AN ENGINEERING APPROACH TO BUSINESS TRANSFORMATION

by

CORNELIS MELLET MOLL

A thesis submitted in partial fulfilment of the requirements for the degree of

PHILOSOPHIAE DOCTOR (ENGINEERING)

in the

FACULTY OF ENGINEERING

UNIVERSITY OF PRETORIA

November 1998

"If a man hasn't discovered something that he would die for, he isn't fit to live."

Martin Luther King

THESIS SUMMARY

AN ENGINEERING APPROACH TO BUSINESS TRANSFORMATION

- CORNELIS MELLET MOLL

SUPERVISOR: Prof. PS Kruger

DEPARTMENT: Department of Industrial and Systems Engineering, Faculty of Engineering, University of Pretoria.

DEGREE: Philosophiae Doctor (Engineering)

Organisations are subject to change in their environments. In response to these changes, they have the option of transformation – a process of realignment in order to adapt to their circumstances. There are various approaches in management theory and in the consulting industry whereby organisations can realign themselves. These approaches vary from behavioural approaches, management approaches, information technology approaches and financial approaches. Generally they tend to focus on only some of the components of business transformation and neglect those that are outside the boundaries of the particular subject area of the approach.

Industrial Engineering is a cross-functional discipline that focuses on the improvement of business systems. The author believes that Industrial Engineering provides the right theoretical home for these approaches, and has the ability to integrate the various methods because of its cross-functional perspective. Also, the foundations of many of the current approaches are without substance. It is in these areas where the author believes Industrial Engineering can provide a vast contribution.

This thesis uses a generic engineering approach in order to define an integrated and comprehensive framework for business transformation. In doing so, the Industrial Engineering discipline is expanded. This framework is known as Business Engineering.

The approach that is presented is based on a phased process consisting of the following elements:

- A business analysis phase.
- A business design phase.
- A business transformation phase.
- A business operation phase.

These phases are executed through the application of the fundamental engineering skills of innovation, systems thinking and the application of the sciences.

SAMEVATTING VAN PROEFSKRIF

'n INGENIEURSBENADERING TOT BESIGHEIDSTRANSFORMASIE

- CORNELIS MELLET MOLL

PROMOTOR: Prof. PS Kruger

DEPARTEMENT: Departement Bedryfs- en Sisteemingenieurswese, Fakulteit Ingenieurswese, Universiteit van Pretoria.

GRAAD: Philosophiae Doctor (Ingenieurswese)

Organisasies word beïnvloed deur verandering in hul omgewings. As 'n reaksie hierop kan organisasies getransformeer word – 'n proses van herbelyning ten einde die organisasie in staat te stel om aan te pas by hierdie veranderings. Daar bestaan verskeie benaderings in die bestuursteorie en die konsultasie-industrie waardeur organisasies hulself kan herbelyn. Hierdie benaderings wissel van gedragswetenskaplike benaderings, bestuurswetenskaplike benaderings, benaderings wat baseer is op die implementering van inligtingtegnologie en finansiële benaderings. Dit fokus egter in die algemeen slegs op sommige van die komponente van besigheidstransformasie en ignoreer die komponente wat buite die grense van die spesifieke vakgebied is.

Bedryfsingenieurswese is 'n kruisfunksionele dissipline wat fokus op die verbetering van besigheidstelsels. Die outeur glo dat Bedryfsingenieurswese die regte teoretiese tuiste bied vir besigheidstransformasiemetodieke. Bedryfsingenieurswese het, vanweë die kruisfunksionele benadering, die vermoë om die verskillende metodieke te integreer. Die teoretiese grondslag van verskeie van die bestaande benaderings is nie altyd suiwer nie en

die outeur is van mening dat Bedryfsingenieurswese grootliks kan bydra tot 'n suiwerder teoretiese grondslag.

'n Generiese ingenieursbenadering word gevolg om 'n omvattende en geïntegreerde raamwerk vir besigheidstransformasie saam te stel en die grense van bedryfsingenieurswese hierdeur uit te brei. Hierdie raamwerk staan bekend as Besigheidsingenieurswese.

Die benadering wat gevolg word is baseer op 'n die fases van 'n proses wat uit die volgende elemente bestaan:

- 'n Besigheidsanalisefase.
- 'n Besigheidsontwerpfase.
- 'n Besigheidstransformasiefase.
- 'n Besigheidsbedryfsfase.

Hierdie fases word uitgevoer deur die toepassing van die fundamentele ingenieursvaardighede naamlik innovasie, sisteemdenke en die toepassing van wetenskaplike metodes.

Acknowledgements

"This is the true joy in life, the being used for a purpose recognised by yourself as a mighty one, the being a force of nature instead of a feverish, selfish little clod of ailments and grievances complaining that the world will not devote itself to making you happy."

George Bernard Shaw

In submitting this thesis, I wish to take this opportunity to express my sincerest gratitude towards the following individuals for their specific contributions:

- My Creator for making all of this possible;
- my wife Karen and daughters Helena and Klara for believing in me;
- my father for teaching me the value of an education;
- my mother for teaching me that there are many things in life which can not be expressed in numbers;
- my sister René for her valuable input into the final document;
- my superiors Mr Ben Alberts, Jac van der Walt, Piet Venter and Ernst Venter for the opportunities they have created for me;
- the late James Ochse for introducing me to Industrial Engineering;
- my friends and colleagues Stephen Bosman, Nico Marais, Pieter Britz, Gerrit van Zyl, Johan Bloemhof and Van der Spuy Brink for the many stimulating conversations I have had with them through the years;
- my promoter, professor Paul Kruger for his role in my personal development through the years;
- Pieter le Roux for his assistance in finalising the manuscript;
- my clients whose requirements have lead to the development of the approach;
- various individuals from the consulting industry from whom I have learnt so much; and
- Tchaikovsky, Beethoven and Mozart for their company.

When I first enrolled with the University of Pretoria as a freshman in 1985, a phrase was instilled in me. *Ad destinatum persequor*. I now understand what it means.

Foreword

"It was the best of times, it was the worst of times,
it was the season of hope, it was the winter of despair."

Charles Dickens in "A tale of two cities"

In order to introduce the reader to this thesis, I thought it would be sensible to address the obvious thoughts that the first sight of the title might have stirred. Thoughts such as:

- The meaning of the term *business transformation;*
- the meaning of the term *engineering approach;*
- the way in which I have executed my study; and
- how this study has added value to me as an Industrial Engineer and the field of Industrial Engineering.

In addition, I thought it necessary to add some of my personal views in order to illustrate my own commitment to the chosen topic. After all, it is my thesis. Also, in some way I wanted to show the reader that my interest in the topic has extended past the point of academic knowledge or practical application into some form of insight that has added to my career as an Industrial Engineer and, indeed, my life. I have worked on this thesis for the past five years in many ways, through academic research, through executing various projects, through teaching, through thinking and reasoning and through being a practitioner in the field. In this period I have, on the personal front undergone a form of transformation. I have fathered two daughters and, in the process shifted my emphasis in life from the exact sciences to a behavioural approach.

If a sceptic would ask me why it took such a long time to deliver the final product, I would contest that the value I have gained through it far exceeded the mere academic value. Its greatest value was the way in which it enabled me to integrate my life, my career and my academic research. The final product ended up being something of a photograph of my knowledge at the time. Similar to photographing a moving object, certain elements may seem blurred on the final picture, but then, they usually make the best pictures.

I have realised that there are three fundamental cornerstones for the development of one's knowledge. They could best be illustrated as shown in figure 1.

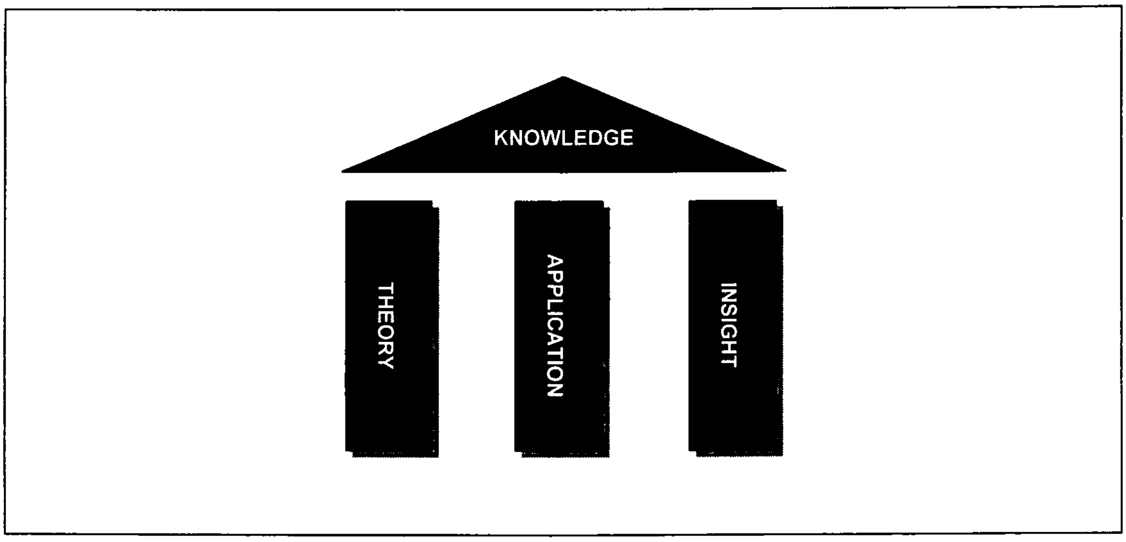

Figure 1 - The cornerstones of the development of knowledge

It is almost inevitable that the concept of *transformation* will provide for a multitude of academic and consulting related writings. It is thus reasonable to question what makes this thesis special.

We seem to think that the structure and culture of our society are changing. However, like watching the hands of a clock or the growth of a living organism and trying to visualise the movement, these changes are not readily apparent. We see various new phenomena and proclaim them to be signs of change. These include the way in which the Internet is changing the world of communication, the latest release from Microsoft Corporation and the decline of communism.

Is the world a better place as a result of these changes or are they merely like the changing of the seasons, adapting to different circumstances but still the same? A wise philosopher once observed that the more things change, the more they stay the same.

Philosophically, there are two ways of proving or disproving whether the supposed changes did in fact reflect a true shift in society. The one would be to observe the state of society at discrete time intervals and scientifically determine whether the changes that occurred were significant. The other would be to assume that change *is* occurring and to construct a theory or a model that provides a framework for understanding the effects of these changes. The first approach, although scientifically pure and just, adds little to our insight other than the ability to claim scientific proof of what we might already know. The second approach on the other hand, leads us to think. It leads us to think about what caused the changes and what their effect will be. And it creates a framework or paradigm for our understanding. It is also more enjoyable and fulfilling to become able to distinguish the true structural changes or *megatrends* from what can be termed *noise* by constructing a workable and useful framework. I have followed this approach in my work. While it is true that science would claim such an approach to be non-academic or mediocre, I would maintain that a theory is useful as long as it is true and that even scientifically proven theories remain true only within the boundaries of the science of the day.

Transformation, for an individual, means to become discontent with one's situation, in spite of one's successes in the past, thereby constantly seeking a different and challenging future. This process could be gradual or abrupt. It is often referred to as *positive dissatisfaction.*

My life, like that of any other human being, has always been a form of transformation. It takes on many forms, such as transformation of oneself, transformation of one's career, transformation of others and transformation of the workplace. But it is only when transformation becomes a way of being, a way of living, a way of approaching problems, rather than merely creating new surroundings and then maintaining them for a lifetime, that one becomes interested in understanding the fundamentals of transformation. My interest in the concept, and my writing a thesis about it was not borne out of academic requirement or the following of trends but out of my curiousity as to why transformation has been such a significant force in many of my surroundings.

While writing this foreword, I was watching my six-month-old daughter, teaching herself to crawl. I was not teaching her, she was teaching herself. She was creating a sense of discontent with her situation of not being able to move around by her own means. She was protesting profoundly and, in the process, she was beginning to crawl. It was a transformation for her, as she was now able to interact on a higher level with her environment. At this point, it struck me how much we learn, how much we adapt, and to what extent we transform ourselves when we are small, and how this process declines as we grow older.

There are three major entities that are of interest when studying transformation. The first being transformation of oneself, the second being transformation of organisations and the third being transformation of society. This thesis deals with the transformation of organisations, specifically business organisations. To understand this however, we must also understand the other two major influences namely individual transformation (a change in perception of individuals within the organisation) and secondly the changing society (changes in the structure or culture of society).

These relationships are shown in figure 2.

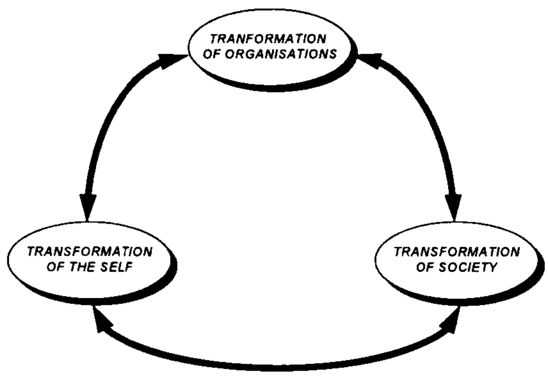

Figure 2 - The relationships between individual, organisational and social transformation

The approach that is followed to study a topic is a paradigm through which we view the world. It acts as a filter. By following a specific approach, we see a part of the information more clearly than with any other approach, whilst in the process, we obscure other parts thereof.

There are many approaches one could follow to form a better understanding of business transformation. One could for instance follow an approach based on the behavioural sciences in which transformation is viewed as a form of human behaviour and business transformation is a process that has developed into a new leadership role. One could follow an approach that is based on the social sciences and in which transformation is viewed as a process of realignment in society, in economics or in politics. Similarly, one could follow an approach that is based on the management sciences, viewing transformation as a management function. There are possibly also other approaches one could have followed.

I have chosen to follow an engineering approach for three reasons. Firstly, being a trained and practising engineer, to me it is a logical way of viewing things. Secondly, I believe an engineering approach is one of the least inhibiting as its only aim is to apply the sciences for the benefit of mankind. Thirdly, and most importantly, I believe that the possible impact of an engineering approach on our understanding of the topic could be gigantic.

Engineering, in its widest sense, can be viewed as two consecutive sub-processes namely innovation (concerned with the invention and creation of new things) and application (concerned with the development, utilisation and maintenance of existing things). Both of these processes are supported by a third, namely the utilisation of the sciences.

These processes are summarised in figure 3.

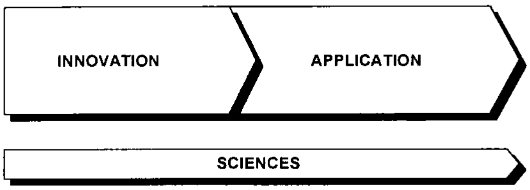

Figure 3 – A holistic view of the engineering processes

There are engineers and scientists involved in this process and there are two types of engineers. There are those who apply and maintain things, and those who create and invent things. The former focuses on constantly developing and maintaining our understanding of the existing, whilst the latter focuses on the creation of a fundamentally new understanding.

I have always questioned our emphasis on the maintenance of the existing understanding, as true excellence should surely be achieved through new ways of doing things rather than merely doing the same things to perfection. As a result, I have never excelled in the maintenance of current understanding. Rather, I have viewed engineering (to engineer) as primarily concerned with the creation of a new understanding for the benefit of mankind.

I do not propose that all of the formulae and methods that engineers apply would similarly apply to business transformation but rather, I have tried to show how an engineering mind set, through the use of its metaphors and philosophies can be applied to business transformation issues.

My journey in working on this thesis began during early 1992. At this point in time, apart from the sense of expectation and turmoil in the country and in most business enterprises in South Africa, I was at a point of reinvention of my own career. These two factors, the one an individual reorientation, the other the transformation of society, lead me to my research. Being an Industrial Engineer, I was moderately disillusioned with the career prospects for my profession because of its apparent inability to solve the changing business problems of the day.

I realised that four factors have contributed to the Industrial Engineering discipline becoming less relevant:

- The fact that an increasing number of senior managers in organisations have undergone post graduate managerial training;
- the fact that an increasing number of senior managers in organisations are today computer literate and self reliant in the application of technology in improving their, and their organisation's productivity;
- the fact that the multidisciplinary consulting industry has grown and is providing solutions to the various new business problems that arise; and
- the fact that the knowledge industry is outgrowing the traditional industries which have been the main focus area of Industrial Engineering.

The net effect of these changes has been that organisations, and indeed their management, have become less reliant on Industrial Engineering skills to solve the problems of the day. But then, these are normally the first signs of the fact that the Industrial Engineering discipline is also undergoing some form of transformation.

Many Industrial Engineers at the time shifted the emphasis of their work towards information technology and in doing so, reinvented their careers. I went through the same process at the time and landed within an information technology organisation. I maintained that, as an Industrial Engineer, I do have a contribution to make and that my contribution would not be to become an information technology practitioner but rather to re-focus my knowledge of Industrial Engineering within this environment.

Marco Polo observed that the best way to understand one's own culture is under continuous exposure to a foreign culture. In my case, this observation has proven to be true. I spent the five years from 1992 to 1997 within an information technology organisation before returning to Industrial Engineering. In this time I discovered my roots and I believe I have developed new and original ways of applying sound

Industrial Engineering. I had the added advantage of not being drawn into any collective thinking and was forced to develop new and original ways of doing things. It is my opinion that the field of Industrial Engineering can be expanded in many ways, thereby ensuring that it remains relevant.

I have since had the privilege to be asked to develop and lead a Business Engineering organisation for Iscor Mining, with the existing Industrial Engineering organisation as core. I do not view Industrial Engineering as obsolete but rather, as a proponent within the system, I saw an opportunity to expand the activities of our Industrial Engineers. This organisation and its contribution to the company serves as practical proof of what can be achieved through using Business Engineering and business transformation approaches.

"Progress comes as much from creative reorganisation of what we already know as from discovery of new things. Einstein's contribution to physics was organisational. All the facts that were available to him were available to others. In the last two decades science itself has undergone extensive reorganisation with the emergence of many new interdisciplines. A filing system can always be reorganised without changing its content, but doing so may increase our access to, and understanding of, that content. Therefore we should not embed our current system of classifying knowledge in student's minds as fixed categories. They should be encouraged to organise their learning in ways that best serve them, not us.

When we isolate a subject we inhibit exploration of its relationship to other subjects. Disciplines are craft unions preoccupied with preserving their academic prerogatives. Academic departments do not organise knowledge; they organise teachers and disorganise knowledge. Disciplinary departments and bounded subjects are antithetical to Systems Age education.

A curriculum is a solution to a problem that does not exist. Even if it did exist its solution would change rapidly with respect to time and place. Curricula as now conceived are a denial of the rapid rate of cultural and technological change.

Because what one learns is not nearly as important as learning how to learn, and because questions are at least as important as answers, students should be free to design their own curricula. It is at least as revealing of a student's quality to evaluate the curriculum he has designed as it is to evaluate what he has gotten out of it. To design a curriculum is to ask a set of questions. What he gets out of it is a set of answers."

Russel L Ackoff in "Redesigning the Future"

This is my journey, my crusade that I have embarked upon. I hope that the trail that I leave will create an opportunity for greater minds than mine to travel and conquer. I will meet them somewhere along the way.

I hereby submit this thesis as my own original work. May the reader find value from it.

Mellet Moll

Summer 1998.

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Part One - Introduction

"And a merchant said, Speak to us of Buying and Selling.

And he answered and said:

To you the earth yields her fruit, and you shall not want if you but know how to fill your hands.

It is in exchanging the gifts of the earth that you shall find abundance and be satisfied."

Kahlil Gibran in "The Prophet"

1 Objective

Part One of this thesis introduces the reader to the proposed engineering approach to business transformation in terms of the following:

- A background on the effect of changes in society on the business world and the subsequent need for business transformation;
- defining the objectives for the thesis;
- defining the scope of the thesis;
- presenting an overview of the thesis;
- presenting the approach that is followed in the thesis; and
- presenting the methodology that was followed in researching the subject matter.

2 Background

Change could be perceived as a tidal wave that flows over mankind. It can not be explained in isolation, but can be understood by studying the way in which it affects our lives.

Organisations were created to refine and trade in the resources that satisfy our needs. They are constantly exposed to change. A business, being an organisation of people, broadly resembles the same collective behaviour as the individuals it consists of. For instance, it shows a similar hierarchy of basic needs (Maslow: 15) from an initial need to survive, to more sophisticated needs like growth, prosperity and regeneration. It lives for fifty to sixty years, although there are the odd exceptions that have lived for hundreds of years. De Geus (12) explains that there are various other similarities between humans and organisations. They are born, they grow, they learn, they mature, they reproduce, they become obsolete and they die. In this process, however, they are active in various spheres and they serve a purpose in their lives. This he calls a living company.

An organisation is affected by its relationship with its environment. If the environment becomes increasingly turbulent, the ability of the organisation to adapt to the changing environmental circumstances becomes increasingly crucial. External change is an important factor that influences the destiny of an organisation. But it is not the only factor - the other factor being a change in the perceptions and the thinking of the individuals within the organisation.

Can an organisation anticipate change and transform itself beforehand? Even more importantly, can an organisation transform itself, and by doing so, impact so significantly on its environment that it causes the environment to change? What are the relationships between transformation amongst the individuals within the organisation, the organisation itself, and the environment? Our understanding of these interactions is relatively limited.

The rate of change is increasing, or at least, the complexity of the environment leads us to believe it is. It has become difficult to comprehend the possible end result of environmental changes if turbulence keeps increasing exponentially. There are organisations that have recognised the need to align and continuously realign. And they seem to live longer – like the natural progression of all living beings, it is those who adapt to the changes around them that stay alive. Over time, they evolve into something completely new and different.

It has become a fashion amongst academics and consultants to develop approaches and methods that are aimed at renewing organisations in relationship to this changing environment (Appleton: 3, Champy: 6, Davenport: 9,10, Hammer: 13,14, Woolf: 20), and continuously optimise their performance under these new conditions. Most of these approaches however, address only pieces of the puzzle.

An integrated approach is thus required for the transformation of organisations. This approach should consist of the following elements:

- An assessment of the business system;
- construction of a model of the business system;
- application of methods to identify areas of misalignment with environmental change;
- design of solutions for the identified business problems;
- implementation of these solutions; and
- continuous improvement and adaptation of the business system with the changing environment.

Many of the current approaches are often termed *engineering, reengineering, innovation or redesign* (Champy: 6, Davenport: 9,10, Hammer: 13,14) of the business although often having nothing to do with the engineering disciplines[1]. The role of one or two business resources are often elevated in most of these approaches without the consideration of other factors involved, their possible interrelationships or the sustainability of the solutions that were created. There is in fact very little engineering as defined in the engineering profession, present in current approaches.

Industrial Engineering is a discipline that is equipped with all the necessary skills to be a key stakeholder in business transformation issues. Industrial Engineering originated from the various transformational issues that resulted from the industrial revolution[2]. But, as times change, new tools are required.

In an effort to define the underlying principles of the approach required to transform an organisation, a subject area known as *Business Engineering* has emerged. It serves as a theoretical home for the field that studies business transformation. It is used as an academic context for this study. The subject area has since been established as part of the post graduate course in Industrial Engineering at the University of Pretoria, as well as the post graduate course at the School for Business Leadership at the University of South Africa under the guidance of the author (16,17,18).

The term *Business Engineering* has generally been accepted and is often employed by other practitioners in the field.

[1] *Mainly management consultants, information technology consultants, auditors, human resource consultants and a small number of Industrial Engineers.*

[2] *The case in point being Frederick Winslow Taylor's scientific school of management which lead to the conception of modern Industrial Engineering.*

3 Objectives of the thesis

The following objectives are pursued in this thesis:

- Understanding the fundamentals of business, transformation, the engineering approach and the underlying concepts and philosophies of Industrial Engineering;
- formulating an approach to analyse organisations;
- formulating an approach to design organisations;
- formulating an approach to transform organisations;
- formulating an approach to continuously improve organisations;
- positioning the current extensive Industrial Engineering tool set within the proposed approach; and
- commenting on the areas in which it seems possible to expand the Industrial Engineering discipline.

4 Scope of the thesis

The study deals with the subject of transformation of organisations from an undesirable current state to a more desirable future state that is in equilibrium with its changing environment. It is supposed that improvement constitutes an increase in the *value creation potential* (Copeland: 8) of an organisation.

Value creation is aimed at the satisfaction of stakeholder requirements. These requirements are:

- Generating maximum returns for the owners of the business;
- satisfying customer requirements as a means to the above end; and
- maintaining a balance with the requirements of all the other stakeholders involved.

Value is created through the analysis, design and transformation of an organisation, whilst value is added through the continuous improvement of operations.

The driving forces of transformation are examined and an approach is defined through which an organisation can be transformed. This is done through the eyes of an engineer. Conclusions from the investigation are aimed at expanding the applicability of Industrial Engineering into the field of business and vice versa.

5 Overview

An engineering approach is based on three fundamental skills:

- Innovation;
- a systematic and structured approach; and
- application of scientific methods.

Industrial Engineering is focused on using these skills in an industrial environment to integrate and optimise the performance of complex resource-based systems. However, these characteristics are present in the operation and management of organisations in general and the application of an engineering approach and specifically Industrial Engineering in the development of methods to solve the problems of business transformation is therefore feasible.

It might be argued that the issues of business optimisation and transformation are in fact the very essence of Industrial Engineering (the Scientific School of Management) (Taylor: 19) but in practice Industrial Engineers have mostly been involved in industrial operations.

Davenport and Short (10, page 55) write as follows on this changing role of Industrial Engineering:

"At the turn of the century, Frederick Taylor revolutionised the workplace with his ideas on work organisation, task decomposition and job measurement. Taylor's basic aim was to increase organisational productivity by applying to human labour the same engineering principles that had proven so successful in solving the technical problems in the work environment. The same approaches that had transformed mechanical activity could also be used to structure jobs performed by people. Taylor came to symbolise the practical realisations in industry that we now call Industrial Engineering (IE), or the Scientific School of Management. In fact, though work design remains a contemporary IE concern, no subsequent concept or tool has rivalled the power of Taylor's mechanising vision.

As we enter the 1990's, however, two newer tools are transforming organisations to the degree that Taylorism once did. These are Information Technology - the capabilities offered by computers, software applications, and telecommunications - and Business Process Redesign - the analysis and design of workflow and processes within and between organisations. Working together, these tools have the potential to create a new type of Industrial Engineering, changing the way the discipline is practised and the skills necessary to practice it."

Although these authors' definition of Industrial Engineering is over-simplified and *information technology and business process redesign* are merely elements of a larger whole, it should not distract attention from the fact that Industrial Engineering could benefit from redirecting its focus towards the business transformation movement and the subject matter related to it.

6 Approach

6.1 An engineering approach...

An engineered solution, as will be explained in Part Two, has a life cycle with a number of phases that can be distinguished (Blanchard: 5):

- Need analysis;
- conceptualisation;
- construction;
- implementation;
- operation; and
- phase out.

To use an engineering approach means that formal methods are applied within a logical and structured framework in order to construct a solution to a need. In engineering, these methods are aligned with the various life cycle phases of the solution.

In general, four generic engineering phases can be distinguished in the life cycle of the proposed solution. These life cycle phases are:

- Analysis;
- design;
- implementation; and
- operation.

These phases form a process as shown in figure 1.

