prahalad (1994) have argued in favour of recognising the strategic need of configuring the organisation's intent around current and potentially acquirable resources, i.e., resources that could be obtained by the organisation that present a significant advantage. The allocation of resources turns crucial as a small company might be able to succeed in defending the market niche in which it is currently positioned.

#### *4.3.2.4 Time constraints*

As the objectives and goals are defined, it is important to specify the necessary time constraints that would enable the organisation to achieve the



proposed strategic intent. Harrison (1995) has proposed the concept of 'strategic maturities' as points in time when an objective or an activity in the strategic realisation program should be accomplished. The measurement and progress of the strategic intent is a crucial part of the strategic program (Ansoff, 1965; Lorange and Vancil, 1977; Ansoff and McDonnell, 1990). Time constraints enable the organisation to assess the progress of the implementation of the strategic intent and help the organisation determine if there is a need of a corrective action, in case the activity has not been completed or if there are foreseen problems with its completion.

#### *4.3.2.5 Strategic program*

The strategic program is a document in which the organisations states the intent of the strategy realisation process, specifies an assignment of the necessary resources, time constraints and configurational changes that will need to be enacted in order to implement the proposed strategic intent. It provides the organisation with a detailed analysis of the activities, performance indicators, portfolio of products, areas of investment, etc. that will be used in a specific timeframe (Harrison, 1995). The program also addresses which resources will be allocated in the organisation, responsibilities and alternative courses of actions. It has been suggested by Monfared et al. (2002) that manufacturing organisations need to be 'change capable' in order to succeed in uncertain environments. Likewise, the strategic program needs to enable sufficient flexibility within the organisation so that when a set of possible scenarios of action have been determined the necessary configurational changes can be enacted readily and effectively. The strategic program should be encoded in a form suitable for use within the organisation, the intent of the business model should provide actors involved in the strategic thinking process with evidence about particular outcomes of an intended strategic intent.

#### *4.3.3 Strategic Deployment*

Strategic deployment, or implementation, manages the communication efforts between the strategic programming process and the related daily operations of the organisation. It constitutes a set of activities that are performed throughout the organisation in order to enact the proposed strategic intent. It manages the transition from the current 'As – Is' state into the proposed 'To – Be' state by performing necessary configurational changes in the target processes by measuring their performance related to the expected one. Hammer and Champy (HC2001) propose a radical approach to redesigning target processes, yet this focus is challenged by Quinn (1980) who favours an 'incremental' approach, i.e., 'small steps' towards achieving the proposed strategic intent. It should be noted that not all processes of the organisation are candidates of a given configurational change. For example, basic purchasing and accountancy will typically remain unchanged over several timeframes of other configurational changes. This researcher argues that strategic implementation can be a mixture of various degrees of radicalism in that some processes can be changed faster and more extensively than others. Yet a complete radical transformation of the organisation is not always desirable for practical and cultural reasons. Proposed changes to relevant processes need to be assessed and evaluated before implementation as to define potential issues that might arise. When implemented, those changes need to be observed and monitored, so as to design appropriate measures to tackle any issues arising. This might be in the form of an adjustment to the configuration of the process or some key factor related to it. If the change of configuration affects several areas of the organisation, suitable interaction is required between the strategic deployment and the strategic programming teams, as premises for the original strategic plan may need to be modified as well as the objectives, timeframes, resource allocations, etc. envisioned in the strategic program. The strategic thinking process can be also affected by a major change in the configuration, as it might introduce new information that was not available when an earlier version of the strategic intent was developed. The occurrence of such major changes may be infrequent and may be triggered only by a major change in the organisational environment, such as new technology emergence, or emergence of a significant competitor

or new governmental pressure. If a major change occurs, then there should be an effective and timely communication between the strategic programming team and the other teams (thinking or deployment teams) involved in order to assess the nature and extent of the necessary adjustment. Evidently therefore, strategic deployment provides feedback to both strategic programming and thinking. To the strategic programming process it provides information about the current state of enterprise processes and their competences, capacities and so forth, and enables programmers to develop a 'realistic' view of the capabilities of the organisation. It has been mentioned earlier that the thinking, programming and deployment sub-processes provide a 'feedback loop' to each other. Strategic deployment should analyse any need for change capability and compare this with existing change capabilities. Since deployment will in general cover the production areas of the enterprise, it is necessary that the personnel in those areas are involved in operationalising strategy deployment. Hamel (1996) even suggests that production personnel should be present during strategic thinking sessions, for this would reduce later implementation problems, i.e., lack of commitment, miscommunication, etc.

#### *4.3.3.1 Strategic Issue Management*

Traditionally, strategic issue management is considered part of the strategic programming process (Mintzberg et al., 1998), yet it enables the management of those issues raised by the implementation of a strategic intent in an organisation. Muralidharan (1997) reviews several approaches to 'strategic control', from traditional control to periodic review, and concludes that when done periodically, strategic control enables the organisation to review the assumptions of strategic programming in order to make necessary adjustments to the program. The main focus of management control is to: identify the strengths and weaknesses of the organisation as a strategic intent is implemented; to monitor the impacts of the environment with respect to those issues previously identified and propose; and to enact the necessary changes that would enable the organisation to deal effectively with the perceived threats. A similar conclusion is reached in the works of Ansoff and

McDonnell (1990). The authors mention the utilisation of 'strategic issue management' enables the organisation to review the performance of its strategic program more frequently; thus enabling necessary changes than the reviews that can be made by the strategic programming process. A major factor that contributes to the need for strategic issue management is a fast changing environment of the organisation

Ansoff and McDonnell (1990) have characterised 'strategic issue management' (SIM) as follows:

- ❖ Real time management
- ❖ Continuous surveillance of variables and assumptions in the environment.
- ❖ Cuts around organisational boundaries and hierarchies, usually a team manages the changes and reports to the senior management
- ❖ It supposes a management action, not a plan.

The focus of the Strategic Issue Management is to adapt the current strategic program to the performance and the environment of the company. When a major change is needed, a review of the strategic program should be done and the strategic programming process should be enacted. However, it should be noted that the SIM process may enable limited changes in order to adapt the strategic intent without a major change to the program itself.

#### *4.3.3.2 Implementation Plan*

The implementation plan (Freeman, 2003) defines necessary steps that enable each subset of the organisation to realise the premises of the strategic intent. It contains an operational description of the activities, resources, time constraints and performance indicators as well as the necessary process configuration changes that enable the organisation to implement the strategic intent. A basic premise of the strategic implementation plan is that it provides a route via which the organisation can transform itself from the present 'As –

Is' state to the proposed 'To – Be' state, together with any need transitional configurations that are required to reached the proposed intent.

#### **4.4 RELATION BETWEEN SUBPROCESSES IN THE STRATEGY REALISATION PROCESS**

From the foregoing discussion, it was concluded that the three identified sub-processes of the strategy realisation process would interface to create a strategic intent to be implemented in the organisation. It was conceived that the model created by the strategic thinking process would be enriched by the activities of the strategic programming sub-processes where specific objectives, performance measures and potential resources would be allocated or the investment in such resources would be devised. Similarly, the strategic deployment sub-process would enact and monitor relevant objectives within the enterprise.

Although typically the enactment of sub-processes has been reported (DeWitt and Meyer, 2004) as a sequential, i.e., a waterfall approach, set of events, it can be argued that feedback occurs between sub-processes. The strategic programming sub-process analysis the underlying assumptions of the business model, generated by the strategic thinking sub-process, and develops a critique of the potential candidate intent. Similarly, the strategic deployment sub-process can identify potential areas where the constraints imposed by the strategic plan would exert undue pressure on the current or potential candidate configuration of the production systems.

Figure 4.3 graphically depicts the relation and the identified interfaces between sub-processes in the strategy realisation process. The output of the 'Strategic Thinking' sub-process is a business model which is the rationale and assumptions behind a potential strategic intent. It is a generic view of the organisation, the environment and the constraints present in such intent. The 'Strategic Programming' sub-process analyses such intent and communicates a feasibility analysis, where further test to the assumptions and rationale of the business model might be necessitated as current and potential resources,

timeframe, market conditions, etc are analysed. The ‘Strategic Programming’ sub-process produces a so-called ‘strategic program’ which contains detailed activities, resource allocation, milestones and timeframes necessary to achieve the proposed strategic intent within the organisation.

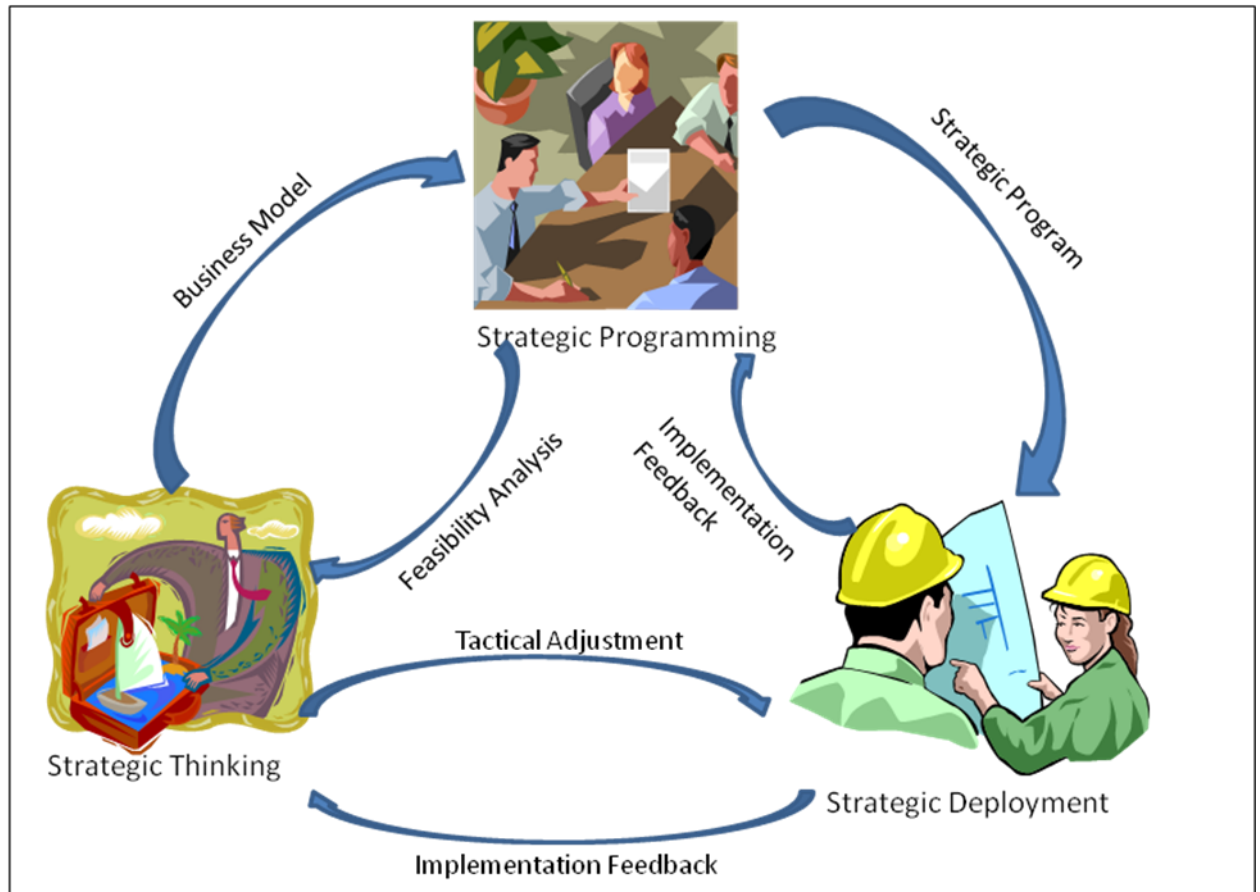


Fig. 4.3 Relation between sub-processes of the strategy realisation process

#### 4.5 TOOLS UTILISED TO MAP THE STRATEGIC INTENT IN AN ORGANISATION

Table 4.1 depicts tools that have traditionally been utilised to underpin objectives within a proposed strategic intent within an organisation. Such approaches enable the communication of such objectives at all levels of the organisation. However, such tools present a so-called ‘prescriptive’, i.e., a generic, strategic intent regardless of the organisation’s current or potential candidate configurations. It is therefore necessary to include the various

process networks present within a particular organisation in which the strategy realisation process is enacted.

| Tool                        | Scenario Planning  | TOWS Matrix   | Porter Five Forces  | Balance Scorecard   |
|-----------------------------|--|---|---|---|
| Advantages                  | <ul style="list-style-type: none"> <li>• View of 'alternative' configurations of the ME within a given set of parameters</li> <li>• Enables analysis of behaviour of multiple key variables under multiple environment conditions</li> </ul> | <ul style="list-style-type: none"> <li>• Assessment of company's strengths and weaknesses compared to their competitors.</li> <li>• Develops alternative courses of action</li> </ul>           | <ul style="list-style-type: none"> <li>• Exhaustive analysis of the company's stand within a particular industry</li> <li>• Broader sense of strategic environment</li> </ul>   | <ul style="list-style-type: none"> <li>• Graphical representation of overall strategic objectives in multiple areas and key performance indicators</li> <li>• Identifies performance indicators for relevant areas of the organisation</li> </ul> |
| Limitations                 | <ul style="list-style-type: none"> <li>• Complexity in creating alternative configurations.</li> <li>• Biased focus on the probable outcome of the environment</li> </ul>  | <ul style="list-style-type: none"> <li>• Possible bias in selection of strengths and weaknesses</li> <li>• Difficultness to properly assess the level of each strength or weaknesses</li> </ul> | <ul style="list-style-type: none"> <li>• Too complex to implement in a SME context.</li> <li>• Requires too much information to provide a meaningful analysis.</li> <li>• Information detached from analysis relevant where all known competitors can be identified and vast statistical information can be obtained</li> </ul> | <ul style="list-style-type: none"> <li>• No account of current or potential configurations of organisation</li> <li>• Only accounts for capital and physical resources, other constraints not accounted for</li> </ul>                            |
| Inputs                      | <ul style="list-style-type: none"> <li>• Distinctive alternatives for a variable under study for the enterprise</li> </ul>   | <ul style="list-style-type: none"> <li>• Performance on measured variables regarding established parameters in regard to the enterprise competition</li> </ul>                                  | <ul style="list-style-type: none"> <li>• Statistical analysis of performance of current and potential competitors, current and potential government regulations, market analysis, product analysis, financial information.</li> </ul>   | <ul style="list-style-type: none"> <li>• Objectives as defined by senior management</li> <li>• Financial constraints as defined by organisation</li> </ul>  |
| Environments of application | <ul style="list-style-type: none"> <li>• Low level of uncertainty.</li> <li>• Distinctive alternatives of configuration can be established</li> </ul>  | <ul style="list-style-type: none"> <li>• Varied levels of uncertainty</li> <li>• Objective performance measurements can be established to compare companies' performance</li> </ul>             | <ul style="list-style-type: none"> <li>• Little or no uncertainty from the environment</li> <li>• Vast wealth of statistical data can be obtained</li> <li>• Major competitors can be clearly identified</li> </ul>   | <ul style="list-style-type: none"> <li>• Varied levels of uncertainty</li> <li>• Clearly identifiable objectives envisaged by senior management</li> </ul>  |

Table 4.1 Comparison between various strategic tools identified in literature



Further to understanding how the strategy realisation process can be decomposed into more elemental processes, it was considered that the use of state of the art modelling methods and tools (such as: enterprise modelling, systems thinking and discrete event simulation) would be beneficial to strategy realisation. Here it was envisaged that the explicit capture and ongoing re-use of models of specific business process networks, relevant actors and constraints related to any target organisation could facilitate manipulation of those models within ‘virtual environments’ by various user groups concerned with strategic thinking, strategic programming and strategy deployment. In this way it was presumed that better designed and integrated strategic intents could be devised; faster and more effective strategic programming and deployments could be made; and that this would lead to significant competitive advantage in organisations that engage with such a model driven strategy realisation process.

To capture the relatively enduring, i.e., static aspect of the organisation, it was considered the use of an enterprise modelling technique. From the previous literature review, it was considered that CIMOSA would enable the researcher to capture at various levels of granularity. It was considered the use of static model.

#### *4.5.1 CIMOSA Modelling Framework*

CIMOSA is the acronym for the Computer Integrated Manufacture Open System Architecture. CIMOSA was developed with a number of related ESPRIT project by the AMICE consortium during the late 1980s to early 1990s. Its primary architects were Kosanke (1995), Zelm et al. (1995) Kosanke and Zelm (1999), Vernadat (1996) and Berio and Vernadat (1999). The main purpose of CIMOSA is to provide support for process oriented modelling in an enterprise by providing modelling concepts, modelling frameworks and modelling formalisms to explicitly decompose and describe its characteristic properties. (Kosanke and Vernadat (in Molina et al., 1998). CIMOSA provides means of creating a ‘holistic’ view of projects, by formally representing information regarding business processes and their related

information, behaviour and activities. The modelling constructs provided allow the organisation to formally specify a consistent set of requirements and operations description. Kosanke and Vernadat mention that CIMOSA enables the users to model “business requirements, deriving enterprise system designs and support its maintenance and operation (Kosanke and Vernadat in Molina et al., 1998).

#### 4.5.1.1 CIMOSA modelling constructs

The operation in any enterprise can be described as a network of co-operating processes that share common resources. CIMOSA provides common modelling constructs to represent the main enterprise objects, such as: domains, events, business processes, enterprise activities, functional entities, etc. Figure 4.4 classifies the modelling constructs defined by the CIMOSA specification.

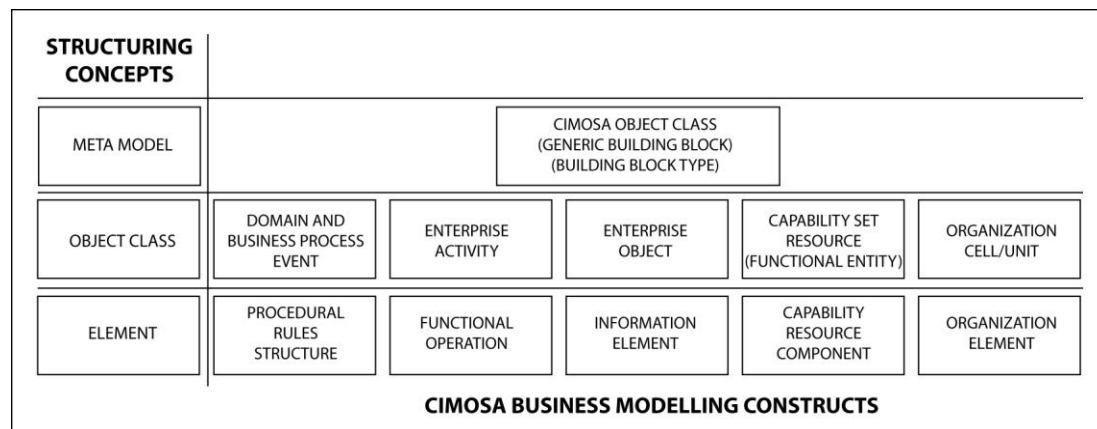


Fig. 4.4 CIMOSA Business Modelling Constructs (Kosanke in (Molina et al., 1998))

#### 4.5.1.2 CIMOSA Object classes

The following object classes will have an instance in models created utilising CIMOSA. There is no formal graphical representation specified for each object class, but formal description of each element has been defined for tools that implant CIMOSA concepts (such as FIRST STEP and SEWOSA) so that these tools can graphically model characteristics such as: type, identifier,

objectives, resource inputs, etc. (Vernadat, 1996], Kosanke and Vernadat in Molina et al., 1998])

**Domain:** CIMOSA defines this as being a functional area of the enterprise that has a common organisational goal. A domain has several stand-alone processes, called 'domain processes' and is characterised by a name, scope, list of domain processes and relations with other domains.

**Event:** An event changes the status of one or more variables of modelled system. It may be generated by external or internal actors, i.e., from within enterprise domains or environmental domains. Each event is characterised by a name, source and process that enables or triggers a condition of existence.

**Domain processes:** These are sets of end to end activities needed to realise enterprise functions. These activity sets (or processes) exist independently from other processes in a organisation, i.e., they are so called 'stand – alone ' processes. Each domain process is characterised by a name, a list of triggering events and its behavioural rules.

**Business Processes:** These are subsets of domain processes; they are enacted by a parent structure and not by an event.

**Enterprise Activities:** These are a set of ordered actions performed to achieve a specific goal. An activity transforms an object (whether physical or logical) from an initial to a final state. The following characterise an enterprise activity: name, inputs and outputs (functional, control and resources), status of termination, duration (minimum, maximum and average), transformational function, i.e., what the activity does.

**Functional Operation:** This is an atomic task that is a part of an enterprise activity.

**Resource:** This is an entity, human or technological, needed for the execution of a given activity. Two conditions are needed for a resource to assist in an

activity namely: that it is available and it has the necessary competencies or the knowledge to perform the requirement of the activity, in order to function properly. Each resource is characterised by the following: identification, capabilities, capacities, availability and components in the case of a component resource (Vernadat, 1996).

#### *4.5.1.3 CIMOSA Diagrams*

Further work done within the MSI Research Institute within Loughborough University has provided a graphical framework to utilise the CIMOSA modelling constructs (Monfared, 2000). Each diagram presents a unique view and complements information encoded by other CIMOSA diagrams.

##### *Context Diagram*

This diagram represent the main domains of the enterprise and it is utilised to define which domains are of the interest to the modeller (CIMOSA domains) and which are out of the scope of the project (non – CIMOSA domains). The graphical representation of the domains is by an oval, with the non – CIMOSA domains presenting a diagonal line in the right side. Each domain is defined by an action verb, i.e., 'To Produce'. Various levels of decomposition can be added if necessary to further define the scope of the project.

##### *Interaction Diagram*

This diagram presents interactions within domains or sub-domains described at the same level of abstraction. Events that trigger the enactment of domains are represented as is the exchange of necessary resources (data, human or physical) that enact each domain.

##### *Structure Diagram*

The Structure diagram presents the hierarchical organisation of domains and their components. It provides a relation between the 'parent' domain and the associated sub-domains. Several layers of decomposition can be added in these diagrams.

### *Behaviour Diagram*

The Behaviour diagram presents set of activities that may be enacted by resources with specific system variables assigned. The results of the activities might differ in a time dependent manner and alternate routes of action may be specified by these models.

### *Activity Diagram*

The activity diagram presents the flow of information, control and resources during the enactment of business processes and their elemental activities. CIMOSA provides its own set of building blocks to model components of this type of diagram.

### *4.5.2 System Dynamics*

The previous methodologies presented enable the representation of the activities, resources and constraints in an organisation. However, these representations illustrate an enduring state, i.e., do not acknowledge a potential effect on an increase of activity of execution of one component of the model. The need for tools that can capture the time dependent effects and causes are therefore needed so as to effectively to assess current capabilities as well as proposed reconfigurations within the enterprise. Such a simulation should enable the modeller to visualise several 'scenarios of operation' in which the organisation may configure its resources.

The use of system dynamics has been documented in the literature (Forrester, 1962; Senge, 1990; Forrester, 1991) to model decisions and policies in the organisations. Most of the work has concentrated on the utilisation of causal loops which enables the modelling of causal relations between variables identified. The simplicity and ease of use of this technique has enabled the creation of models that are easily maintained by users that not necessarily have a background on enterprise modelling.

## **4.6 POTENTIAL RESEARCH FRAMEWORK**

It follows that the use of such methods and techniques would facilitate the underpinning of aspects of the strategy realisation process. It is therefore considered that a research methodology can be conceived to model both static and time dependent aspects for each of the subprocesses of the strategy realisation process.

Following the previous decomposition of the strategy realisation described in previous sections, together with the relevant sub-processes, and the proposed research toolset, it was considered that various modelling tools would be necessary to underpin the organisation's process networks. Each individual sub-process within the strategy realisation process would be aided by a partial or full application of the identified modelling tools and methods. A combination of both static, i.e., non-time dependent modelling views of the organisation and dynamic, i.e., time dependent, would enable the strategists in the three subprocesses of the strategy realisation process to visualise potential benefits and impacts of the proposed strategic intent.

Figure 4.5 depicts such decomposition and the proposed modelling applications that can be visualised to aid with the underpinning of the relevant elements of the enterprise which are under study. It is conceived that such an approach would be beneficial to enable senior management to observe potential behaviours within the organisation.

Chapter 5 will investigate a new proposed methodology to underpin the aspects of strategy realisation within an organisation utilising modelling technologies described.

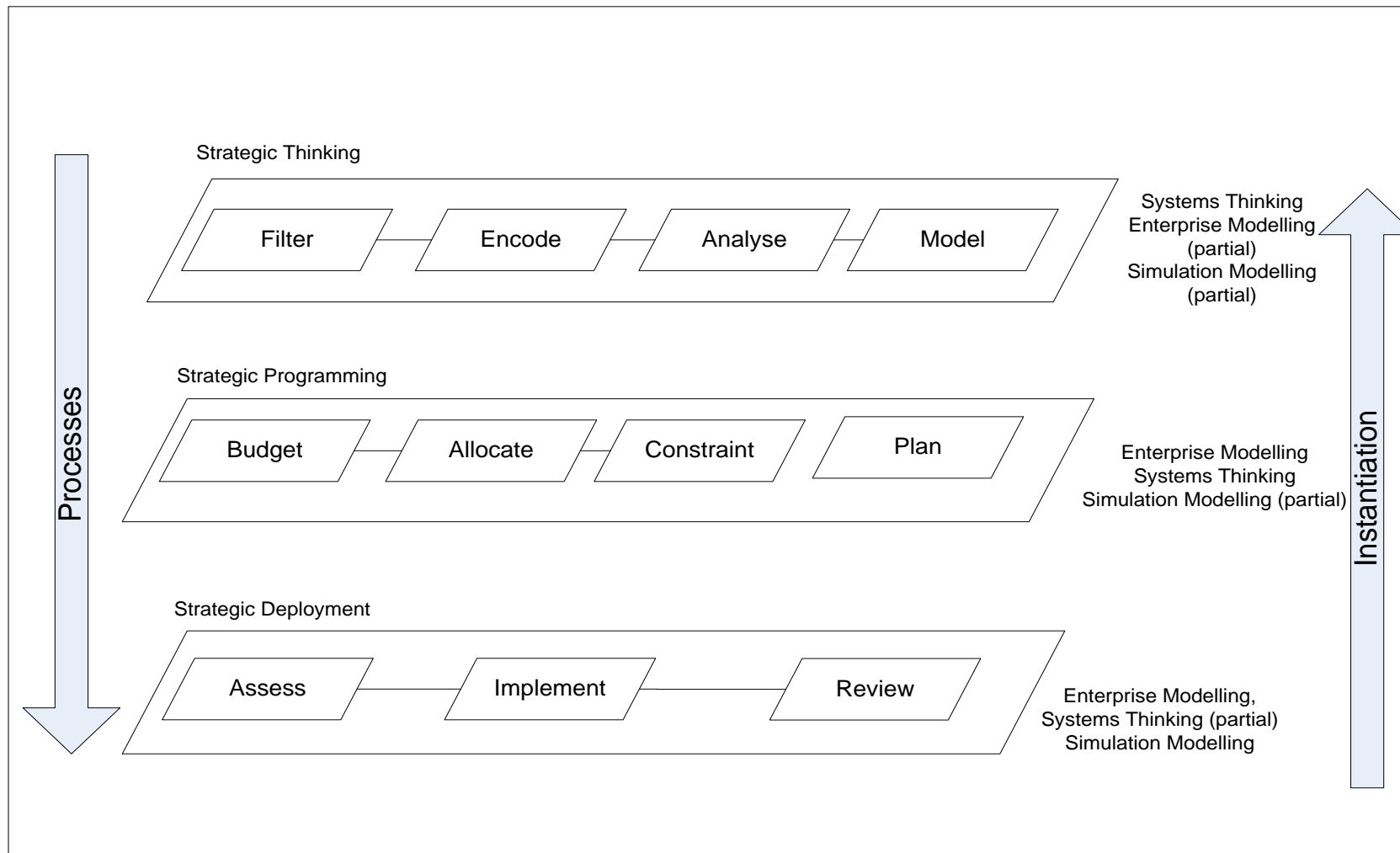


Fig. 4.5 Use of modelling tools in support of Strategy Realisation process

# CHAPTER 5 METHODOLOGY

## SPECIFICATION

### 5.1 INTRODUCTION

Previous chapters have identified the scope, focus, and the set of objectives to be achieved. Also the hypothesis central to the present research has been identified. A coherent and unified approach towards the strategy realisation (that would enable organisations to better underpin their strategy realisation process as well as serve as a template) was suggested. Also considered has been the theoretical constructs that facilitate the development of decomposable, reusable and enriched models, to underpin characteristics and relations present in the organisation's own process network; so as to assist the deployment of a potential strategic intent within such an organisation. The present chapter discusses relevant modelling requirements, and based on that discussion makes a selection of appropriate modelling and simulation frameworks developed to model the case study processes, including the networks of processes found in case study enterprises.