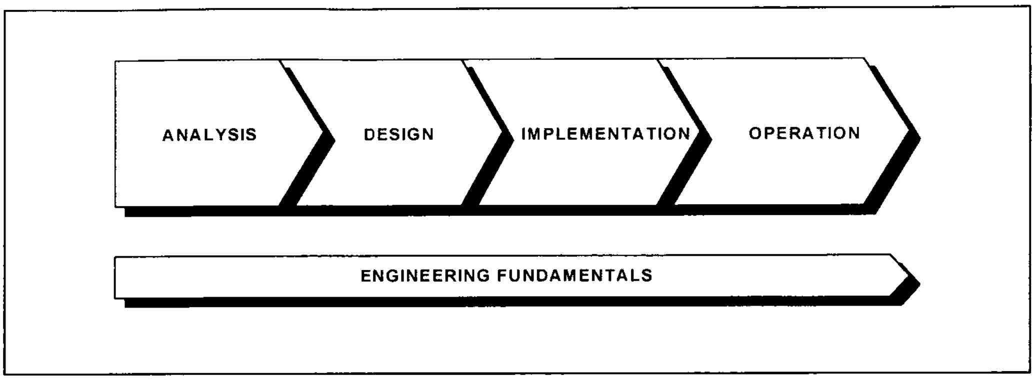

Figure 1 - The phases of engineering

To follow an engineering approach to business transformation, this basic approach of utilising the engineering processes is thus applied to the transformation of a business organisation.

6.2 ...to business transformation

Business transformation is understood to be a process of constantly adapting to the changing environment (Woolf: 20). An organisation continuously strives towards a state of dynamic equilibrium both externally (in relation to its environment) as well as internally (in relation to the resources it consumes).

This is achieved through two processes namely:

- Alignment, aiming to satisfy the requirements of the larger whole of which it is part, be it the requirements that the environment sets for the entity or the requirements that the entity sets for its resources; and
- transformation, aiming to continually learn from, align with and adapt to the requirements set by the larger whole, measuring the feedback from the alignment process and correcting it through transformation.

6.3 The Business Engineering Process

"With understanding, we can design and create our own futures."

Russel L Ackoff (2, page 12)

The application of an engineering approach in transforming an organisation would suggest that through thorough analysis, design, implementation and operation, an organisation can be transformed in order to ensure alignment through the various phases as shown in the business transformation framework.

This premise has led the author to organise his knowledge, and subsequently this thesis, according to this phased approach. The process that was derived from this thinking, is known as the *Business Engineering Process*. By using the Business Engineering Process as an approach, various new insights can be discovered about business transformation.

The Business Engineering Process is shown in figure 2[3].

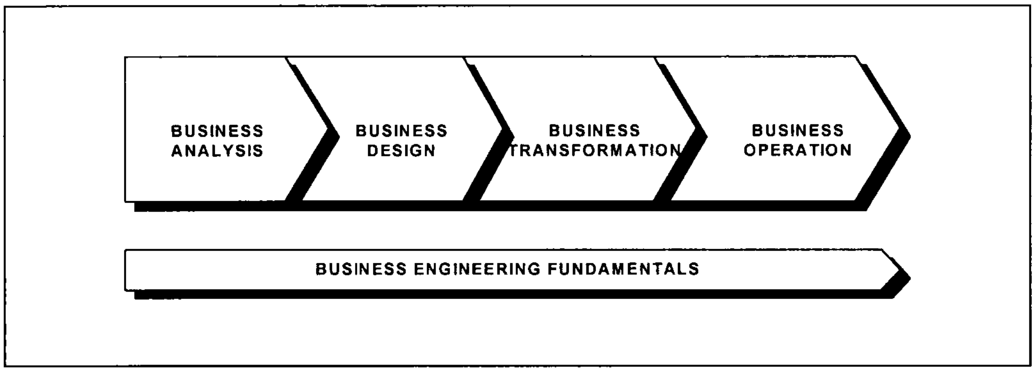

Figure 2 - The Business Engineering Process

3 *The reader will note that business transformation, in this suggested process, is viewed as the process of implementing a new business design that was developed by analysis of the various influencing factors.*

A brief outline of the organisation of this document follows. The basic process nomenclature is followed in describing each of the process elements.

It is based on the generic properties of a process or sub-process namely (Blanchard: 5):

- The objectives and basic principles of the process or sub-process (why ?);
- the definition of the process or sub-process (what ?); and
- the methodology that is used within the process or sub-process (how ?).

A process or sub-process has three further specific properties. They are not addressed in such detail in this thesis as they are situation dependent. These properties are:

- The accountable and responsible parties involved in the execution of the process or sub-process (who ?);
- the resources that are used in the execution of the process or sub-process (with what ?); and
- the schedule according to which the process is executed (when ?).

6.3.1 Fundamentals

There are indisputable truths, undisputed beliefs and fundamental assumptions underlying any approach. They are the building blocks of the theory.

In order to understand the concepts related to business, the engineering approach and the philosophy of Industrial Engineering, their basic principles are examined. To contribute to the philosophy of Industrial Engineering, an understanding is required of it.

A subject area defined as Business Engineering is discussed and a theory of Business Engineering is formulated. Subsequently, the concepts of business engineering are refined.

6.3.2 Business analysis

In order to transform an organisation, it is necessary to form a thorough understanding of the various issues that the organisation faces.

The process of analysis is concerned with the study of data in order to derive a focused set of conclusions which serve as constraints, opportunities or problems to be addressed in the business design phase. In engineering terms, they are often referred to as design criteria.

An approach, based on the technique of environmental assessment is formulated in order to understand the interaction between an organisation an its environment. In order to define the role that an organisation plays in its external environment, the dynamics of society is assessed. Similarly, the relationship between the organisation and its environment is assessed. Lastly, the organisation itself is assessed.

6.3.3 Business design

An architectural view is taken towards the design of an organisation.

The concept of business architecture is presented as an approach to design organisations. In the engineering metaphor, the role of an architect is one of unconstrained conceptual design, after which the engineer investigates the practical implications of the design. This then leads to one ore more iterations through which the engineer and the architect refine the design in order to optimise its practical and architectural value. A similar process is followed in order to design organisations. This part of the thesis addresses elements such as strategic architecture, structural architecture, cultural architecture, resource architecture and management architecture.

6.3.4 Business transformation

Business transformation is viewed as the implementation of the proposed design, having analysed all of the relevant factors. Its aim is to ensure equilibrium with the changing environment.

A model is presented which firstly defines transformation and subsequently provides an approach to manage transformation successfully. It is shown how external environmental forces influence transformation, as well as how the internal desire from individuals can cause transformation. Transformation is like revolution, and the principles upon which successful revolution is based, are used in the approach. In order to manage transformation successfully, the reasons for success and failure of transformation efforts are assessed and used to construct a proposed model.

6.3.5 Business operation

A business becomes operational once the proposed architecture has been implemented and value is being drawn from its use.

It is the belief of the author that historically, the majority of effort spent by Industrial Engineers was focused on improving the operation of a business. An approach is presented that positions these classical Industrial Engineering methods within the overall process through the application of Operations Management, Operations Research and Continuous Improvement methods.

6.3.6 Conclusion

In order to evaluate the success of the approach that was presented, the three perspectives of knowledge are analysed namely theoretical value, applicability and insight.

In terms of theoretical value, it is shown that the approach that was presented is object based, cross-functional and fundamental. In terms of practical value, a number of practical applications, as well as the results that were achieved, are shown. Lastly, the insights and future challenges of the approach are shared.

7 Research Methodology

"If these be vague words, then seek not to clear them.
Vague and nebulous is the beginning of all things, but not their end.
And I fain would have you remember me as a beginning.
Life, and all that lives, is conceived in the mist and not in the crystal.
And who knows but a crystal is mist in decay?"

Kahlil Gibran in "The Prophet"

The research was conducted by using a fundamental engineering process as an approach to business problems and position current and proposed methods within this approach. A new theory emerged from this marriage between two distant concepts.

A literature study was conducted in all of the related fields. These are:

- Engineering fundamentals;
- Industrial Engineering;
- Business Transformation;
- Future Studies; and
- Management Theory.

From these, through practical application in various business transformation projects, it was attempted to develop a generalised approach. This conceptual approach was refined in order to provide a postulate, being that an engineering process can be used to transform organisations. Through practical application, this proposed theory was tested and adapted through various iterations until the results proved to be successful in terms of value created for organisations (the ultimate aim of transformation being the improvement of value for organisations).

There are three ways in which a new theory can be developed through research (Cooper: 7, Yin: 21):

- The development of an approach or framework from case studies;
- the development of an approach as a result of learning from experience; or
- the development of an approach from experimentation and subsequent statistical analysis.

Purists might argue that new theory can only be developed through the last method. They tend to forget the origins of the great theories of our time. Psychoanalysis, evolution, the divine theories, many of the future studies, none of these were developed by experimentation. They were in fact postulates that were adopted by society because their opposites could not be proven. The conditions for these types of theories to be accepted are that they should be logical and could be used to explain various phenomena. Also, they should be comprehensive and based on an integrated whole. As long as they are not proven wrong, they are deemed appropriate.

In order to develop such a theory, the reasons, definitions and methods involved in the theory should be presented in a systematic and comprehensive way. The author has chosen to present his theory, created from his experience, in such a fashion.

Leibnitz (4) observed that there are two kinds of truth - truths of reason (their opposites might be possible) and truths of fact (true in all worlds). He argued that all reasoning is underwritten by two principles - the principle of *contradiction,* and the principle of *sufficient reason.*

"The connection between the two principles and the two kinds of truth is shown by the fact that the principle of contradiction is sufficient on its own for a demonstration of the whole of mathematics, but that the principle of sufficient reason is needed in addition in order to pass from mathematics to physics."

Leibnitz (4, page 127)

Truths of reason can be established by analysis, by resolving them into the simple ideas and primary principles out of which they are constituted and which themselves require no proof. The Business Engineering theory is based on these principles.

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Part Two - Fundamentals

"It cannot be that axioms established by argumentation should avail for the discovery of new works; since the subtlety of nature is greater many times over than the subtlety of argument. But axioms duly and orderly formed from particulars easily discover the way of new particulars, and thus render sciences active."

Francis Bacon in "Novum organum"

1 Objective

Part Two of this thesis introduces the reader to the fundamental principles of business transformation and engineering in terms of the following:

- A background on the philosophic approach underlying the thesis;
- the fundamental building blocks of business transformation;
- the fundamental building blocks of engineering;
- Industrial Engineering as a discipline within engineering; and
- Business Engineering as an emerging discipline in the intersection of Industrial Engineering and Management Theory.

The Business Engineering Process is proposed as a road map for the rest of the thesis. Part Two of the thesis provides the support base of this process.

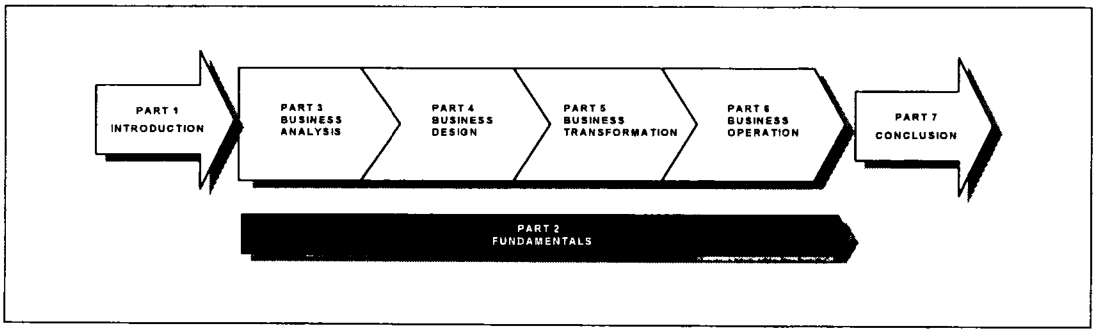

Figure 1 - The fundamentals of the Business Engineering Process

2 Basic principles

2.1 The philosophic approach

In order to apply a theory, it is necessary to understand the underlying thinking on all levels of abstraction. The approach required in the application or expansion of the theory should therefore be based on some form of logic or structure. In the analysis and synthesis of engineering and business transformation, it is essential to define the levels of abstraction according to which the theory is to be presented.

The following levels are proposed:

- The holistic perspective where focus is directed at the relationships of a theory with similar theories;
- the underlying philosophy or basic principles that focus on the core assumptions of the theory;
- the approach followed in the confronting of these general situations by the application of the underlying philosophy and logic;
- the concepts that are applied in the execution of the approach;
- the models or representations by which the concepts are structured; and
- the techniques that are applied.

The successful application of a philosophy and derived theory is dependent on a thorough understanding and successful application of all levels of abstraction. It must however be borne in mind that a theory is as strong as its weakest link and, having followed the guidelines of a theory thoroughly and insightfully, an absence of success will indicate incompleteness of the theory, which should be confronted on the philosophical level. In practice, it would not be attempted to confront every situation on a philosophical level unless the incompleteness of current philosophy is apparent in terms of the situation.

Figure 2 shows the relationships of the different levels of abstraction.

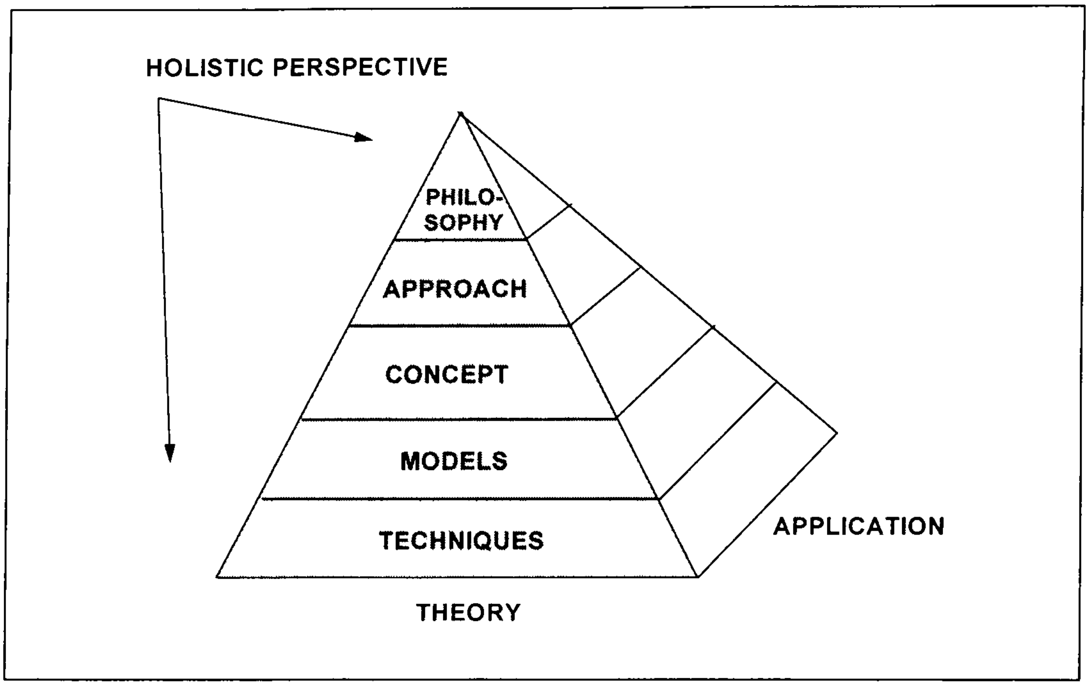

Figure 2 - Levels of abstraction

The reasons for the failure of new theories are generally based on either a misinterpretation of the underlying philosophy or the incompleteness of the theory.

Current approaches to business transformation are contaminated by both of these factors. This investigation into fundamentals aims to create an understanding of the underlying philosophy (current and expanded through this thesis) of business transformation in order to derive all the next related levels of abstraction. Where possible, proof, or at least fundamental logic is provided in support of the philosophical contribution of this thesis.

2.2 Analysis and synthesis

2.2.1 Perspective

Ackoff (1,2) describes the evolution of human understanding of affairs as being based on the level of development in society and the metaphors used in a particular era of development. He defines similar patterns in man's historical development of thinking and understanding of the environment than those cited by Toffler (22,46) and defines:

- An Agricultural Age;
- a Machine Age, which is characterised by analytical and functional thought processes; and
- a Systems Age, which is characterised by synthetic and holistic thought processes.

Of interest to this study is the difference between the approaches to thinking and understanding of business and environmental transformation in the latter two ages.

2.2.2 Analytic thinking in the Machine Age

The method upon which understanding is based and the general investigative approach is one of analysis and functional decomposition.

The underlying principle is that all objects and events, their properties and knowledge of them are made up of undividable elements. In the Machine Age, the sciences flourished. A product of this was the atomic theory as initiated by Dalton, Rutherford and Bohr, namely that all matter is ultimately composed of undividable atoms. In order to understand a concept it should thus be decomposed into its simplest form and investigated on that level, and the characteristics of the whole is based on the sum of the characteristics of the parts. Similarly, it was in this era that Freud defined the theory of psychoanalysis that is a decomposition of human behaviour into its most basic elements. Darwin proposed the theory of evolution, reconstructing historical human development to its simplest form.

The role of analysis in problem solving similarly aims to reduce a problem to a set of simpler problems. Solution or optimisation at this level implies a total solution. What was learnt from the successful mechanisation of the Machine Age, became generalised.

2.2.3 Synthetic thinking in the Systems Age

The method upon which understanding is based and the general investigative approach is one of synthesis, a holistic perspective and systemic relationships.

The underlying principle is that all objects and events, their properties and knowledge of them are parts of larger wholes. In order to understand a concept it should thus be positioned amongst its interrelated peers. It is not contrasted a-gainst the analytical approach and is in fact compatible with it. This way of thin-king lead to the conception of the systems approach and the study of relationships between elements. The synthetic mode of thinking approaches problem solving not by taking the problem apart but by viewing the problem as part of a larger problem. This approach is based on the observation that when each part of a system performs as well as possible relative to the criteria applied to it, the system as a whole seldom performs as well as possible relative to the criteria applied to it. This follows from the fact that the sum of the criteria applied to performance of the parts is seldom equal to the criteria applied to that of the whole. System per-formance therefore depends critically on how well the parts fit and operate toget-her and not merely on how well each performs when considered independently.

One important consequence of synthetic thinking is that science itself has come to be reconceptualised as a system whose parts, the disciplines, are interdependent. This contradicts the hierarchical notion of science in which there is only a one-directional dependence amongst disciplines. Scientific disciplines are no longer thought of as dealing with different aspects of nature, nor is nature believed to be organised in the same way science is. The disciplines are increasingly thought of as points of view. Of these, most are applicable to the study of phenomena and problems.

In analytical thinking, behaviour is explained by identifying what caused it but never by its effect, whereas in synthetic thinking, behaviour is explained by what produced it and by what it produces or intends to produce.

2.2.4 Business thinking

In the business context, what are termed the *top-down* and *bottom-up* approaches to understanding and optimising an organisation and its environment correspond with the previously mentioned two approaches. These approaches should both be present in business transformation.

2.3 Fundamental logic

2.3.1 Perspective

Fundamental logic can be applied in two distinct fashions namely an inductive or a deductive fashion. Traditionally one is taught to follow a deductive approach to logic. Hammer and Champy (20), pioneers of the business reengineering movement, argue that the opposite approach, namely inductive logic should equally be present in the understanding and application of business transformation, particularly as a result of the emergence of new technology.

Deductive logic towards technology tends to create an analytic and technical approach to technology, where it could also be viewed as an enabler. An enabler is a solution in search of a corresponding problem. This is fundamental to all forms of innovation.

2.3.2 Deductive logic

Deductive logic is based on the premise that an understanding of the derived relationships between the parameters of any given situation will ultimately reveal new insights. This approach is particularly significant in reactive problem solving situations.

2.3.3 Inductive logic

Inductive logic seeks to find opportunities or problems for the implementation of corresponding solutions that already exist. It will be shown in this thesis that business transformation is highly dependent on innovation, for which the method of provocation (De Bono: 11), based on induced logic, works extremely well. This method reverses the traditional deductive logic.

2.3.4 Business logic

Talwar (44) observes that business transformation can generally be divided into two categories namely:

- Organisations that have reached a crisis point in need of solutions to their existing problems; and
- organisations that are prospering but are concerned about their future survival.

These categories correspond with the approach taken by Handy's so-called sigmoid or logistic curve (21). The sigmoid curve is often used to describe the life cycle of an organisation. It is reasoned that an organisation will be subject to an initial rapid growth phase, followed by a phase of maturity and relative stability and lastly a phase of rapid decline. The need for transformation occurs firstly in the growth/maturity area, to ensure the initiation of a next sigmoid curve, or in the maturity/decline area as a reaction to the emerging signals of possible decline.

The sigmoid curve is described by the logistics equation:

$$1/S = K + MN^T$$

or by the Gompertz equation:

$$\log S = K - MN^T$$

In both cases T = elapsed time, S = cumulative demand for business output and K, M and N are constants.

Based on these equations, it can be proven that:

- The growth phase is defined as $dS/dT > 0$;
- the maturity phase is defined as $dS/dT = 0$;
- the saturation phase is defined where $dS/dT < 0$; and
- the points of inflection where $d^2S/dT^2 = 0$.

The sigmoid curve is shown in figure 3.

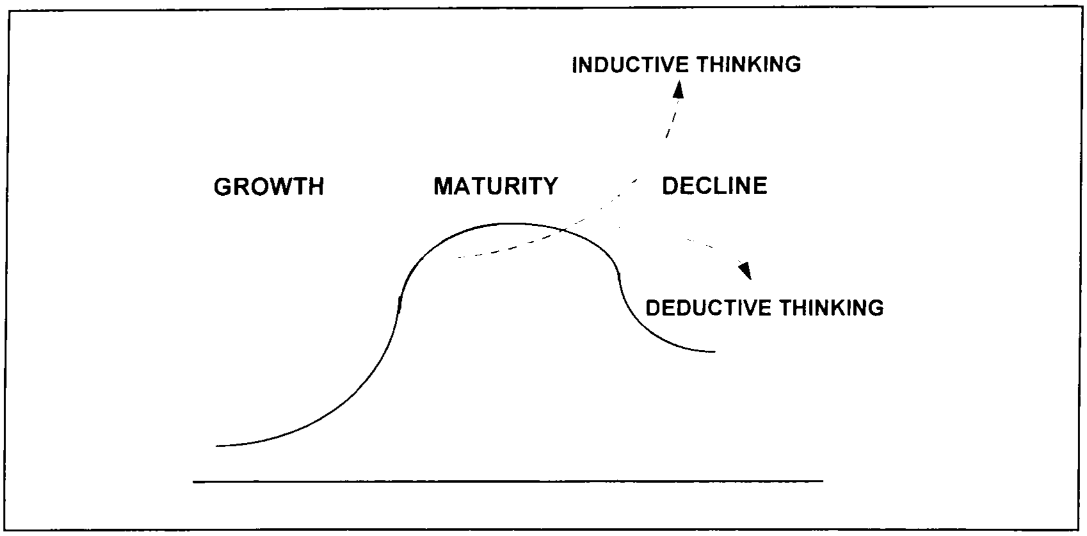

Figure 3 - Sigmoid curve

Three types of behaviour (Handy: 21) occur in these phases namely:

- Formative behaviour (growth) – this behaviour occurs in the growth phase and is normally of short duration, highly conceptual in nature and the rules are established for growth in the system;
- normative behaviour (perfecting) – this behaviour occurs in the maturity phase and is of longer duration and less conceptual, focusing on doing more of the same; and
- integrative behaviour (reframing) – this behaviour occurs in the area where a new sigmoid curve is discovered and new paradigms emerge.

3 Business transformation fundamentals

3.1 Business

To measure the state of an organisation, a model is required by which the state can be compared at various moments in time. In order to do this, the fundamentals of business must be understood.

According to Goldratt (18,19), the goal of an organisation is sustained value creation for the stakeholders of that organisation. The state of an organisation is thus expressed in relation to the amount of value it creates, as well as its ability to maintain this process. It is suggested that the state of an organisation can broadly be viewed in two dimensions from which four elements can be derived:

- A continuum between financial value created (prosperity) and non-financial value created (survival); and
- a continuum between strategic (long-term) and operational (short-term) performance.

These dimensions are shown in figure 4.

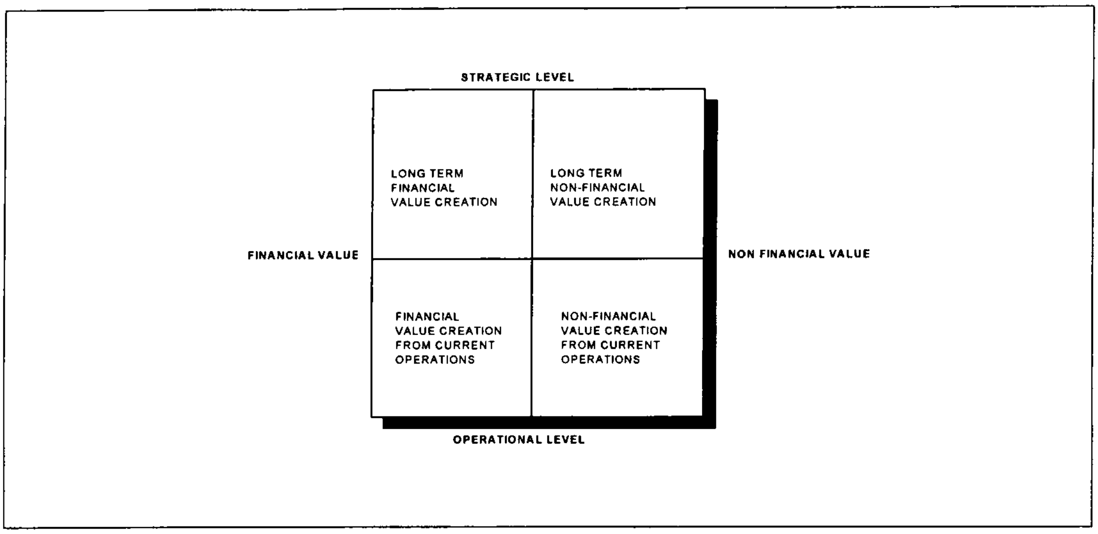

Figure 4 - The various dimensions of business performance

While some may argue that growth might be another parameter influencing the state of an organisation, it is viewed as a consequence of the value that it creates. In practice, the financial value created might have a short-term element based on maximising the value created by current operations whilst it might have a long-term element of applying the proceeds from maximising the value created by current operations in securing growth opportunities on the long term – jumping the sigmoid curve. It is thus assumed that an organisation regenerates wealth by consuming some of the wealth it has created in order grow.

3.2 Transformation

Business transformation is defined as the alteration of an organisation from a current and undesirable state to a more desirable state under which the organisation can remain in dynamic equilibrium with its environment.

In order to measure business transformation, the mathematical difference between the various states can be calculated for each of the quadrants measured in paragraph 3.1 of Part Two. It is typical of organisations that transformation rarely results in improvement in all four parameters. So for instance strategic performance and operational performance have a reciprocal relationship – by investing something over a long-term, a short-term performance gain has to be sacrificed and vice versa. Similarly, financial and non-financial performance tends to have a reciprocal relationship. The object of business transformation is thus not to maximise each dimension but rather to maximise the area between these points within specified conditions.

There are two types of organisational behaviour - incremental and entrepreneurial (Ansoff: 4). Business transformation requires entrepreneurial behaviour whilst business operation requires incremental behaviour. Increased turbulence will therefore require an increased ability to demonstrate both of these abilities at once, in other words, to keep the wheels rolling whilst designing the organisation of tomorrow.

An example of the transformation of business parameters is graphically shown in figure 5.

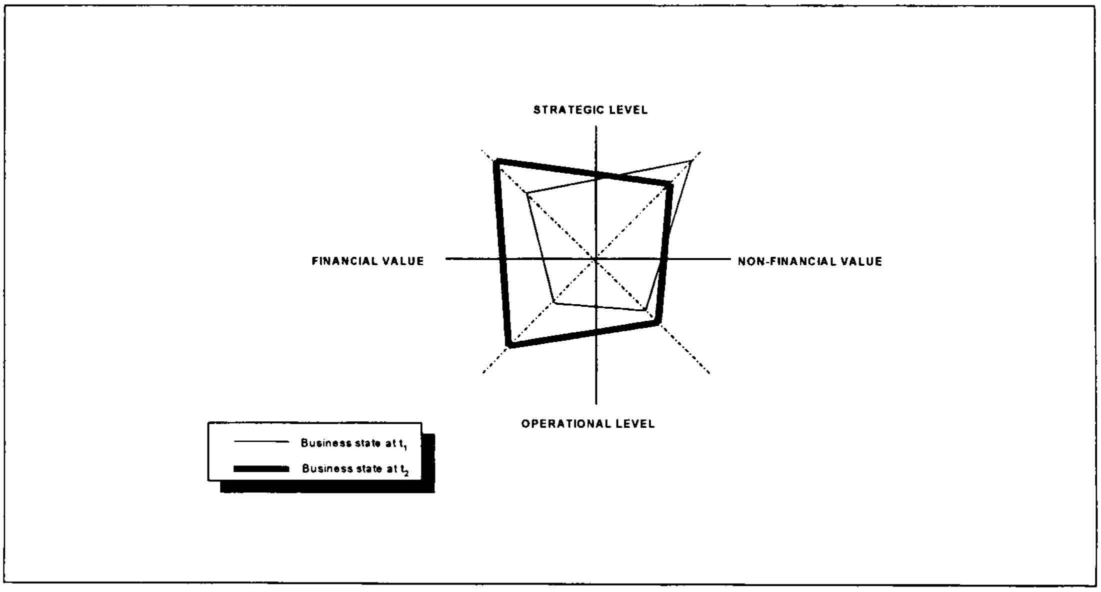

Figure 5 - Transformation of business parameters

4 Fundamentals of the engineering approach

4.1 Basic principles

The classical approach to engineering is shown in the process model in figure 6.

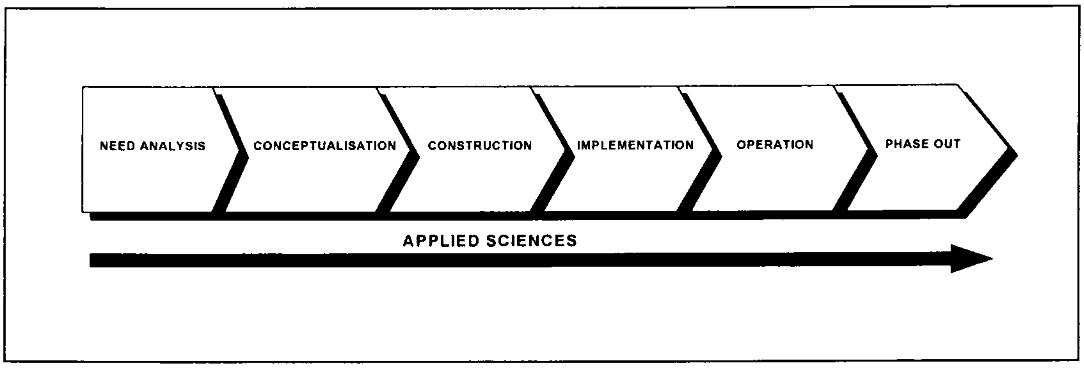

Figure 6 - The classical approach to engineering

Engineering is the profession that strives towards the development of solutions for the satisfaction of human requirements by the application of the sciences (Blanchard: 5).

This process is based on an understanding of these requirements; the invention, conceptualisation and creation of solutions; and the development, application and maintenance thereof. The three fundamental skills necessary for the delivery of an engineered solution are:

- Innovation;
- a structured and systematic approach; and
- the application of scientific methods.

These skills are applied intuitively by engineers. Because they are so crucial to the delivery of an engineered solution, they are examined in more detail.

4.2 Innovation

4.2.1 The need for innovation

Innovation is the first of the three skills that are applied in an engineering approach.

Although many authorities (Buzan: 6, De Bono: 8,9,10,11, Neethling: 36) use the terms *innovation* and *creativity* interchangeably, innovation, for the purposes of this thesis, will be viewed as being concerned with the development of concepts and solutions for industry and business through lateral thinking, which should be contrasted against creativity which is viewed as an artistic skill.

Innovation is defined as a change in perception of the environment; the generation of concepts and models based on these new perceptions; and judgement of the outputs of the innovation process in accordance with these new insights.

There are four primary reasons for the importance of innovation (De Bono: 11):

- The introduction of information technology into commercial use has transformed the role of human resources in organisations to an intellectual role, in contrast to the era of pure industrialism where human resources acted as extensions to machines. The capabilities offered by information technology and automation have extended from initial computation and storage and retrieval capabilities through operational automation to neural networking, expert systems and decision support. This general tendency shifted the emphasis back to a redefinition of the role of the human resource, concentrating on the skills not yet offered by technology. Up to date, the ability to innovate has not yet been reproduced by technology.

These new roles of human and technological resources in the intellectual process are shown in figure 7.

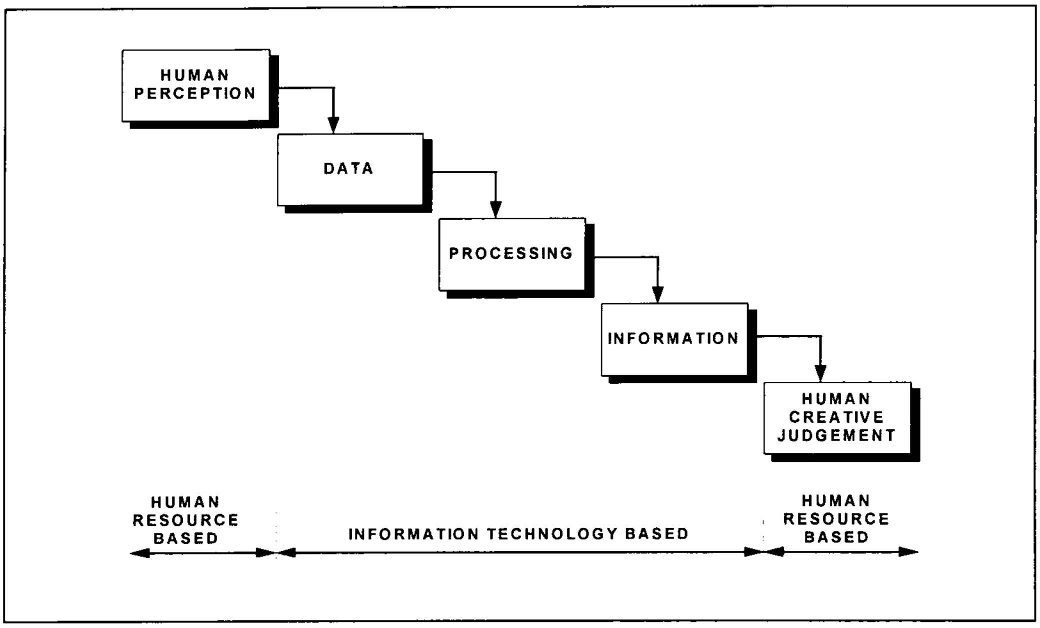

Figure 7 - The role of human and technological resources in innovation

- At some stage in future the application of technology across organisations will have homogenised to such a level that it will no longer act as a source of competitiveness, and competitive advantage will then be offered by the human skill to perceive and interact with technology. The ultimate competence will then be innovation.
- The exponential rate of environmental change forces a focus on intellectual resources to stay in equilibrium with the environment.
- Generally, innovation is aimed at objectives such as improvement and simplification, problem solving and task setting, creation of value, the adaptation to future discontinuities and for motivational purposes.

The process of business transformation requires a continuous approach towards the development of new concepts and solutions for the requirements and expectations of organisations. Other skills, in addition to technical skills are therefore required to enable an organisation to deal with environmental change.

4.2.2 The thinking process

"Moreover, the works already known are due to chance and experiment rather than to sciences; for the sciences we now possess are merely systems for the nice ordering and setting forth of things already invented; not methods of invention or direction of new works"

Francis Bacon in "Novum Organum"

It is not possible to innovate through a deductive logical thought process, although the domain of innovation as a field of study has its own logic.

The concepts and solutions that are generally accepted as the breakthroughs of the current society were mostly never intended to be the way they turned out. They were created by chance. They were based on some form of induction or an investigation that seemed unrealistic at the time. Innovation therefore, has tended to be a random event that merely occurred along the way, and engineers will generally not argue that they have mastered the process of innovation.

Upon examination of the way in which all current innovations in use were developed, it can be declared that they occurred by mistake, by accident or by madness (De Bono: 11).

Innovation occurs in an illogical fashion. The principles upon which these innovations are based are perfectly obvious and logical afterwards, therefore some may argue that a deductive logical thought process will ultimately lead to innovation. If a deductive logical thought process is employed however, no results are achieved. Innovation is therefore a process of defining new logic based on what is, according to understanding at the time, illogical. An external intervention or provocation is required as a catalyst for innovation.

The inherent thinking and the influence of provocation are shown in figure 8.

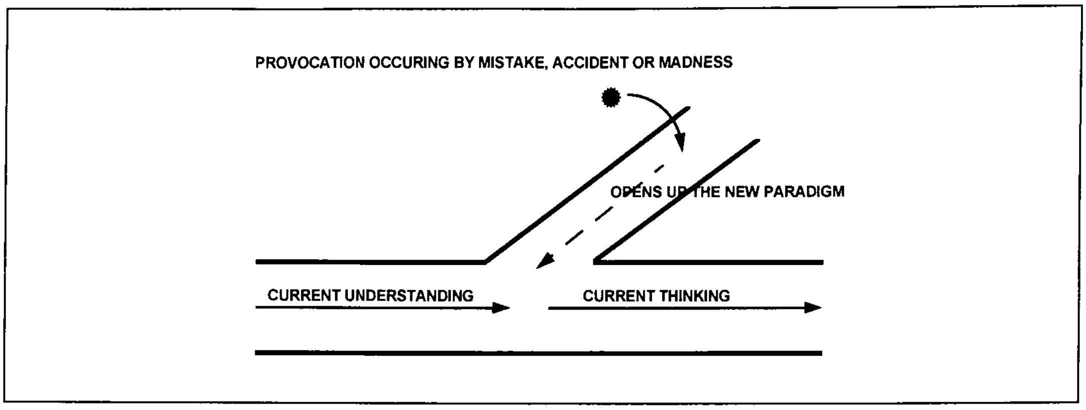

Figure 8 - Inherent thinking and the influence of provocation (De Bono: 11)

All current authorities in the field of innovation (Buzan: 6,De Bono: 9, Neethling: 36) agree that this inability to consciously innovate is based on the fact that no deliberate efforts were made in history to develop and teach innovative skills to mankind. The continuum of time is used to analyse the evolution of the thinking processes inherent in society. This continuum is shown in figure 9.

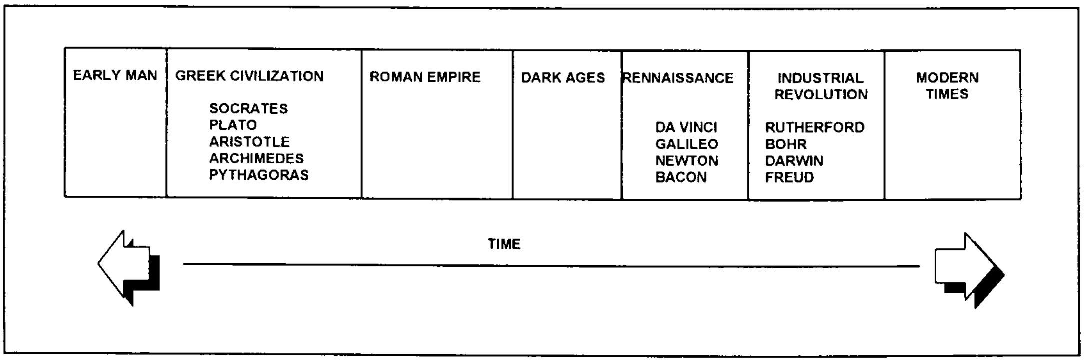

Figure 9 - Continuum of time

Of early man's thought processes, little is known other than that the earliest innovations such as fire and wheels most probably also occurred coincidentally. During the Greek Civilisation, philosophy as it is known today dawned due to the emphasis placed on the development of thinking skills. During the Roman Civili-sation, much emphasis was placed on the maintenance of knowledge, effectively that knowledge which was developed by the Greeks. The Dark Ages conceived little more than religious thinking and teaching, often oppressing innovative or scientific thoughts, whilst the Renaissance gave birth to humanistic approaches aimed at debating the religious thinking of the Dark Ages; as well as giving birth to modern science. During the Industrial Age, as explained, focus was directed at mechanisation and analysis.

In order to understand the misconceptions that serve as a base for the thinking process, the Greek teachings should thus be examined, the three main contributors being Socrates, Plato and Aristotle, as there was merely expanded upon their philosophies through the ages (De Bono: 11):

- The Socratic approach is aimed at argument, questioning and criticism and became a cornerstone of modern engineering thought;
- the teachings of Plato expanded on that of Socrates, focusing on universal truths, that is, proving the truth; and
- the teachings of Aristotle focused on categorising objects and events and then applying sets of rules applicable to each category.

None of these approaches enables innovation, but rather they thrive on analysis of current understanding.

4.2.3 The innovation process

From the fundamental point of view as presented in this thesis, it is of interest to understand the underlying process of innovation. The process presented here is the generic approach that was derived from De Bono's concept of *Six Hat Thinking (9)* and Buzan and Neethling's *Whole brain thinking (6,36)*.

This process is shown in figure 10.

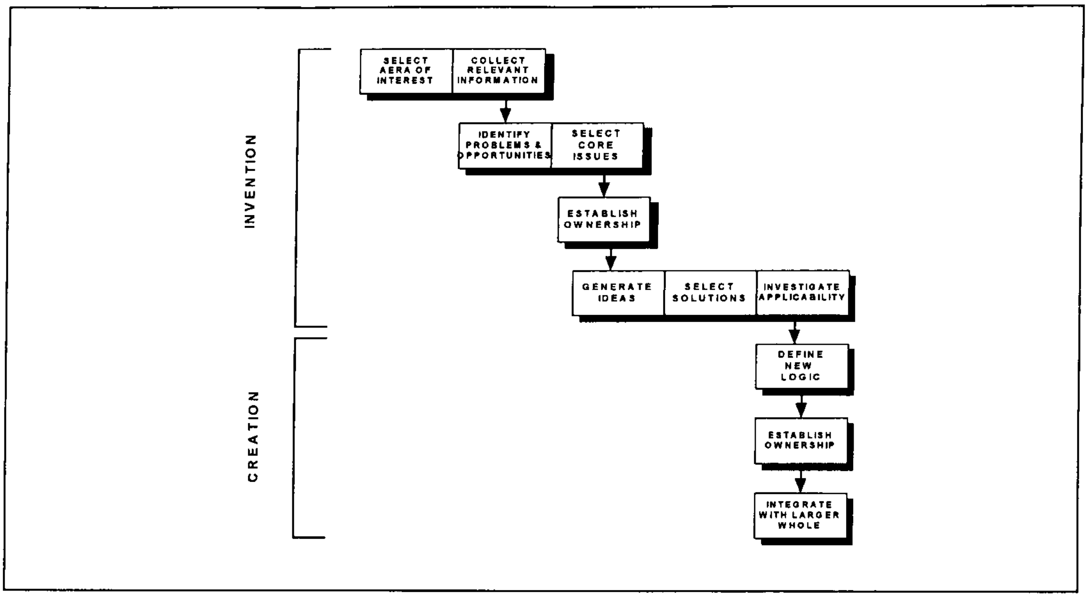

Figure 10 - The innovation processes

The invention process consists of the following activities:

- Select an area of interest based on either the existence of problems and opportunities;
- collect information without prejudice towards the possible relevance of the information;
- identify problem areas and areas of opportunity;
- select the core issues that must be addressed;
- establish ownership of these issues;
- generate ideas or solutions for these issues;
- select the most suitable ideas or solutions; and
- investigate the applicability of the proposed ideas or solutions.

The creation process consists of the following activities:

- Define the logic of the proposed ideas or solutions; and
- establish ownership of the proposed ideas or solutions.

4.2.4 Methods

Methods are needed to stimulate the thought process that leads to innovation. This paragraph discusses the three major innovation methods (De Bono: 11).

(a) Challenge

Challenging a concept is an approach that seeks an answer to the question: "Why do the current objects/events exist?"

The object of the approach is to understand the core principles and assumptions underlying the area under scrutiny in an effort to provoke the generation of alternatives. Focus is aimed at current thinking; situations in general; systems and objects; questioning issues such as necessity, reasoning and uniqueness.

(b) Alternatives

The generation of alternatives is an approach that is aimed at the identification of mutually independent concepts directed at the issue at hand, and focusing idea generation on each of these concepts.

The approach followed to generate alternatives is shown in figure 11.

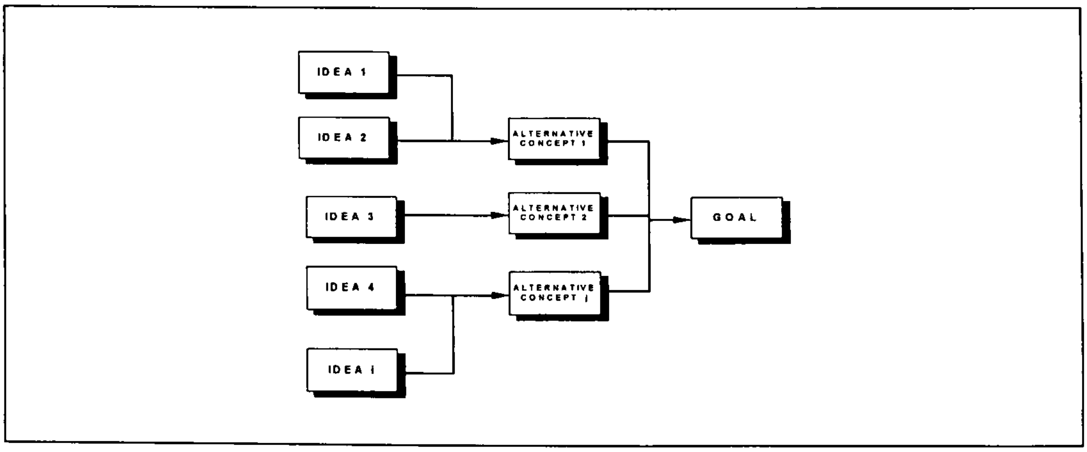

Figure 11 - Ideas and alternatives

(c) Provocation

Perhaps the most powerful group of techniques in the innovation process are the techniques aimed at provocation, that is, selecting some illogical proposal and investigating it to an extent where provocation occurs towards the formulation of an idea or solution which is feasible; and definition of the new logic thereafter.

De Bono (11) suggests that there are in fact three logical operators in response to any information presented namely a positive operator, a negative operator and an operator that designates interest or provocation. Two issues have to be assessed namely the establishment of provocation and the generation of ideas from such provocation.

The different methods in the establishment of provocation are shown in table 1.

TYPE OF PROVOCATION	METHOD	PRINCIPLE APPLIED
Random occurrence	None	It is one's privilege to treat an idea which seems not feasible as a provocation
Deliberate	Escape	Removal of a necessary ingredient from the system and development of a concept that ensures normal operation without such an ingredient
	Reversal	Changing the relationships within the system
	Exaggera-tion	Magnification or reduction of the dimensions of the system
	Distortion	Changing the sequence of the elements of the system
	Wishful thin-king	Focusing on solutions which seem impossible but, if they can be implemented, will lead to fundamental changes in the environment
Starting over	Metaphor	Selection of an analogy and analysis of the properties of the analogy in order to synthesise them into the current situation
	Random trigger	Selection of random words, events or objects and further investigation leading to new ideas

Table 1 - Establishment of provocation

The different methods employed in the investigation of provocation are shown in table 2.

METHOD	PRINCIPLE
Extraction of principles	Extract one of the principles, concepts or fundamentals of the provocation and apply it to the situation under scrutiny
Focusing on differences	Investigate the difference between the situation under scrutiny and the provocation and expand on this
Focusing on advantages	Investigate the advantages of the application of the provocation
Focusing on special circumstances	Investigate possible circumstances other than the situation at hand to which the provocation can be applied
Dynamic Simulation	Analyse the effects of implementation of the provocation on a moment to moment basis, focusing on the state transformations

Table 2 - Idea generation from provocation

4.2.5 Relevance in business transformation

Innovation leads to a change in thinking, which in turn leads to the products or services provided by organisations being different, or to the processes or systems that produce them being different. Collectively these components are known as business innovation. Within business transformation, it is suggested that business innovation consists of the following elements:

- Product innovation aimed at different products or similar products with different properties being offered to the marketplace;
- process innovation aimed at organisations employing different processes or systems or similar processes or systems with different properties; or
- innovative thinking aimed at viewing business situations from different perspectives, leading to new and original concepts.

4.3 Structured and systematic

4.3.1 Systems theory

A structured and systematic focus is the second skill required in an engineering approach. The term systematic was derived from the term system.

This skill is used in order to understand the systemic relationships between an entity and its environment as well as the internal relationships within the entity. It forces one to focus on the relationships, be they sequential or causal, between entities. The cornerstone of a structured or systemic focus is the definition of the systems concept, which is a way by which the relationship between environmental requirements and satisfaction thereof can be understood. This inevitably leads to the viewpoint that engineering is a multidisciplinary system within an environmental system that supplies input and expects output, and that a structured approach is the means through which engineering reacts.

"SYSTEMS THEORY - the transdisciplinary study of the abstract organisation of phenomena, independent of their substance, type, or spatial or temporal scale of existence. It investigates both the principles common to all complex entities, and the (usually mathematical) models that can be used to describe them. Systems theory was proposed in the 1940s by biologist Ludwig von Bertalanffy and furthered by Ross Ashby. Von Bertalanffy was both reacting against reductionism and attempting to revive the unity of science. He emphasised that real systems are open to, and interact with, their environments, and that they can acquire qualitatively new properties through emergence, resulting in continual evolution. Rather than reducing an entity to the properties of its parts or elements, systems theory focuses on the arrangement of and relations between the parts that connect them into a whole. This particular organisation determines a system, which is independent of the concrete substance of the elements. Thus, the same concepts and principles of organisation underlie the different disciplines, providing a basis for their unification. Systems concepts include: system environment boundary, input, output, process, state, hierarchy, goal orientation and information."

Francis Heylighen in "Principia Cybernetica", Cambridge Dictionary of Philosophy (48)

The evolution of the sciences, in the 1950s, lead to the conception of what is has generally been termed the systems approach. Attention was drawn to this concept by the work of biologist Von Bertalanffy (48) who predicted that it would become a fundamental of modern scientific thought. The concept is not new but its organisational role is.

Ackoff (1) defines a system as a set of two or more interrelated elements of any kind. Therefore, it is not an ultimate indivisible element but a whole that can be divided into parts.

The elements of the set and the set of elements that form a system have the following properties:

- The properties or behaviour of each element of the set has an effect on the properties or behaviour of the set taken as a whole.
- The properties and behaviour of each element, and the way they affect the whole, depend on the properties and behaviour of at least one other element in the set. Therefore, no part has an independent effect on the whole and each is affected by at least one other part.
- Every possible subgroup of elements in the set has the first two properties: each has a non-independent effect on the whole. Therefore, the whole cannot be decomposed into independent subsets. A system cannot be subdivided into independent subsystems as they will not be able to do what the whole system is designed to do.
- System input creates some for of expectation of a corresponding output.
- Every system strives towards some form of entropy.

Because of these properties a set of elements that form a system always has some characteristics, or can display some behaviour, that none of its parts or subgroups can. A system is more than the sum of its parts. Furthermore, membership in the system either increases or decreases the capabilities of each element; it does not leave them unaffected.

Viewed structurally, a system is a dividable whole; but viewed functionally, it is an undividable whole in the sense that some of its essential properties are lost when it is taken apart. The parts of the system may themselves be systems (subsystems) and every system or subsystem may in itself be part of one or more larger systems. Therefore, systems thinking tends to focus on phenomena as elements of larger wholes rather than wholes to be taken apart.

4.3.2 The life-cycle concept

Having understood the properties and functioning of systems generically, an understanding is required of the basic structure that the systems approach enables. Blanchard (5) suggests the application of a life-cycle approach.

A system does not exist coincidentally but exists in order to obey the rules set by some predetermined external purpose by initially pursuing the purpose and if it can in fact be reached, maintaining the properties of the purpose for the length of the useful life thereof, after which the system either seizes to exist or a new cycle is initiated.

A system interacts with its environment (larger whole) from which the purpose is derived based on the requirements set by the environment. It subsequently processes these requirements and the resources given by the environment into something that satisfies the requirements.

Blanchard's life cycle concept is derived from the point of view that life in general is cyclical and can be modelled as a system as shown in figure 12.

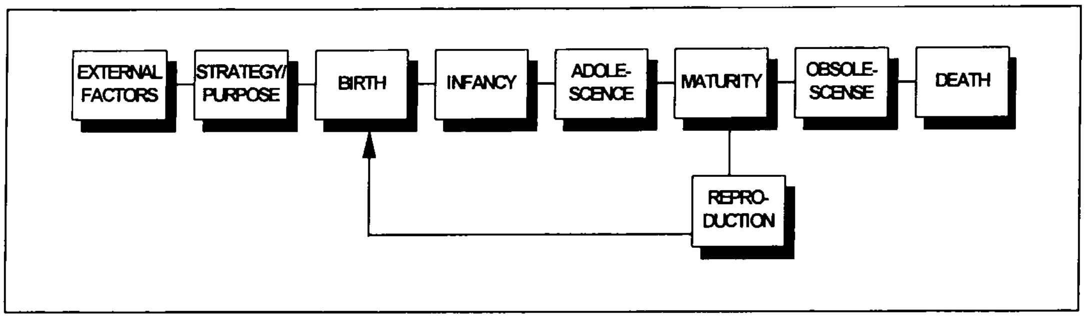

Figure 12 - The life cycle of a system

The model is based on the life cycle of living beings. Entities are born into nature or society with the purpose of interacting with the larger system of which they are part (such as the ecosystem), and for as long as they are able to contribute towards the requirements of nature, sustain their own being, reproduce and eventually cease to exist.

There is a correlation between the life cycle of man and that of man-made systems. In the investigation of man-made systems, the environment needs to be assessed in terms of its interaction (supply and demand), what it requires from the proposed system, what processing is needed to satisfy these requirements and what resources are needed for conversion or processing. Hereafter, an examination can be made of what happens to the system after these requirements are fulfilled in terms of reproduction and disposal.

4.3.3 Levels of abstraction

Implied in the argument in paragraph 4.3.1 is the notion that systems are part of larger systems and larger systems are made up of subsystems.

Systems can be viewed by means of conceptual models, depicting the basic concepts that are pursued by each element, and such conceptual systems can be viewed as set of *activities* related to the pursuit of a function. These activities can further be analysed in terms of the *events* taking place within them in the form of transactions relating to the whole. Any system whether a larger whole, subsystem or element thereof, presents unique, but conceptually similar configurations.

4.3.4 Cybernetics

If systems are viewed as a way through which interaction with the environment occurs, the performance of this interaction can be measured. If, according to the measurement, performance is not satisfactory the system responds by transforming itself and measurement is repeated. This approach, also termed feedback control, lead to the discipline of cybernetics (Weiner: 49) being created. Feedback control can take place in real time. This, together with the complexity of the environment may hide the relationships between input and output. This often leads to discarding cybernetics in complex situations and limiting its application to engineering designed products. The theory however, is also applicable to complex real word systems such as social structure and business transformation even if limited to a way of thinking rather than through a formal application. Cybernetics leads to the notion of viewing systems as cycles that are adaptive and learning.