### 5.2 MODELLING REQUIREMENTS DEFINITION

To fulfil the objectives identified in Chapter 3, it was concluded that the following requirements needed to be satisfied:

- A coherent set of decomposition principles are needed to underpin the organisational structure, thereby providing 'coordination' between relevant actors, processes and resources
- Identification and specification of current and potential candidate interfaces via which relevant organisational components can be integrated



## *Chapter 5 – Research Methodology*

- Characterisation of causal relations present in variables associated with the strategic intent
- Facilitate development and reuse of models developed to perform additional analysis or deployment of alternative strategic intents
- Facilitate simulation of organisational behaviour under current or alternate resource configurations

It was conceived that by creating potential candidate models that realise the requirements above mentioned the following benefits should be realised:

- Facilitate analysis of the impact on current or proposed actors, processes and resources of potential candidate configurations resulting from alternative candidate strategic intents to be deployed in the organisation.
- Document potential candidate process networks to be deployed in the organisation as well as potential actors, roles, competencies, resources, etc. that will be required
- Document potential causal relations between variables considered as critical for the proposed strategic intent so as to provide a validation of considered factors and to facilitate further development
- Provide a quantitative as well as a qualitative analysis by and in support of strategy realisation actors, with potential outcomes of an potential candidate intent and the effects such an intent would have on current or proposed actors and their process networks
- Provide analysis of impacts on current or proposed organisational configurations of a proposed strategic intent as well as analysis of user defined performance metrics
- Provide support at all levels of the strategy realisation process in response to shifting business objectives and internal or external environmental pressures for a change capable system
- Provide support for organisational design by enabling identification of potential value to potential candidate solutions and manage and reuse knowledge existing within the organisation

- Generally, it should provide support on all aspects of a system lifecycle for a manufacturing enterprise and its inherent process networks.

### **5.3 MODELLING FRAMEWORK SELECTED**

To satisfy the abovementioned requirements and achieve the potential benefits envisaged suitable enterprise modelling and simulation modelling approaches were considered. From previous literature review, and the author's previous experience utilising enterprise and simulation modelling methodologies (and their related frameworks, modelling constructs, methods and tools) it was expected that in combination these modelling technologies would provide supporting functionality that would facilitate the realisation of strategy realisation objectives and would at least in part satisfy requirements previously stated. Chapter 2 provided a theoretical background into several modelling frameworks, such as, CIMOSA, PERA, GRAI-GIM that have potential to structure and systemise strategy realisation activities. Because the aim of this study is to investigate the supporting of the strategy realisation process utilising existing enterprise and simulation methodologies, no further development was envisaged to be made upon a selected methodology. The usage of simulation modelling was considered to be beneficial to provide semantically enhanced models that could be computer exercised to enable analysis of potential behaviours in differing organisational configurations of process networks, resources, actors, etc. Thereby it was presumed that the use of suitable modelling technologies would facilitate assessment of impacts of proposed strategic intents.

Table 5.1 illustrates a comparison made by the author of existing enterprise modelling frameworks and their suitability to support aspects of the strategy realisation process.

|                                | <b>CIMOSA</b>   | <b>GRAI – GIM</b>  | <b>PERA</b>  | <b>Causal Loops (System Dynamics)</b>  |
|--------------------------------|---|--|--|--|
| Dynamic modelling capabilities | <ul style="list-style-type: none"> <li>Limited analysis of the behaviour of processes during enactment.</li> </ul>                    | <ul style="list-style-type: none"> <li>Enables modelling of temporal and information flow aspects of decisions.</li> <li>Encodes initial and final activity states.</li> </ul> | <ul style="list-style-type: none"> <li>No constructs of its own, does not provide concepts for dynamic thinking</li> </ul>   | <ul style="list-style-type: none"> <li>Provides causal modelling and some decisional analysis.</li> </ul>              |
| Decomposition principles       | <ul style="list-style-type: none"> <li>Enables the decomposition of a task into minor tasks</li> </ul>                                | <ul style="list-style-type: none"> <li>Provides several temporal layers to support decomposition and to analyse decisional and activities flows.</li> </ul>                    | <ul style="list-style-type: none"> <li>Provides a rationale behind intended projects.</li> <li>Regarded as policy and general entourage of the system life cycle and project.</li> </ul> | <ul style="list-style-type: none"> <li>No decomposition principles are provided.</li> </ul>                            |
| Exception handling             | <ul style="list-style-type: none"> <li>Alternate flows can be modelled but no reference to conditions enacting those flows</li> </ul> | <ul style="list-style-type: none"> <li>Alternate flows of information and activities can be modelled based on outcomes of decisions made.</li> </ul>                           | <ul style="list-style-type: none"> <li>Only supports exception handling from a design point of view.</li> </ul>  | <ul style="list-style-type: none"> <li>Exception handling can be modelled as differing values of relations.</li> </ul> |
| Strategic realisation          | <ul style="list-style-type: none"> <li>Policy making in the</li> </ul>  | <ul style="list-style-type: none"> <li>Decisional only, it</li> </ul>  | <ul style="list-style-type: none"> <li>Provides the</li> </ul>   | <ul style="list-style-type: none"> <li>Used to model the</li> </ul>  |

|                      |  |   |   |  |
|----------------------|--|---|---|--|
| process view         | organisation, outside of CIMOSA scope  | represents decision flows and information that later will impact on the organisation      | rationality behind the projects intent. Regarded as policy and general entourage of the system life cycle and project.      | impact of policies, but limited strategic understandings embedded into causal loops modelling methods. |
| Causal relationships | <ul style="list-style-type: none"> <li>Concentrates on process flow, not on causal relation</li> </ul> | <ul style="list-style-type: none"> <li>No causal relations can be established.</li> </ul> | <ul style="list-style-type: none"> <li>Does not support the notions that causal relations needs to be maintained</li> </ul> | <ul style="list-style-type: none"> <li>Majors on modelling causal relations.</li> </ul>                |

Table 5 1 Overview analysis of literature on the Enterprise Modelling Method

From table 5.1, it was concluded that CIMOSA has the necessary decomposition principles that would facilitate the capture and reuse of a coherent subset of models; so as to: depict hierarchical relations, adequately encapsulate loosely coupled components of the system and capture process networks with relevant actors and resources needed. The use of causal loop was also considered as it has the potential to enable the portrayal of causal effects present in the strategic intent. Therefore, reasons for selecting previous modelling methodologies are;

CIMOSA's enterprise modelling framework, methodology, architecture and constructs have been considered to be state of the art as a means of facilitating the underpinning and characterisation of process networks present in an organisation (Kosanke, 1995; Vernadat, 1996).

CIMOSA provides an architecture that facilitates multiple perspectives modelling of generic, partial and particular aspects of organisations throughout the lifetime of such organisations (Vernadat, 1996; Kosanke, 1999)

CIMOSA provides modelling constructs that enable the modeller to create a graphical representation that can encompass several facets within a particular model (Berio and Vernadat, 1999).

CIMOSA's hierarchical and system decomposition principles facilitate reduction in complexity of the models of organisations under study, by capturing partially decoupled elements and depicting their underlying relationships

Further development of diagramming capabilities utilising CIMOSA has yielded additional views on the enterprise systems. These diagrams facilitate analysis of current and potential candidate configuration (Monfared, 2000)).

Previous research in the MSI Research Institute has extensively and successfully deployed CIMOSA models to characterise process networks existing within manufacturing enterprises collaborators operating in various industries (Monfared and Weston, 2002). Therefore, relevant expertise was available to assist the author of the present research to deploy CIMOSA's modelling framework

Causal loop diagramming was selected to underpin causal relations pertaining to a strategic intent, based on the following reasons;

Causal loop diagrams have previously successfully underpinned management policies and the underlying variables that affect such policies and decisions (Forrester, 1992).

Strategic intent have been characterised as 'patterns' of relations between variables (Fowler, 2003) that are present with inherent causal relations.

Causal models facilitate analysis of effects of policies in current organisational configurations (Heracleous, 1998).

Causal loop thinking can facilitate the creation of enhanced models that reflect upon shared knowledge across relevant stakeholders, which can provide a basis for experimentation (Fowler (2003))

Previous research experience (of the research group in which the author was working) when utilising system dynamics and causal loop diagrams across multiple areas of the organisations (Byers (2003)) was a guiding factor to utilise this modelling technique to further represent causal relations observed within a proposed strategic intent

#### **5.4 NEED FOR A COHESIVE APPROACH TO MODELLING TO REPRESENT THE STRATEGY REALISATION PROCESS**

Previously selected methodologies facilitate the underpinning of some aspects of the strategy realisation process present in the organisation, such as causal relations inherent in the rationalisation of the strategic thinking process which can facilitate capturing loosely coupled components of the organisation under study, as well as relevant resources and roles present to enact such components. However, it was concluded that an isolated methodology cannot fully underpin the strategy realisation process in a way which would enable the organisation to capture potential candidate configurations needed to achieve the goals and objectives set out by senior management. Although intents have been reported to formalise the strategy realisation (Kaplan and Norton, 2000; Yu, 1999; Senge, 1990) there is a lack of coherence that would

facilitate implementation throughout various levels of the organisation. System dynamics have facilitated organisational learning (Fowler, 2003; Senge, 1990). However, previous models of proposed enterprise systems have served only one level of the organisation, typically for senior management. Therefore, as no further decomposition can be made, organisations face the increasingly complex task of implementing a strategic intent without consideration of the lower level interactions that exist within the organisation's process network. Furthermore, models developed on an 'ad hoc' basis provide limited analysis outside the subset conditions of the environment that are considered within the strategic intent.

CIMOSA has been utilised widely across industry to underpin relatively enduring characteristics components of the enterprise, provided that such components present are a loosely coupled, i.e., can be encapsulated. CIMOSA has facilitated development of models that capture multiple perspectives of the organisation's facets (Kosanke, 1995; Vernadat, 1996). However, it has been noted that there are some limitations in the modelling capabilities and application constrains (Berio and Vernadat, 1999). CIMOSA's focus on the organisation has been traditionally identified with the operational aspects of the enterprise (Ortiz et al. 1999; Reyneri, 1999). Literature reviewed has limited the application scope of CIMOSA to tactical and configuration aspects present within a manufacturing enterprise. However, there is little or no mention towards interaction with the strategy realisation process. Indeed, some authors have considered strategy to be outside of the focus or scope of CIMOSA or even enterprise modelling (Vernadat, 1996; Kosanke, 1995). Increasingly however, literature concerning the strategy realisation process has stressed a need to formally model aspects of organisations to better implement a proposed strategic intent (Kaplan and Norton, 2000).

Therefore, the author decided to utilise jointly previously described methodologies to underpin the process networks present in the enterprise and causal loop diagrams to capture the strategic intent to facilitate analysis of potential impacts of the strategic intent in current and potential configurations

of the enterprise and to assess potential candidate resources and outcomes from a specific strategic intent. Essentially, a combined use of such methodologies would benefit the research by providing: a) structured step wise modelling architecture, framework and modelling constructs that coherently capture the enterprise's process networks and further developments, enabling the analyst to iterate through the stages applying and reusing modelling elements; b) decomposition principles that enable the study of causal relations at different levels, therefore enabling a coherent implementation of the strategic intent throughout the organisation and c) both methodologies provide a baseline from which enhanced rich simulation models that facilitate quantitative analysis of the proposed candidate strategic intent can be deployed. Models created will inform the strategy realisation by providing multiple perspectives of current operations, interfaces, relations and resources attached to enact them so as to present a test bed for potential candidate configurations. As the intention of such models is to be reusable, it is envisioned that models can facilitate the analysis of multiple strategic intents so as the (1) the organisation can decide optimal configuration which will enable the attainment of potential objectives as defined within a proposed strategic intent and (2) as its operating and environmental conditions change, models can be reused to reassess and develop current and possible future strategic intents.

## **5.5 MODELLING THE STRATEGY REALISATION PROCESS**

After a suitable modelling approach was selected, it was concluded that a number of steps were needed to achieve modelling of the strategy realisation process in an organisation. Figure 5.1 depicts the steps considered by the author to facilitate modelling of the strategy realisation process.



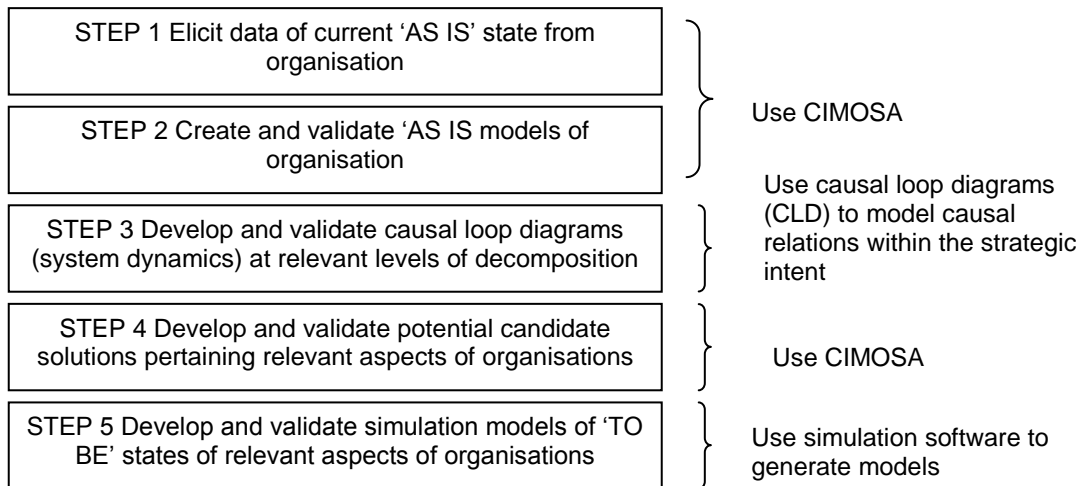


Fig 5.1 Proposed research methodology for capturing the strategy realisation process

The first step is to elicit knowledge and data about the current process network of the organisation. This is achieved by obtaining relevant process documentation and interfaces of the organisation. Stakeholders of relevant processes within the organisation are interviewed so as to obtain a unified set of representations of the process networks. This can be complimented with any procedural manuals that the organisation might have developed.

The second stage is to create static 'As Is' representations of the enterprise to provide an enriched model of the enterprise's components, relationships that exists between them, relevant resources and interfaces currently deployed. CIMOSA's modelling framework and constructs provide support to achieve this step by providing templates in which previously elicited data from the organisation can be characterised, organised and presented in a coherent manner. This models need to be validated by the organisation so as to ensure correct representation of the current process network.

The third step is to develop and validate with the organisation a set of causal loop diagrams relevant for each level of decomposition that will be potentially affected by the strategy realisation process. Focus on the particular process networks that will be considered will remain part of the organisation's particular strategy realisation process. These models can be jointly used with models created in the previous step to serve as basis for simulation models.

## *Chapter 5 – Research Methodology*

After models are created and validated in relation to the current situation, several new candidate solutions can be envisioned so as to realise the goals and objectives set out for the organisation within the strategic intent. Models of relevant process networks are mapped to explore potential resources, interfaces needed to fulfil a new organisational configuration. Models created represent candidate 'To Be' configurations.

Finally, simulation models with current and potential models developed are enacted utilising a computer executable model simulation software so as to provide a comparison based on specific performance metrics defined by the organisation that facilitate analysis and comparisons of the results obtained from such executable models.

The next chapter of this thesis applies and tests the abovementioned steps in a case study scenario of a collaborator of the MSI Research Institute; which relates primarily to data elicited in a small manufacturing enterprise by the researcher and other members of the Institute.

# **CHAPTER 6 CASE STUDY**

## **BRADGATE FURNITURE**

### **OVERVIEW**

#### **6. 1 INTRODUCTION**

Previous chapters have introduced to the reader the problem domain, lack of provision in current strategy realisation and enterprise modelling literature and a selected research framework that realises the research objectives previously defined of the present thesis. A suitable organisation was selected in which the proposed methodological approach could be implemented so as to assess the hypothesis of the present research. The present chapter discusses a case study within a privately owned small to medium manufacturing enterprise and the application of the proposed approach to analyse a proposed strategic intent and the impact of such intent within present process networks within said organisation.

#### **6. 2 BACKGROUND INFORMATION ON BRADGATE FURNITURE**

Bradgate Furniture is a privately owned small to medium enterprise (SME) that specialises in manufacturing, assembling and delivering a broad range of pine and a small range of birch wood furniture, primarily aimed at the upper and middle residential classes. The company was founded in 1979 by Rodney and Fiona Jones and has experienced a sustained level of growth which has enabled the organisation to expand its range and production facilities to their current location on a small industrial estate in the village of Burton on the Wolds, Leicestershire, United Kingdom.

The company's senior management is comprised by Rodney Jones, Managing Director, and Fiona Jones, Commercial Director. They take joint responsibility to ensure that the operation of the organisation runs smoothly

and effectively. They are the primary strategist of the organisations as co-owners of the organisation.

The company has a relatively flat hierarchical structure. This enables the managing director and the commercial director to benefit from a so called 'hands on' approach to the organisation. This is evidenced by the managing director assisting, if required, the production floor team in case of a staff shortage in any production area. This facilitates understanding of particular needs of the shop floor and potential impacts of a specific strategic intent. Both owners will routinely speak to the production team so as to assess current and potential needs of investment in capacity and training requirements. The company has a relatively low staff turnaround as it is perceived that there are strong professional and personal relations within the workforce.

Fig 6.1 illustrates the organisational chart of Bradgate Furniture.

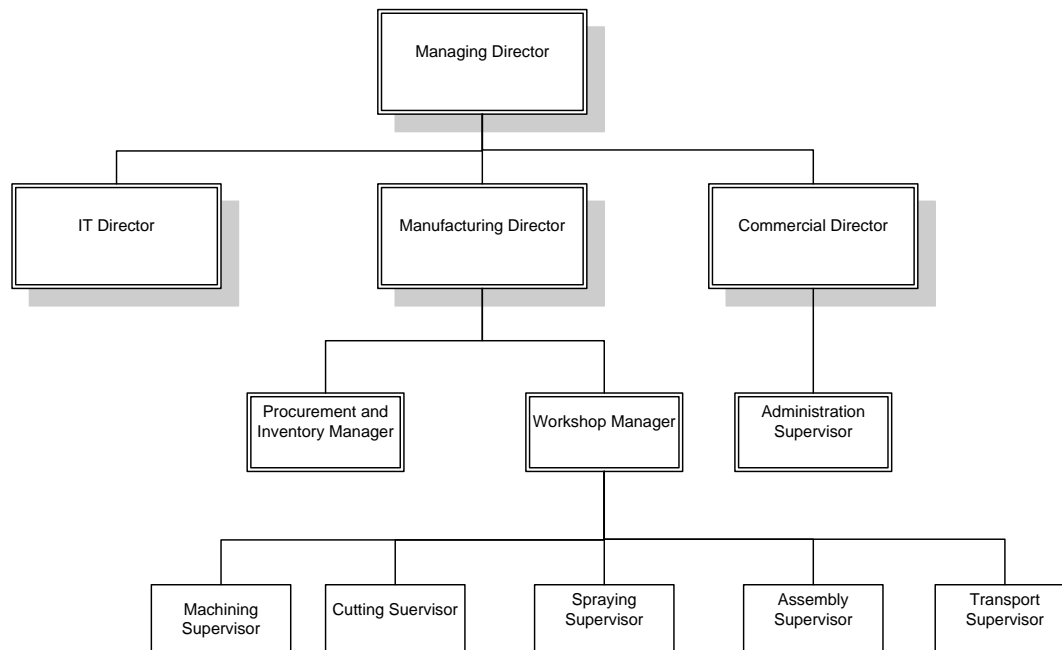


Fig 6.1 Organisational hierarchy in Bradgate Furniture

The latest figures on annual turnover for the company are in excess of £2.5 million pounds per year. The organisation has experienced an upward cyclical trend in sales of product. Whilst the company acknowledges that most of their

## *Chapter 6 – Case study Bradgate Furniture Overview*

sales present peaks and valleys, there has been an overall increase of 8% in total sales from the previous year. A key element that has driven such increase is an aggressive marketing campaign and brand awareness displayed by the organisation throughout its general supply chain network. This, in turn has generated increased business for the organisation.

Bradgate Furniture's supply chain network consists of multiple vendors located across the UK and the European Union. Bradgate Furniture has a policy of multiple sourcing and grading of suppliers where possible so as to ensure that its materials will be of consistent high quality. Multiple sourcing has also enabled the organisation to drive down the costs of raw materials and has facilitated an increased bargaining power which has led to minimal price increases. This, in turn, has enabled the organisation to remain competitive in its pricing strategy, which has consolidated the reputation of the organisation as a provider of increased quality at affordable prices.

The organisation does not sell directly to its final customers. Instead, they possess a large network of commercial partners called 'stockists', who are furniture retailers, who trade directly with the final customers. As with the suppliers, Bradgate Furniture does not depend on a sole commercial partner to market or retail their products, which enable the organisation to have presence in a variety of locations throughout the United Kingdom. It has also enabled the organisation to survive closure of 'stockists' in the past. Products are requested by these 'stockist' and delivered utilising a small fleet of delivery lorries that the organisation owns.

The company offers a wide range of products in a variety of finishes and colours. The product range includes such lines as tables, drawers, bed furniture and chairs. Colours range include: Natural, Wax, Newhaven, Sienna and Kenilworth. Figure 6.2 illustrates a selection of products available through the company's catalogue.



LF2 Large Flip Top Table with Twin Pedestal

BFD4 Breakfront Fully Glazed Display Dresser

DL6 Fourl Legged D/L Table Round

UD9-10 Cross Back Chair/Carver

Fig 6.2 Selection of products manufactured by Bradgate Furniture

As orders arrive to the organisation, they are categorised by the stockist’s location and due date. Orders are assigned to folders that represent the lorry that will deliver them. Capacity of the lorry is measured in monetary value of the orders, not necessarily with dimensional constraints. When the capacity of the lorry is reached, production will start on all orders contained in said folder. Capacity of individual lorries is represented in table 6.1

| Vehicle | Capacity |
|---------|----------|
| Lorry 1 | £10,000  |
| Lorry 2 | £9,000   |
| Lorry 3 | £10,000  |

Table 6.1 Capacity of lorries in Bradgate Furniture

Bradgate Furniture employs a Made to Order (MTO) philosophy in which products are made to serve an existing customer order. As the orders are obtained from the sales process, different production areas will collaborate to achieve the quantity of the order. Although each product will have a specific set of operations, there are several areas which work in a 'workshop' manner, i.e., all Spraying of the products will be done in a specific area regardless of the product fabricated. Work areas include: Assembly, Machine/Cutting, Spray, De-nibbing Finishing and Packing and Despatch. Assembly process receives the orders and tries to fulfil the order with existing parts. If more parts are needed, it will request them to the Machining/Cutting centre. Parts are then Sprayed, Denibbed. Some colour products will require a second spraying and denibbing, such as Sienna and Newhaven and will then proceed to the Finishing area where fixtures, i.e., door handles, will be attached to the product and finally the product is packed and sent to the corresponding lorry to be delivered. Bradgate Furniture assumes any damage caused for transport.

### **6.3 STRATEGY REALISATION IN BRADGATE FURNITURE**

As Bradgate Furniture is an organisation managed by its owners, the strategy realisation process is enacted mainly by the owners of the organisation. Both Managing and Commercial directors have equal input in creating the strategic intent, although it is mainly the Commercial Director who will program and oversee the deployment of the strategic intent throughout the organisation.

Sub processes of the strategy realisation process are enacted mainly by the owners. Information relevant to the organisation, which can be utilised in a strategic context, is filtered individually by both the Managing and Commercial Directors who will have a series of informal discussions throughout the year. Information can be obtained from a variety of sources, such as: stockists, specialised review magazines, show rooms, supply chain networks, etc. After discussions, the directors proceed then to formulate several potential candidate strategic intents if it is considered that there is an opportunity or a perceived threat to the organisation. The Commercial Director would then

create a basic trial financial run utilising a spreadsheet so as to assess the potential financial viability of the considered strategic intent. After the potential candidate strategic intent is deemed to be financially viable, the Commercial Director assess commercial viability by a series of discussions within relevant actors along the organisation's supply chain.

When it is determined that a potential candidate strategic intent is commercially viable, the Commercial Director allocates relevant resources and identifies critical success factors as well as constraints needed to successfully implement the potential candidate strategic intent. As the Commercial Director oversees the financial aspects of the organisation, she will be responsible to procure necessary funds, if necessary. The strategic intent is conceived in the mind of the Managing Director in conjunction with the Commercial Director. Since both directors have a personal relationship, there is frequent communication between parties. Ideas are roughly formed and implemented by a 'trial and error' method. Typically, the Marketing Director, Fiona Jones, will collect the data from the environment, i.e., by talking to providers, stockists and in show case rooms. Raw data will be then inputted into a spreadsheet to assess the potential intent and to decide the necessary course of action that will be followed. There are informal discussions between Directors to assess the validity of the strategic intent. Once a plan to implement is generated, the Managing Director speaks with the relevant key personnel in the production floor to ensure the strategic intent is viable.

#### **6.4 STRATEGIC CONTEXT AND POTENTIAL STRATEGIC INTENTS TO BE CONSIDERED AS PART OF THE CASE STUDY**

Changes in the current market share forced a major competitor of the company to withdraw its operations from the UK market. This opportunity was seen by the company as a potential growth prospect to further their position in the market. The Managing Director has foreseen that the potential market for



## *Chapter 6 – Case study Bradgate Furniture Overview*

the pinewood furniture would overwhelm the current production capacity of Bradgate Furniture. Therefore an expansion strategic intent has been devised to cope with current events in the market. An increase in sales resulting from the portion of the focus market share would generate sufficient revenue to justify investment in additional production capacity. Sourcing for the increased demand would necessitate the development of other vendors. Production capacity could be obtained by expanding operations abroad to a production facility that the Managing Director knew within the European Economic Area (EEA) that would give the necessary capacity for the increased demand. Transportation of the products would require the subcontracting of a freight carrier that could deliver the production to the relevant stockist within the time frame that the organisation has typically done so.

Several potential candidate strategic options were considered by the organisation to manage the prevalent market conditions. Courses of action reviews by the senior management were: Retrenchment, Diversification and Growth. 'Retrenchment' would signify that the organisation would not attract further business from commercial partners until a further assessment of the departure of the major competitor could be done. It was considered that one of the potential reasons why the competitor decided to leave the market was a decrease in sales which would render participation in such market unprofitable. As the organisation's own predictions of growth tended to refute this claim, this option was not considered.

The 'diversification' option was suggested to increase the company's portfolio unto other market segments. This was rejected as it was felt that the core capabilities of the organisation and indeed product portfolio were adequate. New product or line introduction would be driven by the market yet as anecdotal experience had shown, the commercial partners were keenly aware of market needs and would discuss new requirements well in advance with the organisation. Informal discussions with some partners revealed that the company's product range was satisfactory.

## Chapter 6 – Case study Bradgate Furniture Overview

The 'growth' option was aimed primarily at increasing the overall market share the organisation currently possesses. As the lead market competitor who retired from the market place had a considerable market share, the organisation considered that capturing a small percentage of the market share previously held by said competitor would provide the financial resources the organisation needed to solidify its current supply chain network. Furthermore, with increased volumes of sales, it was considered that further investment was needed to cope with the manufacturing requirements posed by the sales. Therefore, it was concluded that the organisation would opt for growth as a strategy within the current market conditions.

Several subsets of strategic intents were then envisaged as part of the growth strategy. Each subset was considered as part of the organisation's direction towards achieving a greater share of the market. The subsets considered are as follows:

- a) **Market expansion** – with an increased profile of the organisation and given the departure of the leading competitor, it was considered that Bradgate Furniture could capture some of the market share by aggressively marketing to new customers.
- b) **Overseas expansion** – Several sites were identified within the European Union (EU) to subcontract more capacity and therefore have more company considering expanding production capacity to potential Eastern Europe facilities
- c) **Logistics** – Current production system is based mainly on the capacity of the delivery Lorries the organisation possesses. Alternative arrangements could potentially increase current production output.
- d) **Current production facilities** – as a result of the increase of sales by the organisation, there has been concern that the current configuration of the production facilities is not optimal and more resources will be needed to increase current levels of output. Study of current capacity within multiple demand scenarios would enable decision on where to

invest and allocate resources so as to increase current levels of production that effectively copes with demand forecasts.

## **6.5 SELECTION OF STRATEGIC INTENTS TO BE TACKLED WITH PROPOSED METHODOLOGY**

After consideration for all the strategic intent subset the organisation had outlined in the previous section, it was decided that two candidate subsets would be investigated utilising the proposed methodology. Selection of the subsets was done primarily to provide quantifiable elements to the decision making process within Bradgate Furniture. Also, the Commercial Director was keen to observe the results from the selected subsets as it was felt that it would enable the organisation to allocate the resources in an effective and efficient manner.

As the current state of the organisation's productive systems was of great concern to the organisation, it was decided that further analysis and implementation of the proposed methodology, specifically to underpin current activities and provide simulation of current capacity, subset option d) was selected. Senior management considered that anecdotal evidence would support the expansion of the organisation, but it was decided that quantifiable data was needed to support this decision.

It was also considered that further analysis unto the causes and effects of capturing a larger portion of the current market was ideally suited for the proposed methodology. As the Commercial Director developed this subset, it was deemed that multiple demand scenarios needed to be simulated in the current production network so as to identify key issues arising and investment in capacity or resources.

It was felt by the researcher that the previous subsets would provide a suitable 'test bed' for the proposed methodology and were related in a decompositional manner, i.e., the analysis of the overall production network would be informed by the configuration of current production system

## **6.6 OVERVIEW OF APPLICATION OF METHODOLOGY**

It was considered that an application of proposed methodology would enable the organisation to assess potential implications of the strategic intent in the organisations manufacturing system. Relevant models of the organisation would be created so as to document current process networks and would facilitate discussion with relevant actors potential candidate configurations that would enable the organisation cope with challenges and opportunities as set by the senior management. Simulation models would be created to observe changes in behaviour of key variables considered important and effects of potential candidate scenarios. Data generated through these models would then serve as a discussion with senior management so as to guide the implementation of the strategic intent and to assess potential configurations changes necessary to aspects of the process networks within the organisation.

Ensuing chapters discuss the modelling effort made to underpin the strategic intent chosen by senior management and analyse behaviour in the selected variables considered relevant so as to assess the success of implementation of the strategic intent.