4.3.5 System cost-effectiveness

The systems approach defines the concept of cost-effectiveness (Blanchard: 5) in terms of the following two factors in order to determine the performance of a system:

- The financial performance (cost) of the system based on the full life cycle and taking all resources commissioned into account; and
- the technical performance (effectiveness) of the system based on technical parameters such as its reliability, availability and maintainability.

This breakdown is shown in figure 13.

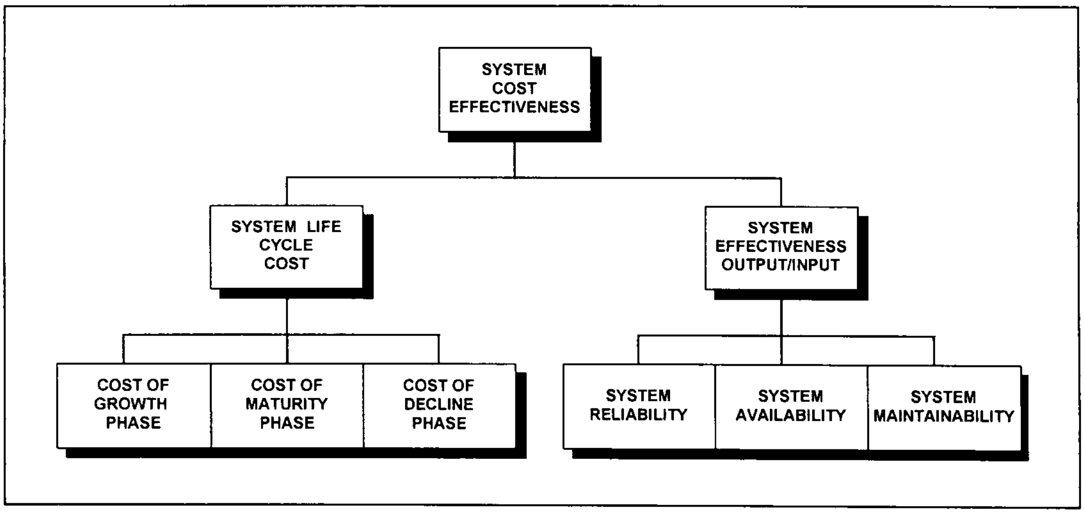

Figure 13 - System cost-effectiveness

4.3.6 Static and dynamic systems

The performance of a system can be assessed in both static as well as dynamic states.

The static state focuses on the different levels of performance, whereas the dynamic state focuses on the transformation process that the system collectively experiences when its elements are left to interact mutually and with their environment. This interaction tends to either strive towards equilibrium (steady state), or it displays a regenerative effect.

System dynamics modelling is an approach initially proposed by Forrester (15,16) in order to model and analyse the dynamic behaviour of systems. The approach has since been employed to model industrial systems, ecological and agricultural systems, as well as the general environmental impacts of human development. System dynamics modelling, similar to feedback control theory applies fundamental laws of nature in order to derive the differential equations that describe the dynamic behaviour of engineering systems. It focuses on the causal relationships between physical entities within the system. It subsequently employs a numerical approach towards the assessment of the dynamic behaviour of systems and solves the inherent differential equations recursively with the aid of computer processing. Simulation modelling as a subject area is based on this approach.

System dynamics modelling represents a system in terms of levels where values are accumulated and which act as photographs of the system state at any given time, and rates (units/time) which exist for a predetermined time interval and influence or are influenced by these levels. These influences are defined as causal relationships between levels and rates. Feedback is constructed once this interaction has taken place. The modelling approach further distinguishes between systemic or physical flow, and causal flow, the latter being the information ordering the interaction between a cause and its effect. It is presumed that a rate always affects a level, whereas a level might or might not affect a rate. Whenever a level influences a rate, feedback is created since a rate always influences the corresponding level. A brief discussion of system dynamics modelling follows.

There are many lessons to be learnt from system dynamics, but perhaps the most important of all is that there are always interrelationships between systems. Even if any given system is modelled as a closed and simple representation of reality, it is only possible because the environment was reduced to a few inputs and outputs through the assumptions that were made. System dynamics modelling has been applied to modelling of the systemic interaction between natural resources and the consumers of such resources (Meadows: 28,29). This analysis can be undertaken at a global level or at the level of a specific industry.

"The most important part of our way of looking, the part that is perhaps least widely shared, is our systems viewpoint. A systems viewpoint is not necessarily a better one than any other, just a different one. Like any viewpoint, like the top of any hill you climb, it lets you see some things you would never have noticed from any other place and it blocks the view of other things. Systems training has taught us to see the world as a set of unfolding dynamic behaviour patterns such as growth, decline, oscillation, overshoot. It has taught us to focus on interconnections. We see the economy and the environment as one system. We see stocks and flows and feedbacks and thresholds in that system, all of which influence the way the system behaves."

Meadows, Meadows and Randers in "Beyond the limits" (29 page 27)

The system dynamics approach is based on the following elements:

- A system or subsystem to be modelled;
- causal relationship logic within the system;
- basic entities within the system of which the levels can be measured;
- the levels of these entities;
- initial values for these levels;
- rates at which these levels grow under the influence of systemic interaction;
- rates at which these levels decrease under the influence of systemic interaction; and
- closed loops and feedback within the system.

These basic conventions are shown in a simple systems configuration shown in figure 14.

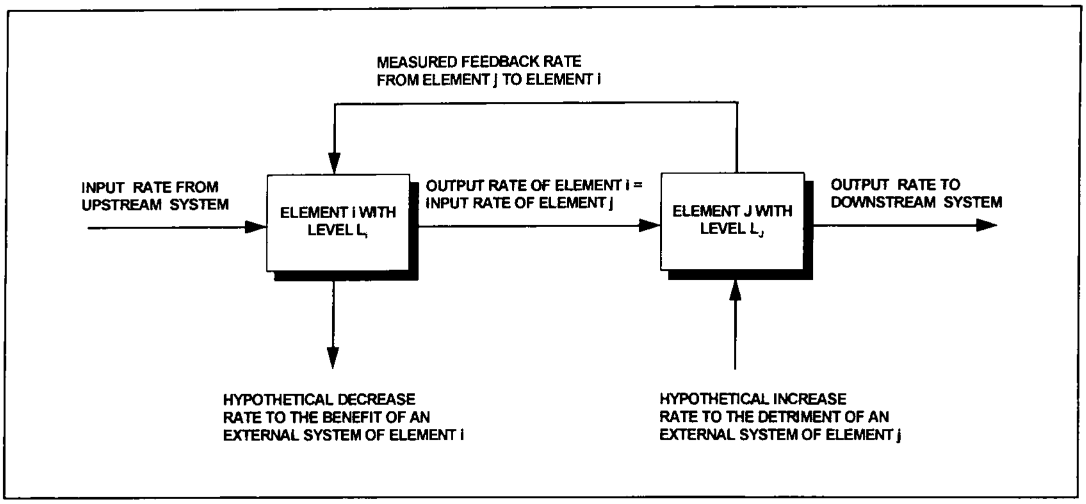

Figure 14 - System dynamics conventions

The system dynamics approach then repeatedly applies two basic recursive formulae (for each time increment) until a pattern emerges in respect of the dynamic behaviour of the system. For obvious reasons, this modelling should be executed with the aid of computers.

The basic recursive formulae that are applied for each element are:

Input of element j_t = output of element i_t

Transformation of element j_t = input of element j_t + (net rate * Δt); and

Output of element j_t = level of element j_{t-1} + transformation of element j_t.

In these equations, t is a specific moment in time, Δt represents the time increment and the net rate is the net result of increase and decrease rates at element j.

The application of these formulae leads to iterative calculation of the new level and the output rate of each element of the system. The object of the system dynamics model is to show trends in these levels as a result of the interaction within a system. This is achieved when some pattern, steady state or otherwise, emerges.

There are a number of generalities in the patterns that emerge from the data generated by the system dynamics model.

The four basic models (29) that emerge are shown in figure 15.

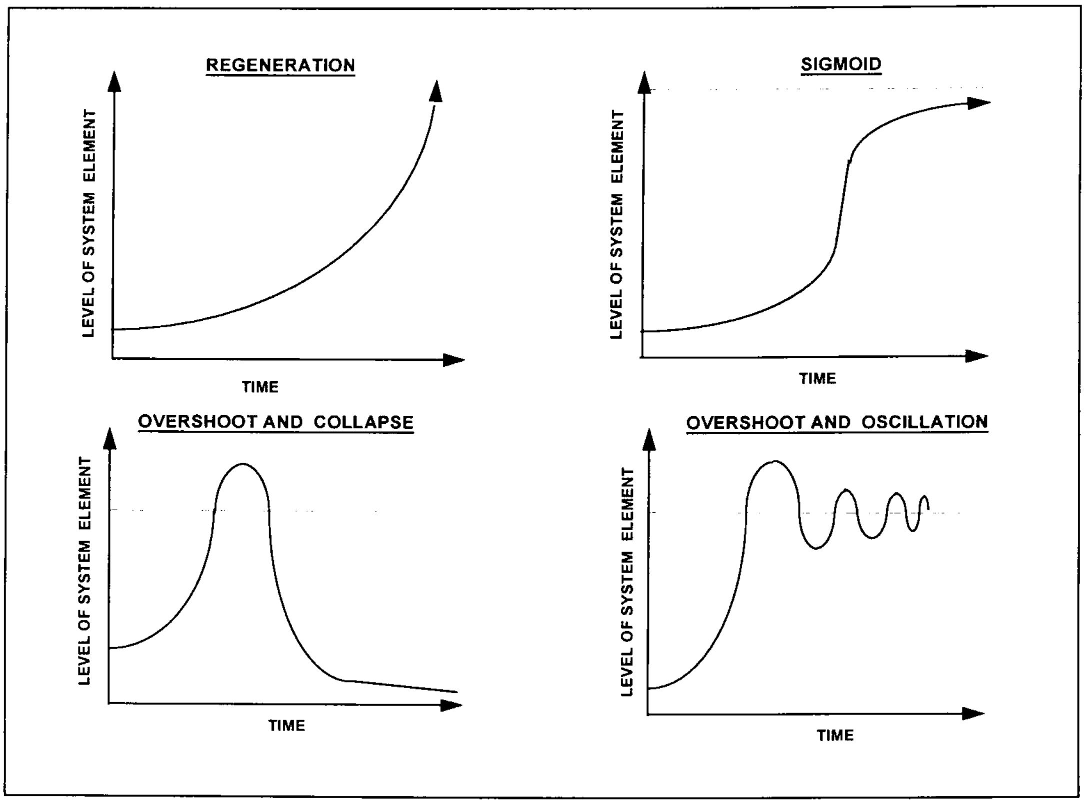

Figure 15 - The four basic system models

(a) Regeneration

Regeneration or exponential growth is defined as growth of an entity level proportional to its current level.

Regeneration occurs for one of two reasons:

- An entity reproduces itself out of itself; or
- an entity is driven by another entity that reproduces itself out of itself.

Based on these conditions, all living creatures as well as their resource requirements are described by exponential growth or decline. The two most significant of these are:

- Society and the resources it consumes; and
- organisations, based on the consumption of resources and the regeneration of wealth (new resources).

(b) Sigmoid approach to equilibrium

Through the logistic or sigmoid approach, a value is pursued as $t \rightarrow \propto$. The sigmoid approach is often an eventuality of regeneration, misleading the scientist to believe that a parameter is regenerating. This assumption lead to a great deal of controversy when system dynamics was first applied to model the earth's ecosystems in the 1970s (Meadows: 28).

(c) Overshoot and oscillation

Overshoot and oscillation are common phenomena in engineering. They occur in systems where the performance is measured and the signal adapted as a result of the measured output. Overshoot and oscillation are the purest and most manageable forms of equilibrium and is achieved through mutual alignment. It is not only manageable, but is tendency towards equilibrium is result of management (feedback control).

(d) Overshoot and collapse

Overshoot and collapse, on the other hand, is purely the result of a lack of management of a system.

4.3.7 Complex non-linear systems

Traditional systems modelling approaches are based on predictable relationships between input and output in systems and initial conditions that do not influence the actual outcome of system interaction. However, there are many cases in which the cause/effect relationships are not evident at face value due to the complexity of the system, and where the relationships between the various parameters are unpredictable. From this line of thinking emerged the field of chaos theory. It was initially applied to evolutionary biology but is similarly applicable to all types of systems that possess the characteristics of complex non-linearity (Wheatley: 50).

Wheatley (50) argues that natural systems have two basic properties:

- Diversity; and
- complexity.

As a result of this, many theories oversimplify the actual complexity of a situation and were borne from the eighteenth century's approach of Newtonian reductionism (the world is viewed as a great clockwork machine that can be decomposed and dissected). In chaos theory however, it is the relationships between elements, rather than the elements themselves that are of importance.

Through chaos, living organisms not only grow at will but has the capability to revitalise itself. De Geus (12) argues that organisations can assume a similar path.

(a) Linearity

In geometry, linearity refers to Euclidean objects: lines, planes and three-dimensional space.

These objects appear the same no matter how they are examined. A non-linear object for instance appears different on different scales. A sphere, for example when looked at from close enough looks like a plane, and from far enough looks like a point.

In algebra, linearity is defined as a function (f) having the properties of:

$f(x+y) = f(x) + f(y)$; and
$f(ax) = af(x)$; where x and y are variables and a is any constant.

(b) Complexity

A system is viewed as complex when the model required to represent it can not be simplified in order to predict the results of reality. A complex system has also been defined as a system that consists of a large number of agents that interact with each other in various ways. Such a system becomes adaptive (or learning) if these agents change their actions as a result of the events in the process of interaction.

(c) Chaos

"Chaos is a name for any order that produces confusion in our minds."

George Santayana

Chaos theory is defined as the qualitative study of unstable aperiodic behaviour in deterministic non-linear dynamic systems being sensitive for initial conditions.

The term *Chaos Theory* is most widely used to describe the discipline of modelling and analysing complex non-linear systems. The term was introduced by Gleick in 1987 (17) and refined by others such as Lorenz (24) through the use of Lyapunov exponents (52).

There has been a significant amount of speculation about the possible use of such an approach in business management, mainly by Peters (37,38), Senge (40,41) and Wheatley (50). None of these theoreticians have up to date demonstrated successfully how to apply the pure scientific formulae of chaos theory on organisations as complex non-linear systems. They have, however, demonstrated very successfully that the metaphors of the approach are extremely applicable in our understanding of organisations as chaotic systems.

In recognising organisations as chaotic systems, the following properties are acknowledged:

- The greater the number of counteracting forces in the organisation, the higher the likelihood of chaos;
- an organisation will always be in one of the following states:
  - stable equilibrium;
  - periodic equilibrium;
  - dynamic equilibrium; or
  - chaos.
- forecasting under chaotic conditions is difficult;
- from chaos, new stabilities emerge;
- similar actions taken by organisations in a state of chaos will not lead to similar results;
- forces of order and stability are used to close a system which is too complex to be mastered;
- search for order is an attempt to build islands of security and rationality; and
- chaos has an underlying order - it contains the seeds of new stabilities.

The differences between order and linearity, versus chaos and non-linearity in organisations are shown in table 3.

TYPE OF SYSTEM	ENVIRONMENT	BUSINESS REQUIREMENTS
LINEAR/STABILITY	closed system stable growth clear levers of change limited competition pliant customers	continuity planning control structuring expansion
NON-LINEAR/CHAOTIC	open and complex systems rapid change intensive competition unexpected outcomes demanding and diverse customers	discontinuity speed service innovation flexibility experimentation

Table 3 - The differences between chaos and order

4.3.8 The learning organisation as basis for analysis of a business system

Organisational learning can be viewed as the process through which an organisation interacts with its environment. This implies that a so-called learning organisation is one that remains in dynamic equilibrium with its environment. The term *learning organisation* was first institutionalised by Senge (40,41) and De Geus (12). In his research, Senge argues that there are five disciplines present in a learning organisation. These disciplines are:

- Personal mastery - the ability of each individual within a system to set goals for him/herself and thereby influencing the performance of the system;
- mental models - the ability of each individual within a system to share a set of mental models, a way of thinking and the ability to create synergy within the system;
- shared vision - the collective ability of a system to strive to achieve an ultimate set of goals;
- team learning - the collective ability of a system to adapt to its environment; and
- systems thinking - the ability of the individuals within the system to understand their interrelationships and strive to improve systemic performance.

4.3.9 Systems thinking

Systems thinking is the fifth discipline that Senge refers to. This discipline incorporates the other disciplines to form a holistic (systems) view of the organisation.

(a) Basic systemic behaviour

There are a number of generic types of systemic behaviour present in any system (41).

Systemic relationships

Systemic relationships occur when the behaviour of one system or subsystem, influences the behaviour of another system or subsystem. This relationship can be causal (B occurs as a result of A occurring) or sequential (B is preceded by A) in nature. When the relationship is sequential, the system is termed a *process*. These systemic relationships are shown in figure 16.

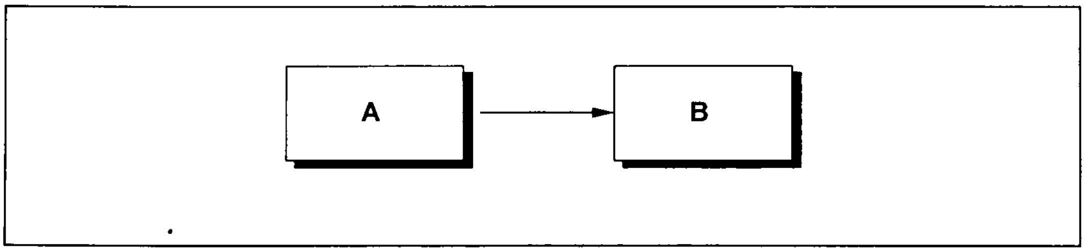

Figure 16 - Causal or sequential relationships

Feedback

Feedback occurs when the behaviour of system or subsystem A influences the behaviour of system or subsystem B and B responds by having some influence back to A.

This relationship occurs when growth in A leads to either growth or decline in B as shown in figure 17.

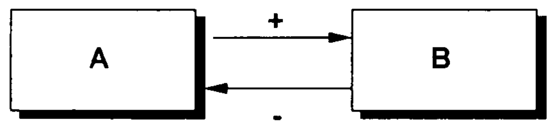

Figure 17 - Feedback

Delays

A delay occurs when a time delay exists before feedback is given. Senge (40) remarks that cause and effect are not always closely related in time and space.

A delay is shown in figure 18.

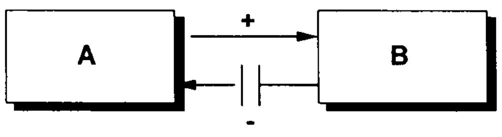

Figure 18 – Delays

Virtuous and vicious cycles

Virtuous and vicious cycles occur when a system which forms a closed loop, builds upon its own growth or decay. An example of a virtuous cycle is given in figure 19.

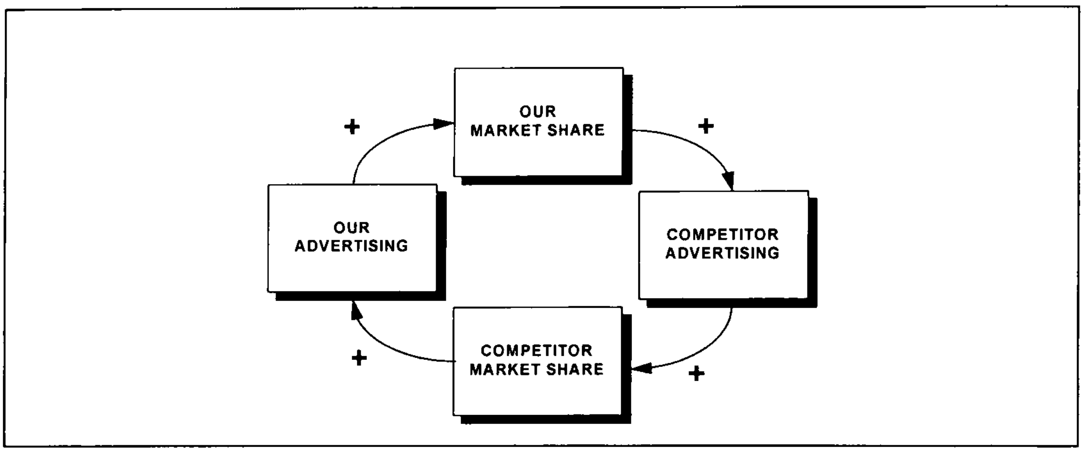

Figure 19 - Virtuous cycle

Balancing effects

Balancing effects occur when growth or decline in another system balances growth or decline in a particular system.

This relationship is shown in figure 20.

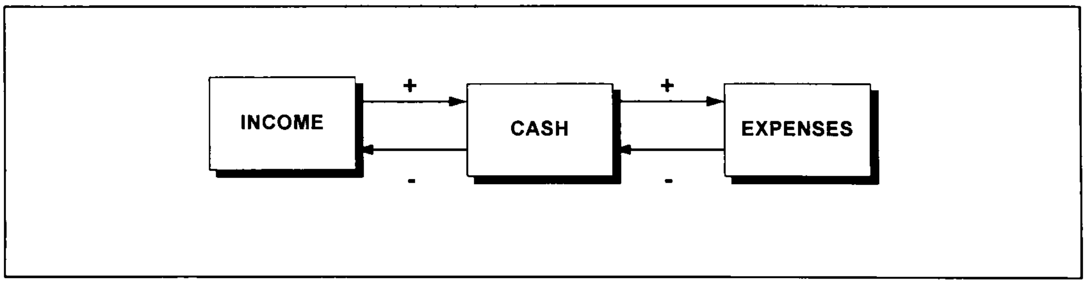

Figure 20 - Balancing effect

Regeneration

Exponential growth or decay occurs when a system reproduces itself or is driven by a system that reproduces itself. It results from a system being dominated by either a virtuous or a vicious loop. The relationship between input and output through the system then tends to be exponential rather than linear.

This relationship is shown in figure 21.

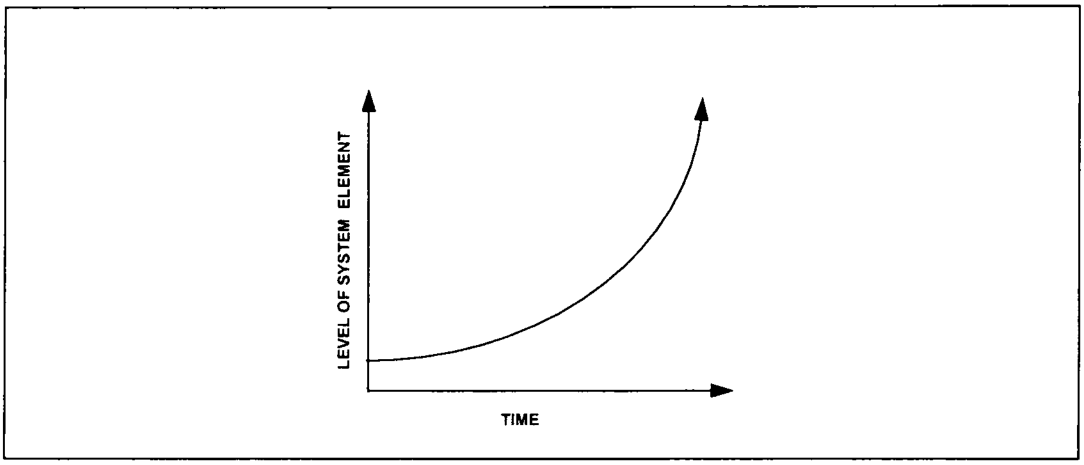

Figure 21 - Exponential growth

Goal seeking behaviour

Goal seeking behaviour occurs when a system shows a tendency to return to its original state after disturbance. This indicates at least one strong negative feed-back loop.

This relationship is shown in figure 22.

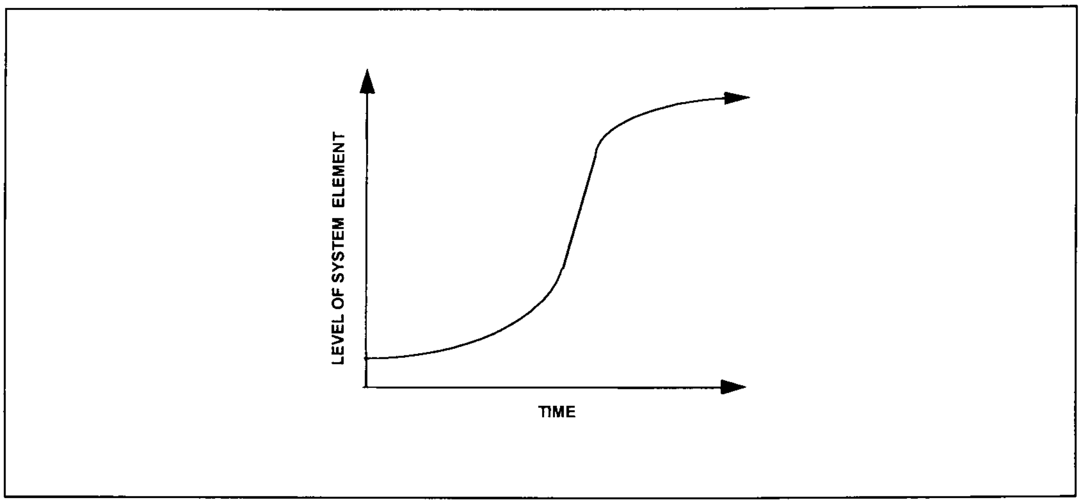

Figure 22 - Goal seeking behaviour

Oscillating behaviour

Oscillating behaviour occurs when a system's output alternates between two levels with a decrease in amplitude.

This relationship is shown in figure 23.

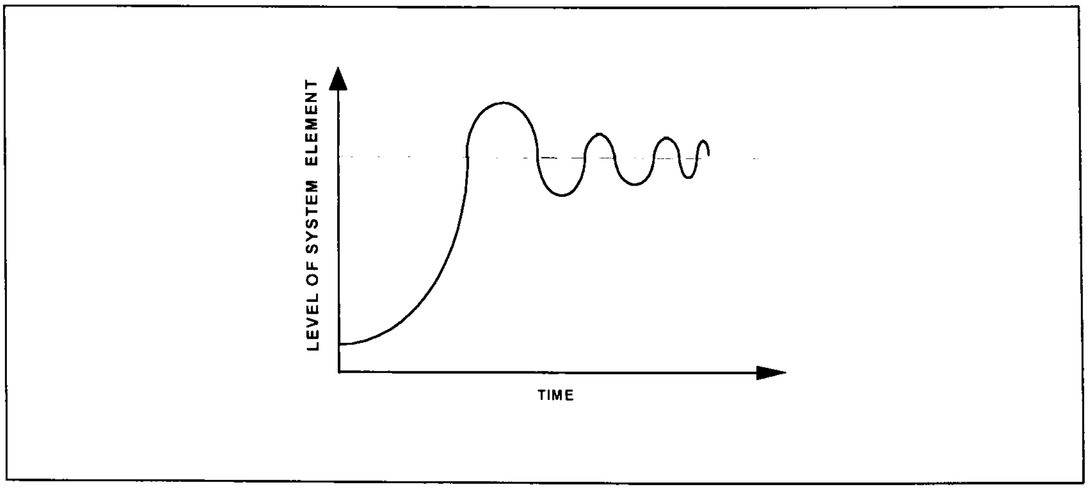

Figure 23 - Oscillating behaviour

(b) Systems archetypes

Similar to the various type of systemic behaviour, there are a number of identifiable systemic configurations which, when identified, can be addressed by specific actions (Senge: 41).

Limits to growth

Limits to growth occur when continuous efforts produce diminishing returns as a limit is approached. A limit to growth is often called a system constraint.

Typical limits to growth are:

- Resources;
- capacity;
- mental models (behaviour and policy); and
- markets.

Drifting goals

To set a performance goal within a system induces two kinds of behaviour:

- Pressure to achieve the goal; and
- pressure to lower the goal.

Drifting goals occur because there is a gap between the goal and the actual condition and the goal is lowered to close the gap.

Quick fixes

Quick fixes occur when a solution that was provided to a problem did not address it fundamentally. The net result of this is that the problem returns over time.

Accidental adversaries

Accidental adversaries occur when two subsystems, intending to contribute to the overall system, negate each other's contributions in the process.

Addiction

Addiction occurs when a system or subsystem, in an effort to solve a problem, becomes reliant on the continuous provision of the solution and this in turn, becomes a problem.

4.3.10 Relevance in business transformation

Upon investigation, the approach of viewing an organisation as some form of system is valid. An organisation is a system with input, processing and output. The view of an organisation as some form of system, facilitates the employment of:

- Cause/effect logic – to analyse the systemic behaviour within the organisation;
- systems modelling approaches - to build models that represent the static or dynamic behaviour of an organisation;
- cybernetics - to manage business performance and adapt according to the feedback that was measured; and
- complex systems theory - to use the metaphors of chaos to evaluate the state of the organisation under complex non-linear conditions.

4.4 Applied sciences

4.4.1 Logic

The application of scientific techniques, based on fundamental truths and universal logic, is the third skill that is required in an engineering approach.

The pure sciences provide the ability to manipulate the relationships between the elements of a system or subsystem. Engineering draws largely upon the approaches supplied by applied mathematics, pure mathematics and mathematical statistics. In Industrial Engineering the economic, management and behavioural sciences are also included.

A brief overview is presented of the fundamental scientific skills that are applied in engineering.

4.4.2 Modelling

In order to gain a complete understanding of a system, it is useful to both analyse the properties of the system, and to synthesise it within the larger whole.

This is usually achieved through the compilation of various types of models. These models are based on assumptions that simplify reality (Winston: 51).

4.4.3 Simplification

The most fundamental scientific method is the simplification of the elements of a system.

Simplification implies the reduction of the elements and complexities to simpler elements. In doing this, pure mathematics is applied (Winston: 51). Implicitly, the properties of a complex system are reduced to a single set of properties where the single property is expressed in terms of a function of the properties of the elements:

$y = f(x_1,x_2,..,x_n)$; where y is the simplified version of the mathematical relationship between $x_1,x_2,..,x_n$

The application of pure mathematics enables the derivation of rules and equations that describe the properties of the system, as well as a quantitative understanding of the system. These rules are required to form a simplified model of the different configurations possible in the system.

(a) Simplification of static models

Static modelling (Winston: 51) implies that the properties of the system are based on some function of the properties of the elements of the system, whereas dynamic modelling implies that the properties of both the system and the elements, are also functions of time. If x_{System} is a property of the total system and x_1, $x_2,..,x_n$ are properties of the n elements of the system, then a static model yields:

$x_{System} = f(x_1, x_2,..,x_n)$; and

$S = g(x_{System},y_{System};....)$; where S is defined as the global state of the system and y_{System} is defined as another property of the system.

(b) Simplification of dynamic models

A study of dynamic models (Winston: 51) yields that the property x of element i of a system is a function of time (t):

$$x_i = h(t)$$

Substitution therefore yields that the dynamic behaviour of the system in total is a function of time, expressed in terms of the state of the properties at any given time:

$$x_{System} = f(x_i(t), y_i(t),...) = f(t)$$

(c) Model creation

In order to create a model or mathematical function that describes the behaviour of a system, the properties of the system are measured and curve-fitting techniques (Miller: 30) applied in order to derive the desired function.

(d) Simplification methods

The methods applied (Miller: 30) in system simplification are shown in table 4.

METHOD	MODUS OPERANDI	OBJECTIVE
Experimentation and Sensitivity Analysis	Empirical investigation into the properties of a system	Assessment of the behaviour of the system under different conditions
Simple linear regression	Modelling an equation of the form: $y = ß_0+ß_1x + e$ by the application of the normal equations	An equation that describes the linear relationship between an independent and a dependent variable based on observed data
Curvilinear regression	Modelling an equation of the form: $y = f(x)$, for example $y = a\ ß^x+ e$ where the relationship demonstrates a non-linear trend	An equation that describes the non-linear relationship between an independent and a dependent variable and simplification of the relationship to the linear case using an appropriate substitution
Polynomial regression	Modelling an equation of the form: $y=ß_0+ß_1x+ß_2x^2+..+ß_px^p+ e$	An equation that describes the polynomial or cyclical relationship between an independent variable and dependent variables
Multiple regression	Modelling an equation of the form: $y=ß_0+ß_1x_1+ß_2x_2+..+ß_px_p+ e$	An equation that describes the linear or polynomial relationship between a dependent and a set of independent variables

Table 4 - Simplification methods

4.4.4 Forecasting

The future behaviour of a system can be determined through an analysis of the underlying relationships between the parameters of the system, or by statistical forecasting methods.

It is possible to distinguish between mathematical (algebraic) methods, statistical methods and qualitative methods of forecasting (Makridakis: 25).

(a) Mathematical methods

In this instance an exact mathematical relationship exists between the elements or parameters of a system and substitution of the known values yields the desired result (Makridakis: 25, Miller: 30).

(b) Statistical methods

In this instance, a mathematical relationship is not known and has to be approximated. Two possible approaches can be followed to forecast the state of the system:

- An analysis can be made of the statistical relationships between observations of different parameters and an equation derived through curve fitting methods (25).
- The general trends in the various parameters can be analysed in terms of time-series forecasting methods (for example Box Jenkins methods). In this instance, the dependent variable becomes a variable over time in equal time intervals. The dependent variable is seen as consisting of four components namely trend, seasonality, business cycle and an irregular component (30).

(c) Qualitative methods

In this instance, forecasting is based on intuition of authorities on the subject at hand (the Delphi method) (Morris: 35).

(d) Forecasting methods

The methods applied in forecasting (Makridakis: 25, Miller: 30) are shown in table 5.

METHOD	*MODUS OPERANDI*	*OBJECTIVE*
Mathematical methods	Application of existing equation	Determination of result based on equation
Regression	As described in 4.4.3 of Part Two	As described in 4.4.3 of Part Two
Econometric Models	Determination of the causal relationships between variables and outputs	Macro-environmental models
Time Series Forecasting	Prediction of future variable based on the trends in existing observations of that variable	Prediction of a variable at a specific point in time
Qualitative Methods	Prediction of future variables based on intuition	Reduction of unknown variables to informed guesses

Table 5 - Forecasting methods

4.4.5 Improvement

The object of the application of scientific methods in the improvement of system performance is the evaluation of the effect of changes in the different parameters or properties of the system on the system as a whole.

Improvement is defined as a favourable change in the parameters of a system or subsystem (Miller: 30).

The measurement of improvement is based on the difference between two states of a system, or two parameters of a subsystem.

Hence change in the system (ΔS) is measured as:

$\Delta S = S_{t+1} - S_{t;}$ and

$\Delta x_i = x_{i,t+1} - x_{i,t;}$ where S_{t+1} and S_t are overall states of the system at various moments in time and $x_{i,t+1}$ and $x_{i,t}$ are parameters of S at various moments in time.

If a non-zero value exists for ΔS which is favourable (positive or negative), the state of the system improved, whereas a non-zero value for Δx_i under the same conditions, indicates a favourable change in a property or parameter.

(a) Deterministic methods

In terms of deterministic methods, improvement constitutes a favourable change in the state of a system. If improvement only occurred in one or more parameters, their relationship with the global state of a system must be determined. It is then required to distinguish between parameters of a system that measure input, and parameters that measure output.

From the static model in paragraph 4.4.3 of Part Two:

$S = g(x_{System}, y_{System})$

If x_{System} is designated as a parameter of output or return, and y_{System} is designated as a parameter of input, an increase in x_{System} would indicate improvement if y_{System} is unchanged, whereas a decrease in y_{System} if x_{System} is unchanged, would also indicate improvement.

If the exact relationship between x_{System} and y_{System} is known, other combinations are also possible. For example, in the case of productivity improvement:

$S = g(x_{System}; y_{System}) = x_{System}/y_{System}$

Improvement occurs in any of the following cases:

$\Delta x_{System} > 0$ and $\Delta y_{System} < 0$; or

$\Delta x_{System} = 0$ and $\Delta y_{System} < 0$;or

$\Delta x_{System} > 0$ and $\Delta y_{System} = 0$

$\Delta x_{System} > 0$ and $\Delta y_{System} > 0$ and $\Delta x_{System} > \Delta y_{System}$; or

$\Delta x_{System} \leq 0$ and $\Delta y_{System} \leq 0$ and $\Delta x_{System} > \Delta y_{System}$.

(b) Stochastic methods

These methods are used when the knowledge of the system is based on statistical variables. There are three elements (Miller: 30) that are used to determine the uniqueness of a statistical probability distribution. These are:

- Locality;
- spread;
- shape (sharpness and scewness).

In determining improvement, it has to be ascertained whether there were significant changes in these elements.

Locality

Improvement can firstly occur as a result of a significant favourable shift in the locality (for example the mean value) of the distribution of the state of a system or subsystem. It can be analysed through statistical tests of significance.

The case of improvement through a favourable shift in the locality of a parameter is shown for the example of the mean value in figure 24.

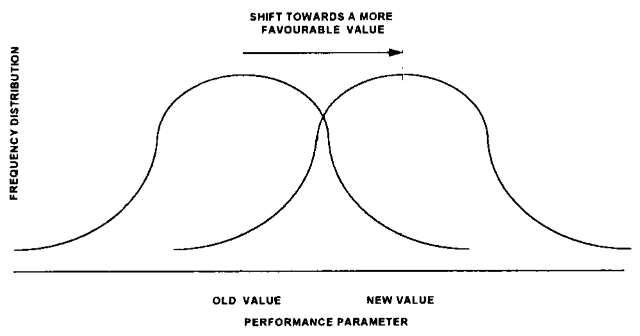

Figure 24 - Favourable change in the locality of a parameter

Spread

Secondly, improvement occurs when randomness is reduced from a system. The reduction of randomness is evaluated in terms of a decrease in the variance from the mean for the parameters or state of the system. Similar to the previous case, it can be determined through an appropriate statistical test of significance.

The case of improvement through the reduction of randomness is shown in figure 25.

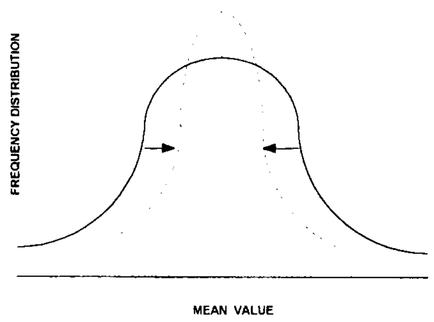

Figure 25 - Improvement through reduction of randomness

Shape

Thirdly, improvement can occur in terms of a change in the shape of the probability distribution that describes the parameter or state of a system. This is the result of a change in the sharpness or scewness of the probability distribution.

(c) Improvement measurement methods

The methods applied in system improvement measurement (Miller: 30) are shown in table 6.

METHOD	*MODUS OPERANDI*	*OBJECTIVE*
Change in locality	Determine by Statistical Process Control (X or R-chart) whether the system is in a state of statistical control Determine by significance tests using a sample value whether the locality of the parameter of a system changed significantly	Prove the emergence of a more favourable value for a given probability distribution
Change in spread	Determine by significance tests using a sample value whether the spread of the parameter of a system changed significantly	Prove the emergence of a more favourable spread for a given probability distribution
Change in shape	Determine by means of Chi-square or Kolmogorov-Smirnov tests whether a more acceptable probability distribution has emerged	Prove the emergence of a new probability distribution

Table 6 - Improvement measurement methods

4.4.6 Optimisation

Optimisation techniques are aimed at determining the most desirable state of a system and determining the conditions (parameters and properties) for which this most desirable state occurs.

Optimisation is defined as the state where improvement has occurred to the limits of inherent capability, or quite simply, that a system has arranged itself to serve its function best within the constraints set by the environmental parameters (Winston: 51).

Two approaches can be followed for the scientific optimisation of the state of a system. The first is an iterative or sensitivity analysis-based approach, where the state of a system is measured for different discrete sets of parameters and optimality is proclaimed for that which constitutes the largest improvement. Secondly, optimisation could be done through analytical methods.

(a) The iterative approach

The complexity of a system often requires that it has to be simplified and assessed using an iterative approach (Winston: 51). Intuition often designates an area where the global optimum lies and this is then tested through various iterations.

(b) The analytical approach

Pure analytical techniques can be applied tin cases where mathematical solutions are possible. There are linear optimisation techniques and non-linear optimisation techniques. Techniques that are applied include linear and dynamic programming, as well as non-linear optimisation (Winston: 51).

(c) Analytical optimisation methods

The analytical methods applied in system optimisation (Winston: 51) are shown in table 7.

METHOD	MODUS OPERANDI	OBJECTIVES
Linear Programming	Optimise the allocation of limited resources amongst competing activities given a specific objective	Determination of optimal mix of limited resources having linear relationships with respect to the given objective
Integer Programming	As for linear programming	As for linear programming but under the additional prerequisite that some of the variables in the equations are integer values
Distribution Programming	Optimise the distribution policy between sources and destinations	Determination of optimal distribution policy
Dynamic Programming	Optimise the decision policy regarding state transformations	Determination of optimal strategy
Goal Programming	Optimise linear relationships based on stakeholder criteria and priorities towards them	Determination of optimal combination of parameters based on the expectation of stakeholders
Non-linear optimisation	Optimise non-linear relationships between multiple variables	Determination of optimal combination of parameters for non-linear relationships

Table 7 - Analytical optimisation methods

4.4.7 Decision support

Lastly, all scientific techniques are ultimately aimed at supporting some form of decision or choice, therefore, a set of techniques exist to evaluate different alternatives against multiple sets of criteria and ultimately judge the proper strategy based on a scientific analysis of preference and uncertainty.

Conceptually the decision support approach is aimed at simplifying the data from the different competing alternatives, ranking them and enabling selection of the proper alternative by relating them to pre-defined criteria.

Morris (35) defines *decision theory* as the study of human decision-making behaviour, involving the development of models or structures and the experimental study of these models. A decision is defined as the conceptualisation of a choice situation, whether in the form of mental image or an explicit model. All such forms of decision modelling involve the simplification of reality.

(a) Decision support methods

The methods applied in decision support (Morris: 35) are shown in table 8.

METHOD	MODUS OPERANDI	OBJECTIVE
Deterministic Models	Investigate optimal decision based on calculation of quantitative criteria	Application of quantitative formula for alternatives
Probabilistic Models	Investigate optimal decision based on probable outcomes of the decision	Calculation of expected returns of alternatives
Qualitative Models	Evaluate alternatives based on qualitative criteria	Ranking of criteria and alternatives against these criteria
Multiple Criteria Models	Evaluate alternatives based on both qualitative and quantitative criteria	Derive an equation that incorporates rankings and quantitative methods and evaluate alternatives using this equation

Table 8 - Decision support methods

4.4.8 Relevance in business transformation

Purists might argue that the fundamental sciences encompass more than what was described in this paragraph, however, the intention was to define only the basic scientific processes and methods which act as fundamentals that are applicable to business transformation.

5 Fundamentals of Industrial Engineering

Industrial Engineering is an application of the classical engineering approach. The case for Industrial Engineering is presented in this paragraph.

5.1 *Definition*

Maynard and Salvendy (26,39) define Industrial Engineering as follows:

Industrial Engineering is concerned with the design, improvement and installation of integrated systems of people, materials, equipment and energy. It draws upon specialised knowledge and skills in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.

The following deductions are made from this definition:

- Industrial Engineering focuses on the design and installation of complex systems (or processes), which implies an interest in the interaction between elements of the system more than the mechanics inside these elements;
- it specifies, predicts and measures the performance of these systems;
- its aim is to ultimately improve the performance of these systems by focusing on the relationship between input and output;
- it strives to integrate all the production factors (resources) into these systems; and
- it applies multidisciplinary and scientific skills in the process.

5.2 Industrial Engineering Process

The Industrial Engineering process that was derived from the previous definition, is shown in figure 26.

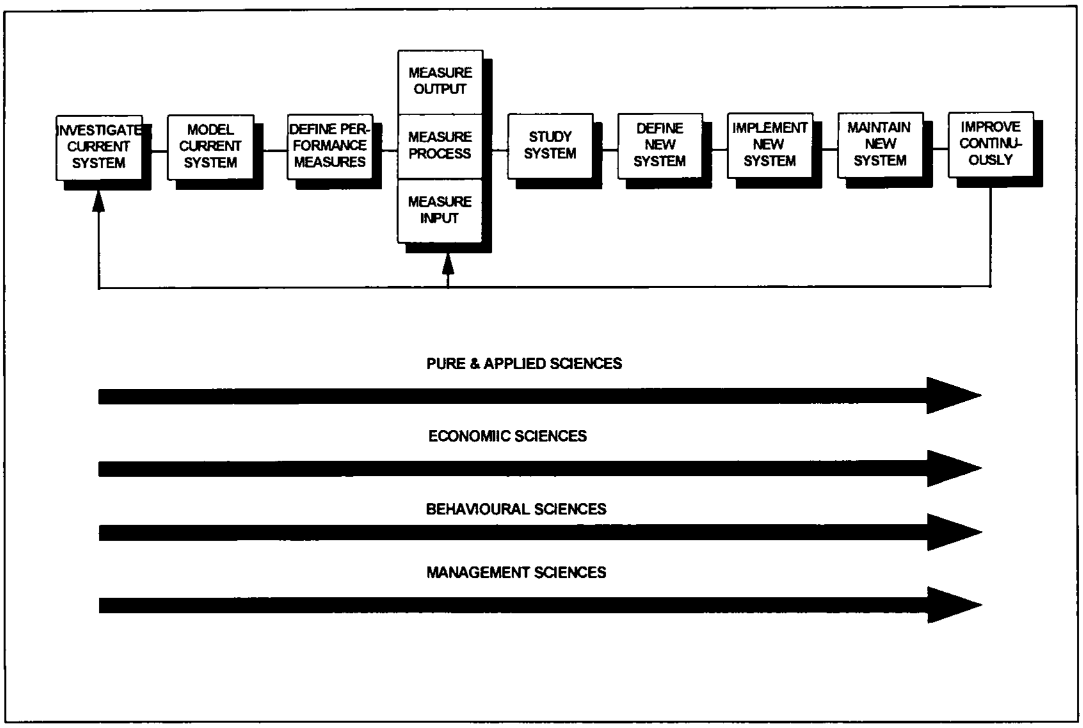

Figure 26 - The Industrial Engineering Process

The Industrial Engineering Process has historically been applied in industrial and manufacturing environments (where the system that is studied mainly consists of raw material input, machines, labourers and some form of assembly or production line). Its association with the manufacturing environment stems from the conception of Industrial Engineering in the Industrial Age, and the general association of the words *industrial* and *engineering* with manufacturing. It is obvious that the Industrial Engineering process can be applied similarly in non-industrial or non-manufacturing environments. Although this has occurred in the past it tended to deviate from the mainstream. The subject area covered in this thesis formally defines an application of Industrial Engineering in a business environment.

5.3 The principles of Industrial Engineering

The principles of Industrial Engineering, in its concern for systems, can be analysed through studying the generic systems model proposed by Sink (42) as shown in figure 27.

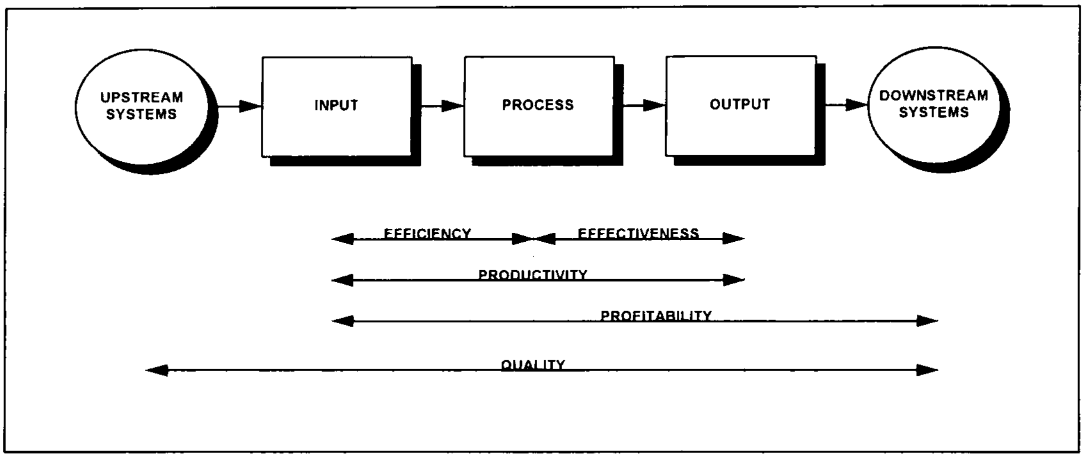

Figure 27 - The principles of Industrial Engineering

5.3.1 Systems focus

A generic system can be viewed as a configuration that translates input received from upstream systems (resources) into output as required by downstream systems (stakeholders). Industrial Engineering is concerned with the generation of improved or optimal combinations of output and throughput in relation to input with respect to these systems.

5.3.2 Productivity management

In order to optimise systems, Industrial Engineering focuses on effectiveness, efficiency, productivity, profitability and quality, an approach termed productivity management (Sink: 42).

(a) Effectiveness

Effectiveness is defined as the degree to which a system accomplishes what it is set out to accomplish (doing the right things). It is the strategic focus of productivity management (Sink: 42).

Effectiveness = (actual throughput)/(expected throughput)

(b) Efficiency

Efficiency is defined as the degree to which a system utilises its resources in correctly performing its function (doing things right). It is the operational focus of productivity management (Sink: 42).

Efficiency = (expected resources converted)/(actual resources converted)

(c) Productivity

Productivity is defined as the relationship between quantities of output (throughput) from a system and quantities of input into that same system (Sink: 42).

Productivity = throughput/input

where:

$\text{Productivity}_{\text{expected}}$ = expected throughput/expected resources converted; and
$\text{Productivity}_{\text{actual}}$ = actual output/actual resources converted

It is often stated that productivity is mathematically related to effectiveness and efficiency in the form of:

Productivity = f(effectiveness, efficiency)

(d) Quality

Quality is defined as the combination of the factors of conformance to technical requirements; fitness for purpose; conformance to financial and resource specifications and accordance to scheduling (Sink: 42).

Quality = (actual return of subsystem)/(expected return of subsystem)

Quality management is a process applied to the five major components of a system namely selection and/or management of upstream systems; management of incoming quality; management of process quality; management of outgoing quality and interaction with customer needs and expectations.

(e) Profitability

Profitability is defined as the relationship between the cost of inputs and processing, and revenues (Sink: 42).

Sink (42) suggests that there are causal relationships between the various elements of productivity management. An adaptation of his thinking is shown in figure 28.

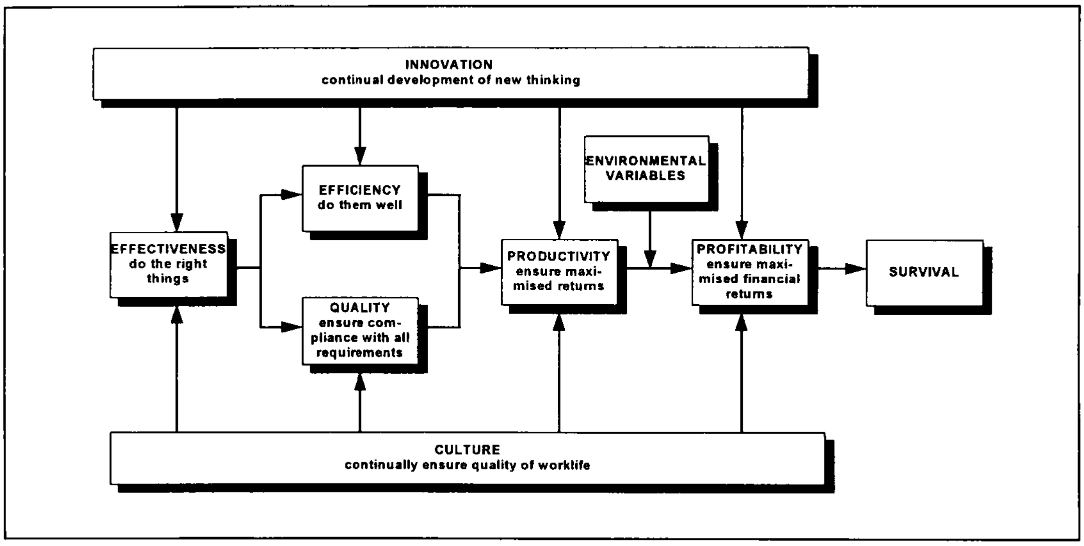

Figure 28 - Causal relationships between the elements of productivity management

The model indicates the rationale that an organisation defines certain objectives for itself and sets out to do these things well, leading to performance against specific criteria, which leads to profitability and ultimately survival.

In the application of this model, various techniques are proposed to improve and measure performance based on the generic cause/effect model presented by Van Loggerenberg (47) as shown in figure 29.

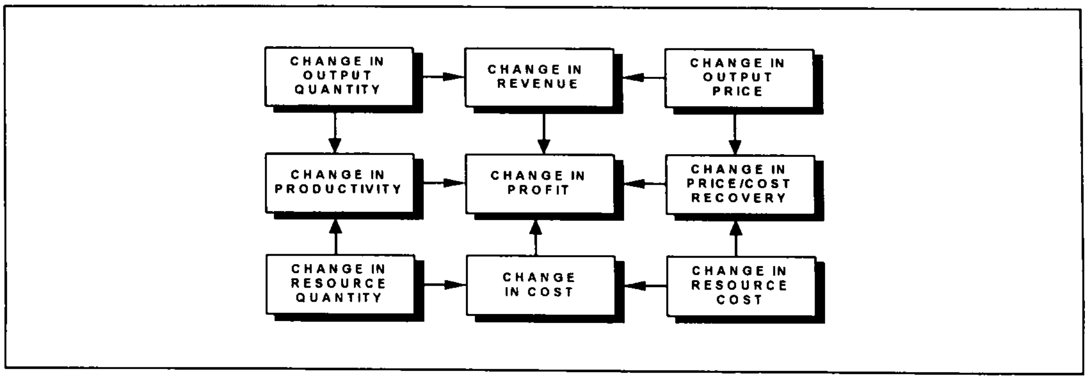

Figure 29 - The cause/effect relationships of productivity changes

5.3.3 Industrial Engineering skills

Industrial Engineering requires a multidisciplinary approach towards problem solving. It is primarily concerned with synthetic thinking (the systemic relationships between systems and subsystems) and secondarily concerned with analytic thinking (the division of any given system into its components and the optimisation of these components).

5.3.4 The principles of Scientific Management

Scientific Management emerged almost simultaneously with the Industrial Revolution. Taylor (45) is generally accepted as the most prominent member of what has become known as Scientific Management. It is appropriate that the fundamentals of Scientific Management is investigated in order to fully understand the substance (if any) of the current criticism (Hammer: 20) against what has become known as Taylorism.

The basic principle of Scientific Management is that work can be analysed (decomposed and optimised on the decomposed level) and that humans can be assigned to those parts of work that their skills are best suited for. This can all be done scientifically.

Scientific Management was founded on the 1776 publication by Smith (43) entitled *The Wealth of Nations*. Smith, a philosopher and economist, recognised that the technology of the industrial revolution had created unprecedented opportunities for manufacturers to increase worker productivity and thus reduce the cost of goods, by what has become known as the division of labour.