# **CHAPTER 7 CASE STUDY BRADGATE FURNITURE MODELLING**

## **7.1 INTRODUCTION**

Chapter 6 outlined key aspects of Bradgate Furniture's product realising processes its supply chain network and its strategy realisation process. An application of the strategic process was discussed with a view to specify requirements of an application of the proposed methodology of the present research. It was considered this would benefit the design of the organisation structure and observe potential impact within the organisation of the strategic intent understudy.

Therefore several models were constructed so as to provide a multi-faceted approach to underpin the organisation's characteristics. CIMOSA models were created to underpin relatively enduring aspects of the organisation. Causal loop models detailed the organisation rationale to justify an increase in production to expand the current market share possessed by the organisation. Simulation models were then created to analyse potential impacts of identified variables by the organisation in the current production configuration so as to assess potential manufacturing capacity investments. This was also created to analyse the second strategic intent outlined in the previous chapter.

## **7.2 BRADGATE FURNITURE MODELLING ENVIRONMENT**

A multi-disciplined team of researchers from the MSI Research Institute captured and documented multiple aspects of the Bradgate Furniture Company, such as: production systems, strategic direction and its human systems and supply chain to gain new understandings of the production systems in place and to propose alternate candidate solutions which would enable the organisation sustain a growth strategy. To formally represent aspects of the production system, and facilitate reuse

it was proposed that aspects of the Multi-Process Modelling (MPM) approach, developed previously by members of the MSI Research Institute (Monfared [M2000], Chatha [C2003]), would be utilised as a modelling framework within which the present author's approach to modelling key aspects of the strategy realisation process could be enacted. This would involve static modelling of the study organisation at a relatively high level of abstraction, followed by more detailed dynamic system modelling (via use of causal loop diagrams and simulation models) of process networks present in the portion of the organisation under study. The first static modelling stage was to be centred on creating a CIMOSA Enterprise Model (EM) of the case study organisation. With respect to the data and the knowledge capture involved in the EM model creation modelling effort was concerted amongst the team of researchers that attended the organisation. However, it should be noted that initial EM created was documented by K.A. Chatha. This researcher participated in the discussions that led to the creation of this EM, as it was perceived that models would have a significant impact in the subsequent design and development of simulation models needed to, who led the modelling effort. When so doing this researcher developed an in-depth understating of the modelled processes as these would significantly impact upon the present research. Elicitation of data and knowledge capture by the CIMOSA EM was performed throughout several interviews with relevant stakeholders and users of the organisation's current production procedures. The author adopted use of the developed EM to further develop models which were part of the proposed methodology to satisfy requirements outlined by the organisation. The primary novel contribution to knowledge subsequently realised by the present research was to present a coherent set of static and dynamic models that would support the decision making process of the organisation and would feedback to the strategy realisation process and the strategists potential impacts within the current process networks of candidate strategic intents.

### **7.3 BRADGATE FURNITURE ENVIRONMENT DOMAIN**

The Bradgate Furniture organisation enacts a collection of multiple dependant process networks. This process network is enacted throughout the lifetime of the

organisation so as to achieve overall objectives and goals as identified and specified by the senior management. Each process network necessitates specific resources to successfully achieve its purpose within the organisation. As process networks interface with each other, the author considered highly beneficial to formally represent such networks so that present and potential candidate configurations and/or interfaces can be identified and understood such that the relevant 'actors' in the company can effectively manipulate present and potential configurations, not only the sets of activities that constitute each process segment but also their underlying interfaces and resources that will enable such configurations to achieve the underlying objectives and act cohesively.

As multiple research perspectives on the organisation were considered, the use of CIMOSA decomposition principles as well as the modelling representations developed by members of the MSI Research Institute was considered beneficial as they would facilitate understandings on the process network by effectively managing complexity of the organisation. Such formalisms included a set of diagrams to represent the interactions between such constructs as domains, processes and enterprise activities. It was considered that such an approach would facilitate documentation and communication of the process networks across the organisations. To the researcher, the decomposition principles utilised by CIMOSA as well as the graphical representation of the process networks would facilitate construction of relevant causal loop diagrams at the relevant level of granularity.

To identify major actors involved in the production and delivery of furniture, a 'Context Diagram' was elicited. Such diagrams identify the major 'domains' or actors which represent a collection of processes which will interact with other relevant processes within domains to enable a central objective. Such domains encapsulate a collection of sub processes, i.e., all activities needed for that domain to exist are contained within one of its processes. Figure 7.1 illustrates the context diagram created for Bradgate Furniture. The overall objective, to make and deliver furniture to (aggregate) order, is positioned in the centre of the diagram. As previously explained, Bradgate Furniture supplies its products to a network of partners, or stockists, located throughout the United Kingdom. As such orders are sent from individual stockist to be aggregated and produced by location and due date. Therefore the domain 'DM1 Stockist' was identified as a major actor to the central

objective. As there was no intention on further decomposing this domain, it was identified as a ‘non-CIMOSA’ domain, that is, a relevant domain to the central objective which is not further decomposed or modelled. This could be the case for limiting the scope of the modelling effort, as it was in the present case. Bearing in mind that the following static models were utilised across the research team, this researcher considered only the production domain detailed later on. Following domains ‘DM2 Raw Material Suppliers’, “DM3 Sub-Products (e.g. Chairs)’, ‘DM4 Miscellaneous Fixture Supplier’ and ‘DM5 Technology Vendors’ followed similar pattern. The domains identified as relevant for all researchers involved in the project were ‘DM6 Bradgate Business Management’ and ‘DM7 Bradgate Produce and Deliver Furniture’. ‘DP6 Bradgate Business Management’ domain was identified as all relevant processes that enabled the interaction between the production system and various other domains. The present research did not consider in detail any of the processes contained in such domain as the intended application domain of the proposed methodology would be in the production area. Therefore, ‘DP7 Bradgate Produce and Deliver Furniture’ was considered the primary domain in which the present research detailed modelling work would be focused.

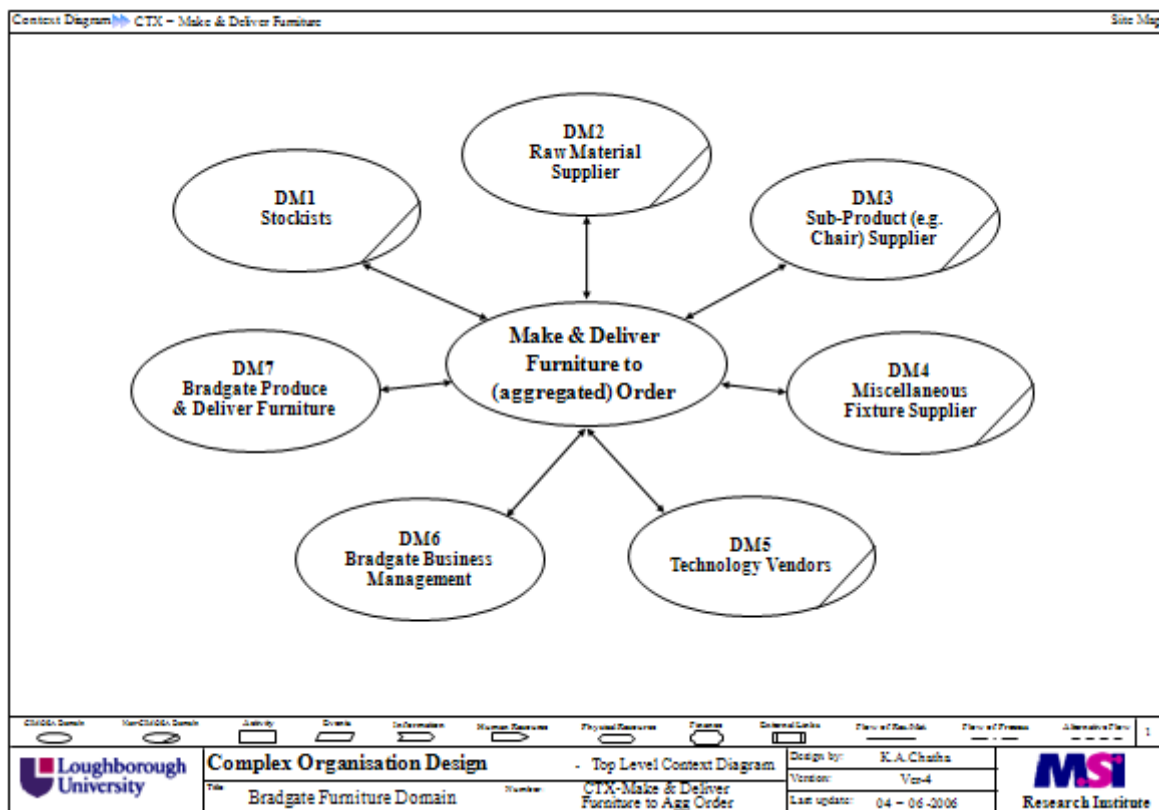




Fig 7.1 Bradgate Furniture Context Diagram

Further decomposition was considered necessary to understand current relation between processes contained in the previously identified domains. These processes are identified in CIMOSA as ‘Domain Processes’ (DP). DP’s within a specific domain may interact with other DP’s in the same domain or may interact through interfaces such as events with other DP’s held in exogenous domains. To represent such interactions, an ‘Interaction Diagram’ was created. Such diagrams present interactions between, although not limited to, domain processes within the same level of granularity. Interactions represented can be an information request been sent from a domain to another, a financial transaction or physical materials requested or sent. It enables the analyst to assess current or potential interfaces between DP’s. Figure 7.2 illustrates the Interaction Diagram elaborated for Bradgate Furniture.

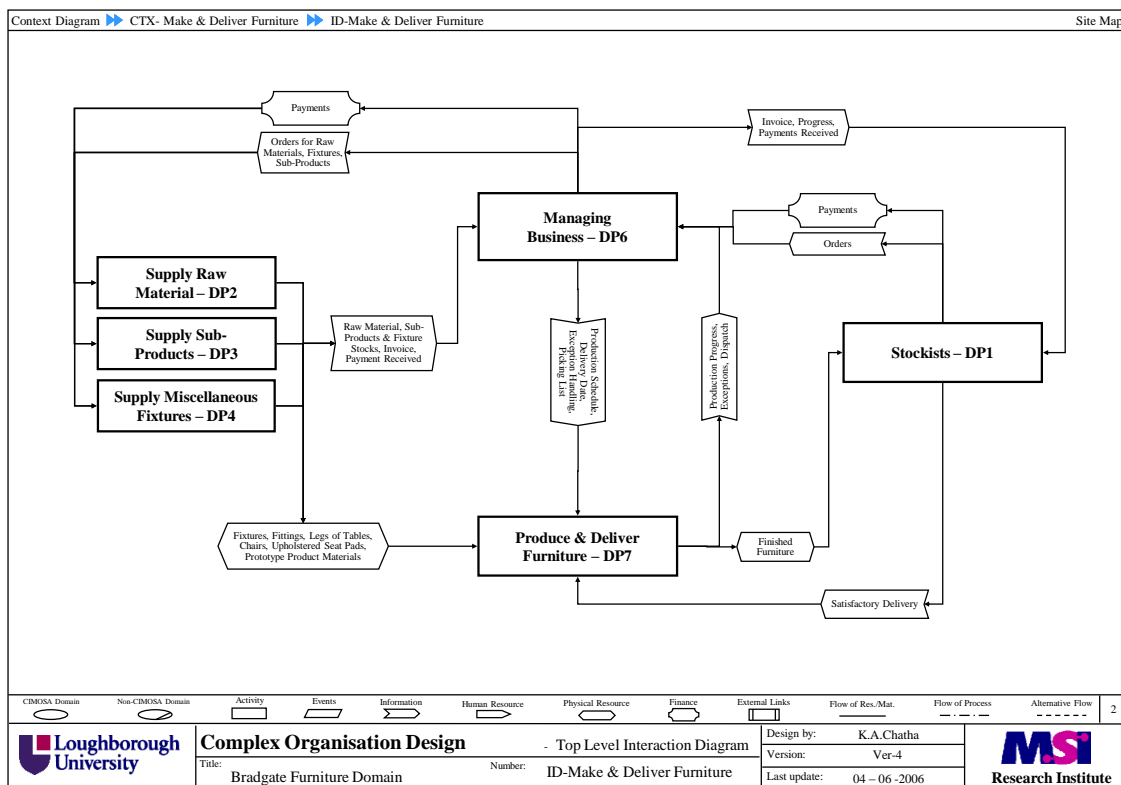


Fig. 7.2 Interaction Diagram for the main Business Processes identified for Bradgate Furniture

This level of granularity facilitated the senior management, particularly as it addressed prime interfaces between domain processes they have responsibility for. Central to this diagram are two DP’s decomposed from the two domains which the

MSI Research team was particularly interested in modelling. ‘DP7 Produce and Deliver Furniture’ was the relevant process identified by the team as critical to all modelling efforts concentrated in analysing current and potential candidate solutions.

At this level of granularity it was considered that sufficient information had been elicited from the organisation so as to meaningfully engage in creating causal loop diagrams that would underpin relevant variables considered by the senior management to be essential to discuss the proposed strategic intent. The reader might wonder if there is enough information to enable a meaningful discussion. Bearing in mind that the proposed strategic intent considers the upper most level of granularity, i.e., it considers the manufacturing capacity as a ‘black box’ and the organisation’s main actors are identified; this facilitates understanding of the organisation’s process networks. Evidently, there is a clear difference of the information that can be represented within a static model and a causal loop diagram. However, at this level of granularity similar aspects of the organisation can be identified and potential interfaces can be shared.

### *7.3.1 Static Modelling Of Actors Involved In Strategic Intent*

Further models were created by the researcher to gain additional understanding of the actors and process networks involved in the proposed strategic intent. It was considered that utilising the same static modelling constructs actors and potential interactions would facilitate the creation of subsequent models by providing a structure framework, i.e., it would structure the relations between actors and potential exchanges between processes. This would facilitate communication between senior management and the researcher by providing necessary requirement to effectively model the strategic intent. Additionally, it would facilitate validation of the modelling effort.

Figure 7.3 is a context diagram of the relevant domain processed identified by the senior management and the researcher to achieve the main objective of the proposed strategic intent. The main objective in creating this model was to elicit relevant actors to identify the relevant interactions that would enable the organisation increase their market share and achieve growth. The identified domains were identified during the strategic thinking process as most of the information gathered

by the senior management to create the proposed strategic intent was elicited at this stage of the strategy realisation process.

The first domain to be represented was 'DM1 Senior Management'. This domain encompasses all the strategy realisation processes as they pertain to identify potential candidate intents from interacting with the subsequent domains. This domain was considered to be foremost in the discussion as the senior management in Bradgate Furniture are solely responsible for creating and implementing the strategy realisation process.

The second domain was 'DM2 Marketing Management'. This domain encompasses the relevant marketing and advertising processes. This domain has a special relevance as most of the sales forecasts processes are contained here which are particularly applicable to the proposed strategic intent. Senior management considered this domain highly relevant in creating most of the organisation's strategic intents.

Further domains were identified as necessary, yet were not included in a potential decomposition of the strategic intent. 'DM3 Stockists' are all those actors and processes that inform of current and expected demand of Bradgate Furniture products. The rationale for the present strategic intent was devised after a series of conversations between the senior management and individual stockists. This domain aggregates the processes relevant to sales and future demand that facilitate projection of market capture by Bradgate Furniture.

'DM4 Finance Management' is a domain within the organisation boundaries but was not considered in the scope of the modelling for the proposed strategic intent. The main objective of this domain is to analyse potential revenues created by an increase in production and delivery of products and create forecasts of revenue for the preceding time periods. This domain interacts with both DM1 and DM2 providing relevant financial data that determines the course of action when implementing a strategic intent.

'DM5 External Suppliers' are all suppliers of raw materials as well as fixtures and some finished products that constitute the product mix of Bradgate Furniture. This domain aggregates all individual processes which are a key element in the supply chain of Bradgate Furniture.

‘DM6 Furniture Production’ aggregates all the productive process networks that were previously described in the present chapter. Given the level of granularity required to analyse the proposed strategic intent, it was considered the main interaction with DM1 and DM2 would be production rates and capacities.

‘DM7 Product Logistics’ aggregates process networks dedicated to transport the finished products to the relevant stockist agent. Although Bradgate Furniture transports all its products, it was considered that the current level of services was appropriate for the current organisation and would not be further decomposed but it it’s an integral part of the supply chain of Bradgate Furniture and enables higher delivery volume.

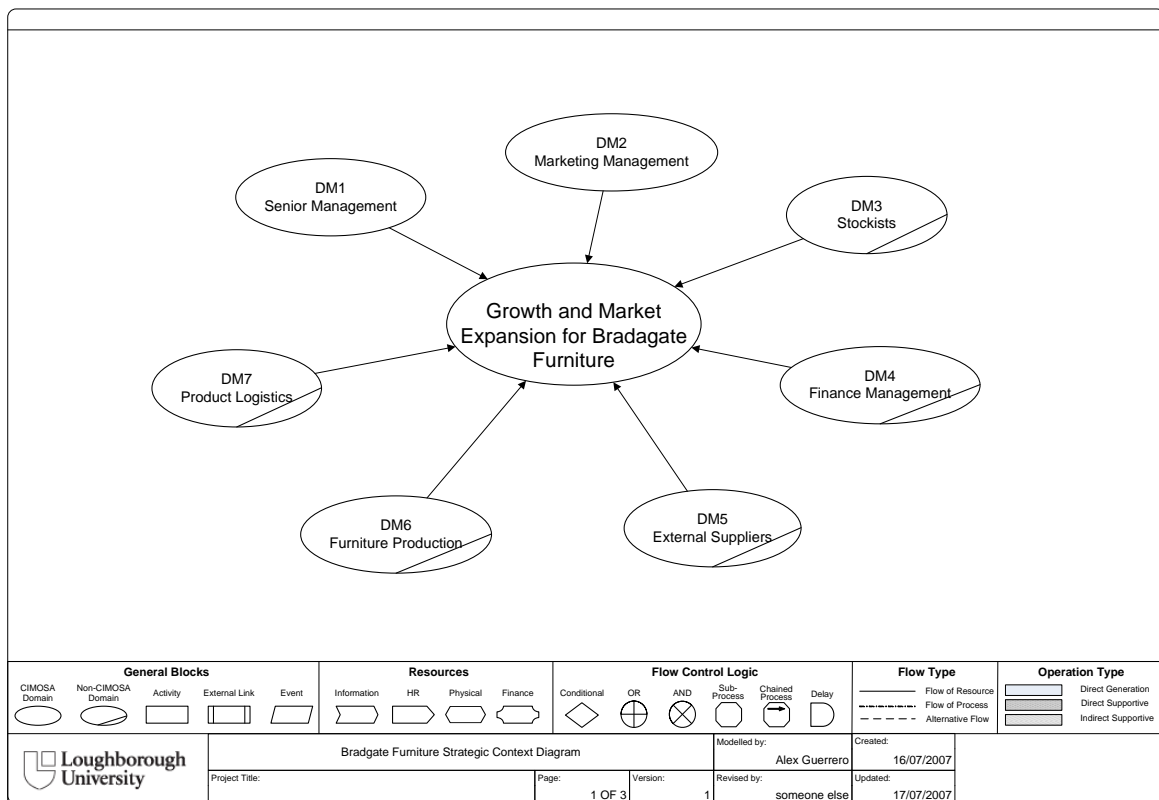


Fig 7.3 Main Context Diagram for the proposed strategic intent

Further models were considered necessary to explain relevant interactions between the aforementioned domains. These models would serve not only to document but as a means to validate the conceptualisation of the strategic intent. By representing relevant actors and interactions between them, a formalisation of the strategic intent would enable the senior management to validate further modelling efforts made by the researcher. Therefore, an Interaction Diagram, i.e., a representation of current interfaces of all relevant processes within the domains, was constructed.

Figure 7.4 illustrates the Interaction Diagram created. To represent different types of interactions between processes and to classify them CIMOSA has defined several constructs which enable the modeller to represent various type of resources that constitute the interface between domain processes. Generally, these constructs represent: Human, Physical, Information and Financial resources. A Human resource can be construed as a single individual or a group of individuals that perform a specific task, i.e., worker or project team. A Physical resource represents a single, or set of, machinery equipment or associated tools required, i.e., a CNC machine. An Information construct represents any relevant data or information transmitted between processes, i.e., demand data. A Financial construct represents any financial transactions, i.e., payments between relevant processes.

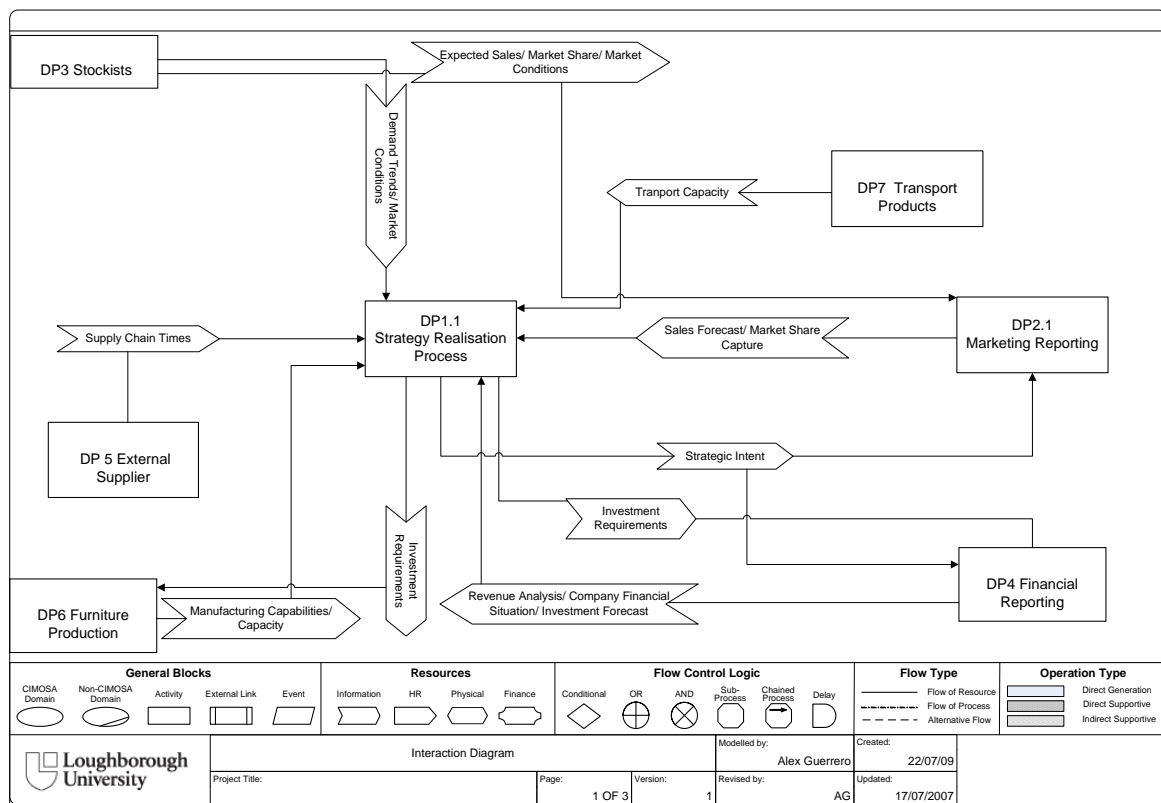


Fig 7.4 Interaction Diagram of the proposed strategic intent

Interactions depicted in Fig. 7.4 are primarily identified as information flows as senior management considered that the basis for the strategic intent was based primarily on the information obtain through a series of conversations and through Bradgate Furniture’s own internal reports. ‘DP3 Stockists’ provided the core assumption of market conditions that had underpinned the main focus of the strategic intent. Both ‘DP1 Strategy Realisation Process’ and ‘DP2 Marketing Reporting’ utilised this

information to create forecasts and to envisage a growth scenario. 'DP4 Financial Reporting' facilitates all financial considerations such as, investment forecasts which enable the senior management to assign resources and monitor potential implementations of the strategic intent.

The relations observed in the Interaction Diagram were a primary template to create some of the causal loop diagram discussed in the following section. As most of the information flow interaction between the domain processes were statistical reports based on performance of variables which were of interest to the senior management, it was considered that, potentially, a similar structure as observed in the aforementioned diagram could serve as a basis to create a causal loop diagram. It must be noted that CIMOSA and Causal Loop Diagrams (CLD) have different perspectives, the former models relative static aspects of a process network and the latter models causal relations between variables, however it was also considered that a potential overlapping in structure and variables could effectively serve as a cross validation for the modelling efforts.

### *7.3.2 Growth through Increased Market Share Participation Causal Loop Modelling*

At this level of understanding of the organisation, causal loops were elicited from the senior management so as to formally capture the strategic rationale behind the proposed strategic intent. It was considered that creating such diagrams would enable identifying relevant variables to the organisation and would also guide the creation of simulation models. Since the retirement from the market place of the major competitor, senior management considered that capturing a portion of the share of the market that this particular competitor encompassed would enable the organisation to secure the necessary resources to finance an expansion of the organisation towards new streams of the marketplace. Since said competitor had gradually decreased the quality of his products, senior management considered that Bradgate Furniture product's had consistent high quality standards and sufficient variety which would enable to easily secure an important portion of the market the organisation was aiming to acquire.

Figure 7.5 illustrates the causal loop created to reflect the rationale behind the proposed strategic intent. Regenerative loop R1 illustrates the effect of an

aggressive marketing campaign the organisation had pursued and which enabled the brand awareness to increase. As the organisation benefited of high reputation amongst its resellers, i.e., stockists it was considered that sudden surge in brand awareness had caused an increase of orders to the organisation. Such surge developed in an increased disposable income that would be invested in the organisation.

Regenerative loop R2 identified the effect of the manufacturing capacity in the organisation and the effect this had on the backlog of orders the organisation was also experiencing. It was considered that an increase in investment on manufacturing capacity would reduce the amount of orders on backlog as this was considered a potential threat to the organisation reputation and ultimately brand awareness.

Regenerative loop R3 illustrates the relation between better brand awareness and competitors. It was observed that as the marketing campaign deployed by the organisation had effectively diminished the impact of competitors and would positively impact on the market share.

Balancing loop B1 depicts the perceived threat of accumulation of backlog of the organisation. As an increase of orders was observed by the organisation, resulting backlog impacted negatively on the delivery time. This was considered to be a strategic advantage for the organisations as previously their delivery time was below industry's average. This was seen as a potential threat as it could undermine the efforts by the organisation to undermine the generation of revenue from new orders.

Balancing loop B2 illustrates the casual relation of backlog and the perceived effect that this would have on the organisation's market share. As with the previous balancing loop, the organisation considered that the recently experienced increase in delivery time would have a negative impact in the capacity to retain a significant portion of the market.

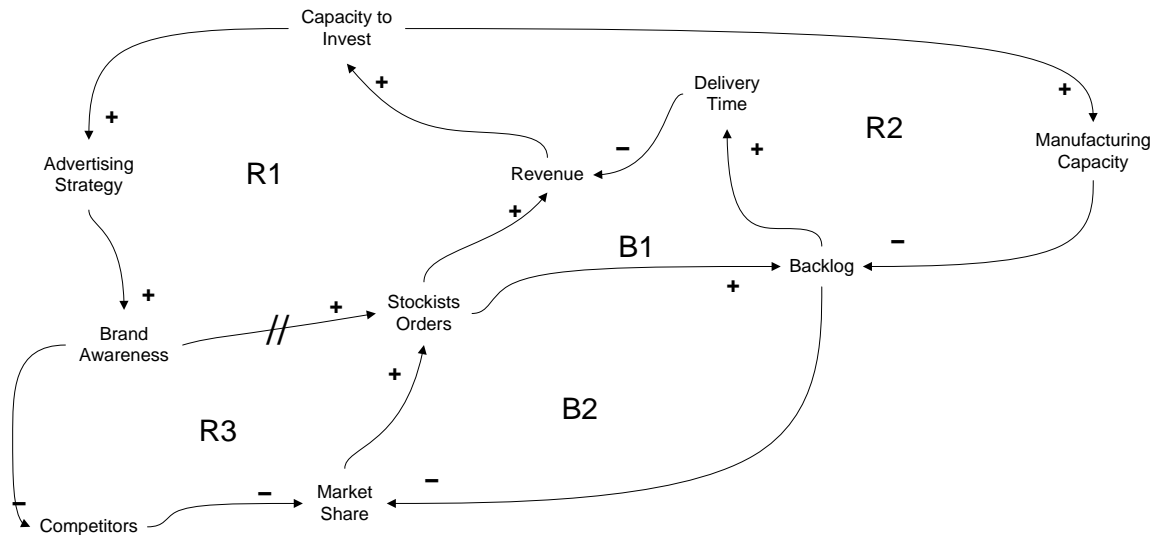


Fig 7.5 Causal loop diagram of strategic intent rationale for Bradgate Furniture

Capturing such models enabled the organisation to visualise the interdependency of variables and potential effects that would enable or hinder the expected growth in orders. It enabled senior management to clearly articulate the strategic intent and communicate to relevant actors in the organisation why such intent would enable the organisation to increase presence in the market and secure fund to invest in expansion. However, further analysis was needed to support senior management decision to implement the proposed strategic intent.

Following section of the present chapter detail the use of a simulation tool and model created to support the present causal loop illustration.

### 7.3.3 Growth Through Market Share Expansion Strategic Intent Simulation Modelling

A simulation model was constructed with the variables identified in figure 7.5. Figure 7.6 shows a screen print of the model. This model represents that causal variables previously identified at the highest level of granularity that was consistent with the focus of the strategic intent. The model was developed to visualise the impacts the potential increase on market share would have on the current production system.