Smith's principle embodied his observations that a number of specialised workers, each performing a single step in the manufacturing process, were more productive than generalised workers fully responsible for the manufacturing of one unit.

Smith (43) pointed out the following advantages of the specialisation of labour:

"The advantage is owing to three different circumstances; first to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many."

Watt (1796) and Babbage (1832) (Kanawaty: 23) presented innovations with simultaneous concern for management and productivity improvement. Watt focused on a scientific approach to management, including aspects such as demand forecasting, production planning and facilities layout, whilst Babbage focused on the economic aspects of labour division.

Taylor elaborated on this approach and defined a set of principles that form the basis of the scientific approach towards the management and operation of human labour. Taylor's basic premise is that the world is extremely concerned with the destruction of natural resources whilst the waste of the human resource goes by unnoticed. Waste of natural resources, including material is readily apparent whilst waste in human efficiency is less apparent and less understandable. Taylor observed that, in pre-Taylor industrial management, the captains of the industry were born, not made. Management was an aristocracy, a class consisting of the elite, those who own the industry. Taylor rejected this. He proposed that the basic aim of management should be the generation of maximum wealth for both the employer and the employees. Taylor proposed that the wealth of these stakeholders is interrelated. Underlying this argument is the principle that higher profits are generated by higher productivity and that these higher profits can contribute to higher wages and vice versa. Taylor observed that in industry more often, the opposite is present.

Taylor attributed the absence of productivity/wage relationships to the following reasons:

- The fallacy that higher productivity will lead to reductions in personnel;
- management techniques focusing on the wrong measures; and
- ineffective and unscientific methods being applied in the analysis of work procedures.

Taylor described the state of work in industry at the time as an uncontrolled event, based on the experience of the skilled workers, and, if benchmarking was done a-mongst the different industrial companies, large discrepancies would be found between the methods applied to the same types of work. Taylor argued that these practices are unacceptable and that generic best practices existed. He suggested that work should be planned ahead on at least a daily basis, that these plans should be derived from what is found to be the best practice, and that incentives exist which motivate workers to execute the work satisfactory.

Taylor proposed four principles to scientifically manage work:

- Development of scientifically based methods for every component of work in order to replace traditional approaches;
- scientific selection, training and development of workers;
- close co-operation between management and labour in order to ensure ade-quate application of the proposed methods; and
- an equal distribution of work between management and workers, specialising in administrative and technical work respectively.

In this process, Taylor focused on Work Study techniques (Kanawaty: 23) and de-veloped an approach whereby the relationship between work and physical exhaustion was analysed. He further stated that, in the scientific selection workers, the physical and intellectual properties of workers should be classified and those with high physical and low intellectual abilities, should be assigned to repetitive and specialised functional work. He described such a worker as:

"He is a man so stupid, that he was unfitted to do most kinds of labouring work."

The next major step in the evolution of Scientific Management came soon hereafter by two United States automobile pioneers, Henry Ford (14) and Alfred Sloan. Ford improved on Smith and Taylor's concept of dividing work into simple, scientifically determined tasks. Ford reduced each job in the automotive assembly process to the installation of a single part in a predetermined manner. Initially, workers walked from one assembly stand to the next, and the introduction of the moving assembly line simply brought the work to the worker.

In breaking down the assembly into a series of uncomplicated tasks, Ford made the jobs infinitely simpler, but he made the management of the process from a product perspective infinitely more complex, especially when diversified products were introduced.

Alfred Sloan, taking over the reigns of General Motors, created the prototype of the management system needed for the Ford production system. Initially the management system was based on ineffective departments, overseeing Marketing, Engineering, Manufacturing and Finance, unable to manage the product mix demanded. General Motors, being diversified and extremely bulky, was subsequently broken down into divisions for each model or subassembly, inherently applying the principles of Scientific Management on the management and organisational level. Managers were assigned to oversee each of these divisions, the only difference being that, whereas workers needed technical skills, management was perceived to manage the financial output of the divisions.

Worth mentioning as further contributors to the refinement of Scientific Management were the Gilbreths, founders of Work Study as a subject area, HL

Gannt, responsible for the establishment of Critical Path Methods, still actively used in planning and control systems (Kanawaty: 23), and Fayol's (Fayol: 13) fourteen principles of management:

- *Division of labour;*
- *authority and responsibility;*
- *discipline;*
- *unity of command;*
- *unity of direction;*
- *individual versus general interests;*
- *remuneration of personnel;*
- *centralisation;*
- *scalar chain;*
- *order;*
- *equity;*
- *stability of tenure;*
- *initiative; and*
- *esprit de corps.*

Fayol was also responsible for the view that business management's role consists of four basic elements namely planning, organisation, leading and control, a premise still in practice today.

After these initial pioneers, the subject of Scientific Management diversified, leading to the development of subject areas such as Operations Research, Systems Engineering and linkages to the behavioural sciences in which Mayo (27) was the most prominent, focusing on the influence of hygiene factors on workers.

Scientific Management is also known as the functional approach. It must be borne in mind that the functional approach was, and still is of extreme importance in labour-intensive industry. It is however true that this approach, albeit applicable to industry, and more importantly so in the industrial era, lead to a form of de-humanisation - human resources were treated like mechanical resources. Furthermore, this functional approach has since become a management practice in non-industrial environments where skilled and intelligent human resources are wrongly utilised if subjected to these approaches. In the current day and age, with few exceptions, *we are not men so stupid,* that we can not do anything but repetitive tasks. The case is therefore not aimed at rejecting Taylorism, but at rejecting the application of Taylorism and similar Scientific Management approaches in non-industrial environments, an aspect for which Taylor was not responsible.

"Machines, not surprisingly, were thought to be reducible to three basic mechanical elements: the wheel and axle, the lever, and the inclined plane. Work was similarly analysed and reduced to ultimately simple work elements. The process of doing so came to be known as Work Study. Machines were developed to perform as many of these basic tasks as were technologically feasible. Men performed those that could not be mechanised. Men and machines were organised into processing networks, the apotheosis of which is the mass production and assembly line.

Mechanisation - the replacement of man by machine as a source of physical work - affected the nature of the tasks left for man to perform. Men no longer did all the things required to make a product; rather they repeatedly performed simple operations that were a small part of the production process. Consequently, the more machines were used as substitutes for men, the more men were made to behave like machines. Mechanisation led to the dehumanisation of man's work. This was the irony of the Industrial Revolution. It is not surprising that a society that thought of the world as a machine came to think of man as one also."

Russel L Ackoff in "Redesigning the future" (1, page 113)

Although the functional approach is contrasted against the modern process approach (in terms of specialised skills, decomposition of work and worker participation) the following similarities exist in the principles applied:

- The separation of the execution of work from its design;
- the assumption that there is an ideal design for any work process;
- the need for measures and controls of work efficiency and effectiveness; and
- the optimal application of human and other resource skills.

5.3.5 The evolution of Industrial Engineering

The evolution of the Industrial Engineering profession has, through the decades been interrelated with the evolution of management and the approaches required by management to improve organisations. The following deductions are made from the evolution of Industrial Engineering:

- Industrial Engineering is principally aimed at the improvement of industrial operations, and although it is often proclaimed to be applicable to other spheres as well, these opportunities have not yet been exploited to their full potential; and
- Industrial Engineering has grown from being aimed initially at the operational level to a strategic and corporate level, creating opportunities for greater impact.

A summary of the evolution of Industrial Engineering is shown in table 9.

PERIOD	FOCUS	CONTRIBUTOR	ENVIRONMENT
Scientific management (Late 1700s to early 1900s)	Specialisation Functional Approach Work Study Assembly lines Administrative Theory Planning and Control Systems	Smith Watt Babbage Taylor Fayol Gilbreth Gannt Ford Sloan	Industrial Revolution World War I Depression Professional Managers
Behavioural Sciences (1940-1960)	Participation Incentive Schemes Ergonomics Hawthorne Studies	Mayo Bamard Drucker	World War II Unionisation Reconstruction
Management Science and Systems Engi-neering (1960-1980)	Operations Research Simulation Modelling System Dynamics Systems Engineering Engineering Logistics Total Quality Management	Forrester Deming Juran Blanchard	Economic growth Rise of the defence industry Cold War Oil crises High Technology Investments Vietnam War
Operations management (1980-1990)	Manufacturing Planning and Control Just-in-Time Business Logistics Productivity Management Lean production	Ishikawa Taguchi Shingo Juran	Competitiveness Rise of Japan Large military spending Economic recession
Business Transformation (1990-)	Strategic Management Business Reengineering Theory of Constraints Benchmarking Information Technology Organisational Learning	Hammer Davenport Martin Senge Goldratt Porter Prahalad Hamel Toffler	Transformation of various governments New world order New socio-economic problems Information super highway

Table 9 - Evolution of Industrial Engineering

6 Fundamentals of Business Engineering

6.1 Basic principles

"Unlike traditional scientific disciplines which seek to distinguish themselves from each other and to spin off new disciplines when new areas of interest develop within them, the new inter-disciplines seek to extend themselves and merge with each other, to increase the number of disciplines they incorporate and to enlarge the class of phenomena with which they are concerned. Even these inter-disciplines are seen as part of a still larger whole, the systems sciences."

Russel L Ackoff in "Redesigning the future" (1, page 52)

The subject area of Business Engineering has been defined in an effort to describe and position the full set of approaches required to optimise or improve the performance of organisations. It is an effort to define a theoretical home for the various business transformation related approaches.

Business Engineering is defined by Moll (31,32,33,34) as the subject area that aims to develop or redevelop an organisation based on the application of an engineering thought process and sound business principles. Business, in this context, is defined as all efforts aimed at the sustained creation of wealth for all the stakeholders of an organisation.

Systems Engineering, the engineering inter-discipline associated with the systems age, defined as the subject area that aims at transforming operational needs to defined systems configurations, is viewed as the parent subject area of Business Engineering, the latter being concerned with the transformation of business requirements into the desired architecture. The primary focus of Systems Engineering in the military environment is viewed as coincidental, as this was a growth area at the time of the inception of Systems Engineering.

Business Engineering should not be viewed as something completely new or revolutionary. It is a subject area composed of relevant extracts from various other subject areas, and it positions the relevant tools and techniques in terms of the general approach required to optimise an organisation. It is a logical extension of Industrial Engineering into the field of business. In general, the engineering approach as described in paragraph 2 of Part Two is followed.

6.2 Business Engineering Process

As required by an engineering approach, a systemic view of the development or redevelopment of an organisation is required (similar to the process described by Cross, Feather and Lynch in 7). The Business Engineering Process provides such a perspective.

A fifth phase in the Business Engineering Process, termed the *initiation* phase, is required in order to initiate the process. After the scope has been determined, a selection can be made of the objects required for the transformation process. A detailed discussion of this initiation phase is not presented in this thesis because of its relatively small contribution to the technical content.

The Business Engineering Process, including the initiation phase, is shown in figure 30.

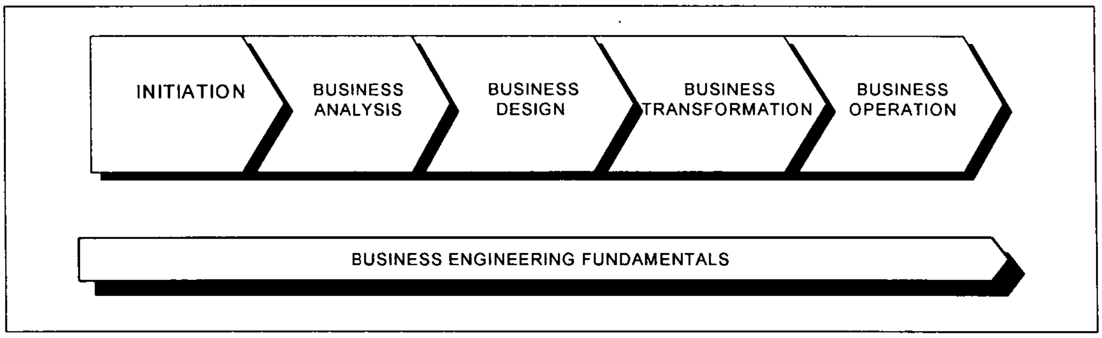

Figure 30 - The Business Engineering Process

6.3 Application

It is proposed that there are three approaches in the application of the Business Engineering Process. They are based on how and where the emphasis is placed within the process.

6.3.1 The analytical approach

"If I had a problem on which my life depended and I had an hour to solve it, I would spend 40 minutes examining it, 15 minutes reviewing it and 5 minutes solving it."

Albert Einstein

The analytical approach to Business Engineering focuses as much attention as possible onto the analysis phase of the Business Engineering Process. In doing so, a thorough understanding is formed of the most significant issues at hand.

6.3.2 The visionary approach

"Some people see things as they are and ask why?
I see things as they could have been an ask why not?"

George Bernard Shaw

The visionary approach in contrast, focuses on the design phase of the Business Engineering Process, the rationale being to rather spend as much effort on the future rather than pondering on things that are bound to change in any event.

6.3.3 The organic approach

"Once the rules of the game are clear, the window of opportunity will have closed."

Santhakam K Shekar

The basic premise of the organic approach to Business Engineering is that both analysis and design do not add any value when viewed independently. In contrast, it is the implementation or transformation phase that delivers the real value. It is thus proposed that an organisation should focus the minimum amount of attention on analysis and design and focus on organic growth (similar to prototyping).

6.3.4 Comparison between the various application approaches

A comparison between these three approaches is shown in table 10.

ELEMENT	*ANALYTICAL APPROACH*	*VISIONARY APPROACH*	*ORGANIC APPROACH*
ADVANTAGES	thorough understanding	forces discontinuous thinking	speed
DISADVANTAGES	can not accommodate discontinuities	neglect of important facts	lack of direction
APPLICABILITY	good information available	no information available	speed is the most important factor
EXAMPLE OF SUCSESS	Royal Dutch Shell	NASA	Virgin corporation
EXAMPLE OF FAILURE	Swiss watch industry	Challenger disaster	various small business enterprises

Table 10 - Comparison between the various approaches to Business Engineering application

6.4 Business Engineering skills and methods

In order to facilitate the Business Engineering Process, specific skills and methods are required. The various disciplines upon which Business Engineering are based (Moll: 31), are shown in table 11.

DISCIPLINE	SKILLS AND METHODS
Business Innovation	Lateral Thinking Parallel Thinking Creative Problem Solving
Business Management	Strategic Business Management Business Process Reengineering Business Performance Measurement Total Quality Management Theory of Constraints
Management Science	Operations Research Systems Engineering System Dynamics Modelling Decision Theory
Technology Management	Information Technology Process Technology Information Engineering Knowledge Management
Business Economics	Economic Analyses Industry Analyses Valuation Methods Economic Value Added Activity Based Costing
Transformation Management	Programme Management Value Management Risk Management Organisational Learning Cultural Assessment Methods

Table 11 - Business Engineering skills and methods

7 Conclusion

An engineering approach to business transformation is based upon the following phases:

- Business analysis;
- business design;
- business transformation; and
- business operation.

All of these are founded on a set of fundamental skills as described in Part Two. In Parts Three to Six of this thesis, the author explains the four main elements of an engineering approach to business transformation. They are based on the Business Engineering Process as presented in paragraph 6 of Part Two of this thesis.

A golden thread that runs through these chapters is the basic process that underlies transformation. It is based on:

- A definition of the current reality of the organisation;
- a definition of the future intent of the organisation; and
- the interventions required in order to transform from the current reality to the future intent.

This process is shown in figure 31.

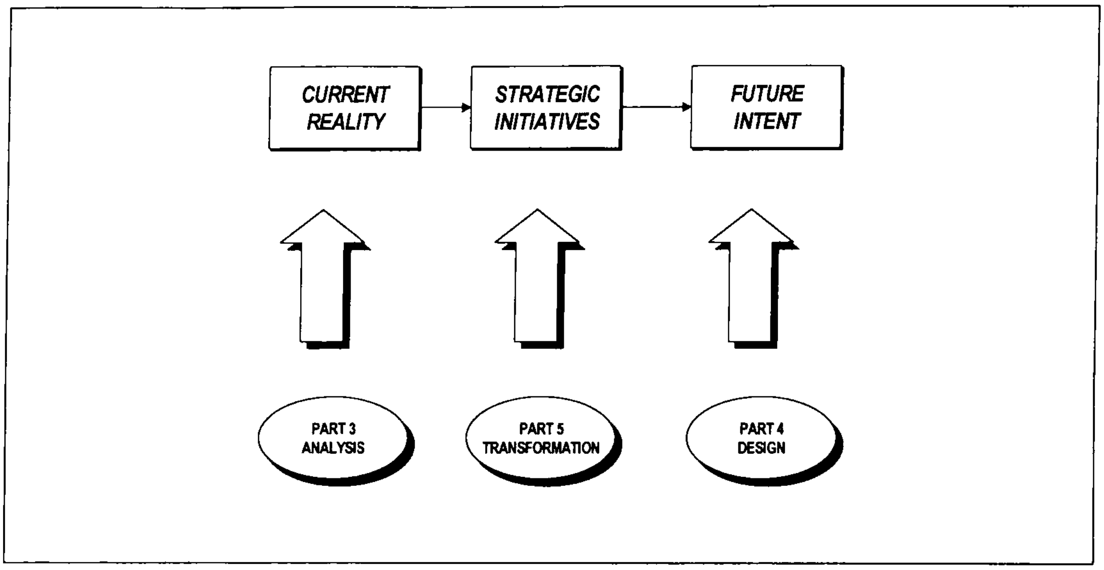

Figure 31 - The transformation process

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Part Three - Business Analysis

"As a multitude of laws often only hampers justice, so that a state is best governed when, with few laws, these are rigidly administered; in like manner, instead of the great number of precepts of which logic is composed, I believe that the four following would prove perfectly sufficient for me, provided I took the firm and unwavering resolution never in a single instance to fail in observing them.

*The **first** was never to accept anything for true which I do not clearly know to be such; that is to say, carefully avoid precipitance and prejudice, and to compromise nothing more in my judgement than what was presented to my mind so clearly and distinctly as to exclude all ground of doubt.*

*The **second**, to divide each of the difficulties under examination into as many parts as possible, and as might be necessary for its adequate solution.*

*The **third**, to conduct my thoughts in such an order that, by commencing with objects the simplest and easiest to know, I might ascend by little and little, and, as it were, step by step, to the knowledge of the more complex; assigning in thought a certain order even to those objects which in their own nature do not stand in a relation of antecedence and sequence.*

*And the **last**, in every case to make enumerations so complete, and views so general, that I might be assured that nothing was omitted."*

René Descartes in "A discourse on method"

1 Objective

Part Three of this thesis introduces the reader to the analysis phase of the Business Engineering Process in terms of the following:

- The basic principles of business analysis;
- the elements of the business environment as the system that is analysed; and
- the various business analysis methods.

The Business Engineering Process was proposed as a road map for the thesis. Part Three of the thesis is an integral part of this process.

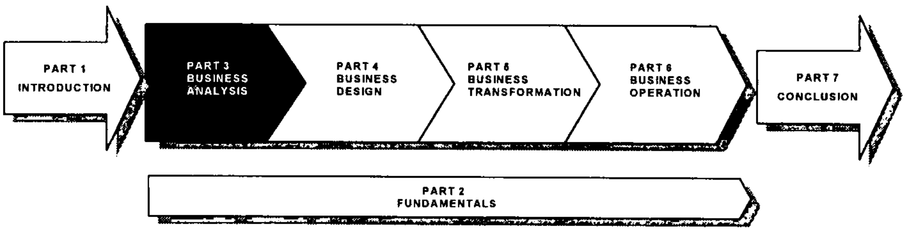

Figure 1 - The analysis phase of the Business Engineering Process

2 Basic principles

2.1 Analysis

Analysis is viewed as the process through which a thorough understanding is formed of the current reality of an organisation. It applies the structured and systemic skills of engineering. It is done to determine the state of health in the organisation on the short-term and long-term. It is a collection of the facts – a process of converting data into information and information into wisdom. Analysis tools are the diagnostic tools with which a practitioner can determine the *current reality* of a business system. Business analysis is in many respects a learning process based on understanding trends within the external environment as well as within the organisation. A systems approach was followed in presenting this chapter – analysing the external, business and internal environments of the business system respectively. This process is shown in figure 2.

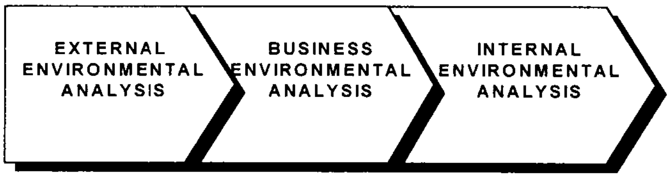

Figure 2 - Business analysis process

2.2 The business system as a basis for business analysis

The external, business and internal environments are used as a framework for business analysis and provide a way of ensuring that the total business system is assessed methodically and in a systematic fashion. This approach builds upon the fundamental principle presented in Part Two of this thesis that external as well as internal change cause transformation. Analysis provides the answer as to what the external and internal changes are. In following this approach, it is necessary to understand an organisation as a system that interacts with an environment through receiving input from that environment and providing output back to the environment. When investigated by itself, an organisation is similarly perceived as an environment that consists of a set of subsystems.

All organisations ultimately exist to satisfy the needs of human consumption. Satisfaction of human consumption occurs in two fashions namely:

- Organisations that effectively serve as links in a system that delivers products or services aimed at the satisfaction of basic needs; or
- organisations that support the efficiency (provide resources) to such a system.

These basic relationships between an organisation and its environment are shown in figure 3.

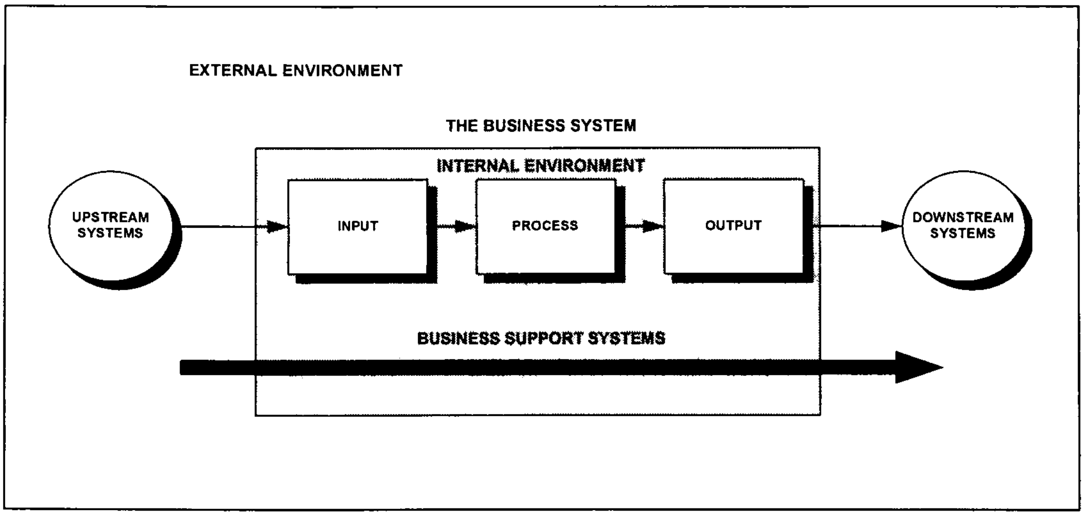

Figure 3 - Systemic relationships between an organisation and its environment

The environment of an organisation consists of three generic elements that are analysed (Thompson: 53). These elements are:

- The external environment;
- the business environment; and
- the internal environment.

2.3 The learning cycle

Analysis is learning. Senge (45,46) and De Geus (12) observe that systems thinking is closely related to learning, learning being the process through which a system improves its performance. It is useful to compare the learning of organisations with the human learning process.

Learning is a prerequisite for successful transformation. Whilst business transformation can be achieved without a learning ability in an organisation, it cannot be maintained. Learning is a two way process, which implies that it occurs in concurrence with teaching. We do not only adapt to our environments, we also manipulate our environments to an extent in which it adapts to us.

"The reasonable man adapts himself to the world while the unreasonable man persists in trying to adapt the world to himself; therefore for any change of consequence, we must look to the unreasonable man."

George Bernard Shaw

Kolb describes the learning process as a cycle (24). The learning cycle distinguishes between four distinct phases of learning:

- A phase in which a question arises through reflection on the current reality of a situation (reflective observation);
- a phase in which an abstract model or theory is constructed (abstract conceptualisation);
- a phase in which the theory is tested (active experimentation); and
- a phase where the effects of the experiment are examined (concrete experience);

These phases are shown in figure 4.

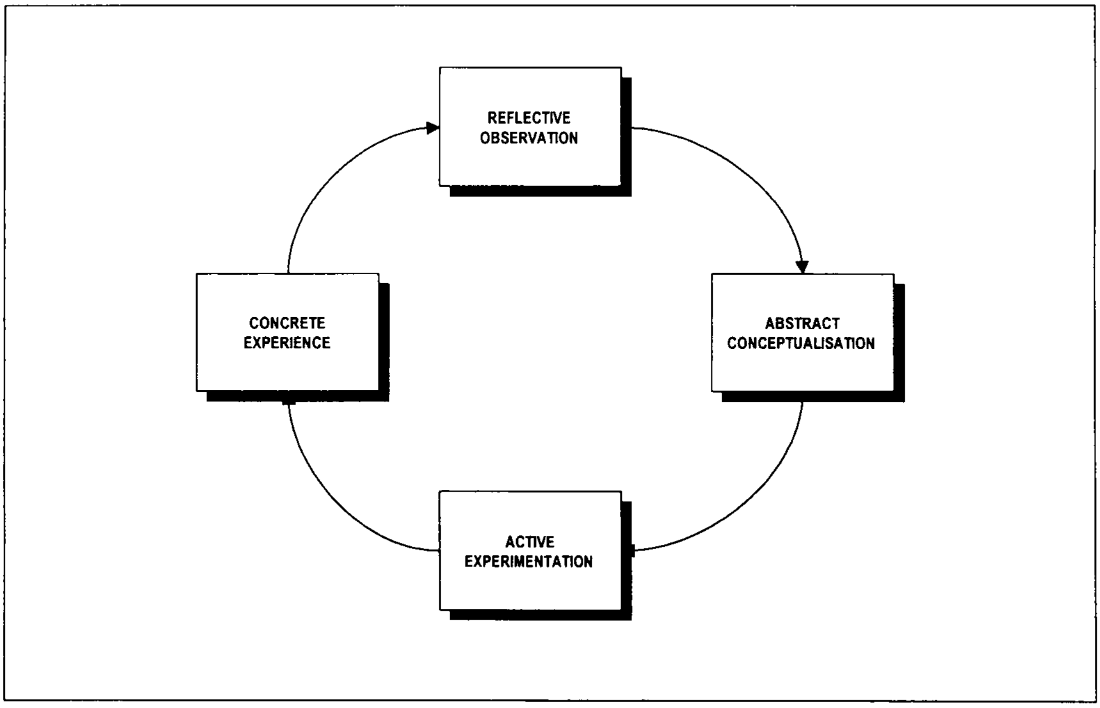

Figure 4 - The learning cycle

3 The business system

3.1 External environment

The external environment is defined as the macro system of which an organisation is a part. It is either an integral part of the macro system, or it plays a supportive role in the macro system (Thompson: 53).

In analysing the external environment, a number of generic elements should be investigated.

3.1.1 Political environment

The direction and stability of political factors are major considerations in the external environment. Political factors define the legal and governing parameters within which the business system operates. Since governance is most commonly restrictive, it tends to reduce the potential of the organisation. However, some political actions are designed to benefit and protect the organisation. Additionally, governments often also serve as a major role player in the organisation itself, acting as a customer, competitor or supplier. The political environment is important because it assesses the future governing mechanisms in the business arena (Thompson: 53).