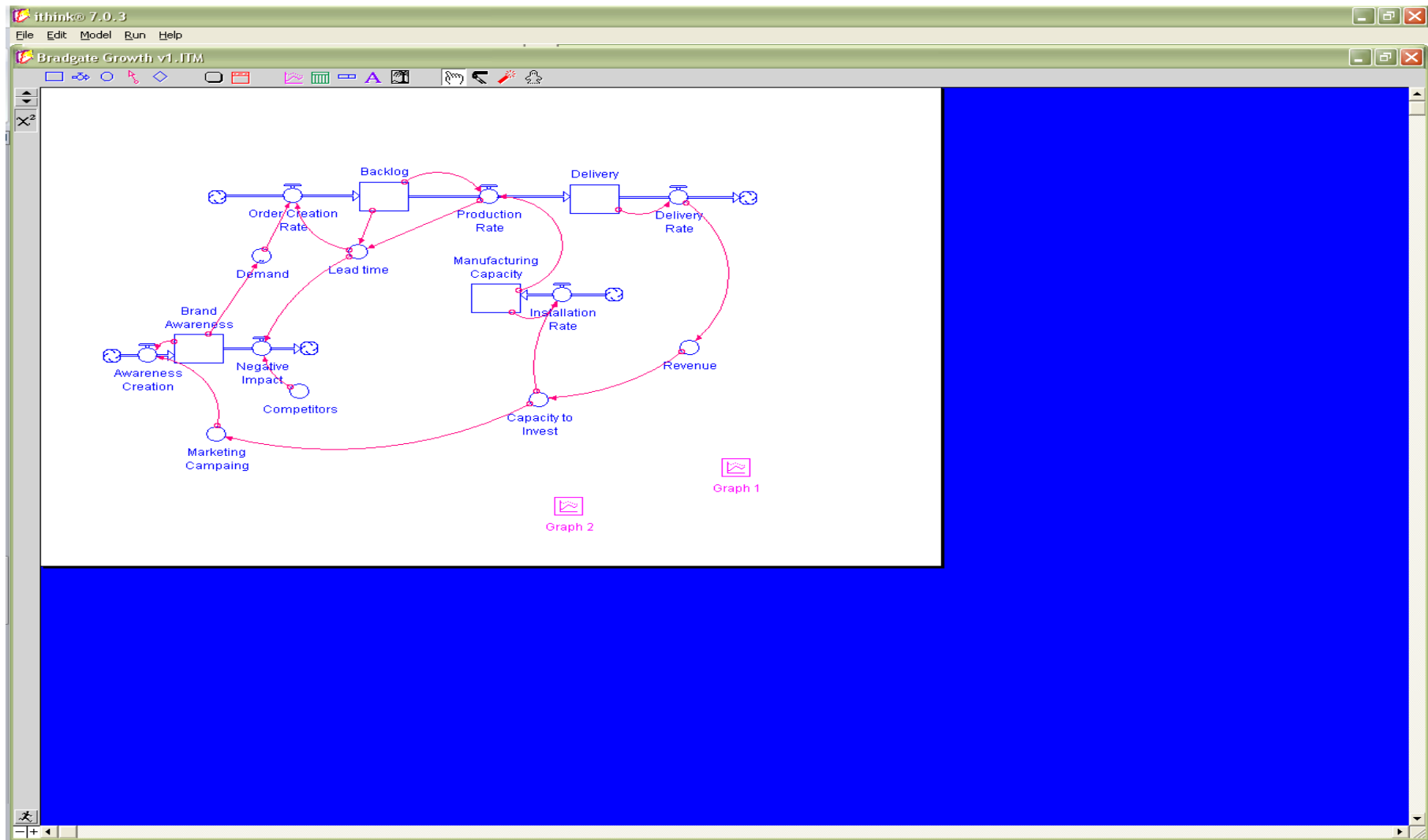


Fig 7.6 Simulation model of growth strategic intent

The backlog in production is represented in the IThink® tool as a 'stock', which is a variable which represents the units that are required by the commercial partners that the organisation has not yet produced. This was one of the key variables the organisation wanted to monitor as an increase would significantly increase their lead time. The manufacturing capacity is represented by an IThink® 'oven' as production throughout the organisation was considered to have a batch configuration. Given that in the spraying area of the organisation an industrial oven was utilised as part of the process, this research considered that this modelling construct could represent the production process accurately. To manipulate the flows of the production, backlog and deliver stocks, several so called 'converters' were utilised. Mathematical relations were conceived that would realistically represent the effect of such variables within the flows of the 'stocks' in the model. An example of this was the variable 'Brand Awareness' which is affected by the number of 'Competitors' and the 'Capability to Invest' variables.

#### **7.4 SCENARIO BUILDING FOR BRADGATE FURNITURE STRATEGIC INTENT**

Having gained an understanding of the organisation's strategic intent and the relevant process network involved through various modelling perspectives, a set of different scenarios was developed with a view to assess potential impacts of varying levels of projected demand of the range of products of Bradgate Furniture. Two scenarios were devised according to the data the senior management of Bradgate Furniture provided. The first scenario was an 'optimistic' scenario, as the sales of the organisation would increase by at least 100% of the current levels of sale. This level of sales was estimated based on the analysis made by the senior management. A more conservative approach to potential demand for products was also discussed as an alternate scenario in which the company would not claim a large portion of the potential market. Senior management at Bradgate Furniture considered that although most of the present environmental conditions would result in sales closer to the optimistic scenario a generation of a more conservative one would enable them to test potential setbacks not considered.

Data from the demand forecasts was divided into ten equally distributed periods which would cover a totality of 25 months. This was to ensure that a period of no less than two years, set by the senior management at Bradgate Furniture, was simulated. Therefore, demand data had to be expressed in similar intervals for simulation purposes.

Table 7.1 illustrates the demand forecasts for both scenarios. The optimistic scenario had a consistent increase, although it was considered that the first months a potential dip in the market could be possible, that enabled the organisation to experience a growth in sales in excess of 200% from present day estimates. As more market was secured from competitors, demand data forecasts predicted a higher demand for Bradgate Furniture Products.

The conservative scenario was devised as an alternate to the first scenario proposed by the senior management. A discernible increase in the overall demand would be experimented; however it would be far modest with increases in demand being relatively smaller. This scenario was conceived by the senior management to simulate a lesser recoup of the market and a shift in potential consumer preferences. The overall increase over a period of two years in product demand for Bradgate Furniture was considered to in excess of 50%

| <b>Month/Scenario</b> | <b>Optimistic</b> | <b>Conservative</b> |
|-----------------------|-------------------|---------------------|
| 0                     | 445               | 445                 |
| 2.5                   | 505               | 540                 |
| 5                     | 535               | 530                 |
| 7.5                   | 540               | 495                 |
| 10                    | 615               | 500                 |
| 12.5                  | 655               | 555                 |
| 15                    | 735               | 625                 |
| 17.5                  | 845               | 630                 |
| 20                    | 875               | 645                 |
| 22.5                  | 885               | 665                 |
| 25                    | 955               | 695                 |

Table 7.1 Projected demand data of Bradgate Furniture

Table 7.2 illustrates the initial simulation parameters utilised by the researcher to simulate the strategic intent within Bradgate Furniture model

| Element                | Parameter   |
|------------------------|---|
| Backlog                | 300   |
| Brand Awareness        | 50  |
| Competitors            | 20  |
| Delivery               | 0   |
| Manufacturing Capacity | 50  |
| Demand                 | Aggregate demand for aggregate production unit.   |
| Lead time              | $\text{Max}(1, \text{Backlog}/\text{Production\_Rate})$   |
| Order Creation Time    | $(\text{Demand\_}/\text{Lead\_time}) * 3$   |
| Production Rate        | $\text{MIN}(\text{Backlog}, \text{Manufacturing\_Capacity})$  |
| Installation Rate      | $\text{IF}(\text{Manufacturing\_Capacity} < 75) \text{ THEN Capacity\_to\_Invest}/2 \text{ ELSE } 0$      |
| Revenue                | $\text{Delivery\_Rate} * 20$  |
| Capacity to Invest     | Revenue   |
| Marketing Campaign     | $\text{Capacity\_to\_Invest}/2$   |
| Awareness Creation     | $\text{IF}(\text{Brand\_Awareness} < 400) \text{ THEN} (\text{Marketing\_Campaigning}/3) \text{ ELSE } 0$ |
| Negative Impact        | $\text{Competitors} * \text{Lead\_time}$  |

Table 7.2 Initial values for parameters set for simulation modelling enactment.

## 7.5 SIMULATION RESULTS

Models were run on the iThink model previously described over a period of 25 months. The simulation parameters for both scenarios were that all values for the

'stocks' type variables, such as Backlog and Delivery were equal to zero. This ensured that results obtained from the modelling simulation would only represent potential increases to the production thus reflecting overall increases in revenue.

Comparisons were made in key variables that the senior management decided to observe. Those variables were revenue, i.e., the amount obtained after delivering the product which would potentially enable the organisation the resources to grow and to invest in more manufacturing capacity. Lead time was another variable that the organisation was especially concerned, as it was a major strategic differentiator from their competitor which had recently suffered as the organisation received additional product orders. Senior management believed that the 'better than industry' lead time the organisation had achieved in previous years was one of the key factors that would enable the organisation to have a sustainable growth.

Backlog was decided to be another important variable to measure the potential effects of the strategic intent. The increase of the current lead time was partly blamed for an increase in backlog; senior management decided that the behaviour of this variable could potentially determine if an increase in investment would be justified.

The last variable that would be compared in both scenarios was the manufacturing capacity; this was so senior management could then justify acquiring additional resources, both technical and human, which would enable the organisation to better respond to growth pressures of the production demand in the current manufacturing system.

#### *7.5.1 Simulation of the Optimistic Scenario*

Simulation of the optimistic demand on the current manufacturing system observed an increase in all the variables that were under study. The overall capacity of the system was reached early on in the simulation period and remained constant throughout. This was a particular constraint imposed by current capacity which was surpassed. Figure 7.7 illustrates the graphical representation of variables under study

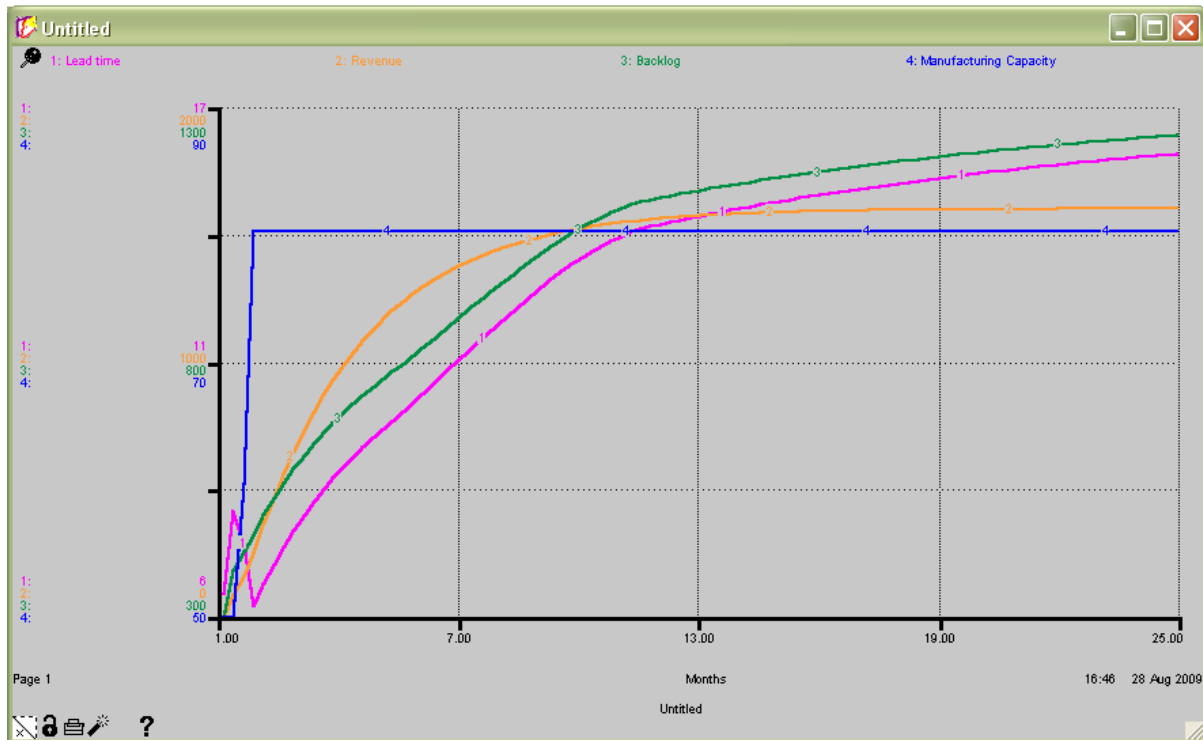


Fig 7.7 Simulation results for the Optimistic scenario of Bradgate Furniture's strategic intent

A cause for concern for the senior management at Bradgate Furniture was that the lead time observed in the simulation results had increased from the current level to the final level. This was unacceptable as it would be considered excessive by industry standards. Additionally, the backlog the system presented increased as well as the lead time. This would negatively impact the potential benefit. The behaviour of the Manufacturing Capacity variable convinced the senior management that unless an investment on capacity of the present manufacturing system was made, it would not be possible to achieve the targets for reducing overall lead time the organisation had set to further acquire a more significant portion of the market.

### 7.5.2 Simulation of the Conservative Scenario

As with the 'Optimistic' scenario, the demand described in Table 7.1 was then inserted into the model and was simulated. This would provide an additional analysis of the current capacity of the manufacturing system under differing product demands. Figure 7.8 illustrates a graphical comparison of the variables

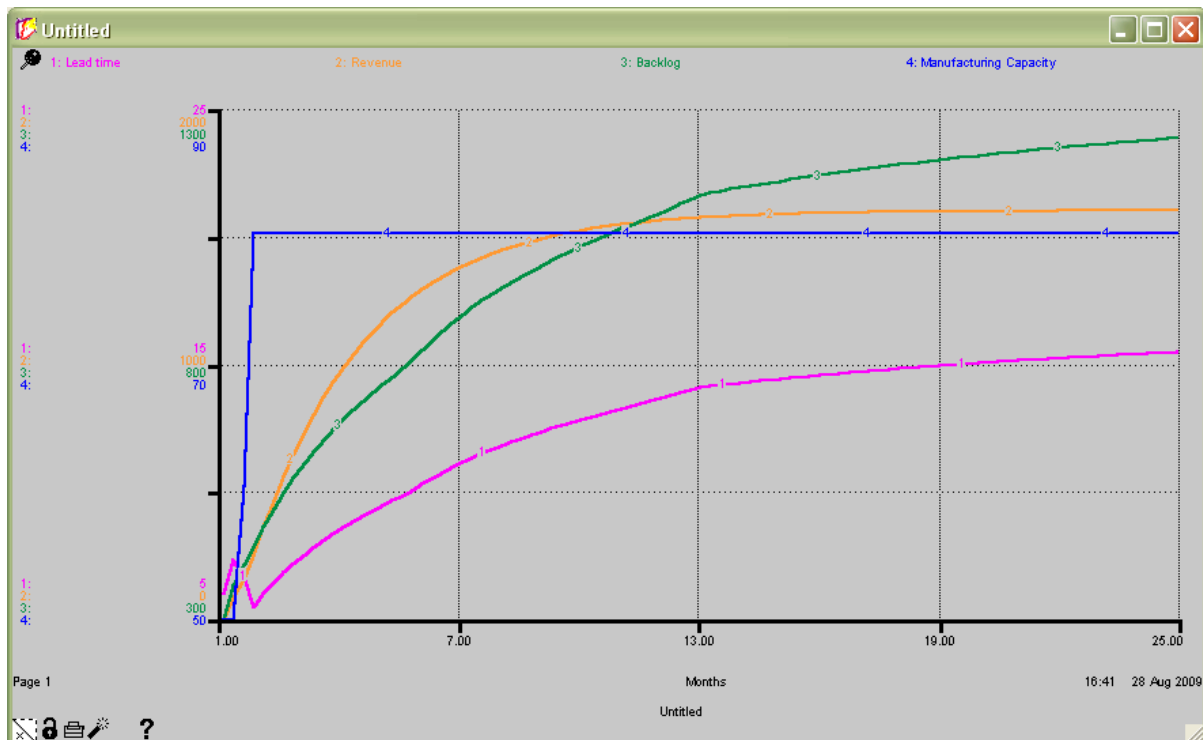


Fig 7.8 Simulation results for the Conservative scenario of Bradgate Furniture's strategic intent

Overall the results for this simulation model were similar to those observed in the optimistic scenario. Manufacturing Capacity in both scenarios peaked early on in the simulation run and stayed in a constant value. Further results confirmed that there was a minimal difference in revenue between both scenarios. It was considered that potential lack of capacity within the current manufacturing system was hindering any potential expansion the organisation might consider. It was therefore imperative that the organisation invested in manufacturing capacity before any attempt to capture any further market share as the brand image could potentially suffer from additional lead time.

Table 7.3 illustrates the final values for the variables obtained from both simulation runs. As Bradgate Furniture has a wide range of products with a varied price specification, it was considered necessary to aggregate all products into a single unit. This unit would then be multiplied by the factor decided by the senior management to produce an 'average' of potential revenue that the organisation would be expected to achieve.

| <b>Variable/Scenario</b> | <b>Optimistic</b> | <b>Conservative</b> |
|--------------------------|-------------------|---------------------|
| Lead Time                | 16                | 16                  |
| Revenue                  | 1607              | 1607                |
| Backlog                  | 1248              | 1238                |
| Manufacturing Capacity   | 80                | 80                  |

Table 7.3 Simulation results for both scenarios for the proposed strategic intent

It was proposed to the senior management that further investigation of the manufacturing system at Bradgate Furniture would facilitate understanding that detect potential areas in which investment would improve performance and would reduce observed levels of lead time and backlog.

## **7.6 CHANGING MARKET SHIFTS IN DEMAND FOR BRADGATE FURNITURE**

The present chapter has discussed two scenarios for a strategic intent deployed in Bradgate Furniture. Models have been created of the organisation, rationale of the strategic intent and simulation models to underpin and analyse potential behaviours of the organisation under specific conditions. Such models enabled senior management at Bradgate Furniture describe, document, communicate and analyse potential behaviour which would potentially impact proposed strategic intents. However subsequent changes in the economic environment caused a rationing of demand for multiple high end luxury products, such as products realised by Bradgate Furniture. Consequently, the demand for such products fell dramatically. A new potential case study would reveal the loss in demand and to what extent the shift in demand would affect revenues perceived by Bradgate Furniture. The following chapter discusses such scenarios.



# **CHAPTER 8 CASE STUDY: BRADGATE FURNITURE ALTERNATE SCENARIO**

## **8.1 INTRODUCTION**

Chapter 7 described a case study company and two related candidate strategic intents that this organisation wished to explore by applying the proposed methodology of the present research. Models were created to document and simulate potential impacts of a proposed growth strategy derived from the demise of a major competitor in the market and promoted via an extensive advertising campaign. Static models were created to represent relatively enduring aspects of the case organisation (and its possible candidate configurations), but it was considered that time dependent aspects identified via the use of causal loop diagrams would be better explored by creating simulation models. This enabled observance of behavioural aspects of selected manufacturing system variables, that the senior management considered important to assess the viability of the proposed strategic intent. Results obtained facilitated discussion with the organisation's management about the feasibility of implementation.

However, changing demand order patterns to those predicted necessitated a new analysis of the potential impact within the organisation's goals. Models created in the previous chapters were reutilised to analytically determine if previous growth targets could be achieved. The present chapter details shifting market conditions, reuse of models and findings obtained when simulating the new market conditions. Strengths and weaknesses of the developed models and their systemic use are identified and assessed so as to propose further improvements to the research methodology.

## **8.2 CONDITIONS AFFECTING BRADGATE FURNITURE'S GROWTH FORECAST**

Bradgate Furniture experienced a decrease in the quantity of orders from their stockist network. Initially, the senior management considered this to be a 'seasonal'

displacement on traditional demand patterns; however, since demand data experienced a consistent decline, further investigation was deemed necessary to understand the shift in market conditions and potential impact within the growth strategic intent that Bradgate Furniture had conceived.

### *8.2.1 Environmental conditions*

Predictions of a continued demand expansion for Bradgate Furniture were centred primarily on a growth forecast the organisation had made based on sales data from previous years. However, further analysis of economic conditions concluded that the basis for the underlying assumptions of growth were extremely optimistic. Indeed market expansion was considered to be exponential as the organisation could easily capture a significant portion of the market share left by the exit of a major competitor from the market. General market conditions were assumed to be unaltered, i.e., demand for high end market products such as Bradgate Furniture, availability of financial credit to finance any purchases by the organisation, or indeed the supply chain including the end user. Such assumptions made possible that organisation could predict a sustained growth, yet there was no provision for a shift consumer demand, or financial constraints. Senior management were convinced that the forecast was realistic and did not consider any alternative scenarios. Deterioration in the supply of credit and shifting trends in consumer demands drove the organisation towards a new situational framework in which most of the underlying assumptions made were re-examined to assess potential impacts to the demand for Bradgate Furniture products and necessary adjustments in the projected expansion of the organisation.

Products produced and marketed by Bradgate Furniture are directed at 'middle class' end customers. Their marketing and pricing strategy has been to deliver high quality goods in different styles and finishes. Therefore, most of their current stockists are selected high street stores that also aim to supply furniture to this segment of the market; although a much smaller fraction of their stockists include discount furniture stores. This strategy has enabled them to report revenue increases mentioned in previous chapters. The sales forecasts and the growth strategy were primarily based on the assumption that the upper middle classes, would continue to acquire most of the production. This coupled to a thriving housing

market would mean that the number of household sales would be continuously growing giving rise to a greater demand for their high quality products.

General economic conditions within the UK in the middle of 2007 were affected by a rationing of credit imposed by banks and other lending institutions. This severely affected the available income that could be invested, not only within the business industry but by consumers. The preceding decade has sustained a continued increase in house property prices which enabled most consumers to obtain additional credit securing the new lending against the increase of house property value (Pricewaterhouse Coopers [PWC2008]). This facilitated consumer spending across multiple products and services industries. Initial forecast of Bradgate Furniture included an expansion in the market share that was partially driven by prospective growth in the UK economy. However conditions deteriorated when an increase in non-payments, or defaults, by an increasing number of homeowners who could not continue to finance their existing debts and had to be declared bankrupt. This, in turn, led to domestic financial institutions, such as Northern Rock, been unable to secure lending from the so called 'wholesale market' to fund the deficit created by such defaults to severely restrict availability to credit for individuals and organisations. This had an adverse effect on the potential acquisition capability of consumers and organisations, who were unable to secure resources for their manufacturing systems. Increasing levels of finished goods stocks meant additional costs for organisation which added pressure on organisation's finances. This spread in the early quarters of 2008 to several other banking and lending institutions. As lending institutions had to underwrite, i.e., assume the financial responsibility for all those defaulted loans, several billions of pounds from its debtors, a new set of rules applied for obtaining new financial instruments to secure loans. This occasioned the housing market, and the consumer spending, to reverse previous sustained growth trends. Since obtaining a loan became increasingly complex, consumers significantly decreased their overall spending. This had a negative impact on organisations as fewer products were sold. Discounts had to be offered to attract customers to purchase products. Figure 8.1 illustrates a structural conceptualisation of relations deduced from the above understandings about financial market and customer behaviours change between house prices and consumer spending.

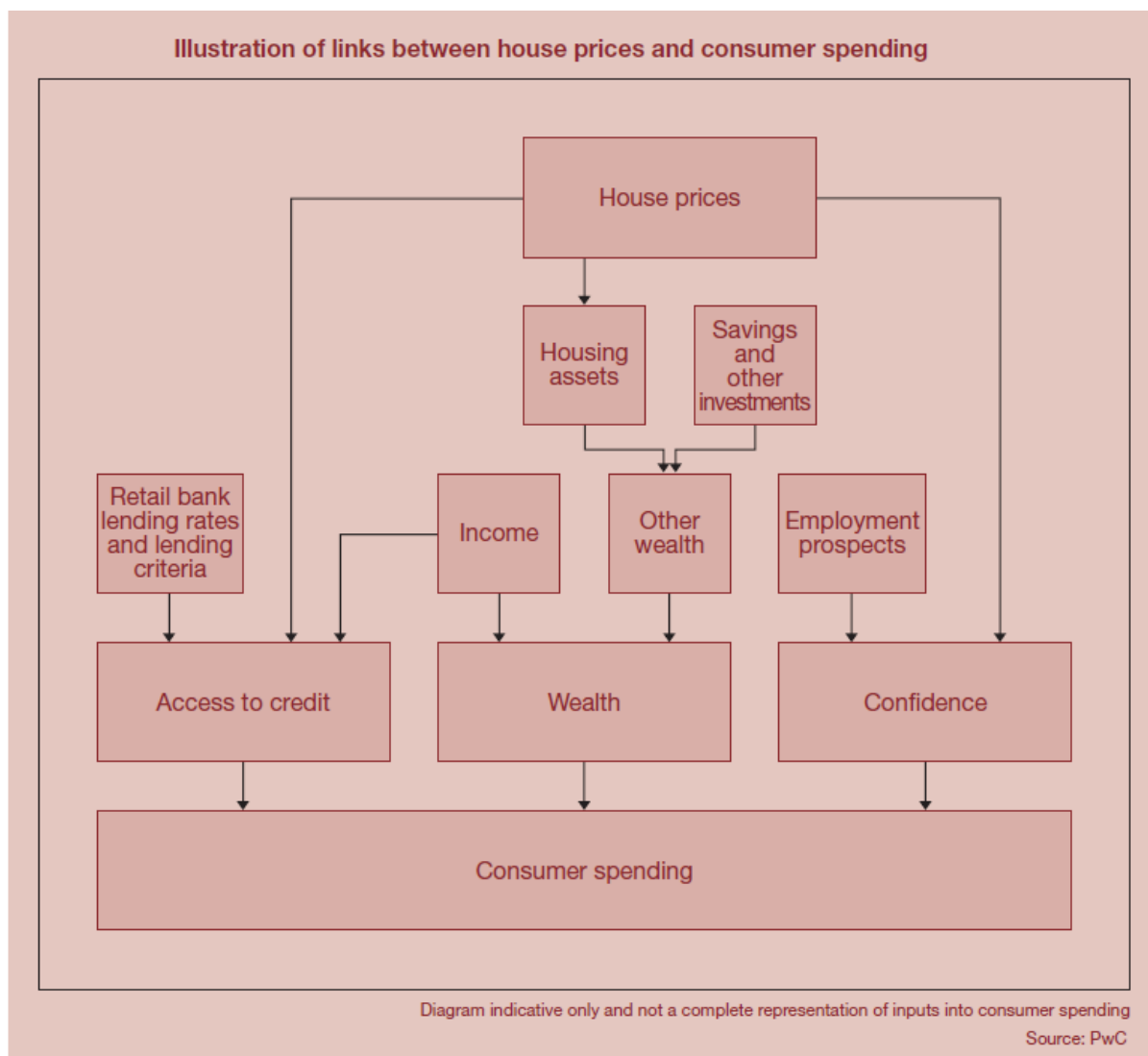


Fig 8.1 Links between consumer prices and consumer spending (from PricewaterhouseCoopers, 2008)

Organisations such as the case study furniture company had to downscale their potential growth figures amid a general slowing down of orders. As an increasing number of consumers altered significantly their spending patterns, i.e., deferring purchases or selecting alternative inexpensive brands, organisations such as Bradgate Furniture were obliged to shift expectations of growth. Additionally, organisations were forced to reduce their retail price to attract further consumers, to the organisation’s product mix. Such conditions obligated organisation to reduce costs as further reductions had to be made in the final sale price to retain a profit margin. It was generally observed that the demand for goods and services declined in all economic sectors. Figure 8.X illustrates the comparison between house prices and consumer spending within a two decade span.

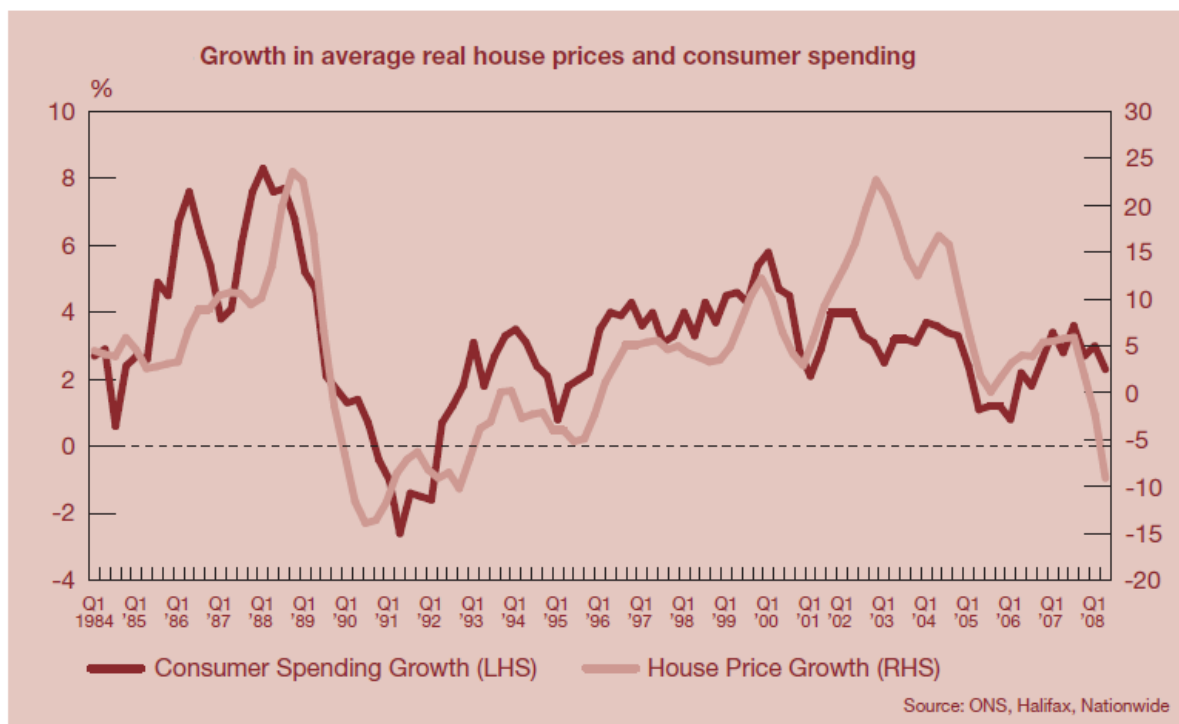


Fig. 8.2 House price and consumer spending comparison (from PricewaterhouseCoopers, 2008)

### 8.2.2 Related effects on Bradgate Furniture forecasts

Within such a complex economical environment, senior management considered that initial growth forecasts would have to be revised as interim sales data collected through stockists as well as informal discussions with peers in similar sized organisations across a number of industries reflected a recessive tendency on their average sales forecasts. Bradgate Furniture subsequently experienced a steady decline in orders placed by the stockist to the organisation. As it became evident that the decline in orders would continue for a sustained period of time, it was decided to prepare two scenarios for the organisation in which subsequent fall in orders would be analysed in terms of potential revenue.

Models discussed in the previous chapter were reutilised for the present analysis. As a potential guideline for future impacts, it was considered that simulation with such models would provide an overview of potential impacts within the organisation and would enable a decision of the company’s future.

The first scenario envisioned would take a decline of nearly 15% of the current level of sales. Senior management at Bradgate Furniture considered this a conservative approach as anecdotal evidence of previous economic hard times experienced within the UK in the 1990s. During such times, Bradgate Furniture experienced also a decrease in sales which deferred potential expansion plans the management had for the organisation; however, those plans were later achieved when economic conditions turned more favourably.

A second scenario was built upon a more pessimistic view of the economic situation experimented. As potential defaults on banks affected credit conditions, the senior management were convinced that a second scenario predicting a more complex trading condition would in fact be needed. A potential loss of up to 25% of sales was projected as a worst case scenario. This scenario was forecasted to analyse potential revenue losses and impacts within the production systems. The results obtained from both scenarios would dictate further action needed by the organisation to survive an uncertain economic climate.

Table 8.1 illustrates both scenarios considered. A 25 month period was envisioned to cover more than the following two years senior management wanted to initially predict with the current models so as to ascertain potential impacts. The sales forecast information was divided into 10 equal periods of 2.5 months, reutilising the same approach as that utilised in the previous chapter.

| Month/Scenario | Conservative | Pessimistic |
|----------------|--------------|-------------|
| 0              | 455          | 455         |
| 2.5            | 462          | 462         |
| 5              | 453          | 447         |
| 7.5            | 425          | 438         |
| 10             | 385          | 432         |
| 12.5           | 399          | 381         |
| 15             | 387          | 378         |

| Month/Scenario | Conservative | Pessimistic |
|----------------|--------------|-------------|
| 17.5           | 357          | 372         |
| 20             | 387          | 348         |
| 22.5           | 390          | 342         |
| 25             | 386          | 348         |

Table 8.1 Projected Demand data for decreased sales scenarios

Such forecasts would be utilised to predict potential impact in revenues for the organisation. Senior management considered that the most likely scenario would be the so called ‘conservative’. As the potential market share left by the previous competitor was considerable, the organisation was optimistic that any decrease in demand would not be greater than that projected. Such data would be then inputted to a simulation model to assess potential impacts in Lead Time, Revenue, Backlog and Manufacturing Capacity

### 8.3 MODEL REUTILISATION

One of the objectives of the present research is to produce reusable models that can assist the strategy realisation process. The benefits for such an approach should be apparent to the reader: reduced reconfiguration time needed, reduced time needed to gain understanding of the represented relations/constructs/resources and modelling constructs and rapid deployment. Whilst creating the necessary models to capture required aspects of the organisation, special consideration was given to involvement in their creation and validation of the relevant actors and stakeholders within Bradgate Furniture so that models depicted could then be utilised in future instances by those actors with minimal or no supervision of the researcher or indeed, the MSI Research Institute personnel that was involved in the project. By adopting such an approach, it was considered that the modelling efforts would benefit Bradgate Furniture organisation at large as any knowledge captured of the process network and utilised to create various modelling representations would be shared and would rest within the organisation.

Therefore all models created previously to depict static, causal and simulation aspects of the organisation were reconfigured to analyse the current situation within Bradgate Furniture. Validation and suggestions of potential areas of improvement for

such models were mainly done by senior management. The researcher enacted their reflections so as to better replicate conditions posed by the new environment.

### *8.3.1 Static modelling*

Static models constructed in the form of an EM of Bradgate Furniture Ltd., enabled the organisation to clearly associate relevant components of the organisation and provided a structure for decomposition which facilitates understanding and documentation of hierarchical and general temporal relationships between enterprise elements i.e., interfaces between different processes and resources deployed to realise those processes. It was observed that static models indeed facilitate understanding of the organisation and could facilitate communication between the MSI Research Institute team and the senior management of the case company.

Models previously created and documented in Chapter 6 were utilised to analyse the current organisation configuration to assess potential areas in which the projected economic environment would alter enduring relations within the organisation. After several discussions of how would a potential change with current network of stockist would alter the relations previously documented between relevant domain processes and sub processes it was concluded that no such alteration was present within the new environment. Senior management concluded that the static nature of the processes would not be affected as the major change was external and did not have a bearing in the manufacturing process network. Therefore the process networks previously identified and documented would not suffer a reconfiguration as essentially the changes the senior management foresaw were directed at the production level required.

### *8.3.2 Casual loop diagramming*

Causal loops developed in the previous chapter were reutilised to model impacts of the observed order decrease. It was observed that the existing diagrams designed to analyse impacts of a growth strategy could also enable analysis of a decrease in market participation following a reduction in customer orders for the organisation, models could be reused adding necessary variables that represented. It was considered that a decrease in consumer spending would negatively impact the demand for Bradgate Furniture products. Causal loop diagramming facilitated senior management to articulate the principal reasoning of the strategic intent. Through



usage of causal relations, additional impact from sources senior management considered would impact the current demand for Bradgate Furniture products were represented as an impact on the 'Market Share. Figure 8.3 illustrates the new variables considered by senior management. 'Disposable Income' was conceived as the amount of potential income end users would have which would directly impact the orders placed by the stockists. Although Bradgate Furniture has not a direct sales policy, it was considered that this factor would be a potential threat to the demand of the top end quality products the company produces. Informal conversations with the stockists had made the management aware of a reduction in disposable income of their customers added by the tightening credit supply available to end customers. It was therefore identified that a reduction in the disposable income in the end user would have a direct impact in the demand levels required by Bradgate Furniture's stockists.

The second variable considered was 'Customer Enquiries'. This variable summarised the new enquiries made to stockists by end users. In view of a reduction of disposable income, the marketing manager at Bradgate Furniture had identified a causal relation of end user customer making new or additional requests for products to their stockists. This was reinforced by informal conversations held by the marketing manager with various stockists throughout the UK. As most of the products of Bradgate Furniture are aimed at an upscale market and the deterioration in credit conditions seemed to have an impact in the spending patterns of potential customers, this variable was considered within the overall Bradgate Furniture strategic intent for growth.

Figure 8.3 illustrates the causal relations observed by the senior management. Both variables previously described have been included in the growth models of the organisation. It was considered that the reduction on 'Customer Enquiries' and 'Disposable Income' would negatively impact the potential capture of the 'Market Share' since less orders would not provide the necessary revenue needed for an expansion. Senior management considered this to be a major threat to their growth plans and subsequently decided to observe the potential impact of such variables within the overall strategy intent previously described.



Given a new set of simulation data scenarios, it was considered that a new set of simulation models would be necessary to assess the quantitative impact within selected variables of the Bradgate Furniture enterprise model. Within the current economic conditions, a quantitative approach was deemed necessary to assess any potential impact to the overall strategic intent so as to better prepare the organisation for any unexpected situations that might arise. It would enable senior management to consider the impact of the envisioned variables would have on the current production systems as well as to measure the impact on the overall strategic intent. Specifically, it would enable the decision to continue to pursue a growth intent or to diversify into other areas or retrench for the foreseeable future, until new economic data would support an expansion intent of the organisation.

After careful consideration, it was decided that such models would be built upon existing models, so as to draw upon the existing knowledge the organisation had about the relations between factors as well as to facilitate further use of such models in an array of potential candidate contexts. For the researcher, reusability of models was a key element within the proposed methodology as this would enable the organisation continue to explore any potential strategic intent with the models created and would facilitate knowledge transferring from the researcher to the organisation once the project concluded. Therefore, changes within the operational and strategic environment which caused senior management to reconsider the premises for their initial strategic intent were observed to be a prime candidate for a case of model reutilisation. Additionally, the modelling effort was significantly reduced from the conceptualisation to the realisation of the models as the previous models created enabled a 'baseline approach' in which previous experience was reutilised to understand the interactions between elements within the organisation. This was also useful in determining the interfacing elements of the enterprise modelled with the external factors that were causing the diminishing orders for Bradgate Furniture.

Within the context of a retrenchment of orders caused by external factors to the organisation, such models facilitated an analysis of the potential market implication of such decrease and provided a forecast of the behaviour for a select set of key variables within the proposed strategic intent. The main objective in creating such model was to facilitate discussions within senior management team so as to develop

alternate candidate solutions that would enable the attainment of the growth strategic intent.

Figure 8.4 illustrates the model created to simulate the new scenario in which the organisation was present. As the conditions of orders deteriorated, an additional variable 'Consumer Spending' was added to the model. This variable reflected the impact a decreasing spending pattern forecast projected by senior management of Bradgate Furniture would have on the overall orders, or demand, from stockists. It was considered that the impact of this variable would be on the overall demand the organisation had for its products as stockists received less orders from the 'end users'.

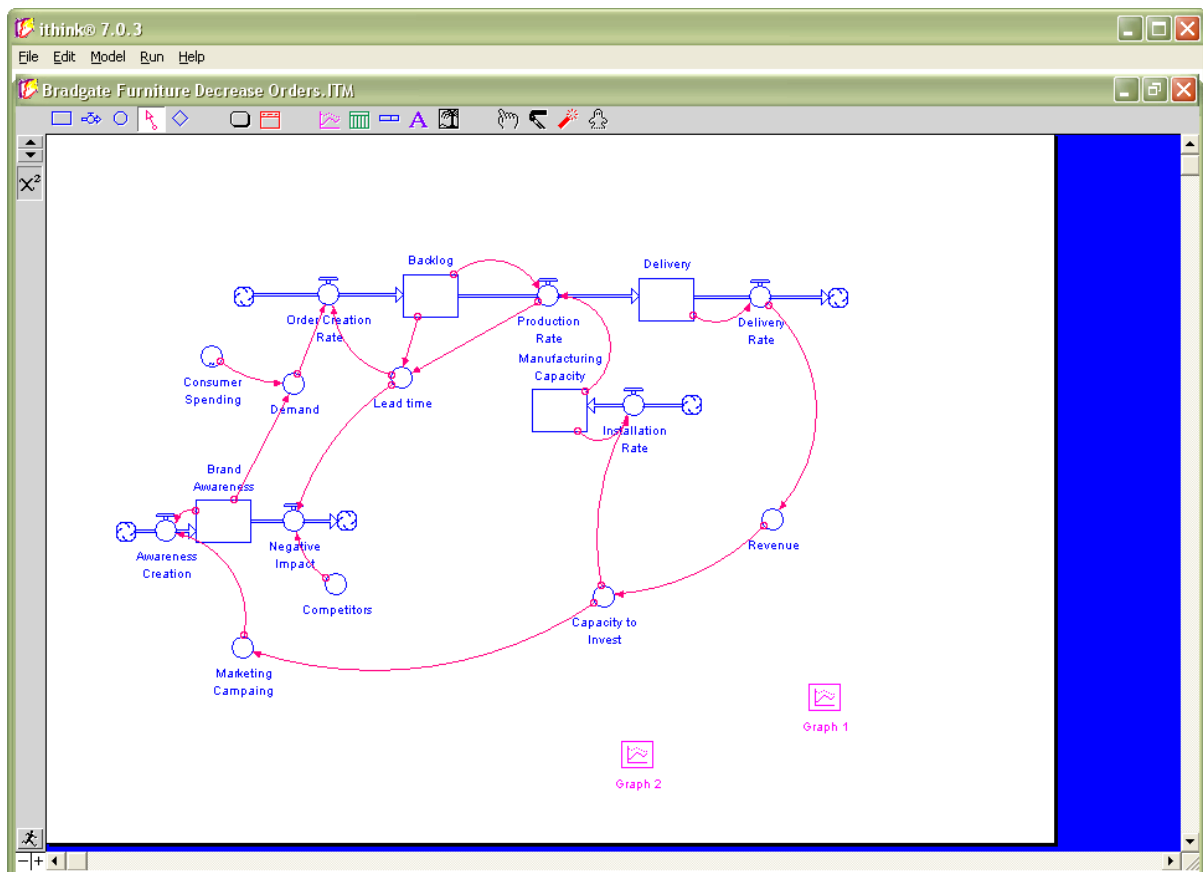


Fig 8.4 Results from analysing projected growth scenario within Bradgate Furniture

Senior management at Bradgate Furniture considered no further impacts upon the model previously created for the organisation as the only perceived impact of the declining sales stockist were reporting would not have an impact on the overall production systems of the organisation. It was concluded that declining sales would impact the 'Revenue' variable previously identified. Senior management were keen

to assess potential behaviour of such variables. This would provide a key element to consider if the organisation could indeed expand or should another strategic intent be needed. Additional variables such as 'Lead Time', 'Backlog' and 'Manufacturing capacity' were also considered as critical as each variable would facilitate discussion on where key resources should be allocated in order to achieve the proposed expansion intent as conceived by the organisation.

As the organisation has experienced an increase in the current lead time over the initial expansion phase, senior management considered that monitoring this variable would expose the impact on a key strategic advantage the organisation had over their competitors. Previously, lead time was just over half the standard of most competitors which made possible a consolidation of the brand image within the stockist and the end users. Recent increase in such lead time led to some stockist complaining to the organisation about longer delivery periods, however, no effect was observed on the amount of orders the organisation experienced. Senior management was adamant that this variable be monitored as it was felt that brand awareness would suffer if stockist, and end users, could not obtain the ordered products before their competitors.

Backlog experienced by Bradgate Furniture had increased over the initial stages of expansion and was considered one of the possible causes for an increase of lead time. Increase in orders experienced had an adverse effect on the delivery of previously contracted orders which, in turn, increased the average lead time the organisation registered. Senior management were concerned of such an increase since a portion of the stockist network had expressed concerns over the long term effect this would have on the viability of an expansion strategy as, potentially, it could dramatically reduce interest in the brand by end users.

Senior management at Bradgate had considered expanding the production facilities to additional sites to cover projected excess in demand. Since the organisation had experienced additional pressure on the manufacturing systems from the backlog from orders, it was considered that an overall expansion in capacity would alleviate pressure mounting on the enterprise. However, as the projections for demand would be revised in the economic situation of the organisation, senior management thought that a review of the potential capacity needed in new economic environment would add to the assessment of the current strategic intent. Therefore, the 'Manufacturing

Capacity' variable in the model would be analysed so that new projections of demand would in fact affect the previous intent of expanding Bradgate Furniture capacity with additional sites could be justifiable.

#### 8.4 NEW STRATEGIC INTENT MODELLING RESULTS

Previous sections have detailed new strategic conditions that affected the proposed strategic intent. As the organisation experienced a decrease in orders, new demand projections and reconfiguration of the previously utilised models had to be constructed to face the new set of constraints.

To simulate the impact of such conditions, two scenarios were envisioned, namely: a conservative scenario in which the decline of orders would be minimal and a pessimistic scenario in which the expected loss of stockists demand would be in line with previous records of major decline in orders. Both scenarios were envisioned with historical data the organisation had from similar economic conditions.

Table 8.2 depicts the results from such scenarios. Discussion of individual case scenario results will be detailed in further sections. As discussed in the previous chapter, the units utilised for the model results were an aggregate product which would be multiplied by an aggregate revenue cost. This was done to be consistent with the modelling assumptions of a single aggregate product demand, product cost and product revenue.

| Variable/Scenario      | Conservative | Pessimistic |
|------------------------|--------------|-------------|
| Lead Time              | 9            | 11          |
| Revenue                | 1156         | 1032        |
| Backlog                | 702          | 789         |
| Manufacturing Capacity | 78           | 78          |

Table 8.2 Results for both Conservative and Pessimistic scenarios

##### 8.4.1 Conservative scenario results

Fig. 8.5 illustrates the simulation graphical results of the major variables the organisation wanted to monitor. Lead time was a critical variable for the organisation as it was considered to be strategic differentiator over their competitors. However,

recent data suggested that it was levelling with that of other competitors which left the organisation bereft of its former advantage. Modelling results indicated that lead time would present a 'spike increase initially, although it would stabilise through the simulation run. It was considered that this would be in line with the expectations of senior management however, further study would need to be done to minimise this result to gain their previous strategic advantage.

Revenue was the second variable which the organisation was interested in monitoring. The simulation model result indicated that although it would increase rapidly through the first periods of the simulation horizon, this increase would not be sustained and it would stabilise further on. This raised the possibility that any growth would not be sustainable in the long run and financial commitments would have to be analysed, as potentially revenue would not be sufficient to enable long term commitments to expansion.

Backlog was another variable the organisation wanted to explore its behaviour. It was believed that the behaviour of this variable was linked to the behaviour of 'Lead time' which, as previously stated, was of great interest for the senior management. Modelling results demonstrate this relation to be closely coupled. The initial 'spike' growth would then follow a period of decline and stabilisation, parallel to that of the lead time variable. Results for this variable indicated that Backlog would only be reduced with an additional increase in capacity as the 'Manufacturing Capacity' variable peaked at the maximum capacity the organisation had considered.

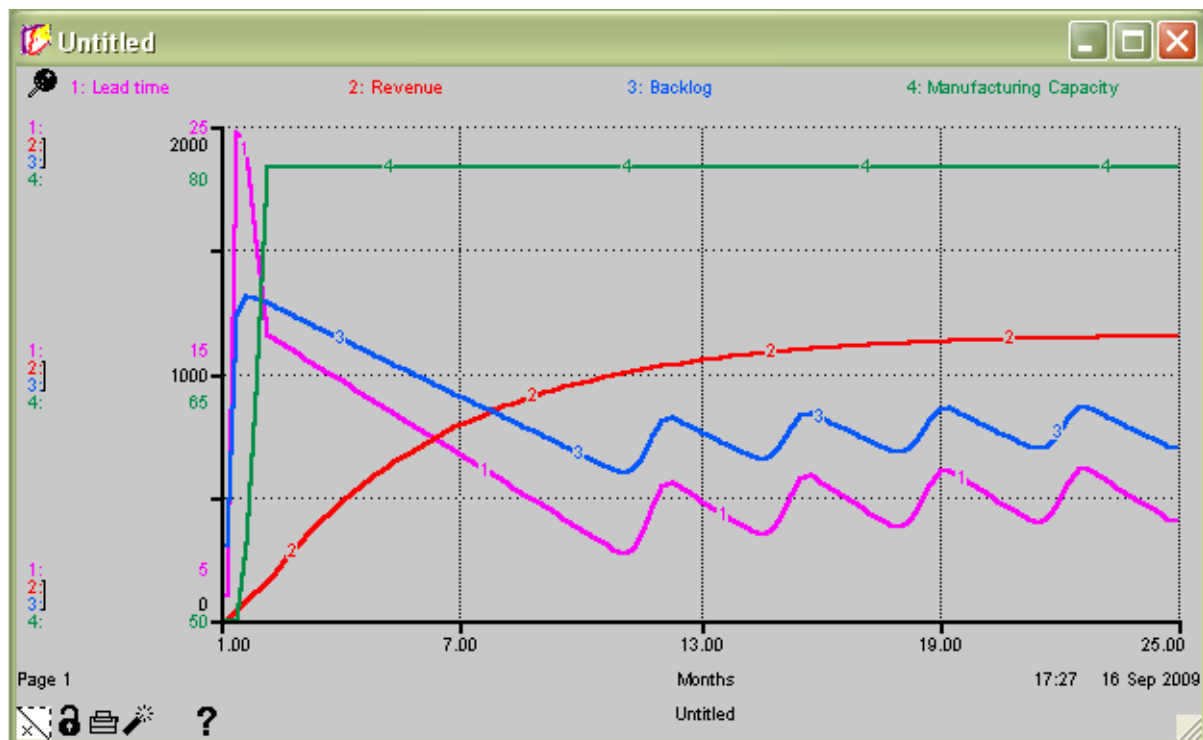


Fig 8.5 Conservative scenario modelling results for declining sales environment in Bradgate Furniture

Senior management considered that unless additional financial sources could be assured, potential expansion of the organisation could be deterred by the projected decrease in orders. As the projected revenue from the model did not cover the expected targets set by the organisation, senior management considered that a general lack of available credit to small and medium enterprises would not facilitate the organisation’s strategic intent.

#### 8.4.2 Pessimistic scenario

This scenario was developed by the senior management as a worst case scenario. Data for this scenario was projected from historical data the organisation had from the organisation’s experience in similar economic conditions faced in previous decades. It was suggested that such case would deliver a ‘bottom line’ to the organisation in terms of expected reduction in demand and therefore would facilitate discussion of the sustainability of a growth strategic intent.

Fig. 8.6 depicts modelling results for the pessimistic scenario. It can be observed that variables selected by the organisation present a similar pattern to the conservative scenario; however quantitative analysis demonstrated their numerical value to be relatively smaller. It was observed that the ‘Revenue’ variable presented



an initial growth followed by stagnation in value, similar to the results of the Conservative scenario. Senior management considered that further investment in capacity would be needed to reduce the experienced lead time, however, 'Backlog' variable results indicated it would not majorly affect the expected outcome.

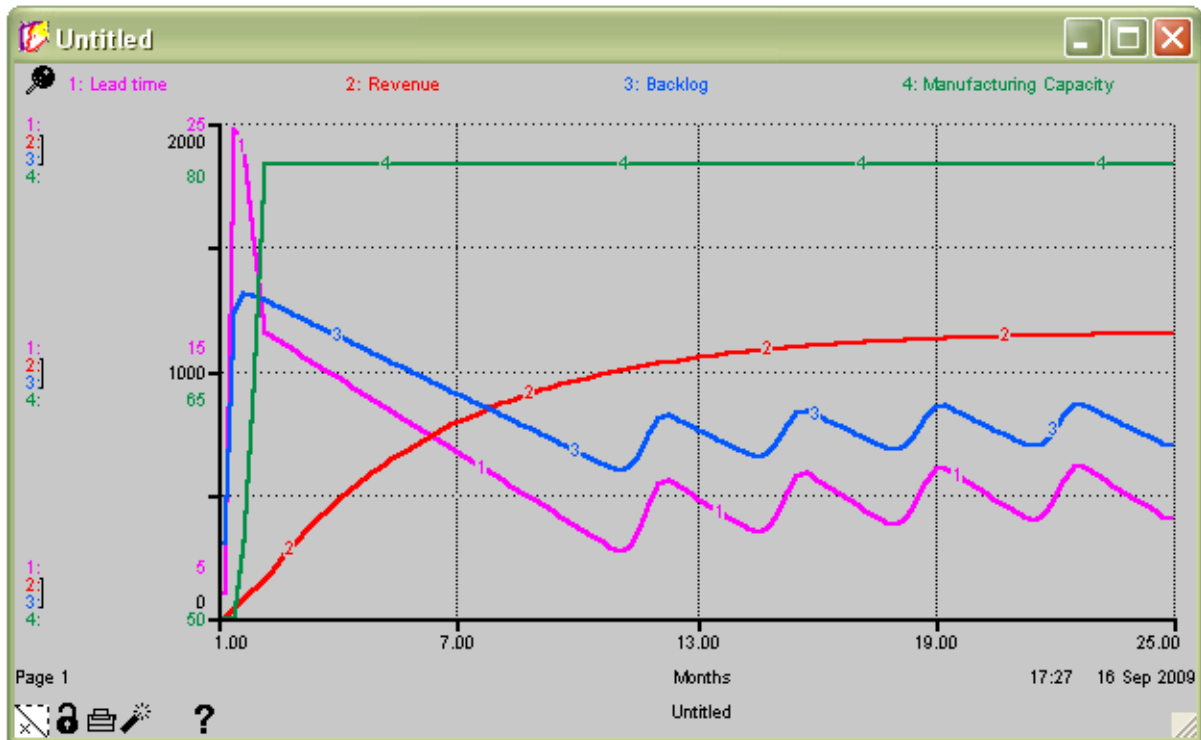


Fig 8.6 Pessimistic scenario modelling results for declining sales environment in Bradgate Furniture

### 8.5 METHODOLOGY APPLICATION RESULTS

Bradgate Furniture had attempted previously to map its current production process system. A disjointed approach led to individual areas of the organisation being partially modelled, i.e., serialisation of operations performed to realise particular products. Senior management considered that the approach taken would not lead to improvements as models created were lacking in multiple aspects such as: resources needed, operations times and interfaces with other parts of the production system. As potential growth was expected, it was identified that a new approach was needed to provide useful models of the organisation that could enable a discussion of potential actions needed to mitigate the impact on current production networks.

Application of the proposed methodology in Bradgate Furniture facilitated documentation of current productive processes and relevant interfaces. This enabled senior management to assess potential impacts of process reconfiguration and interfaces needed. It was also concluded that a graphical representation of the production processes facilitated communication between relevant stakeholders within the organisation, i.e., information flowing between various sections of the organisation was standardised so as to communicate production requirements more efficiently. Previous attempts by senior management to capture the production processes had been disjointed and no overall model of the organisation was developed. Although senior management had a 'hands down' approach to the production system, knowledge of the interfaces between multiple processes remained unclear.

## **8.6 STRENGTHS OF THE APPLICATION OF THE METHODOLOGY**

From the foregoing discussion it was observed that the application of the proposed research methodology had potential strengths and weaknesses.

### *8.6.1 Research Methodology's Strengths*

Several strengths of the present methodology were encountered in the Bradgate Furniture case.

- Enabled the documentation of processes and enabled the organisation to have a clear picture of the various process networks within the manufacturing systems.
- Provides reusable models that may serve as base line for analysing various strategic intents. Models created previously were analysed by senior management and the researcher. It was observed that after some practical experience utilising the software application, senior management were able to reconfigure and model the organisation within a reduce time framework, i.e., a few weeks and visits. It is considered the transfer of modelling abilities reduced the necessity for an external analyst and enabled senior management to successfully model the organisation.
- Quantitative scenario analysis of strategic intent enables analysis of impact within current or proposed configurations. Senior management considered

that the use of simulation models enabled them to assess potential impacts of the strategic intent resulting in a reduction of time necessary to find the optimal system configuration by several orders of magnitude against common practices of empirical data used previously.

- Communication between relevant areas of the organisation enabled common understanding of proposed strategic intent.

It is this researcher's belief that further dissemination of enterprise and simulation modelling concepts within wider industry would benefit any organisation as documentation of current and potential candidate configurations would facilitate introduction of strategic intents within the process networks and would identify potential inhibitors with minimal expenditure. Further application the proposed methodology within a wider variety of enterprises with varying degrees of complexity would be beneficial.

It was also suggested from this case study that usage of a graphic user interface simulation tool greatly enhanced understating of potential impacts on relevant variables within models.

### *8.6.2 Research Methodology's Weaknesses*

The application of the proposed research methodology within Bradgate Furniture highlighted potential weaknesses or areas or opportunity for improvement.

- Enterprise modelling enabled documentation of current and potential candidate system configurations, facilitating discussions amongst senior management and the researcher. However it was considered that static modelling was more suited to describe current interactions between actors within the production system as the effects of the overall organisations were best served by the utilisation of causal loop diagrams.
- Need for an external agent to the organisation to explain various modelling approaches and simulation software application.
- Application of the present methodology was limited to specific strategic intents envisage by the senior management that had already been conceived and planned. Involvement of the MSI team was on the latter stages of the strategy

realisation process, therefore wider application towards the strategy realisation process could not be achieved.

- Further interfaces which enable a correlation between the static and causal loop models would be beneficial as it was felt that CIMOSA decomposition principles greatly facilitate coherent sectioning of the organisation.
- Additionally, it was considered that continuous simulation provided sufficient level of detail at an 'aggregate', i.e., single product level rather than a more complex product distribution which necessitated competition for existing resources.

# CHAPTER 9 CASE STUDY RAPID PROTOTYPING MOULDINGS

## 9.1 INTRODUCTION

Previous chapters have outlined an organisation's strategic realisation process and have documented two differing scenarios of a potential strategic intent. Environmental conditions forced the organisation to revise a growth prospective and adjust it to a retrenchment. In the end, the demise of the organisation was attributed to highly adverse economic conditions as well as a market shift towards alternative product brands. The strategic realisation process was discussed as environmental changes. Several models were created to document multiple aspects that would underpin the impact of the candidate strategic intent within a selected portion of the enterprise, mainly, the production system. Results from simulation models were discussed with senior management to further enhance the decision making process.