(a) Governance

Political factors firstly influence the stability and regulation of the marketplace. Generically, the following regulatory parameters are designed by governments and must be analysed:

- Macro-economic policy and economic models employed;
- taxation;
- translation of community requirements into formal legislation;
- governance of global trade;
- incentive schemes;
- labour governance;
- industry governance; and
- local governing practices.

(b) Government's role in the business system

Secondly, governments are role players in the business system with specific up-stream and downstream requirements that they enforce by law. These roles serve as further factors that need to be analysed in order to position an organisation. Three distinct roles are identified:

- A supplier role where government acts as the owner of the natural or other resources;
- a customer role where political initiatives demand products or services from industry; and
- a competitor role where governments historically created those necessary industries (parastatal corporations) where private initiative did not exist.

3.1.2 Economic environment

In analysing the economic environment the nature and direction of the economy in which an organisation operates is studied. Because consumption patterns are affected by the relative affluence of various market segments, an organisation is compelled to consider the economic trends that influence its industry. Generally, a distinction should be made between economic policy and governance, industry factors and economic parameters (Porter: 35).

(a) Economic policy and governance

An analysis should be done of the formal governing factors in the economy, regarding the fiscal and monetary policies of the country. In such an analysis, a study should be conducted of the relative position of an economy on a continuum with a free-market economy on the one extreme and a regulated economy on the other. Factors arising from such a study should be investigated.

(b) Industrial economic factors

Globally and nationally, indicators often exist that influence the state of a whole industry. General trends in these factors are often cyclical and an understanding is required of the cyclical nature of demand patterns and those factors influencing demand and supply in the industry. It is of value to model these cycles and forecast their future patterns.

(c) Economic parameters

Macro-economic factors such as the availability of credit, the level of disposable income, the prosperity of consumers and the general state of wealth of the economy must be analysed. Factors such as prime interest rates, inflation rates, levels of employment and trends in the growth of the gross national product need to be considered and their future values predicted.

3.1.3 Social environment

In analysing the social environment of an organisation, it is necessary to study the value systems, culture, religion and ethnic complexities of the communities in which it operates.

In order to survive, an organisation must adapt to the factors emanating from society and, where applicable and possible, influence these factors. The organisation should project an image of social consciousness - an awareness of, and active contribution towards these factors. Society at large expects respect for the lifestyles and diversities of the different communities. The most common social issues that must be addressed are the following (Toffler: 54):

- An understanding of the values and beliefs of all communities;
- sensitivity for diversities such as gender, age, ethnic and religious diversity relating to employees, customers and the community at large;
- the creation of mutual respect for diversity;
- sensitivity for quality of life issues relating both to employees and the community at large;
- respect for the lifestyle of diverse communities; and
- participation in specific social improvement programmes.

3.1.4 Technological environment

To avoid obsolescence and promote innovation, an organisation should study the technological changes that might influence its industry. Creative technological adaptations can initiate capabilities for the development of new products, improvement of existing products or improved efficiency of the primary business process in an inductive fashion. For these reasons, an organisation should strive towards an understanding both of existing technological advances as well as probable future advances that might bear an effect on the business. The techniques employed in the prediction and evaluation of the impact of technology on an organisation is known as technology forecasting (Thompson: 53).

It is suggested that technology is viewed in the following two dimensions:

- A continuum between technology with a high rate of change versus technology with a low rate of change; and
- a continuum between technology with high capital expenditure versus technology with low capital expenditure.

From these, four variants are derived that require different responses from an organisation.

These variants are shown in figure 5.

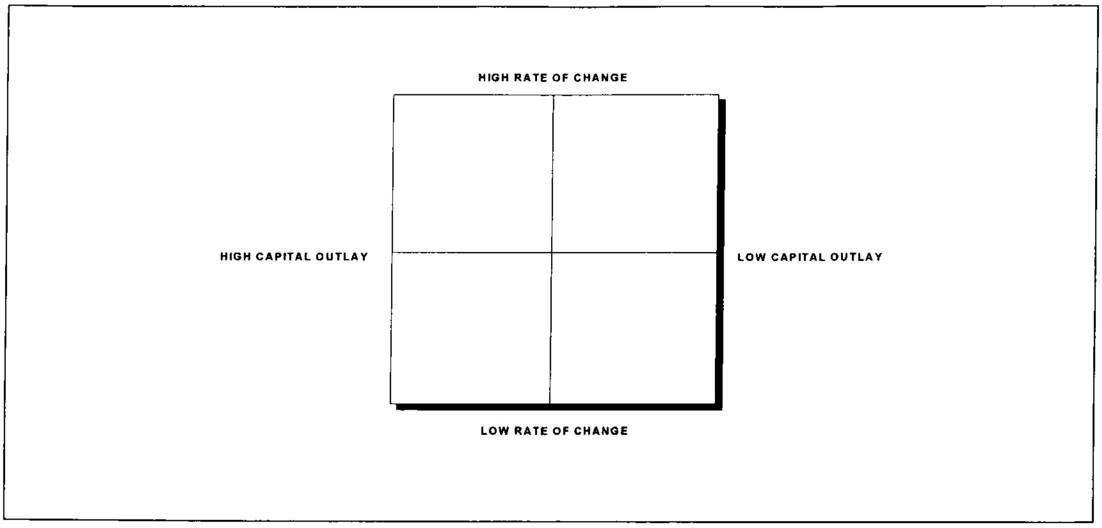

Figure 5 - Technological change

It is suggested that technology can be analysed in terms of these variants by identifying the following:

- Technology with a high rate of change and large capital outlay;
- technology with a high rate of change and low capital outlay;
- technology with a low rate of change and large capital outlay; and
- technology with a low rate of change and low capital outlay.

3.1.5 Ecological environment

A factor driven to prominence by forecasts of the impact of organisations on natural resources (Meadows: 30,31) is the reciprocal relationship between business and the ecology. The term ecology refers to the systemic relationship between all life forms and the natural resources provided by the earth.

This trend is a consequence of social changes – a shift has occurred in social awareness in science from physics and chemistry to biology and ecology. Organisations are being held responsible for their ecological impact and negligence in this area is being viewed as immoral. Twenty years ago it was perfectly moral to pursue technology and prosperity at the expense of the ecology. Today it is unacceptable. It has become the responsibility of any organisation to determine its ecological impact and to launch effective and visible actions to eliminate this. Governments, in their role of regulating the environment, have also become involved in this area, enforcing the community requirements of ecological consciousness.

The System Dynamics Movement (Meadows: 30,31) has added to this concern through the dynamic models that were created of the consumption of the earth's natural resources and the effects of growth in population.

3.1.6 Global environment

Globalisation refers to the approach of an organisation entering world-wide markets with standardised products or services (Porter: 35).

Organisations tend to break away from the paradigm of a national economy base and move towards a multinational or global economy base. It has thus become a necessity to analyse the global environment. Such cases exist whenever it becomes advantageous for organisations to explore technologies existing abroad, or in cases where growth objectives, competition, or opportunities drive an organisation towards doing so.An organisation involved in international operations is confronted by special considerations. Multinational organisations headquartered in one country with subsidiaries in other countries experience difficulties that are understandably associated with operating in two or more distinctly different competitive arenas and associated with a multitude of foreign value and belief systems. The evolution of global organisations can be viewed on four distinct levels of activity (Porter: 35):

- Global trade, where export-import activity exists, which still has a minimal impact on the business state as such;
- an international organisation, where foreign licensing and technology transfer exists and resources are often based on availability in the international arena;
- a multinational organisation, where direct investment is made in overseas operations, local labour is employed, and the organisation becomes a key player in the different economies of the nations in which it is involved; and
- a global organisation, with substantial increase in foreign investment and foreign assets comprising a significant portion of the total assets, global approaches exist to different elements of the business processes and all the elements of the external environment are viewed in a global context.

3.2 Business environment

The business or task environment is defined as the level of operation at which a specific organisation interacts with its environment, consisting of a description of the input, processes and output of the system, and the inherent attributes that influence this operation (Thompson: 53).

In viewing an organisation as a system, the analysis process is focused on the stakeholders, value chain, industry, markets and competitive forces that affect the organisation. The approach taken in the discussion in this paragraph is therefore a systemic one, firstly discussing the elements of the business system on the output side of the system, then discussing the elements that are part of the actual process and lastly a discussion of the elements that are part of the input side of the system.

3.2.1 Value creation

The ultimate aim of an organisation is to create value. In analysing the success of any business system, the first and foremost element to be addressed is therefore the amount of value it creates. As shown in Part Two of this thesis, value creation has four generic components namely:

- Financial value created in the long-term;
- financial value created in the short-term;
- non-financial value created in the long-term; and
- non-financial value created in the short-term.

3.2.2 Stakeholders

The notion of an organisation only existing in order to create profits irrespective of the impact of such an organisation on the macro system has been rejected by many. Ackoff (1,2) suggests the alternative of focusing on all the stakeholders of the organisation. The theory derived form this, known as *stakeholder theory*, is expanded in this paragraph.

Stakeholders are defined as all parties that could potentially benefit from the existence of an organisation through the value it creates (Ackoff: 1).

Stakeholder theory maintains that the purpose of an organisation should be derived from balancing the conflicting claims of its various stakeholders. The organisation has a responsibility to all of these parties and should configure itself so as to give each a measure of satisfaction.

Four classes of stakeholders are identified namely:

(a) External stakeholders

These are the stakeholders that are part of the external environment and consist of the following:

- The community at large;
- governments (local, central and international);
- other political influences and pressure groups;
- environmental movements; and
- other parties prominent as a result of external environmental factors.

(b) Industry stakeholders

These are the stakeholders directly involved in the industry of the organisation consisting of the following:

- Competitors in the saturated industries, having a reciprocal stake in terms of market share;
- competitors in unsaturated/emerging industries having a stake based on alliances and a joint approach towards the expansion and promotion of the industry; and
- industry partners with whom an organisation has some form of alliance.

(c) Primary stakeholders

These are the stakeholders without which an organisation can not exist. They give definition to the primary activities of the organisation:

- The clients/customers; and
- the owners.

(d) Secondary stakeholders

These are the stakeholders to whom parts of the business are either outsourced or by whom resources are supplied to the organisation:

- Management;
- employees;
- suppliers of business resources;
- custodians of business resources; and
- contractors to whom elements of the business are outsourced.

The relationship between the various stakeholders and the business system is shown in figure 6.

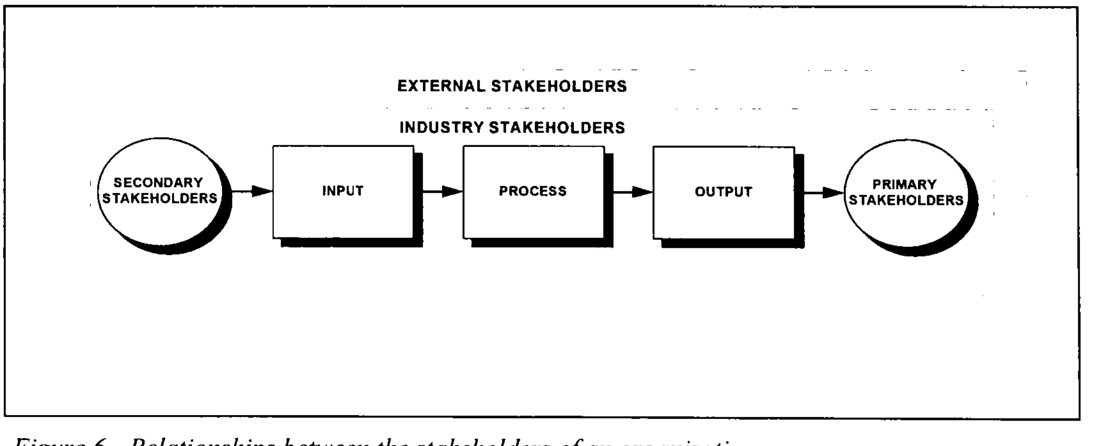

Figure 6 - Relationships between the stakeholders of an organisation

3.2.3 Value chain

The value chain of an organisation is a means of understanding the processes required for creating value and satisfying stakeholder requirements.

Porter (33,34,35) proposes the concept of a *value chain* as a way of understanding the value creation within an organisation. There is a generic value chain that underlies any organisation. This value chain does not necessarily start and end within the boundaries of an organisation because an organisation can outsource elements of the value chain or might merely be a player in a larger *value stream*. Another reason for modelling the value chain of an organisation is the fact that a clear distinction is made between activities that directly contribute towards business output, and those that indirectly contribute. The collection of activites that directly contribute to business output is called the primary business process while the collection of activities that indirectly contribute is called the secondary business processes.

The generic *Porter value chain* is shown in figure 7.

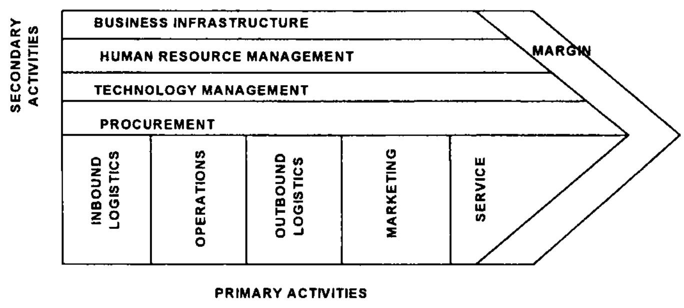

Figure 7 - Porter's value chain

This generic value chain is not so much of importance because of its content as much as it is of importance because of the thought process that is demonstrated by it. The following basic definitions are applied in the value chain:

- A primary business process (core process) is directly committed to the creation of business output for the primary stakeholders (owners and customers) – its focus is effectiveness;
- a secondary business process (support process) is indirectly involved and act as the custodians of the various business resources (production factors) – its focus is efficiency;
- a primary business process generates direct cost and corresponding value; and
- a secondary business process generates indirect cost and value.

In order to model the primary process of the value chain, the view of the primary stakeholders is taken and the process is defined by which their requirements are met. In order to model the secondary processes, the corresponding views of all the other stakeholders are taken and the processes are modelled through which resources the requirements of these stakeholders are satisfied.

A simplified version of Porter's model is shown in figure 8.

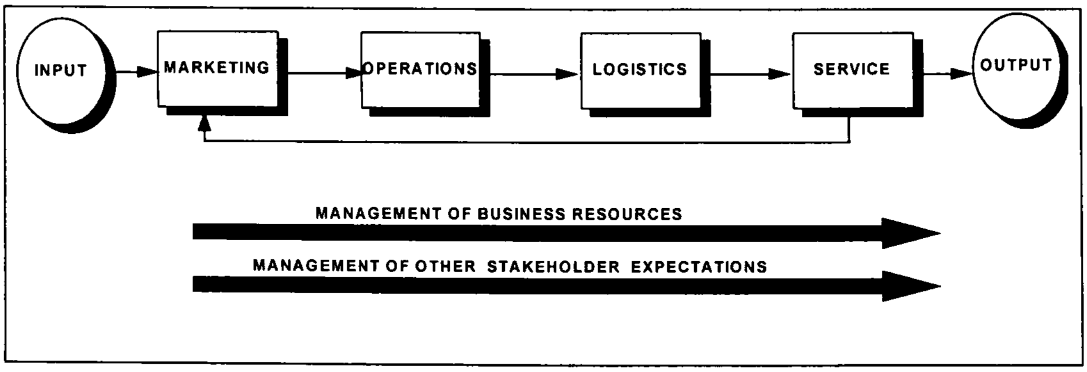

Figure 8 - Adapted value chain model

3.2.4 Industry

An industry is a collection of organisations that propose to satisfy similar client/customer requirements (Porter: 33).

When analysing an industry, the following factors are evaluated:

- The boundaries of the industry;
- the structure of the industry;
- the nature of competition; and
- trends within the industry.

3.2.5 Competitiveness

Competitive forces shape the playing field within an industry. Porter (33) suggests the *five forces model* as a means of understanding competitiveness.

The five forces model is shown in figure 9.

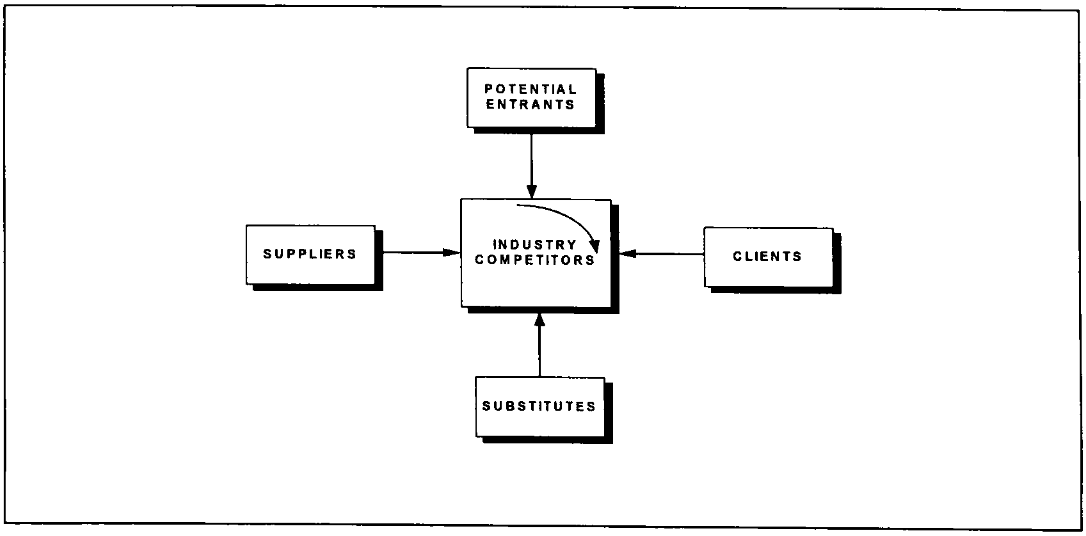

Figure 9 - Five forces model

In short, the adapted model requires an understanding of the following factors:

- The market needs that are being satisfied by a particular organisation and the products on offer;
- existing competitors and the rivalry between them;
- potential competitive threats to the industry as a whole;
- potential substitutes to the industry as a whole;
- the nature of the customers (downstream system) of the industry with an emphasis on the collective power of the all the businesses in the industry to influence or expand the market;
- the nature of the supplier base (upstream system) of the industry; and
- barriers to entry into the existing business system set for/by an organisation.

Another way of viewing competitiveness (Sassenberg: 42) would be to understand the levels of competitiveness of an organisation as a hierarchy:

- Capital – competitiveness that is based upon having more capital than the competitors;
- skill – competitiveness that is based upon being on equal terms with the competition with capital but having better skills and competencies than the competition;
- speed – competitiveness that is based upon being on equal terms with the competition with skill but having a better responsive ability than the competition; and
- psychological robustness – competitiveness that is based upon being on equal terms with the competition with responsiveness but having a bigger desire to achieve the proposed results.

3.3 Internal environment

The internal environment is defined as to be the set of subsystems that collectively serve as a system (Thompson: 53).

An organisation consists of various elements or subsystems that can influence its course significantly. These are the determinants of the internal environment of an organisation.

3.3.1 The organisation's strategy

Ansoff (3,4) suggests that an organisation's strategy is primarily concerned with the way in which it proposes to interact with its environment – how it proposes to influence what it can not control by using the internal environment over which it has control. In an analysis of the internal environment, it is of significant importance to determine the influence of the organisation's strategy on the external environment.

3.3.2 The leadership of the organisation

"There goes my people. I must follow them. I am their leader."

Mahatma Ghandi

The leadership within an organisation has a significant effect on the internal environment of an organisation. There are various leadership styles that can be present within organisations. These can alternate from being very prescriptive in the one extreme, to very consensual in the other extreme. In understanding the leadership of an organisation, it can be determined how the leadership influences the course of the organisation. For example, Senge (45) describes the various roles played on a ship and asks who of these is the leader. He concludes that the leader, first and foremost, is the designer of the ship. He explains leadership as being the ability to influence the course of action of a system, and concludes that the designer of the ship is the person having the biggest effect on its course of action. He subsequently explains the various roles of a leader as having:

- A role of designer;
- a role of coach and mentor; and
- a role of stewardship.

A lot is said in management literature about the difference between leadership and management (Peters: 32, Quinn: 39) (the first being viewed as the ability to influence the course of action of a system, the second being viewed as the process through which the output of the system is being governed).

These differences are shown in table 1.

PROPERTY	***LEADERSHIP***	***MANAGEMENT***
FOCUS	Strategic	Operational
TIME FRAME	Long-term	Short-term
ACTIVITIES	Visioning Implementation of the vision Influencing Feedback Control	Planning Measurement Directing Corrective actions Reporting
TRANSFORMATION LEVEL	Second-order transformation	First-order transformation
LEVEL OF INFLUENCE	Externally focused	Internally focused

Table 1 - A comparison between leadership and management

3.3.3 Organisational behaviour

An organisation is its people. They are the elements of which the organisation is made up. The internal environment of an organisation relies heavily on the human resources of the organisation in respect of:

- The productivity of the human resources;
- their sense of ownership and contentment;
- the climate within the organisation; and
- the collective skills of these human resources.

There are two types of organisational behaviour namely entrepreneurial behaviour and incremental behaviour (Ansoff: 3,4). Business transformation activities require entrepreneurial behaviour whilst business operation requires incremental behaviour. It must be understood what the abilities of a particular organisation are with regards to each in order to undertake a business transformation process.

The basic hierarchy of human needs (Maslow: 28) determines the behaviour of individuals. Beck (6) suggests that each individual level on a Maslow hierarchy could be split into a dimension in which an individual achieves this level, and a dimension in which a group achieves this level. Hence, the following levels are defined:

- *I survive;*
- *we protect;*
- *I control;*
- *we conform;*
- *I perform;*
- *we relate;*
- *I learn;*
- *we experience.*

By following the same line of thinking a model is presented by which the various levels of organisational behaviour can be determined as shown in figure 10.

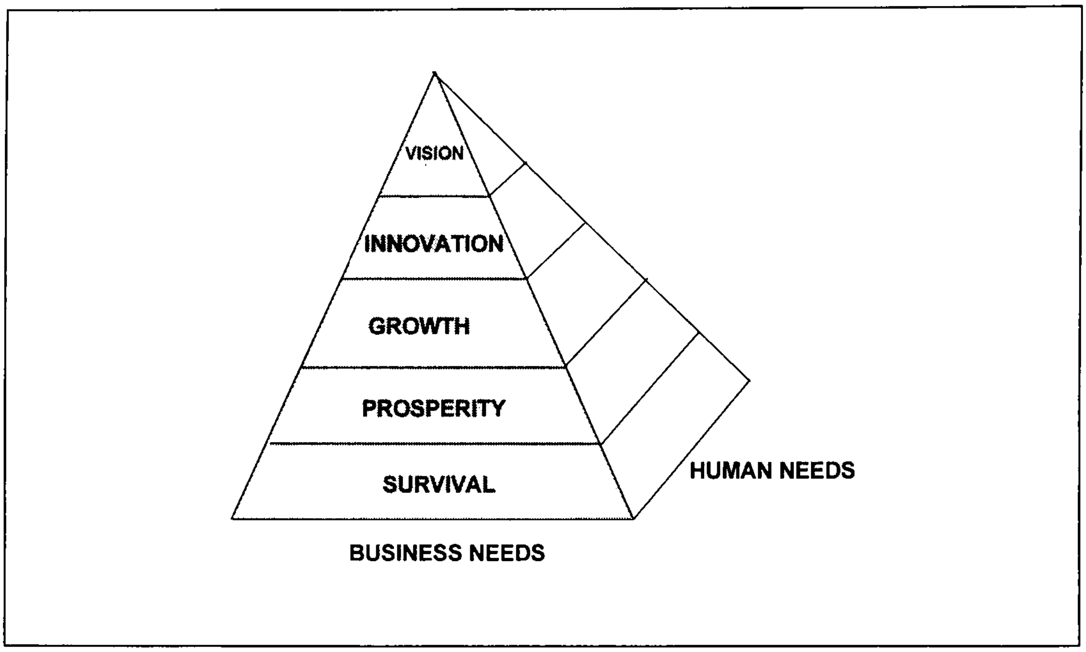

Figure 10 - The basic needs of an organisation

3.3.4 The organisation's core processes and competencies

Core competencies (Prahalad and Hamel: 37,38 ,Stalk, Evans and Schulman: 49) are those fundamental skills that an organisation possesses that are world class.

Martin (27) defines core competencies as exceptional skill with a critical resource or technology that can be applied to a multiple of products.

A more complete definition would be:

- The mastery of a specific skill or resource;
- which can be applied to a number of products or services; and
- can not be imitated.

Competencies can be classified on four levels namely:

- Unconscious incompetence;
- conscious incompetence;
- conscious competence; and
- unconscious competence.

These competency levels are shown in figure 11.

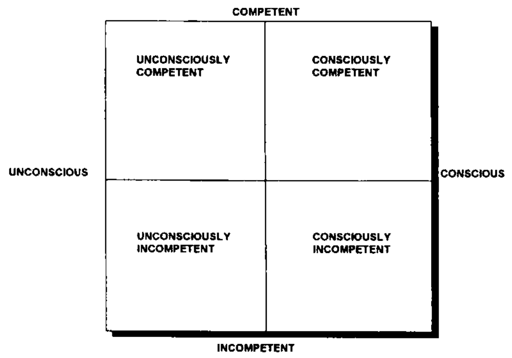

Figure 11 - Competency levels

The latter of these (unconscious competence) should be examined for possible current core competencies, whilst the others might lead to possible areas where competencies have to be formed.

The identification of core competencies leads to their exploitation and elimination of areas where core competencies do not exist. An organisation must evaluate its process in order to determine its core competencies and should determine the resources available for these competencies in order to determine the capability that corresponds with these competencies.

3.3.5 The organisation's resources

An active organisation is a system that receives input and transforms this input into output. This implies that this input, or resources that the organisation requires, are also determinants of the internal environment. These resources are:

- Natural resources based on raw material, land and energy sources;
- capital resources based on financial resources and capital equipment; and
- knowledge resources based on information, technology and intellectual capital.

The availability of these resources has a significant impact on the performance of an organisation. They are analysed by an assessment of the organisation's requirements for each compared to the actual situation.

4 Business analysis methods

Because the aim of this thesis is not to explain the business analysis methods in detail, only a brief discussion is presented for each with specific reference to positioning the method within the analysis framework and adding some personal insight from the author in areas where value could be added.

4.1 Analysis of the external environment

4.1.1 Econometric modelling and forecasting methods

Statisticians suggest econometric modelling (Makridakis: 25) as a method by which quantifiable external forces can be modelled in order to determine the course of action for an organisation.

In order to develop econometric models, the external parameters that should be modelled in such a fashion must be determined. Such an understanding is required in order to formulate the correct assumptions. The following general trends are observed in most published reports on environmental changes (Meadows: 31, Ringland: 40, Schwartz: 44, Toffler: 54), complicating the forecasting process and distorting the ability to correctly interpret the results of the forecast:

- Increased available knowledge based on an increased growth rate in the development of knowledge;
- increased complexity of the environment in terms of diversity and interdependence; and
- increased turbulence.

The environmental factors indicating these trends are based on both macro-economic factors (known as economic variables) as well as industry-related factors (known as industry variables).

Examples of economic variables are:

- Inflation rate per country;
- prime interest rate per country;
- gross domestic product per country; and
- economic growth rate.

Examples of industry variables are:

- Demand cycle of the industry; and
- performance of the competition.

4.1.2 Scenario planning

Scenario planning is a method through which the future external environment is analysed based on multiple outcomes (Ringland: 40).