The present chapter utilises the proposed methodology of the present research to further investigate the usefulness of static, causal and dynamic modelling tools and methods to support the decision making process within an organisation

## 9.2 ORGANISATION OVERVIEW

Surface Generation [SG2010] is a privately owned UK small to medium enterprise (SME) founded in 2002 as a spin-off from a leading European research and technology centres. Surface Generation has assembled an internationally recognised, multi-disciplinary team of stakeholders with a proven innovation, process development and enterprise track record. Founded by a team including PERA and the University of Cambridge the company's revolutionary Near-Net-Shape and Subtractive Pin Tool, mould making, process fundamentally altered the economics of small volume production of large products by utilising rapid prototyping to develop customised epoxy based moulds. Production of such moulds is done in conformance to specifications previously agreed with individual customers. The organisation boasts over 10 years of expertise of rapid prototyping tools and methodologies in

producing moulds for such organisations in industries as varied as Aerospace, Automotive and Biomedical sectors.

Rapid prototyping is the name given to a host of related technologies utilised to fabricate physical objects directly from CAD data sources. The advantage of utilising such methodologies over conventional production systems is that it enables multiple layers of materials to uniquely bond to configure a predetermined object or form. Such systems are also known as: additive fabrication, three dimensional printing and solid freeform fabrication and layered manufacturing. They offer advantages in many applications compared to classical subtractive fabrication methods such as milling or turning

Main advantages to this technique of manufacturing include:

- Objects can be formed with any geometric complexity or intricacy; without the need for elaborate machine setup or final assembly
- Object can be made from multiple materials or as composites or materials can even be varied in a controlled fashion at any location in an object.
- Additive fabrication systems reduce the construction of complex objects to a manageable straightforward and relatively fast process

These properties have resulted in their wide use as a way to reduce time to market in manufacturing. Current production systems such as these are significantly utilised by organisations to better understand and communicate product designs and rapid prototyping tooling which necessitated in manufacturing such products. End users can be found in such industries as: health services, construction and media among many others which have a high demand for these products.

### **9.3 PRODUCTION SYSTEMS IN SURFACE GENERATION**

Surface Generation has developed a unique production methodology to enable a flexible production system which facilitates the organisation to deliver complex requirements posed by its varied customer's base. Two key components of such manufacturing system are: licensing and reselling.

### 9.3.1 Licensing and Reselling

Surface Generation has designed the Near-net-shape Pin Tooling and Subtractive Pin Tooling processes to be:

- complimentary to users' existing manufacturing infrastructure.
- fully scalable according to customer requirements.
- give highly competitive, 6-18 mth, customer ROI's.
- constructed from off-the-shelf technology.  
retrofitted onto existing machine tools.

These benefits, coupled with Surface Generation's pro-active approach to intellectual property rights, give vendors the ability to generate revenues from sales, retrofits, consumables and maintenance. This is backed up by a clear development path which will give the opportunity to offer clients ongoing performance upgrades.

### 9.3.2 Retrofit

Surface Generation's Near-net-shape Pin Tool (NPT) and Subtractive Pin Tool (SPT) technology have been developed to allow simple retrofitting on to users' existing 3 or 5 axis milling machines.

Surface Generation's proprietary software combined with off-the-shelf hardware allows this simple upgrade to significantly enhance users' productivity and profitability.

This approach allows existing CNC vendors to carry out upgrades themselves and support machines on customer's premises with technology that is familiar to them and with minimal disruption

### 9.3.3 Capabilities

Rapid Prototyping Mouldings Reconfigurable Pin Tooling technology has been designed specifically to be accurate, cost effective and rugged. Built around a shared drive philosophy, a single Driver Module is used to adjust multiple Support or Consumable Modules thereby minimising installation and operational costs. Capable

of producing plastic, metallic and plastic moulds, this approach reduces effort and material required to make a tool to a fraction of conventional processes. Additionally, the following advantages can be argued:

- rapid iteration of designs through material addition or subtraction.
- immediate re-use of over 90% of the mould for future projects.
- tools can be re-used not stored.
- lowers environmental resource consumption.
- economic production of a batch size of one component.
- integrates into existing production facilities.
- delivers an exceptionally rapid return on investment.

This unique process allows even 'soft' tool surfaces to produce medium volumes through the refurbishment of discrete regions of the mould. The basic flexibility of the NPT & SPT approach allows them to operate in a broad spectrum of pressure, temperature and impact environments and permits the precision manufacture of moulds ranging in size from sports goods to aircraft wings

#### **9.4 STRATEGY REALISATION PROCESS WITHIN SURFACE GENERATION**

Surface Generation is an entrepreneurial style organisation (Segil [S1996]) in which the managing director has the responsibility to develop all areas of the strategy realisation process. Therefore, it is the responsibility of the managing director to devise, program and implement all aspects of a proposed strategic intent. It is the senior manager to address issues pertaining to strategy, marketing, product development, etc. A pragmatic approach is taken when deciding potential candidate strategic intent and it is based primarily on the forecasts produced by the senior management. Decisions concerning potential reconfigurations of the organisation are solely taken by the senior manager.

##### *9.4.1 Strategic Thinking*

Strategic thinking is an ongoing process for the organisation as the senior manager is constantly innovating in product capabilities and ranges of products. Multiple contacts within his customers provide information about market share, technology



developments, new product development, etc. This information is filtered by the senior management to produce potential candidate scenarios and models of the organisation's production and marketing strategy. Therefore, the CEO has a keen interest in keeping constant contact within his supply chain network which would generate additional information which would feed the strategic thinking process. Most of the models generated are so called 'mental models' which are translated into a spreadsheet application in which potential forecasts of demand and revenue are created. Quantitative analysis is made with such forecasts and provides a clear understanding of the potential outcome of the information received. When an idea can produce a significant result, it is then assigned resources within the organisation and objectives are identified which will facilitate the organisation an assessment at a later stage.

#### *9.4.2 Strategic Programming*

The strategic programming of the organisation is mainly a financial consideration using a detailed demand forecast, based on the previously created for the strategic thinking process with additional information gathered from historical data or projections made by the senior management for the original strategic thinking intent. Senior management establishes ideas for growth, retrenchment or diversification regarding a product line or market. Using a simple spreadsheet, senior management analyses multiple 'what if' scenarios to validate the plausibility of a potential strategic intent. Resources needed for the attainment of the goals envisioned in the strategic intent are allocated within current resources. Current commitments are considered before additional tasks are allocated. Milestones are identified clear financial objectives are established. This enables the senior management to assess the viability of the proposed strategic intent within the current state of the enterprise. Acceptable performance limits, i.e., range of performance of variables acceptable for the organisation, are set to observe behaviour of objectives and variables considered critical for the strategic program.

#### *9.4.3 Strategic Deployment*

Managing through routinely operations senior management collects and assesses information on performance, achieved progress, potential threats so that initial assumptions for the strategic intent can be monitored according to previously

established performance limits. Potential performance deviations of any of the critical success variables are considered in order to revise performance indicators and assess if additional action is needed. If performance trends tend to indicate such limits will be breached, corrective action is envisaged and carefully monitoring of situation is enacted. In such process, senior management will obtain feedback from operational staff regarding potential opportunities or threats as identified.

## **9.5 METHODOLOGY APPLICATION**

The methodology previously enacted within Bradgate Furniture was also deployed in this organisation. The strategic intent developed by the senior management would primarily affect the capacity of the manufacturing systems of the organisation by altering the number of available pinheads utilised so that additional production capacity could meet a potential demand surge. Demand forecasted by senior management indicated an increase in potential orders as the organisation was attracting more customers through a targeted marketing campaign and 'word of mouth' publicity. Senior management was convinced that potential new orders would test the capability of the current manufacturing system and was eager to assess the necessity of additional tooling which would potentially enhance the production throughput. Investment in capacity would alleviate potential pressures on manufacturing system as well as enable scheduling of operations. Therefore, a target throughput was identified to fulfil demand forecast predictions. It became clear that the present case study enabled the organisation to reconfigure its current production system to cope with a potential growth demand. By reconfiguring potential operation times, the current growth strategic intent could be tested within a new manufacturing system configuration. Additionally, testing various configurations would facilitate discussion on assigning resources to meet the forecasted demand.

It was conceived that the utilisation of simulation modelling as well as enterprise and causal loop modelling would enable the senior management to assess the potential expansion of the production output by introducing varying levels of pinbeds and alternate operation times. Additionally, it was considered that the use of simulation models would facilitate observance of the behaviour of the throughput variable, considered to be critical for the success of the strategic intent.

Based on the requirements of the present environment, it was considered that a change in the methodology would be needed to address key constraints posed by the organisation. Previously, the proposed methodology had utilised a continuous simulation approach as it was observed that it enabled the monitoring of variables of a continuous nature and that data provided followed a statistic pattern. The present manufacturing system presented additional complexities that necessitated a change of simulation methodology, using discrete event simulation. Potential alternate methodologies considered were: operations research and discrete event simulation. After assessing benefits against pitfalls of implementation it was decided that discrete event simulation would be the methodology that the researcher would utilise to represent the manufacturing system of Surface Generation. Among the benefits expected from this approach were

- knowledge from the researcher due to several projects in which such methodologies had been utilised
- discrete event nature of the manufacturing system
- multiple variables that needed to be considered to successfully model current and potential manufacturing system

It was therefore considered that this methodology would deliver similar results in terms of providing a quantitative assessment of variables and would indeed support the decision-making process of the organisation. It was also considered this technique would provide additional insights into the behaviour of the organisation and provide in-depth analysis of the operations and timing necessary to attain the proposed manufacturing objectives as delimited in the strategic intent.

As management was not certain as to the necessary level of tooling and potential working patterns, multiple alternate candidate models of the organisation were developed to provide an array of configurations the organisation could potentially implement to observe which candidate solution would better comply with the required throughput. Therefore, a modified version of the original methodology was applied within the organisation; in the simulation methodology previously described as it was considered the requirement of the organisation were better met utilising discrete event simulation.

#### *9.5.1 Static modelling of Surface Generation*

As the strategic intent concerned mainly the production system of the organisation, it was considered that static models of the production system would be required to further understand the impact of the proposed strategic intent. Therefore, a context diagram was developed to identify the relevant actors of the production system to be recognised so that further decomposition could be generated. The main purpose of such diagrams was to provide a common understanding between senior management and the researcher so that a clear representation of the organisation would be developed and correct, i.e., sufficiently accurate, models of the organisation would be represented.

Figure 9.1 depicts the context diagram defined for Surface Generation. As the objective of the present diagram is to identify relevant actors within the current level of decomposition, a central domain was identified as 'To Make and Build Rapid Prototyping Moulds'. This domain represents the central objective to which external actors are linked through relevant interactions that enables the attainment of such objective.

Two major CIMOSA domains, or domains which will be further modelled and decomposed, were identified. 'DM1 Produce Moulds' encompasses relevant activities needed for the production of rapid prototyping moulds. This domain encapsulates the manufacturing system of Surface Generation and was the primary focus of concern with respect to exercising the present strategic intent. The 'DM2 Engineering Moulds' domain was identified by senior management as a critical part of the manufacturing system as one of the key strategic advantages of rapid prototyping is the flexibility of reconfiguration of the so called 'pinbed' technology. Senior management desired to observe potential interfaces between such domains to gain further understanding of impending impacts to attaining the production output objective.

The remaining domains were considered to be non-CIMOSA domains, i.e., domains which would not be further decomposed but have an impact within the central objective. 'DM3 Vendors' encapsulates all activities which different vendors the organisation possess have on the current manufacturing system. 'DM4 Administration' encompasses all activities related to Surface Generation administration of the production system. It was considered that such activities would not impact on the scope of the project, so it was decided it would not be necessary to

decompose such domain. ‘DM5 Customers’ groups all interactions external customers have with the manufacturing system, such as product order details. ‘DM6 Fixture Suppliers’ collects all activities regarding external fixtures utilised by the manufacturing system to produce specified moulds. ‘DM7 Logistics’ clusters all activities regarding transportation and delivery of products for the manufacturing system.

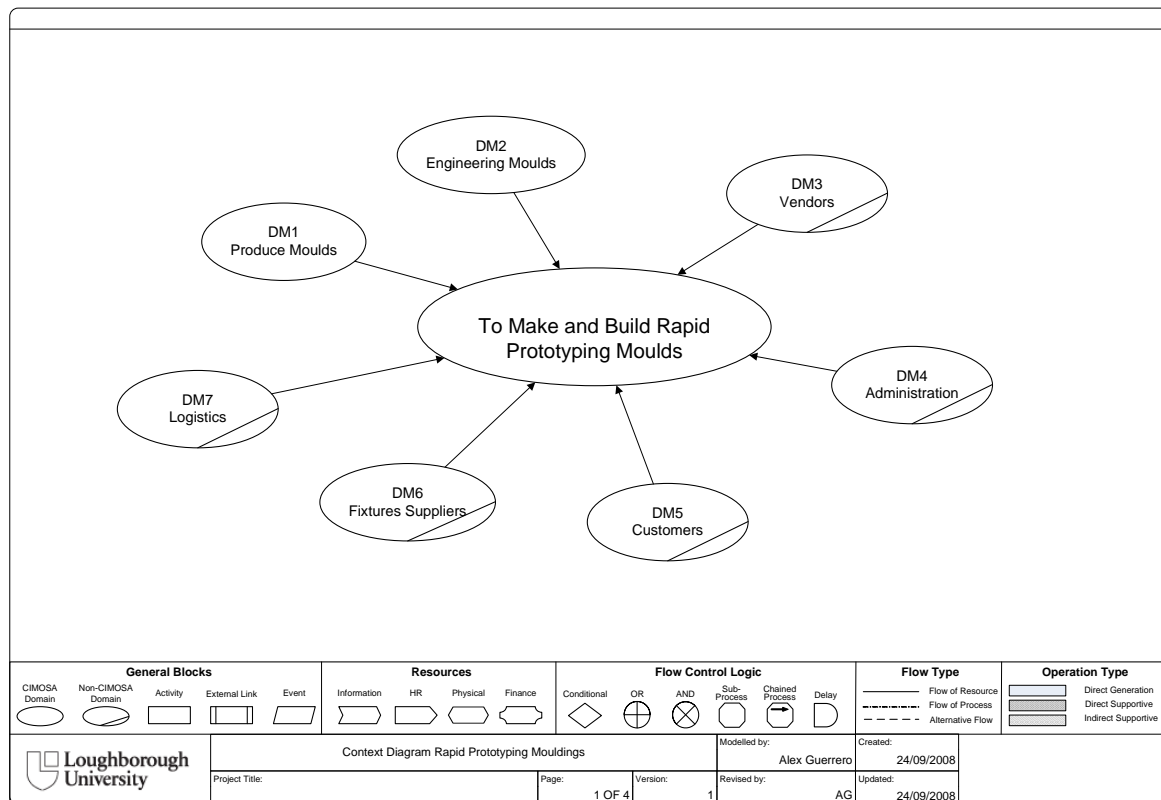


Fig 9.1 Context Diagram for the production system of Surface Generation

Following development of the context diagram for the production system, further decomposition was necessary to gain further understanding of the manufacturing system. Therefore, a ‘DM1 Produce Moulds’ was further modelled to identify relevant business processes which were contained within the domain.

It was considered that to decompose the ‘DP1 Produce Moulds’ a single business process, ‘BP1.1 Produce Mouldings’, would be required. Senior management considered that such decomposition would be sufficient to fully represent Surface Generation current manufacturing system.

Figure 9.2 illustrates the structural diagram that further decomposes BP1.1 Produce Mouldings’. Four main sub-business processes were identified to fully BP1.1.

'BP1.1.1 Prep Beddings' encapsulates the relevant enterprise activities which relate to the preparation of individual pinbeds in which the mould would be created. Enterprise activities contained in this business process are: 'EA1.1.1.1 Build Pinbed', 'EA1.1.1.2 Prepare Pinbed' and 'EA1.1.1.3 Warm Pinbed'.

The second business process identified was 'BP1.1.2 Epoxy Filling'. This business process encompasses to all activities related to pouring an epoxy mixture into the previously prepared pinbed. Enterprise activities contained within such business process are: 'EA1.1.2.1 Verify epoxy levels', 'EA1.1.2.2 Pour epoxy to specifications' and 'EA1.1.2.3 Close lid on pinbed'

The third business process identified was 'BP1.1.3 Curing' which encompasses all activities related to the curing of the epoxy mixture within the prepared pinbed. Pinbed necessitate a so called 'curing' period placed on special curing shelves on which they rest for up to 48 hours to allow the epoxy mixture to harden so that moulds can be utilised. Enterprise activities contained within the present business process are: 'EA1.1.3.1 Transport Pinbed', 'EA1.1.3.2 Load Pinbed', 'EA1.1.3.3 Rest Pinbed' and 'EA1.1.3.4 Unload Pinbed'

The last business process to be identified was 'BP1.1.4 Dismantling'. After individual pinbeds are unloaded from curing shelves, it is necessary to remove the covering carcass so that individual pinbed can be then stored ready for delivery. Enterprise activities contained within the present business process are: 'EA1.1.4.1 Remove Lid', 'EA1.1.4.2 Remove Epoxy model' and 'EA1.1.4.3 Send Pinbed to Buffer'

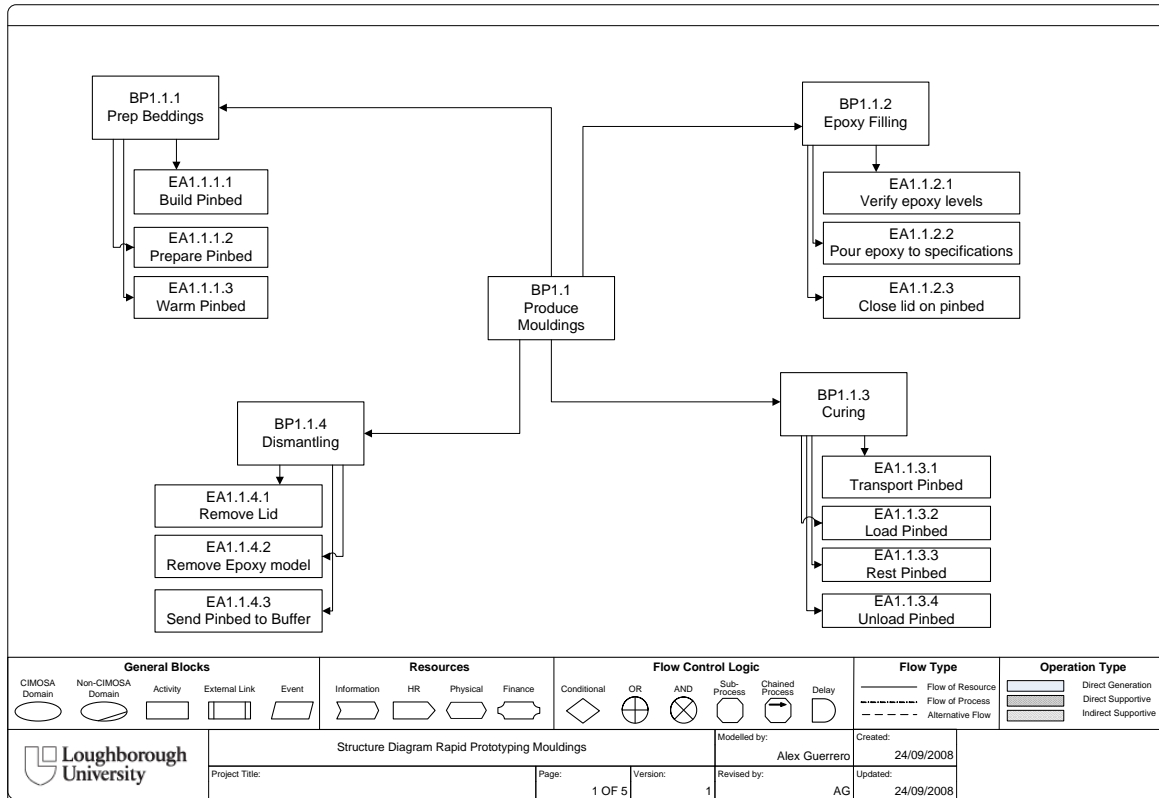


Fig 9.2 Structure Diagram of BP1.1 Produce Mouldings

Further to the structure of the activities present within the current manufacturing system, it was considered that an activity diagram would enable the organisation to better communicate current procedures and interfaces. It was also believed necessary so as to gain additional understanding of relevant processes and actors to identify potential resources which would affect the proposed strategic intent.

Figure 9.3 illustrates the flow of enterprise activities and relevant resources necessitated in the current manufacturing system configuration. Activities follow a sequential pattern for individual pinbeds, however, multiple instantiations of the described system are possible, bearing in mind specific constraints such as delivery times for the epoxy mixture, number of available pinbeds, and spaces in the curing shelves.

The first activity enacted is ‘EA1.1.1.1 Build Pinbed’ in which human type resource ‘worker’ builds the pinbed, a rectangular base in which a particular design of mould will be produced, with the necessary elements to produce the individual mould design. The next activity is ‘EA1.1.1.2 Prep Pinbed’ in which individual pinbed is

readied for warming and pouring stages. If the delivery of the resource 'Epoxy' is ready, the pinbed is loaded into the warming machine and 'EA1.1.1.3 Warm pinbed' activity is commenced. The next activity is 'EA1.1.2.1 Verify Epoxy Levels' in which a worker manually verifies that necessary amount to be poured in the pinbed is present in the delivery from the vendor. When the pinbed reached the necessary temperature for the mixture to be poured, 'EA1.1.2.2 Pour epoxy' is enacted. This activity requires two 'workers' to manage requirements for pouring the epoxy mixture. The following activity is 'EA1.1.2.3 Close Lid on Pinbed'.

Following such activity, 'EA1.1.3.2 Load Pinbed' is enacted as the pinbed is loaded into the curing shelves. 'EA1.1.3.3 Rest Pinbed' is enacted and the pinbed is left for upto 48 hours so that the epoxy mixture hardens sufficiently enough. After this, period, 'EA1.1.3.4 Unload Pinbed' is enacted and a 'worker' takes the pinbed from the curing shelf to the dismantling area. In this area, moulds and pinbeds are prepared to be sent to the finished goods storage and to be reutilised for the next mould, respectively.

The next activity enacted is 'EA1.1.4.1 Remove Lid' in which a worker takes the carcass of the mould, visually inspecting for quality purposes. The following activities are: 'EA1.1.4.2 Remove epoxy model' into the finished goods area, ready to be transported to the customer. Finally, 'EA1.1.4.3 Send Pinbed to Buffer' send the pinbed to the buffer ready for the next design.



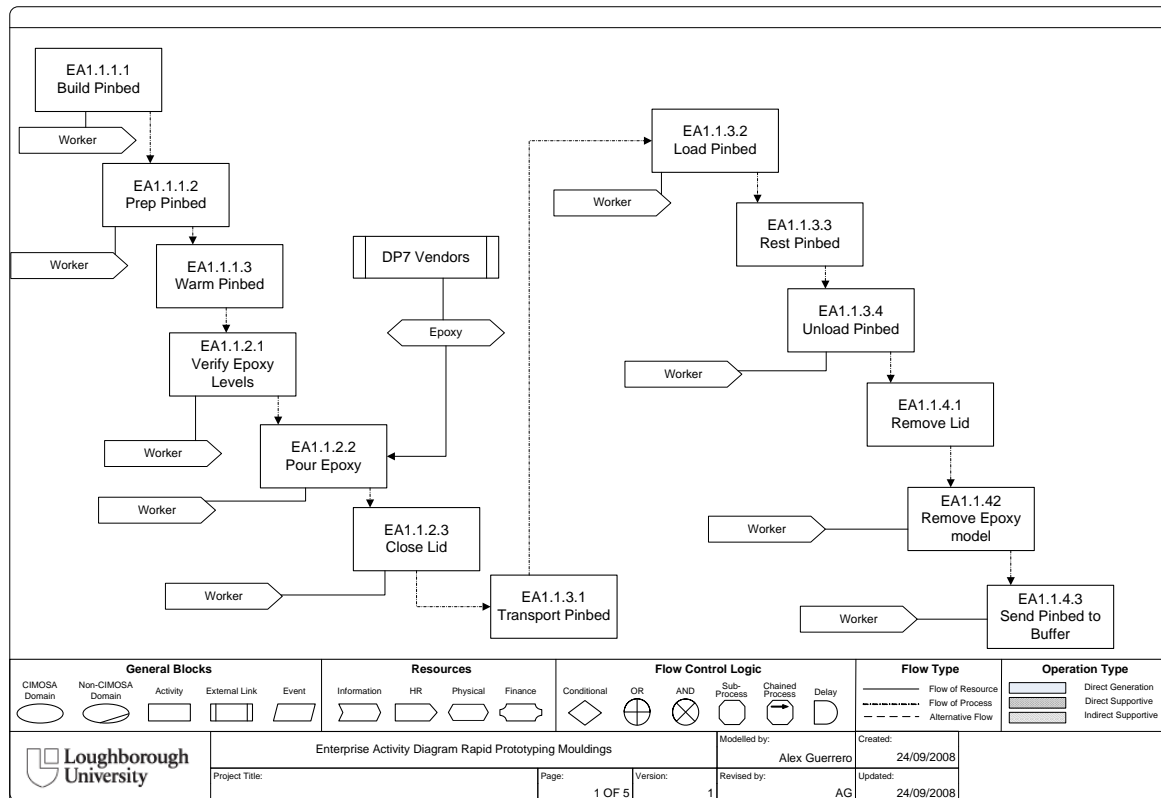


Fig 9.3 Activity diagram of the manufacturing system deployed at Surface Generation.

### 9.5.2 Causal Loop Model of Manufacturing System

A causal loop model was developed of the production system of Surface Generation. The objective was to elicit relevant causal relations in the production system to observe potential balancing and regenerative loops which could potentially be simulated to assess potential behaviours of the variables identified by senior management as key for the successful implementation of the present strategic intent.

A main regenerative loop was identified as R1 that encompassed the main production activities. Variables which compose the present loop are: Pinbeds requested, Pinbeds produced, Pinbeds Delivered and Customer's orders. Pinbeds requested are the number of pinbeds requested to fulfil orders made by 'Customer's orders'. Such orders are forecasted by senior management. Pinbeds produced are the number of produced pinbed regarding manufacturing constraints such as: delivery of epoxy, available space in curing shelves, etc. Pinbeds delivered are

pinbeds ready to be assembled into new customer orders as scheduled by the production control management.

The main balancing loop was identified in B1. Such loop fulfils the moulds requested by the various customers. Variables included in this loop are as follows: Prepare pinbeds, Pour Pinbeds, Cured Pinbeds and Dismantle Pinbeds. Additional variables identified were: Engineering Specifications, Epoxy Delivery, Available Workers and Available Curing Space. The sequential order of activities comprised in the manufacturing system was followed in this loop.

Figure 9.4 illustrates both regenerative loop R1 and balancing loop B1.

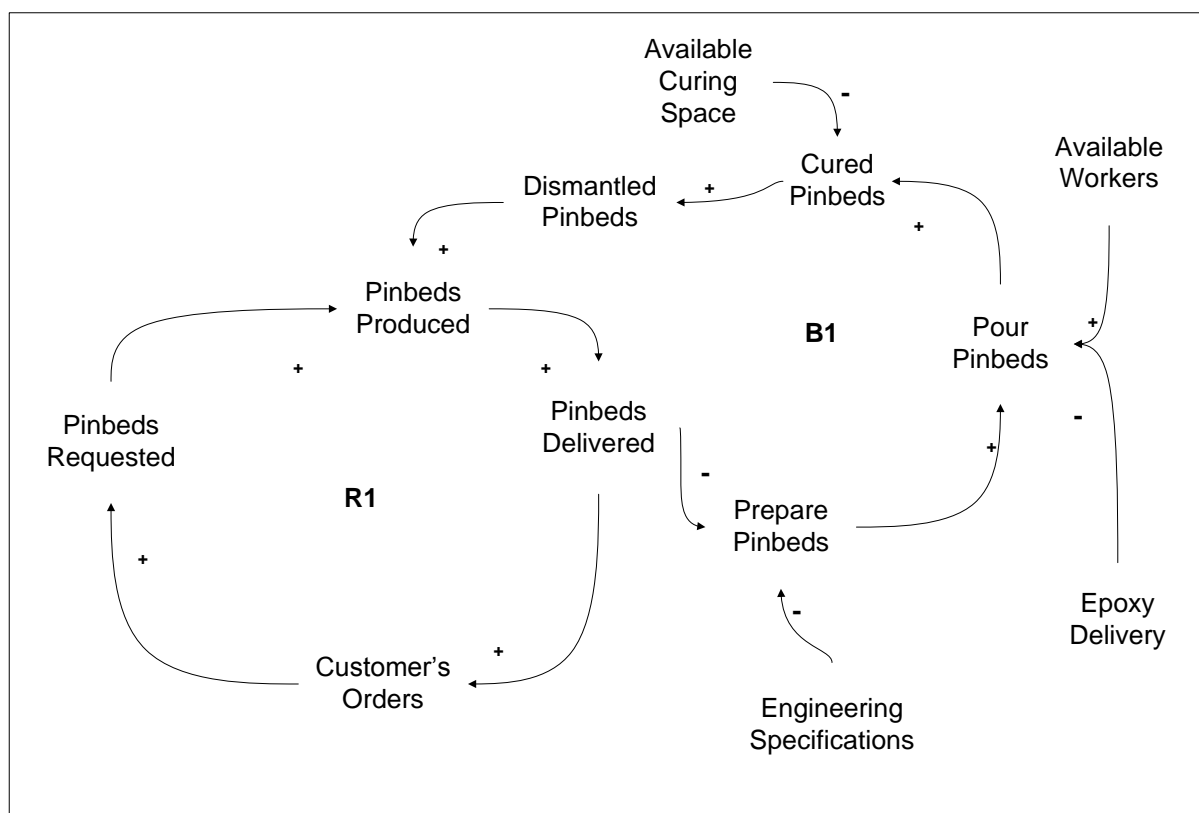


Fig 9.4 Causal loop modelling of the manufacturing system activities at Surface Generation

### 9.5.3 Discrete Event Simulation of Activities In Surface Generation

The proposed methodology had utilised a continuous simulation approach to simulate behaviours of key variables within the strategic intent. It was considered that given the organisation's requirements and constraints a different approach would be necessary to simulate behaviours of the current and potential candidate solutions.

Previously, the researcher had utilised a continuous event simulation tool, namely IThink to model time related variables to observe potential changes in the values of the variables under study. This tool provided simulation capabilities that enhanced the strategy realisation process by providing a quantitative approach that could support decision making in the organisation

Surface Generation’s manufacturing system presented a different set of constraints. The epoxy emulsion necessary for the manufacturing of rapid prototype mouldings was delivered in a discrete event manner. As the production scheduling of the system was focused by such deliveries, it was considered that a discrete event simulation approach would enable the researcher to assess the proposed strategic intent of the organisation. It was also concluded that the inclusion of a different simulation technique would enhance the proposed methodology and would facilitate any reconfiguration decision made by senior management. Additionally, it was considered that the usage of such technique would enable a visual representation of the use of multiple ‘pinbeds’ components within the manufacturing system so as to assess the best configuration possible.

Table 9.1 depicts the current operational times for the necessary operations in the manufacturing system.

| Production Process | Operational Time (in hours) |
|--------------------|-----------------------------|
| Build Pinbed       | 4                           |
| Prep Pinbed        | 3                           |
| Warm Pinbed        | 4                           |
| Pour Epoxy         | 3                           |
| Close Lid          | 2                           |
| Rest               | 24                          |
| Load Rack          | 1                           |
| Cure Shelf         | 47                          |
| Unload Rack        | 1                           |

| Production Process | Operational Time (in hours) |
|--------------------|-----------------------------|
| Rest               | 24                          |
| Dismantle          | 2                           |

Table 9.1 Operational times for the relevant stations as defined by Surface Generation

Table 9.2 depicts new operational times for the operations within the manufacturing system at Surface Generation. Such times were expected and forecasted by senior management, utilising new machines specifications and historical data.

| Production Process | Operational Time (in hours) |
|--------------------|-----------------------------|
| Build Pinbed       | 2                           |
| Prep Pinbed        | 2                           |
| Warm Pinbed        | 2                           |
| Pour Epoxy         | 1                           |
| Close Lid          | 1                           |
| Rest               | 24                          |
| Load Rack          | 1                           |
| Cure Shelf         | 23                          |
| Unload Rack        | 1                           |
| Dismantle          | 1                           |

Table 9.2 New operational times and processes as defined by Surface Generation

### 9.5.3.1 Discrete Event Simulation Models for Surface Generation

Following both static and causal loop models, a discrete event simulation model was conceived to further test the behaviour of the production output the current manufacturing system could produce under current constraints. Activities described in the present model are similar in description name to those from the static and causal loop diagram models, however, individual work stations mirror the relevant portions of the system needed to have a ‘complete’ picture of the system.

In selecting suitable software to simulate the manufacturing system models, several candidates were considered. The researcher possessed experience in multiple

software solutions, however, Tecnomatix Plant Simulation was chosen as the simulation tool to represent and simulate the models created. Reasons for choosing such software application were:

- Experience gathered by the researcher in multiple projects using such Tecnomatix Plant Simulation
- Software enabled the creation of carrier type of production units which replicated behaviour of the pinbed components
- Enabled the use of human resources with multiple capabilities
- Enabled the programming of behaviour of the individual simulation elements in models facilitating greater customisation capabilities

Figure 9.5 details the model created by the researcher within Technomatix Plant Simulation application software.

The entry point for the simulation units is named 'Pinbeds' and creates the available number of pinbed which will be present on the system in the present simulation run. A so called 'moving unit' which will represent the virtual pinbed in the modelling software will be created and will go in all individual stations. Individual pinbeds go to the first operational workstation labelled 'Build Pinbed'. Two human resources called workers will participate for the full operational time while the individual pinbed is processed in this particular workstation. Following such station the individual pinbed will travel to the next workstation labelled 'Prep Pinbed'. After this workstation, 'Warm Pinbed' is enacted so that pinbed will be ready to be poured with the epoxy mixture. The workstation 'Pour epoxy' will merge both pinbed and epoxy mixture into a single unit; however, the pinbed will continue to be a separate entity which at the end of the production cycle will be recovered. The next workstation is 'Close Lid'. The pinbed goes to the 'Rest' workstation in which it will stay for the following 24 hours. This station has no worker attached as the pinbed is left unattended. The following workstation is 'Load Rack' pinbed into the curing shelves. These 'Curing Shelves' are represented by a buffer like entity which operates a FIFO (First In, First Out) policy, where pinbed will rest for a period up to 48 hours. Following this period, the next station will be 'Rest' in which a visual inspection will be performed, and finally the pinbed will be moved to the 'Dismantle' work station in which the mould

and the pinbed will be separated, the mould will go to the finished stock storage and the pinbed will go to a buffer ready to be reutilised for the next man manufacturing design.

It was considered that the present model could provide a schedule of operations based on the assumption that the system was completely empty. A table containing times of execution for all operations, regardless of the particular pinbed, was deemed necessary to observe all activities and potential impacts of delivery times for the epoxy component. The table 'Op Times' records such times. Additionally, shipping times were recorded in an additional table 'Shipping'. This facilitated senior management to arrange suitable transportation for finished products.

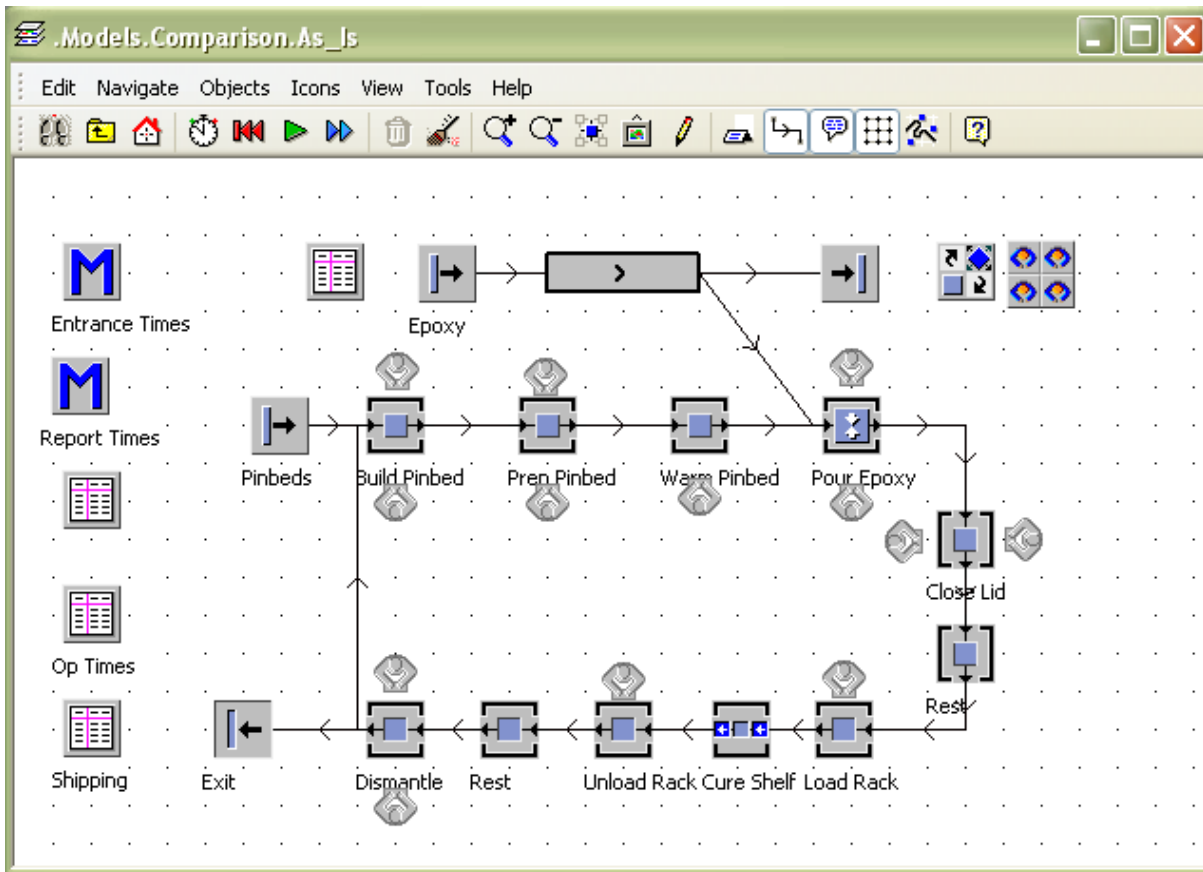


Fig 9.5 Modelling current manufacturing activities at Surface Generation

Figure 9.6 depicts the proposed alternate scenario which takes into account shift working. Currently, there was only one shift between 9 am and 6 pm Monday to Friday, however, senior management decided to explore the possibility of implementing shifts so that additional capacity could enable the organisation to produce additional moulds for customers. A pinbed would not enter the 'Warm

Pinbed’ workstation unless the combined operational times for the ‘Warm Pinbed’, ‘Pour Epoxy’ and ‘Close Lid’ added to the current simulation time would not exceed the shift’s ending time. Additionally, no pinbeds could be transported from the ‘Rest’ workstation to the ‘Cure Shelf’ as this operation necessitates an operator. Therefore, a programme module which implements this constraint was developed.

Flow of activities in the present model flows similar pattern to the one previously described. This enabled senior management to have an understanding of potential consequences of a shift related policy.

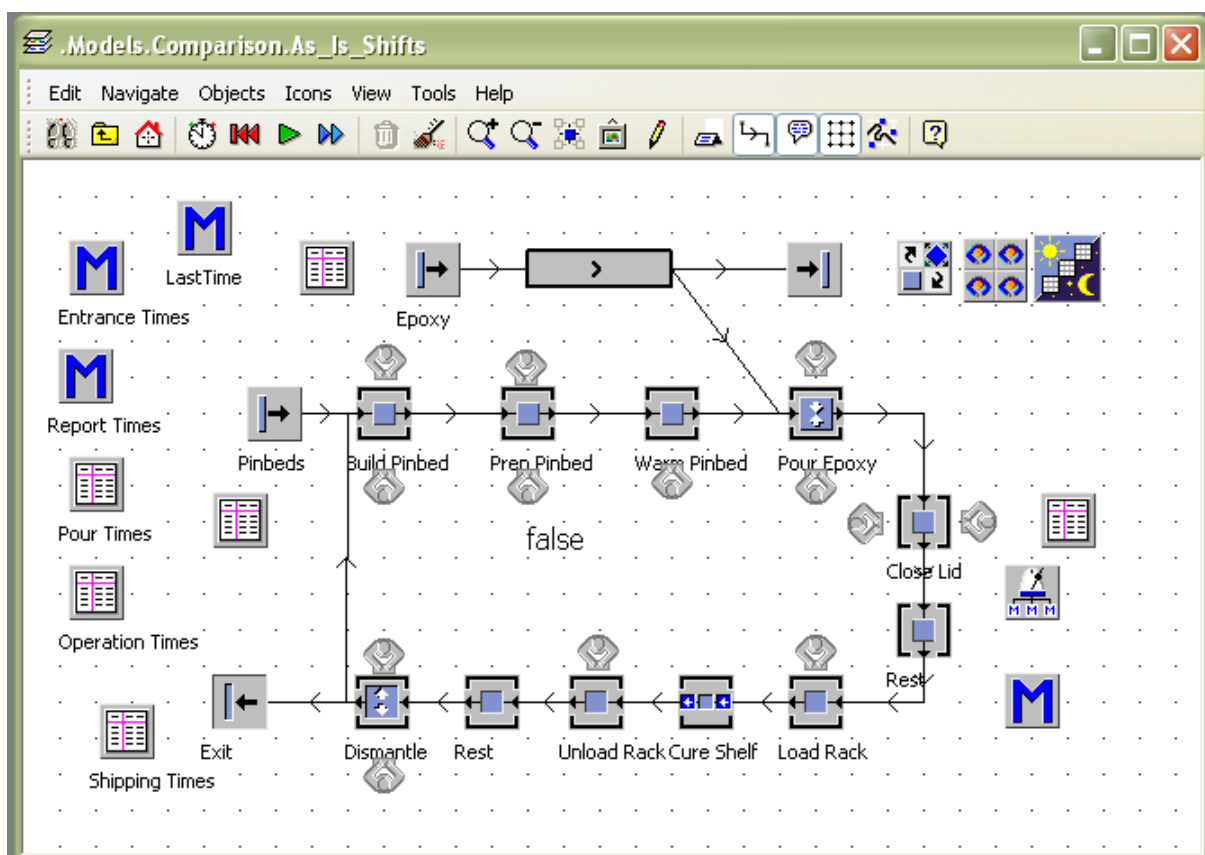


Fig 9.6 Model of a potential candidate solution for the manufacturing system at Surface Generation utilising working shifts.

## 9.6 MODELLING RESULTS AND POTENTIAL IMPACT FOR THE PROPOSED STRATEGIC INTENT

Figure 9.7 depicts a graphical representation of the throughput value for all candidate solutions identified by the researcher and senior management. Senior

management considered that the key variable to plot would be potential throughput per day, as this would enable the selection of the best candidate scenario. The four simulation models, i.e., ‘As Is’, ‘As Is with a shift pattern’, ‘To Be’ and ‘To Be’ with a shift pattern were plotted to observe the behaviour of the production weekly average throughput experienced. From the graph it is clear that the ‘Projected Scenario’ would deliver the maximum benefit for the organisation, however, since such candidate solution did not consider a shift of workers, senior management considered this scenario not to be the best solution and decided to use data from the ‘Projected Scenario with Shifts’ as a realistic scenario to base potential growth and scheduling of operations.

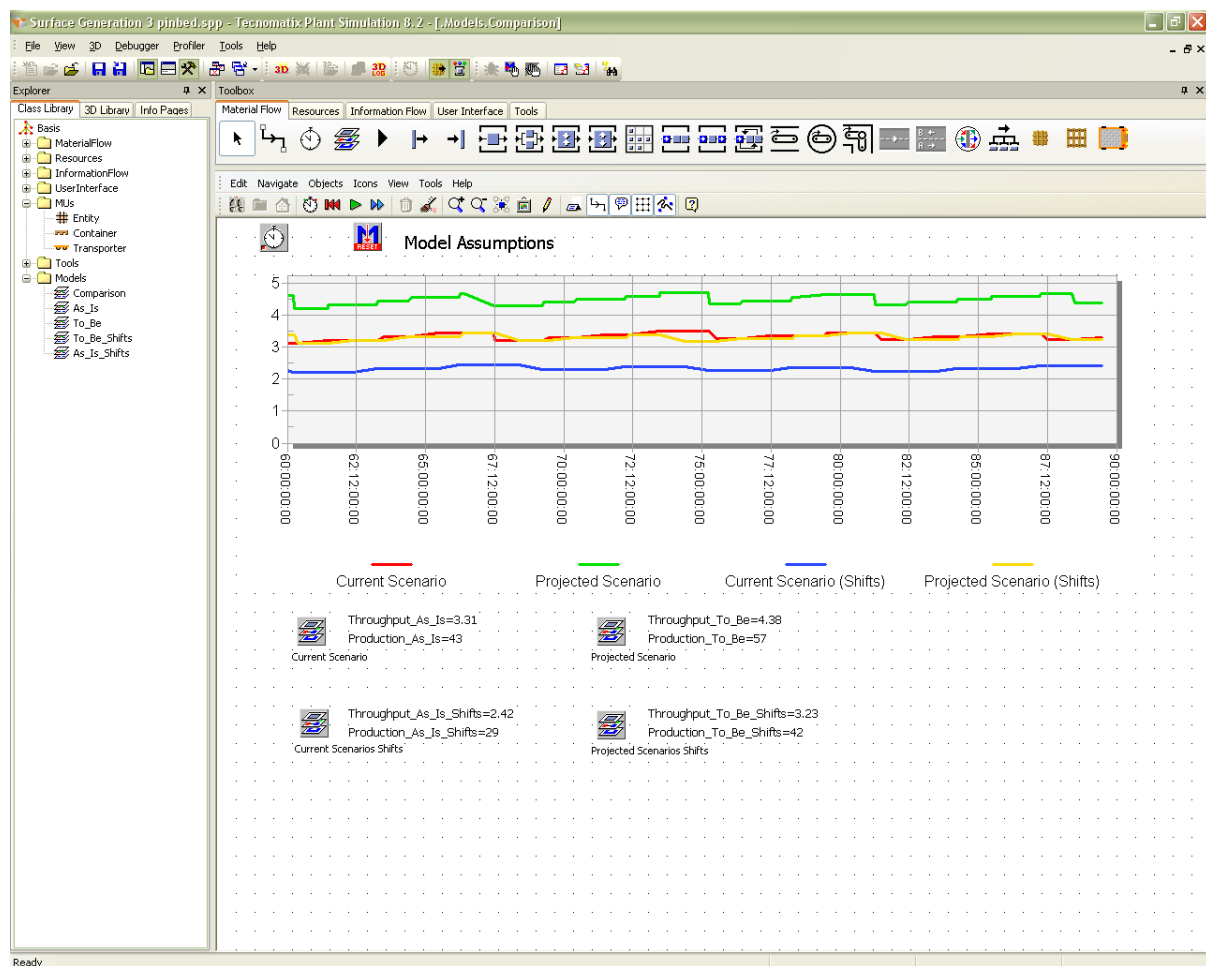


Fig. 9.7 Throughput graph of the potential candidate scenarios considered at Surface Generation

### 9.6.1 Modelling Results for Simulation Models at Surface Generation

Table 9.3 depicts simulation results for the current, or ‘As Is’, and potential, or ‘To Be’ scenarios as envisaged by senior management. As shifts within Surface



Generation were to be introduced, senior management decided to compare a specific number of available pinbeds to the produced units within a period of two consecutive calendar months. Of particular interest to senior management were the average throughput and the pinbeds in left in the system, or work in progress inventory.

It was considered usage of 3 pinbeds for the production of rapid prototyping moulds would result on maximum throughput in the manufacturing system on the 'To Be' scenario. Such configuration recorded a simulation production of 72 units over a period of 13 weeks. Senior management considered such production target to be in line with potential expected demand.

| Model                                   | Pinbeds | Produced units | Throughput per week (avg) | WIP in system |
|---|---------|----------------|---------------------------|---------------|
| As Is (Current Situation)               | 2       | 36             | 2.77                      | 2             |
| As Is (Current Situation) with Shifts   | 2       | 28             | 2.33                      | 2             |
| To Be (Projected Situation)             | 2       | 51             | 3.92                      | 2             |
| To Be (Projected Situation) with Shifts | 2       | 35             | 2.69                      | 1             |
|   |         |                |                           |               |
| As Is (Current Situation)               | 3       | 54             | 4.15                      | 3             |
| As Is (Current Situation) with Shifts   | 3       | 42             | 3.23                      | 3             |
| To Be (Projected Situation)             | 3       | 72             | 5.74                      | 3             |
| To Be (Projected Situation) with Shifts | 3       | 47             | 3.62                      | 3             |
|   |         |                |                           |               |
| As Is (Current Situation)               | 4       | 60             | 4.62                      | 3             |
| As Is (Current Situation) with Shifts   | 4       | 42             | 3.23                      | 3             |
| To Be (Projected Situation)             | 4       | 72             | 5.54                      | 3             |
| To Be (Projected Situation) with Shifts | 4       | 51             | 3.92                      | 3             |
|   |         |                |                           |               |
| As Is (Current Situation)               | 5       | 43             | 3.31                      | 2             |
| As Is (Current Situation) with Shifts   | 5       | 30             | 2.31                      | 2             |
| To Be (Projected Situation)             | 5       | 43             | 3.31                      | 2             |
| To Be (Projected Situation) with Shifts | 5       | 37             | 3.08                      | 2             |

Table 9.3 Results for various modelling instances developed for Surface Generation

## 9.7 METHODOLOGY APPLICATION AT SURFACE GENERATION

As the manufacturing system requirements of Surface Generation were elicited, it became clear that the use of a continuous event simulation software tool would not adequately model the requirements of the production system of Surface Generation. It was considered that overall requirements of the organisation would require a rethink to the simulation method used to document and simulate relevant production processes so that potential candidate solutions could be envisaged. Additionally, it was considered that a continuous simulation approach would not provide the richness of analysis the senior management required to produce relevant candidate solutions. The discrete event nature of the deliveries of a raw material necessary for the production, as well as a multiple configuration requirement of additional resources made it complex to use the tools previously utilised within the present research. It was therefore considered that a change in the modelling paradigm would enable the researcher to fully investigate the proposed methodology within Surface Generation.

After analysing benefits and limitations of multiple modelling techniques, such as operations management, mathematical modelling and discrete event simulation, the researcher considered that the requirements for the present case study would be best met with the utilisation of a discrete event simulation approach. Among the rationale for this decision were:

- Previous knowledge of discrete simulation by the researcher
- Available simulation tools which would enable modelling of the characteristics of the present and potential manufacturing system
- Time efficient analysis of multiple variables and simulation of several scenarios

It was considered that such an approach would enable the organisation to analyse and assess potential interactions between multiple actors within the system. Additionally it enabled the senior manager to compare multiple candidate solutions with the weekly throughput variable.

As most production systems present a discrete event nature, researcher considered this approach to be much more suited for modelling, analysing and simulating processes within a particular manufacturing system. At such level of organisational abstraction a clear separation between system's components and products is necessary as individual components are the subject of a system analysis. Therefore, the researcher has concluded that such approach would be beneficial for the proposed research methodology, to include the usage of discrete event simulation when the system requirements are of a discrete event nature or when grouping of items cannot provide the necessary clarity needed to support the decision making process.

#### *9.7.1 Further methodology application considerations*

Present case studies have highlighted the application of the current methodology within two small to medium enterprises (SMEs). The use of a decompositional approach to understand the enterprise and its requirements and the use of systems thinking and simulation modelling, both continuous and discrete event, were key to gain an understanding of the system's complexities and through the deployment of various models, enable the observation of key interfaces, resources and behaviours of key variables.

From the foregoing discussion, it can be concluded that such an approach could potentially be beneficial for most organisations, not only within a manufacturing environment as it is envisaged that the proposed methodology be deployed within a non-manufacturing domain. The approach utilised by the researcher would indeed enable organisations across multiple industries to better understand potential consequences of implementation of a particular strategic intent within current or potential manufacturing system configurations.

It could be argued that the application of the proposed methodology could be independent of the organisation's complexity or size. Although the present research has focused on two small sized organisations, it can be envisaged that such an approach could be implemented within a larger organisation. The principles of decomposition and simulation would enable the organisation to assess the potential impacts of a proposed intent within multiple levels of organisational decomposition. It

is believed by the researcher that such an approach would be beneficial; however, development and costs would have to be considered for such scenario.

# **CHAPTER 10 RESEARCH CONCLUSIONS AND FURTHER RESEARCH**

## **10.1 INTRODUCTION**

Current research has focused on the components of the strategy realisation process and utilisation of multiple methods and tools to underpin the process networks in relevant sections of the enterprise to assess potential impacts within the process and resources. Objectives were established to delimit the focus and application of current research. Case studies were identified to assess potential strengths and weaknesses of a proposed research methodology.

Previous case studies have demonstrated an application of a coherent set of methods to underpin the organisation and inform the strategy realisation process with respect to the potential behaviour of relevant variables considered to be critical to the successful implementation of the strategic intent.

The present chapter reflects on the application of the proposed methodology within the case studies and asserts potential changes to further underpin strategy realisation in organisations. Research strengths and weaknesses are discussed as well as the objectives set forth. Further research work is identified regarding both the proposed strategy realisation methodology and the modelling aspects used to implement that methodology.

## **10.2 RESEARCH SUMMARISED**

The strategy realisation process has received attention from practitioners and researchers alike. Several attempts at characterisation have been developed, however this researcher considered that most characterisations were fragmented. Integrating ideas and supporting tools and methods have been developed so as to assist the strategists within an organisation to formulate and evaluate current and

potential outcomes of candidate strategic intents. The researcher considered that a suitable utilisation of enterprise modelling, causal loop diagramming and various simulation modelling tools and methods would facilitate assessments of potential impacts of a proposed strategic intent upon candidate configurations of the organisation. Therefore, a scope and focus was identified for the present research. State of the art literature was reviewed to identify current trends in the strategy realisation process and enterprise modelling tools. Objectives were then identified so as to guide the present research. A research methodology, coupled with research methods was then developed to tackle the said objectives. Through the use of ground literature and case studies, a new configuration of a strategic process and an approach to the use of modelling tools and methods was envisaged. It was then considered that the use of case studies would provide a basis to investigate the objectives set in the present research.

Case studies were profiled to test the research objectives. An application of the proposed methodology was implemented within a small manufacturing firm to assess outcomes in respect of differing scenarios: growth and retrenchment. Through a series of interviews, data was collected, modelled and presented to the senior management of the organisation. The proposed research methodology was observed to enable the organisation with respect to documenting and communicating existing characteristics and behaviours of processes and in assessing the suitability of potential candidate solutions to case study problems identified by the researcher in relevant areas of the organisation. A quantitative analysis capability was developed further which was observed to facilitate discussion with senior management about potential impacts of strategic decisions on current production. Change in the organisational environment facilitated access to a different set of constraints which were also simulated and discussed. Positive contributions were made in areas such as manufacturing and logistics.

A further exploratory case was identified in a small organisation. Information was obtained from senior management about the organisation as the proposed reconfiguration intent was devised by senior management and quantitative analysis was required to further assess the viability of a manufacturing strategic intent based on project product demand within the organisation's current production system.

Utilising an alternate simulation modelling methodology, the researcher was able to provide a useful analysis through the application of the proposed methodology

### **10.3 RESEARCH ACHIEVEMENTS**

Following the application of proposed methodology for strategy realisation in previously described cases, the researcher reflected on the extent to which the objectives identified in Chapter 3 were met during this study. Table 11.1 details individual research objectives and consequent achievements. Also tabulated is a commentary on additional insights gained and reasons why certain research aims could not be achieved.

| Research Objective   | Achieved  | Not Achieved  | Additional comments   |
|--|---|---|---|
| To characterise and formally define common elements and steps comprising the strategic realisation process such that the strategic intent of organisations can be created, programmed and implemented in a coherent way. | Strategy realisation process was characterised in terms of three major components, namely: strategic thinking, strategic programming and strategic deployment. Sub-processes within such components were also identified and relevant interfaces were also considered | It is not feasible within a scope of a single PhD research to fully characterise all components of the strategy realisation processes.  | Several organisation configuration and maturity are needed to further validate characterisation developed on the present research.  |
| Characterisation of strategy realisation process in organisations in terms of corresponding steps and processes that are enacted in each sub process   | Characterisation of the strategy realisation process in two small and medium enterprises (SMEs). Overview of similar leadership and strategy realisation processes.   | Some aspects of the strategy realisation could not be observed as it was considered to be confidential to the organisation and the researcher could not gain access to meetings | Elements of the strategic intent are confidential to individual organisations, however case studies provided a generic view of particular applications of the strategy realisation process identified in present research |
| Explicit and formal definition of interfaces that occur between components of the strategy realisation process.  | Definition of major interfaces between identified sub-processes, as well as temporal definition of enactment  | Partial definition of interfaces of a generic strategy realisation process.   | Interfaces identified in Chapter 4 of present thesis.   |
| Reutilisation of the strategic   | Reutilisation of potential  |   | Generalisation of the proposed  |



| Research Objective   | Achieved  | Not Achieved   | Additional comments  |
|--|---|--|--|
| realisation process across the organisation, and possibly between organisations, could be replicated with respect to some mechanistic decision process.  | methodology to replicate two different environmental contexts within an organisation.   |  | strategic intent could be observed across strategic intents within an organisation   |
| Decompose the proposed strategy into a formal description of the corresponding units and their characteristic causal and temporal interrelations.  | Elements of the strategic intent were decomposed within the models created. Causal relations were identified and temporal relations established utilising various simulation methodologies  |  | Formal decomposition was achieved as models of the proposed strategic intent were simulated in current and potential candidate configurations.   |
| To propose and partially test the use of a coherent set of modelling constructs that explicitly and formally define the strategic intent of manufacturing organisations and enables its representation throughout the strategic realisation process. Here the objective will be to explicitly describe reusable enterprise modelling methods models of | Models of the organisation's current process networks were created identifying relevant aspects of the organisation. Causal loop models depicted the rationale behind the strategic intents to be implemented. Simulation models enacted all constraints observed within the organisation | Limited strategic intents were discussed as organisation's top priority was to test potential effects gathered from such | Case studies provided testing of proposed methodology. It was observed that static and causal loop modelling methods would enhance current understanding of process relations within an ME. Simulation methodology varied in selected enterprise; however it provided quantitative analysis in both cases. |

| Research Objective  | Achieved  | Not Achieved | Additional comments   |
|---|---|--------------|---|
| strategic intent and related model of organisation configurations and behaviour, within a specific organisational context           |   |              |   |
| Characterisations of causal and temporal relations between factors identified by the strategic realisation process.                 | Modelling enabled definition of potential causal restrictions and facilitated characterisation of such restrictions within a simulation model.  |              | Causal loop diagrams enabled organisations to fully understand potential relations with relevant factors within a particular strategic intent context                   |
| Simulation of possible outcomes of the proposed intent with respect to the alteration of specific organisation's constraints.       | Individual case studies provided senior management quantitative analysis of behaviour within current and potential manufacturing systems configurations                                   |              | Simulation modelling provided quantitative analysis of various potential candidate scenarios and behaviours of key variables of individual strategic intent objectives. |
| Operationalise the strategic intent by simulating alternative candidate organisation configurations and their resulting behaviours. | Simulation of differing conditions within a particular ME which produced quantitative analysis enabling senior management to consider impacts of proposed strategic intent within current |              |   |

| Research Objective   | Achieved   | Not Achieved | Additional comments   |
|--|--|--------------|---|
|  | configuration of manufacturing system.   |              |   |
| Formalisation of strategic intent so that it can be communicated easily through the organisation | Static models facilitated communication of any potential change in the current process network. Causal loop models were effective in translating the rationale presented by the senior management and communicated across the organisation. Simulation models illustrated potential behaviour under alternative scenarios. |              | Simulation modelling enabled the organisation to observe potential behaviours of the relevant portions of the organisation so as to effectively plan and manage relevant resources in such areas so as to attain objectives stated in the strategic intent. |

Table 10.1 Overall objectives of present research summarised

## 10.4 CONTRIBUTIONS TO KNOWLEDGE

Table 10.1 illustrates the achievements of the present research in relation to the original set of objectives detailed in Chapter 3. This section discusses the contributions to knowledge made.

The guiding hypothesis of the present research was that the use of static and dynamic modelling methods and tools would facilitate the decision process of the strategy realisation process. Case studies research enabled the researcher to provide quantitative and qualitative analysis to senior management within the organisation under study. In Bradgate Furniture, analysis provided enabled the organisation the reconfiguration of some of the key processes of the manufacturing system. It also gave quantitative information about the potential behaviours to key variables set by the senior management. In the Surface Generation case study, it provided senior management with the rationale for accepting new orders and prompted a reconfiguration of the current production system.

The present research has decomposed the strategy realisation process into three main sub processes, namely: strategic thinking, strategic programming and strategic implementation. This decomposition was conceived after a review of the current state of the art literature. Further decomposition was made of each identified sub process, to gain new understanding of the strategy realisation process and of individual sub processes. Interfaces were identified between sub processes so as to indicate relevant flows of information. A non-synchronous approach was argued between processes, as it was considered that although the enactment of the strategic realisation process within an organisation could typically be characterised as sequential, it was considered that both strategic thinking and deployment exhibit a continuous time related instantiation within the organisation. The sub processes identified of the strategy realisation process were identified in multiple levels of a generic decomposition of an organisation, and potential flows of information were documented. A generic map illustrating the strategic realisation process within the organisation was developed to represent various levels of instantiation it has within an organisation.

Various enterprise and simulation modelling tools and methods were discussed and a selection within such an array was elicited so that a methodology that would enable the organisation to successfully document, communicate and simulate a proposed strategic intent. The main hypothesis of the present research is that the usage of enterprise modelling tools and methods enhances the decision support of the strategy realisation process within an enterprise. Therefore, the research focused on delivering a methodology which would enable the decision making process of the organisation regarding potential candidate solutions proposed and analyse potential behaviours of variables considered to be critical to the successful implementation of the proposed strategic intent. Various tools and methods were selected for the relevant aspects of the strategy realisation process to accomplish such goals. Relevant links and potential information flows were identified so that information derived from the models created would facilitate discussion within relevant actors within the organisation.

To test the proposed methodology, case studies were defined within two small to medium enterprises within the manufacturing sector. Such enterprises were selected as currently most of the literature on strategy realisation has been developed with large organisations, so it was considered that deploying the proposed methodology within such organisations would increase the contribution to knowledge from the present research. Additional benefits envisaged were an open access to the organisation's strategy realisation process instances and decision making processes. It was argued that such organisations would be willing to facilitate the researcher model the relevant portion of the enterprise and present results for discussion within senior management. Various models were created of the organisations, which were utilised to further develop the case for the proposed strategic intent. Multiple views of the organisation were thus collected and analysed and discussed with senior management that would enable the deployment of the proposed strategic intent. Modelling efforts were directed towards understanding the manufacturing enterprise's production and supply chain systems so that relevant simulation models would enable discussion of potential effects of proposed strategic intent.

The present research has developed a coherent view of a generic strategy realisation process in an organisation, identified relevant components for such a

process and described the interfaces within such components. It has provided a prescriptive modelling methodology that facilitates documenting, discussion and simulation of the productive processes of the organisation so that potential candidate strategic intents regarding such systems can be assessed and quantified. It has provided an insight into the strategy realisation process within SME's, typically overlooked by literature.

#### 10.4.1 Strategy Realisation Cube

Following overall application of this researcher's methodology, a potential conceptualisation of the strategic process and the methodology developed in the present research was conceived. Given the strategy realisation process and potential application of the methodology at multiple levels of granularity, it was considered that such a representation would facilitate an identification of potential candidate approaches to individual candidate organisations. Figure 10.1 depicts the proposed conceptualisation into a so called 'strategy realisation cube' which conceptualises 'architectural' aspects of the researchers proposed strategy realisation methodology.

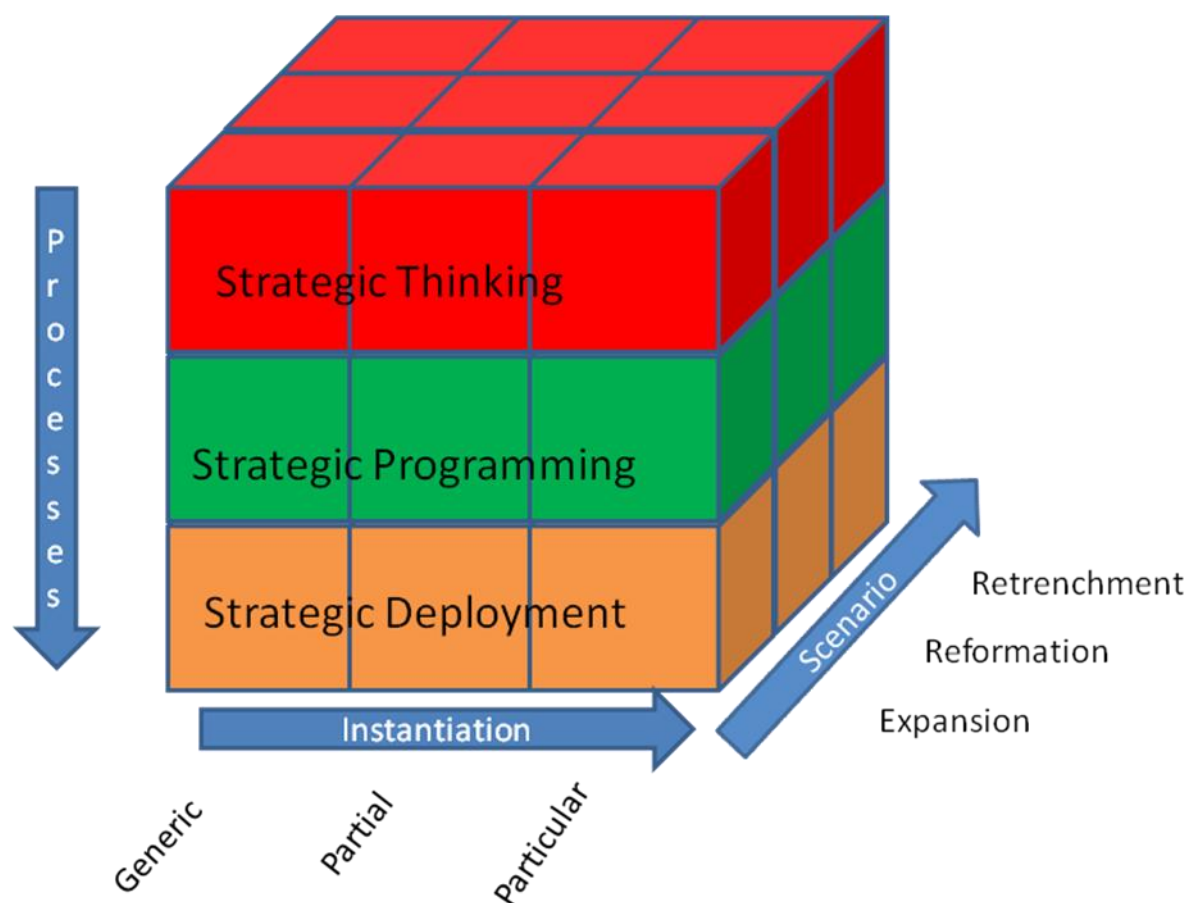


Figure 10.1 Strategy Realisation Cube

*10.4.1.1 Process axis*

The 'Process' axis describes the identified sub-processes of the strategy realisation process as defined in the present research.

*10.4.1.2 Instantiation axis*

The 'Instantiation' axis defines the three main approaches of methodology implementation. A 'Generic' instance of application would only consider the process definition of potential strategic intent within an organisation, relevant information would be identified. A generic model of the organisation would render assistance to major actors and interfaces within the enterprise network; however at this level of abstraction no simulation models would be created. Such a level of model development and use would produce various candidate models of the organisation which could be a 'baseline' for further decomposition or would inform relevant stakeholders of a proposed impact within the organisation. A 'Partial' application would consider the strategic realisation sub-process interfaces and a mixed level of abstraction/granularity modelling would potentially be developed. Such levels of application would render assistance to various potential candidate configurations for an enterprise. Causal loops would be identified and some simulation modelling would be conceived. A 'Particular' approach would define necessary elements within the organisation to assess possible outcomes of an individual strategic intent within the organisation. A specific choice within the simulation technique relevant to particular set of constraints is enacted. Such level of instantiation would further detail models created and use a particular set of tools and methods to simulate behaviours of key variables take the form of detailed modelling of those organisational entities with behaviours particularly relevant to the assessment of a particular strategic intent within an organisation's manufacturing systems.

*10.4.3 Scenario axis*

The scenario axis details the potential scenarios into which potential strategic intents may be categorised. Such a classification is based on the overall objective defined by a particular strategic intent. The present classification is by no means claimed to be complete; however, identified classes along this axis present an array of strategic intents to which a given manufacturing enterprise may aspire or encounter when

enacting the strategy realisation process. It should be noted that an organisation may enact more than one of such classes and potentially there could be overlaps, i.e., an expansion context necessitating additional reconfiguration of current enterprise manufacturing systems. The 'Expansion' context refers to those strategic intents focused on an expansion of a portion of the enterprise, e.g., an increase in the current market percentage. Such strategic intents focus on organisational growth. A 'Retrenchment' context refers to those strategic intents in which the organisation needs to decrease current levels of activity within the whole or a portion of the organisation as external factors require, i.e., falling demand for products, increased legislation, etc.. A 'Reformation' scenario refers to a redesign of current activities due to external or internal stimuli. Changing political, economical, technological, supply chain, etc variables may require a reconfiguration of the organisational process network. Requirements and constraints set by such events would necessitate alternate candidate solutions which would enable the organisation to effectively deploy current and potential resources to attain maximum profit from changing circumstances. Strategic intents typically would focus on organisational change management after events such as mergers, structural changes within the organisation's operation environment, etc.

The present cube could potentially inform strategy makers of potential approaches to enact the strategy realisation process within various types of organisations. Decomposition of the strategy realisation process would facilitate strategy makers; identify relevant interfaces and stages of creation a particular intent within the organisation. It is envisioned that such an approach would encourage discussion on thinking potential candidate intents and assessing deployment of the strategic intent within the intended horizon. Mixed levels of instantiation would facilitate discussion within multiple strategy makers, i.e., senior levels of management within the organisation would typically undertake a generic view of the organisation and strategy realisation process, operative management would potentially be interested in a partial view of the strategy realisation process and business analysts would favour a particular approach in utilising an array of simulation and modelling tools and methods that better characterise the organisation and the effects on key variables of a proposed strategic intent. Differing scenarios would potentially offer



alternate candidate solutions to all levels of strategy makers by posing a mixture of 'alternate realities' with multiple requirements and constraints.

### **10.5 CRITICISM OF RESEARCH**

The present research has adopted a modelling approach to formally document and facilitate assessment of impacts on current or candidate organisation configurations by proposed strategic intents. Modelling tools were found to offer a beneficial vehicle to articulate the organisation's process network. However, some weaknesses were found in the present approach:

Aspects of the strategy realisation process could not be modelled as modelling methodologies selected could not fully capture all environmental variables in which such strategic intents were to be deployed. It was considered that given that modelling methods produce an abstraction of the reality, no methodology could potentially capture all aspects and indeed configurations which organisations present.

Variations of potential strategic intents and processes within the organisation could not be modelled for time and resource constraints.

Multiple factors reviewed in the literature which influence the strategy realisation process could not be assessed such as: organisation's lifecycle configuration, strategic team performance and leadership style.

Elements of the strategy realisation process are confidential to individual organisations. Particularly within the strategic thinking process, encoding and filtering processes are kept within relevant stakeholders. Therefore a generalisation had to be conceived and utilised as a guiding principle within individual case studies.

Improved interfaces between static, causal and simulation models are needed to effectively communicate information elicited and represented in such models. Formal integration within the components of the methodology would benefit both practitioners and academics.

Case studies reflected all the envisioned scenarios of the strategy cube. Bradgate Furniture adopted both a 'Growth' and 'Retrenchment' scenario application. Although most of the development was to produce a set of models which would enable the

strategic thinking of the organisation, such models could serve as a basis for further deployment within the organisation.

Surface Generation adopted a 'Reconfiguration' scenario. Models created enabled the organisation in the strategic deployment phase as senior management had already implemented the two other subprocesses of the strategy realisation process.

Present research is focused on small to medium enterprises (SMEs), further research is needed to validate the present methodology in larger businesses of various forms.

## **10.6 FURTHER WORK**

The strategy realisation process identified in the present research is by no means complete. Further sub processes, interfaces and interactions between components need to be further explored. It is considered that factors such as: personal leadership style, level of organisational maturity, organisation's size, industry's average lifespan, etc. will significantly affect components and/or interfaces of the strategy realisation process.

Use of partial views of the proposed strategy realisation cube will benefit multiple level of users within the organisation, additionally it is envisioned that further population of the proposed cube would provide a more robust view of strategy realisation within an organisation.

Further views of the strategy realisation cube, i.e., additional 'sub-cubes' in the 'scenario' axis would enhance present decomposition and would provide further insights into the strategy realisation within an enterprise.

Additional work within multiple types of organisations across industries would provide data to further populate present cube and would enhance proposed methodology.

Foreseeable changes within global economies can potentially increase pressure on organisations to effectively reconfigure its resources and process networks to cope with new requirements from all actors within the organisation's supply chain. It is expected that strategists will need to perform analyses on an ongoing basis; as apparently the environment in which modern MEs operate is likely to continue to change with increased frequency and uncertainty, therefore introducing greater complexity during strategy realisation. It is envisioned that utilising the proposed

methodology, new (and re-usable) understandings could be gathered from deployment of said methodology as well as gaining new understandings of potentially elements which can be formalised within the strategy realisation process. Wider industrial applications of the proposed methodology would enable greater understanding of the strategy realisation process and further identify how modelling can benefit the strategic realisation process.

As any organisation evolves through its lifecycle, further research could potentially underpin new understandings about the components that the organisation deploys and any additional sub-processes that it is relevant for the implementation of the strategic intent. This would enable academics to further categorise the strategic realisation processes as well as it would enable new understandings amongst practitioners when analysing a particular organisation. .

It is envisaged that the cube proposed in the present chapter can be further expanded. Additional generic scenarios can be identified and typified so that an organisation can use the present decomposition of the strategy realisation process and the relevant level of instantiation to generate the appropriate models to gain additional understanding of the potential behaviours of the relevant process network.

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# APPENDIX A i-THINK SIMULATION SOFTWARE APPLICATION

After developing a causal loop diagram, it was considered that simulation of current variables utilising the iThink modelling (continuous simulation modelling) tool would benefit the discussion; as in principle this tool could be used to quantify potential impacts of an increase in Stockists orders on other key variables such as Revenue generation, Backlogs and Lead times within the organisation. Anecdotal evidence gathered by organisation has reported an increase in the expected lead time, which the organisation considered to be one of their main strategic differentiators as their delivery time was observed to be below the industry standards. As the increase in lead time experienced by the stockist became constant, senior management considered that this could be detrimental to the brand image.

The development of a CLM, and an associated SM it was presumed could further test assumptions and effects on the overall production structure. Here it was expected that graphs representing current and possible future product demand scenarios could be used to inform the strategic thinking involved.

Hence a need for dynamic, i.e., time dependent models was observed that could illustrate current and potential resource utilisation, system behaviours within several candidate scenarios the organisation; forecasted in relation to potential demand for products. Such models would need to be tested within a computer executable tool so as to be able to provide quantitative analysis of the specific performance variables. Such an approach would facilitate prediction of potential behaviours of current and potential candidate configurations identified by the organisation that would enable to implement the guidelines set in the strategy realisation process. Therefore, it was envisioned that a suitable computer executable simulation tool would prove useful in exercising aspects of strategic decisions, prior to any risky and costly investment; but this idea needed to be case tested

*.iThink Software Application*

iThink® is a product of ISEE Systems (formerly High Performance Systems, <http://www.iseesystems.com>) that facilitates creation and visualisation of computer executable models. The modelling technique is based on the solution of an interdependent set of non-linear differential equations; where the solution is achieved via use of a numerical integration method. The iThink tool provides a graphical programming interface where it allows the modeller to create the differential equations and their parameters, values using so-called 'stock', 'flow', 'converters' and 'connectors' modelling constructs. Such an environment benefits from the utilisation of differential equations that enable the analysis of time-dependent variables. Several authors, such as Forrester [F1991], Fowler [F2003], and Senge [S1990] have utilised such a tool to enact the causal relations found in decision-making scenarios. Therefore, the author decided to utilise this tool to simulate causal relations found in the strategic intent in the case study previously described. Additionally, the following reasons were found to provide a stronger case for the adoption of the software tool, namely;

- It was available for the researcher within the MSI Research Institute
- Other researchers had successfully utilised the tool to capture causal relations (Ajaefobi [A2003], Chatha [C2003], Byers [B2003])
- There was a wealth of knowledge the author could rely on to utilise the tool
- Provides support to systems thinking (Senge [S1990], [Fowler F2003])
- Model equations are automatically generated and made accessible beneath the model layer

#### *iThink® Modelling Environment*

iThink® is a multiple window-layered computer executable software tool that facilitates modelling of continuous event models. Figure A.1 illustrates a generic model within the iThink® modelling environment.



Several windows can be accessed to view different aspects of a model

**Map Window** – objects of iThink® are named and connected in this interfaces. Additional information can be stored in a particular object.

**Model Window** – mathematical variables are set. If an element has no set value or formula from which a value can be defined, it will prompt the user by setting a question mark (?) over the object.

**Equation Window** – the underlying mathematical functions are displayed. These equations are generally created by the software application itself, although the user can create complex decision logic for the model.

Several graphical modelling constructs are provided to develop simulation models. These include stocks, flows, connectors, converters and graphs

Stocks represent variables that observe an increase or decrease of value over a period of time. Stocks increase their value with input flows and decrease it by output flows. Stocks can also be utilised to represent

- Oven – it will fill up to a user defined capacity, and then will wait a user specified time and will then release the contents to an output flow.
- Queue – set of items ready to be processed, they operate a first in, first out (FIFO) policy.
- Conveyor - a user defined capacity is processed for a user defined processing time and later released to an output flow.

Flows increase or decrease the value of stocks, ovens, conveyors and queues. Their value can be determined by a user defined constant or by mathematical equation utilising one or more convertors or a time dependent graph. Flows can further be classified into two categories, namely 'uniflows', i.e., cannot accept negative values and 'biflows', can accept negative values.

Connectors enable variables to be related within a mathematical function. Connectors only transmit the value of the originating variable to receiving variable, typically to flows.



Converters are variables that affect flow rates. They can be constant, determined by a mathematical formula or determined by a time dependent graph.

Graphs present graphical representation of multiple user defined variables within a model.

# APPENDIX B TECNOMATIX PLANT SIMULATION

New requirements posed by Surface Generation necessitated a new simulation approach that would enable the study of the key variables for the strategic intent. It was concluded that given the discrete event nature of the manufacturing system, utilising a discrete event simulation software application would benefit the study of such variables and would enable the proposed methodology to be carried out in a different set of manufacturing environment.

Hence a need for dynamic, i.e., time dependent models was observed that could illustrate current and potential resource utilisation, system behaviours within several candidate scenarios the organisation; forecasted in relation to potential demand for products. Such models would need to be tested within a computer executable tool so as to be able to provide quantitative analysis of the specific performance variables. Such an approach would facilitate prediction of potential behaviours of current and potential candidate configurations identified by the organisation that would enable to implement the guidelines set in the strategy realisation process. Therefore, it was envisioned that a suitable computer executable simulation tool would prove useful in exercising aspects of strategic decisions, prior to any risky and costly investment; but this idea needed to be case tested.

Plant Simulation was chosen as a discrete event simulation software application as it enabled modelling the manufacturing system's requirements of Surface Generation. It facilitated graphical representation of the production system's complexities and enabled senior management to observe any potential changes in behaviour of the various key elements of the system.

## *Working in the Program Window*

Tecnomatix Plant Simulation is an MDI (multiple-document interface) application. It runs the Frame window, the dialogs of the objects and the windows of the

3D Viewer, as child windows within the common parent window for Tecnomatix applications, called TUNE (Tecnomatix Unified NT Environment).

Figure B.1 illustrates the graphical elements of the TUNE application windows

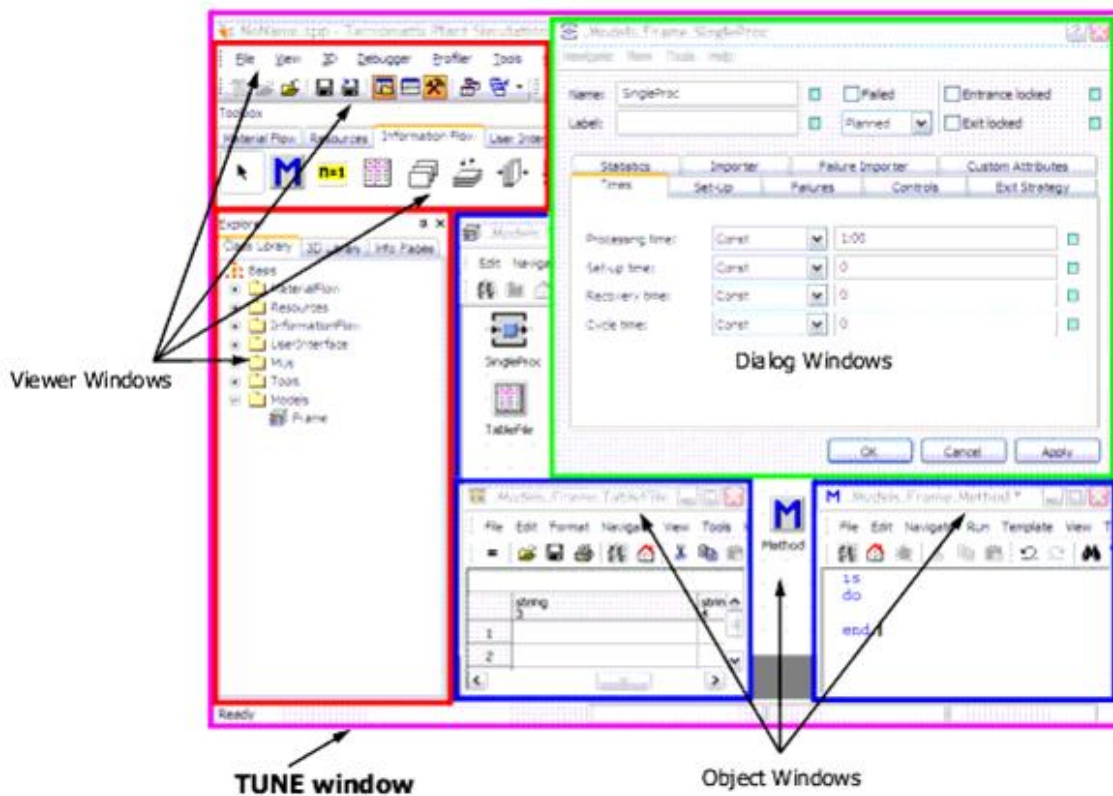


Fig. B.1 Plant Simulation TUNE application windows

TUNE provides three different kinds of windows:

### *Viewer windows*

Viewer windows always open in the foreground, on top of any other windows. Viewer windows can be undocked by drag it out of the TUNE window, move it as a floating window within the TUNE window, and dock it to any of the sides of the TUNE window, instead of closing and reopening the Explorer, the Toolbox, and the Console. When any other such window is clicked, the system hides such window until the mouse is positioned over the name of the window again.

### *Dialog windows*

*Dialog windows* always open in the foreground as they expect input from the user and cannot be minimised or maximised. However, it can be dragged outside of the TUNE window and or be moved around on the entire screen.

### *Viewer Windows*

*Viewer windows* have a red border in the online version of the picture below. *Viewer windows* always open in the foreground, on top of any other windows, i.e., they also are on top of any open dialog windows.

### *Dialog Windows*

*Plant Simulation dialog windows* are the *dialog windows* of the *Plant Simulation material flow objects*, the *mobile objects*, the *resource objects*, the *information flow objects*, and the *user interface objects*.

A *dialog window* always opens in the front as it expects that you select or enter something. You cannot minimize or maximize it.

You can drag a *dialog window* outside of the TUNE window and move it around on the entire screen.

### *Object Windows*

*Object windows* always open in the back. *Object windows* have a blue border in the online version. Figure B.2 illustrates such object windows.

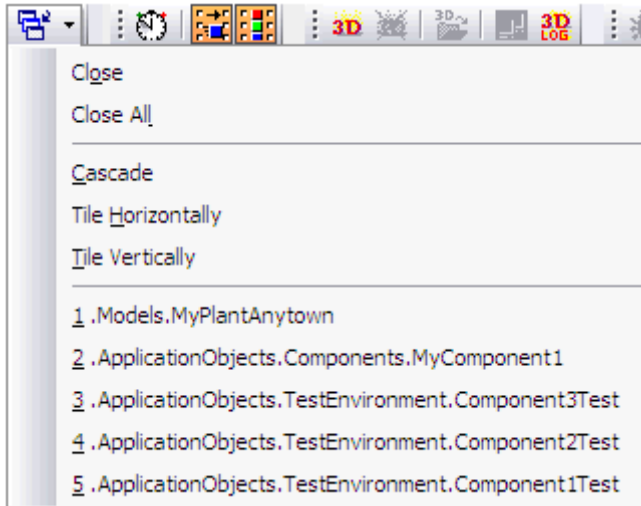


Figure B.2 Window Menu for Plant Simulation

### *Modelling components of Plant Simulation*

Several components of Plant Simulation are used to create models that facilitate the representation of aspects of a discrete event system.

#### *Source*

The *Source* produces MUs in a single station. It has a capacity of one and no processing time. It produces different types of MUs one after the other or in a mixed sequence.

Various types of units can be produced by configuring parameters such as generation times as well as a procedure to determine the types of MUs to be produced. As an active material flow object, the *Source* attempts to move the MUs it produced to objects it is connected to. You also define how the *Source* is to proceed when it cannot move an MU to its succeeding object, by selecting or clearing Operating mode.

*Source* is utilised to create parts and workpieces that move through the relevant components within a particular model.

Figure B.3 illustrates the graphical representation of a Source element within any given model created.



Fig. B.3 A source element

### *Single Proc*

The SingleProc has a single station for processing an MU. The SingleProc receives an MU from its predecessor, processes it and passes it on to the successor.

If the types of MU are not the same, i.e., if they do not have the same name, the SingleProc has to set up to process this new type of MU. While an MU is located on the SingleProc, it does not receive any additional MU. An MU may only enter, when the SingleProc is available, i.e., when no other MU is located on it. Plant Simulation always moves the MU as a whole not continually, i.e., as soon as its front is located on the SingleProc, the entire MU is located on it.

Figure B.4 illustrates the graphical representation of a SingleProc element within any given model created.

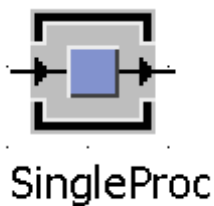


Fig. B.4 A Singleproc element

### *Drain*

The *Drain* has a single processing station. It destroys the MU after processing it. The built-in properties of the Drain are the same as those of the SingleProc. The only

difference is that the Drain destroys the processed MU instead of moving it on to a succeeding object. This element is utilised to remove the processed parts and workpieces from the factory, i.e., modelling the shipping department or completion of the relevant process.

Figure B.5 illustrates a graphical representation of the object 'Drain'.



Fig. B.5 A Drain element

### *TableFile*

The TableFile is a list with two or more columns. Individual cells can be accessed by employing their index, i.e. by their position designated by the number of the row and the number of the column. Values are entered and references to the cells and remove them again. As opposed to the CardFile, the contents of the cells remain in the TableFile, the TableFile can also have blank cells in a range. Cells and rows can be added as needed during the simulation run of the model.

Figure B.6 illustrates the graphical representation of a Tablefile element within any given model created.

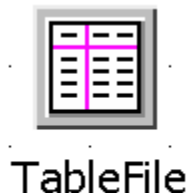


Fig. B. 6 A TableFile element

### *Method*

A method is an object that enables the programming of elements of the model utilising the proprietary language SimTalk. Behaviours of elements such as: creating alternate production routes, altering production times, setting variables, etc. Such methods can be invoked by SingleProc or by the software application during the initialisation or resetting of the models variables.

Figure B.7 illustrates the graphical representation of a Method element within any given model created.



Method

Fig. B.7 A Method element