The problem with forecasting methods in general is the fact that one forecast is produced and this from a relatively small data set. Because of the rate of change in the environment, the past is different from the future. Thus, the more turbulent the environment becomes, the more likely it becomes that discontinuities might occur that could lead to forecasts not realising. In contrast to this, one can accept the future to have a multitude of outcomes and design a strategy accordingly.

A comparison is presented of the difference between traditional forecasting methods and scenario planning in table 2.

ELEMENT	*TRADITIONAL FORECASTING METHODS*	*SCENARIO PLANNING*
BASIC PRINCIPLES APPLIED	Extrapolation of historic trends	Identification of all feasible outcomes of the future
ENVIRONMENT	External environment	External environment
VARIABLES	Uncontrollable	Uncontrollable
INFORMATION USED	Quantitative	Quantitative and qualitative
NUMBER OF LIKELY OUTCOMES	Single point forecast	Multiple outcomes

Table 2 - A comparison between traditional forecasting methods and scenario planning

This rationale lead to an approach of scenario planning being developed at Royal Dutch Shell in the early 1970s under the guidance of De Geus (12), Schwartz (44) and Wack (59,60). This lead to Royal Dutch Shell being able to predict various discontinuities in their environment, the most significant of these being the oil crisis of 1974. They observe that:

- The future is only predictable in its unpredictability;
- the external environment, by definition is based on a set of variables that an organisation has no control over; and
- that a process of scenario thinking is required in order to accommodate this problem.

"If you were an explorer in the early 1700s a map by cartographer Herman Moll might well have guided your explorations of North America. It is, for the most part, recognisable to modern eyes, except for one thing - it shows California as an island.

This error was the result of good Cartesian reasoning: Spanish explorers coming from the south had encountered the tip of the Baja Peninsula; voyaging further north they sailed into the Straits of Juan de Fuca. When they connected the first point to the second they created the Gulf of California.

This would be merely a historical curiosity were it not for the missionaries sent from Spain to convert the heathens in New Mexico. After landing in California, they prepared to cross the Gulf as their maps instructed: they packed up their boats and carried them up over the Sierra Nevada and down the other side, and found...not sea, but the longest, dryest beach they'd ever seen.

When they wrote back, protesting that there was no Gulf of California, the mapmakers replied: 'Well, the map is right, so you must be in the wrong place.' This misunderstanding persisted for 50 years until one of the missionaries rose high enough in the Church to be able to persuade the King of Spain to issue a decree to change the maps.

Once you come to believe in a map, it's very difficult to change it, and, if your facts are wrong, then you'll be relying on a map that's wrong too."

Peter Schwartz at http://www.gbn.org

Schwartz (44) proposes a scenario planning process as shown in figure 12.

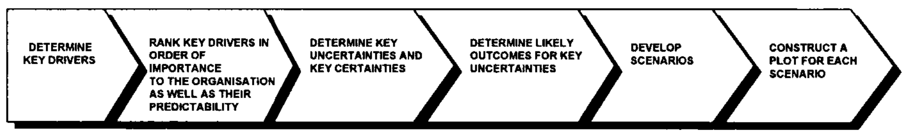

Figure 12 - The scenario planning process

- The process starts with an assessment of the key drivers that can fundamentally change the structure of the external environment.
- These drivers are ranked in terms of importance to the organisation and the level of certainty about their outcomes. These rankings are shown in figure 13.

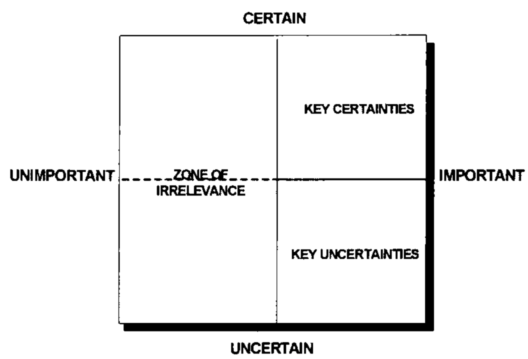

Figure 13 – Ranking external drivers in terms of importance and the level of certainnty

- The drivers are then grouped into key uncertainties for which the outcomes are uncertain, and key certainties, events whose outcomes are relatively certain.
- For these key uncertainties, an assessment is made of the possible outcome(s) that may subsequently occur.
- Trend breakers are identified based on possible outcomes from key uncertainties that might alter the structure of the environment.
- Qualitative scenarios are constructed based on an identification of feasible combinations of these outcomes. It is suggested that something between two and four scenarios should be developed. The disadvantage of developing only two scenarios is that they, in all probability, will not accommodate all possible

outcomes. The disadvantage of developing three scenarios is the fact that they often result in a high/middle/low road approach. This approach was used successfully by Sunter (51) in developing scenarios for South Africa. The high/middle/low road approach does however inhibit creative thinking. Schwartz suggests the building of four scenarios as the most successful. The Mont Fleur scenarios that were developed for South Africa in 1992 is an example.

- A plot is developed by building a story line and adding data to these scenarios.
- Contingency plans can subsequently be developed for each scenario.

4.2 Analysis of the business environment

Methods for analysis of the business environment can generally be viewed in two groups namely:

- Performance analysis methods aimed at an assessment of the absolute performance of an organisation; and
- competitive analysis methods aimed at an assessment of the performance of an organisation relative to another organisation.

4.2.1 Balanced scorecard analysis

The *balanced scorecard,* proposed by Kaplan and Norton (21,22,23) is the most elementary approach to the performance measurement of a business system. It is an approach that simplifies complex theories on business performance measurement.

It does so by evaluating the performance of an organisation's processes against the requirements of the four most important stakeholders of the organisation. These perspectives are:

- The customer perspective – evaluating the performance of an organisation against the requirements set for it by its customers.
- The shareholder perspective – evaluating the performance of an organisation against the value creation requirements set for it by its shareholders.
- The innovation and growth perspective – evaluating the performance of an organisation against the requirements of development, growth and continuous renewal.
- The internal perspective – evaluating the performance of an organisation against the efficiency of its processes and resources.

These perspectives are shown in figure 14.

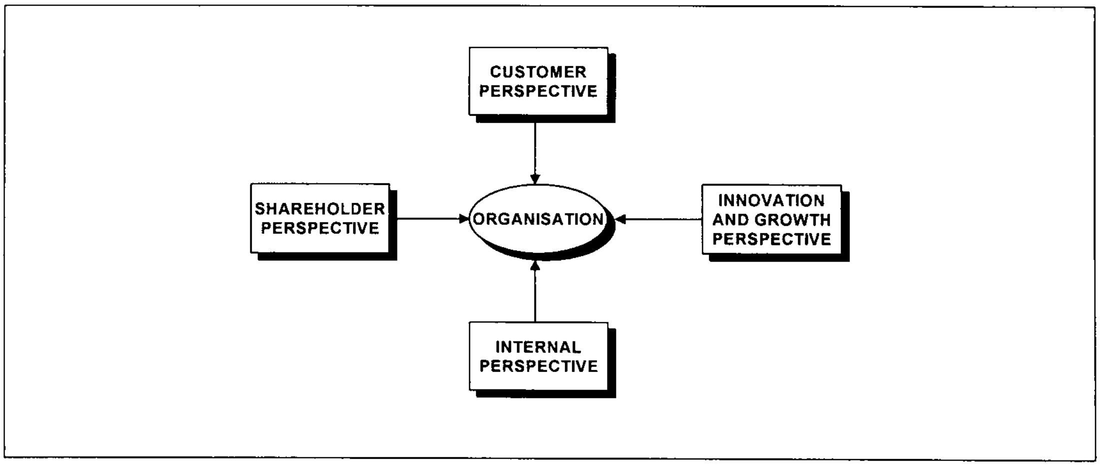

Figure 14 - Balanced scorecard perspectives

It is important to note that the term balanced scorecard implies that performance in the various perspectives tend to negate each other. Excellent performance in one perspective is typically achieved at the expense of performance in another perspective and vice versa. In the practical application of the balanced scorecard as an analytical method, the two main challenges are the following:

- Compiling a balanced scorecard for an organisation; and
- evaluating the performance of an organisation against the balanced scorecard.

(a) Compiling a balanced scorecard for an organisation

From practical experience, the author has found that organisations tend to implement the scorecard on operational level only, thereby neglecting strategic performance. This inclination can be overcome by either adding a strategic perspective to the existing four perspectives or by compiling two balanced scorecards. The first, known as the strategic scorecard, focuses on strategic or long-term performance whilst the second, known as the operational scorecard, focuses on operational or short-term performance.

The following approach is suggested in order to develop a strategic scorecard for an organisation:

- Analyse the strategy of an organisation as the basic context within which the strategic scorecard is to be compiled.
- Identify the core strategic initiatives within an organisation.
- Relate these strategic initiatives in a two dimensional matrix in order to identify performance measures for the various combinations of strategic initiatives versus strategic scorecard perspectives.

An example of such a matrix is given in table 3.

ELEMENT	CUSTOMER PERSPECTIVE	SHAREHOLDER PERSPECTIVE	INNOVATION AND GROWTH PERSPECTIVE	INTERNAL PERSPECTIVE
STRATEGIC INITIATIVE 1		MEASUREMENT 1		
STRATEGIC INITIATIVE 2			MEASUREMENT 2	
STRATEGIC INITIATIVE 3	MEASUREMENT 3			
STRATEGIC INITIATIVE n				MEASUREMENT n

Table 3 - Example of a strategic scorecard

The following approach is suggested in order to develop an operational scorecard for an organisation:

- Analyse the value chain of an organisation as the basic context within which the operational scorecard is to be compiled.
- Identify the key performance areas within the value chain.
- Relate these key performance areas in a two dimensional matrix in order to identify performance measures for the various combinations of key performance areas versus operational scorecard perspective. An example of such a matrix is given in table 4.

ELEMENT	CUSTOMER PERSPECTIVE	SHAREHOLDER PERSPECTIVE	INNOVATION AND GROWTH PERSPECTIVE	INTERNAL PERSPECTIVE
KEY PERFORMANCE AREA 1		MEASUREMENT 1		
KEY PERFORMANCE AREA 2			MEASUREMENT 2	
KEY PERFORMANCE AREA 3	MEASUREMENT 3			
KEY PERFORMANCE AREA n				MEASUREMENT n

Table 4 - Example of an operational scorecard

The approach that is suggested for compiling the operational scorecard is similar to value chain analysis to be explained in paragraph 4.2.4 of Part Three, the only difference being that one deliberately searches for the scorecard perspectives in each of these phases.

(b) Evaluating the performance of an organisation against the balanced scorecard

In evaluating organisational performance against the balanced scorecard, it is important to note that a balanced scorecard is not an analytical method that is used on a daily basis, but rather one to be used as part of a larger Business Engineering effort. In evaluating performance with a balanced scorecard, the following approach is suggested:

- Collect the relevant information for the various metrics that were identified.
- Identify areas of inferior performance.
- Develop a current reality tree in order to determine the root causes for inferior performance (see paragraph 4.2.5 for more details).

4.2.2 Value discipline analysis

The approach of Treacy and Wiersema (55,56) provides an interesting alternative. They analysed the overall focus of the performance of organisations and propose that all organisation focus (in varying degrees) on the three value disciplines namely stakeholder (customer) intimacy, product (service) leadership and operational excellence (throughput). An organisation should aim to be comparable in its industry in two of these, whilst excelling and becoming world class in a third.

These value disciplines and their relationships are shown in figure 15. The three dimensional figures indicated in figure 15 represent the three basic models which organisations can select and the cube in the middle indicates the competitive threshold within an industry.

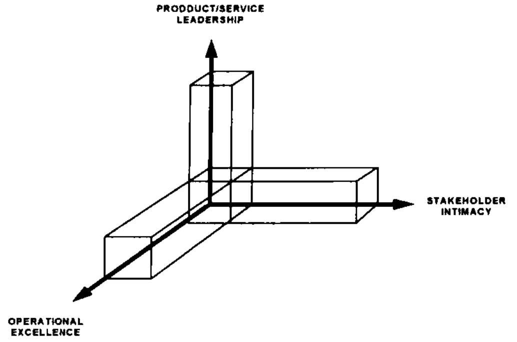

Figure 15 - The value disciplines

In investigating the value disciplines of an organisation, the focus of the analysis is confirmed. If the organisation focuses on product leadership, quality and technology should be the primary drivers of strategic value. If the organisation focuses on customer intimacy, customer satisfaction levels should be the primary drivers of strategic value. Likewise, if the organisation focuses on operational excellence, the throughput, inventory levels and operating expenses should be the primary drivers of strategic value.

4.2.3 Stakeholder analysis

Having identified the various stakeholders of an organisation, the question arises how to analyse the level of stakeholder satisfaction for the various stakeholders. It is proposed that the so-called *stakeholder constellation* (Ackoff: 2) be analysed in order to understand the levels of stakeholder satisfaction.

A generic stakeholder constellation is shown in figure 16.

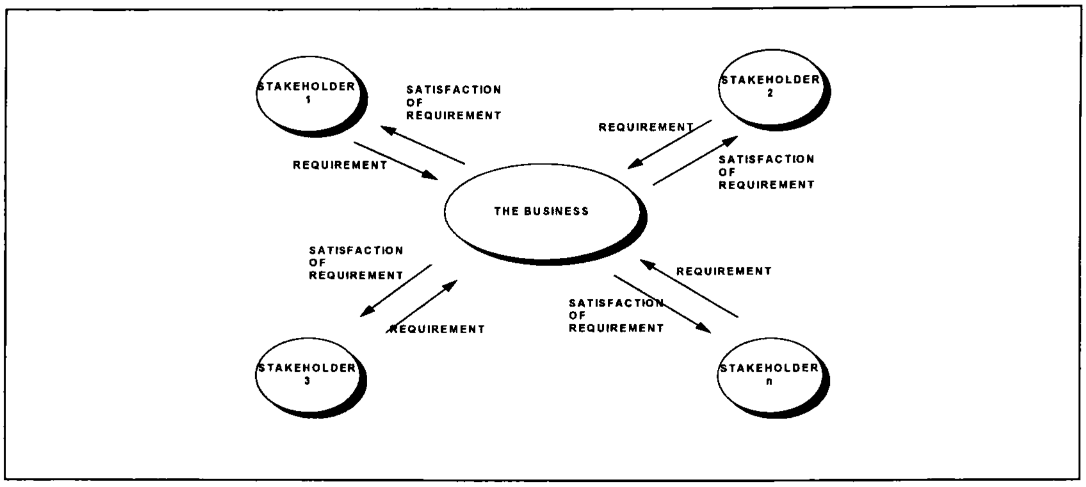

Figure 16 - Generic stakeholder constellation

Whenever the actual outcomes (stakeholder satisfaction) do not match the outcomes that are desired by a particular stakeholder, a performance gap emerges. When this gap is large, there is stakeholder dissatisfaction. When actual performance increases at a rate faster than that of desired performance, the performance gap begins to close.

It is not uncommon for stakeholder interests to conflict. In a time of extraordinary rapid change, these interests may clash even more. Can the mechanisms of value creation be orchestrated such that a balance is struck and multiple performance gaps are closed? In certain cases, the answer to such a question might be no. In fact, organisations might knowingly make strategic decisions that permit or even create performance gaps. But the thoughtful management of these may, in itself, create value. The most common of these conflicts is the conflict between shareholder value and customer value, for which four important variants exist:

- Initiatives with low/negative shareholder and customer value;
- initiatives with high shareholder value but low/negative customer value;
- initiatives with low/negative shareholder value but high customer value; and
- initiatives with high shareholder and customer value.

Stakeholder analysis should be conducted according to the following process:

- Identify the various stakeholders;
- determine the strategic importance of each stakeholder;
- determine requirement set for the organisation by each stakeholder;
- determine the level of requirement satisfaction being delivered to the stakeholder; and
- identify performance gaps from this process.

4.2.4 Value chain analysis

The value chain is a view of an organisation as a series of processes that collectively add value to the output of the organisation (Porter: 34). The value chain of any particular organisation can be compiled and it will loosely resemble the generic value chain as shown in figure 17.

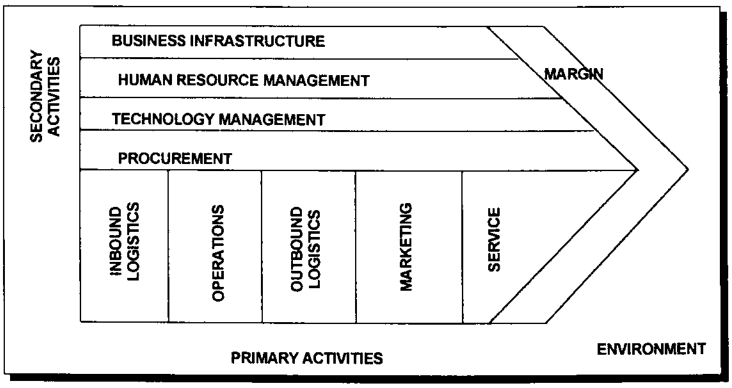

Figure 17 - The generic value chain

This model can be used to analyse organisational performance by adapting the performance measurement approach of Rockart (41). Rockart suggests an approach of defining key performance areas, critical success factors and key performance indicators for business analysis. It is suggested that this approach is used within the value chain framework.

(a) Key performance areas

In any organisation, there are a number of areas in which performance become a necessity for the survival of the organisation. They are the main areas of focus in the organisation. These are key performance areas (Juran: 16).

They have the following properties:

- Each of these areas is responsible for a necessary ingredient towards the output of an organisation; and
- factors can be determined from each of these areas measuring the success of its contribution to the organisation.

(b) Critical success factors

A critical success factor is defined as a factor in which success is a necessity for the collective success of the organisation (Rockart: 41).

The termed *critical* refers to the survival of an entity. If an entity is to be declared critical, the continuation of its *being* is under threat. The term *critical success factor* was institutionalised by Rockart (41) as a means of defining the high-level information needs of an organisation.

(c) Key performance indicators

Key performance indicators are defined as the metrics that underlie the critical success factors of an organisation (Rockart: 41).

It is proposed that a hierarchy can be developed of the relationships between these measures. An example of such a hierarchy is shown in figure 18.

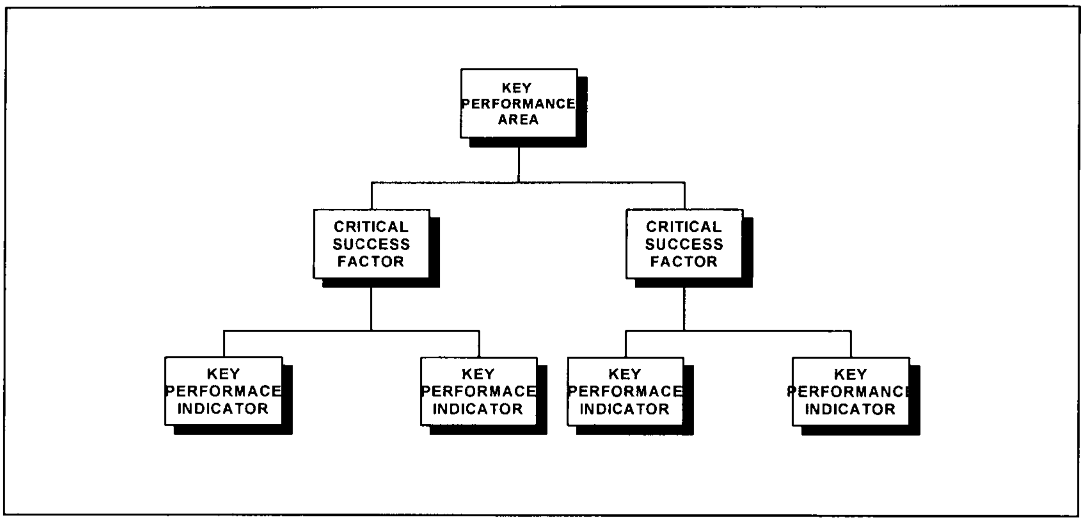

Figure 18 - Hierarchy of key performance areas, critical success factors and key performance indicators

Using the approach of key performance areas, critical success factors and key performance indicators as a means of value chain analysis becomes useful if the processes on the value chain are defined as key performance areas and assessed individually. In such an exercise, the value chain is used as a road map for business analysis, giving structure and focus to the analysis process.

The proposed process of value chain analysis is shown in figure 19.

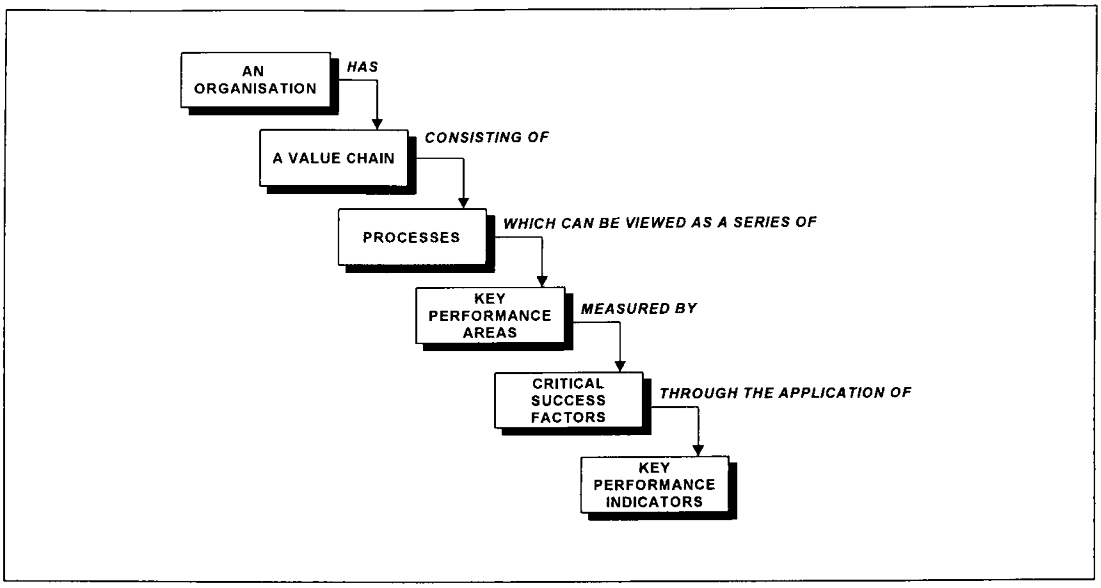

Figure 19 - Proposed value chain analysis process

4.2.5 Cause/effect analysis

Cause/effect analysis is a direct application of systems theory to business problems. Its application has been suggested by both Goldratt (13,14) as well as Senge (45,46). Its basic premise is that business performance as we measure it, is the result of various root causes. Like a patient having health problems, not only the symptom, but also its cause should be diagnosed correctly in order for corrective actions to be taken. Cause/effect analysis should however not focus only on root causes – the undesirable effects might be so dire that they need to be addressed simultaneously. A two-tier process is thus suggested.

Cause/effect analysis has its biggest use in cases where the performance of an organisation has already been measured and analysis, called an analysis of the current reality (current reality tree) is done in order to determine core issues that should be addressed.

The following process is proposed by Senge (46) for the analysis of the current reality of an organisation:

- Determine areas of inferior performance within the organisation by using any of the proposed performance analysis methods;
- determine their causes by asking *why* (what are the reasons?) for this inferior performance; and
- determine the root causes by repeating this process until reasons are found that could be addressed by some form of remedy.

This process is shown in figure 20.

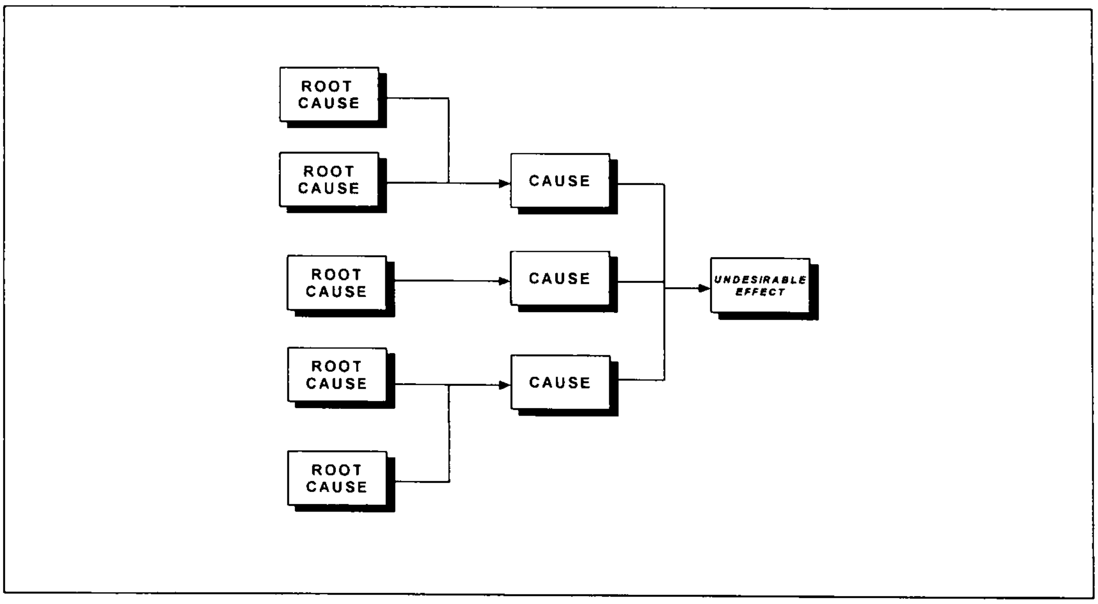

Figure 20 - Current reality tree

Another version of cause/effect analysis is the fishbone method proposed by Ishikawa (18). It is shown in figure 21.

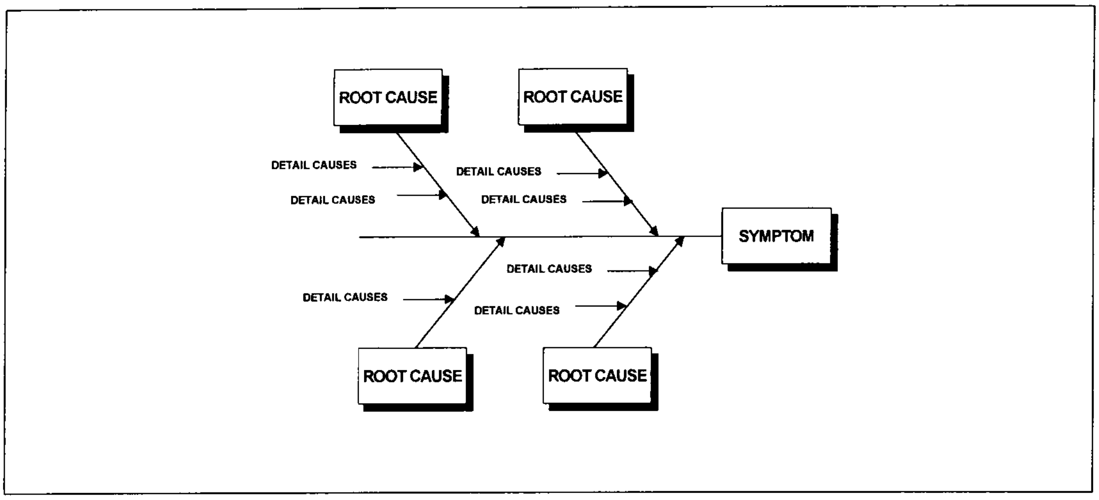

Figure 21 - Fishbone method

4.2.6 Benchmarking

"Fool you are, to say you learn by your experience. I prefer to profit by others' mistakes and avoid the price of my own."

Otto von Bismarck

Benchmarking is a method through which the learning process of an organisation is accelerated. The term *benchmarking* was borrowed from the field of quantity surveillance, a benchmark being a distinctive mark made on a rock, a wall or a building. It is then used as a reference point in analysing current position or altitude in topographical surveys and tidal observations. Generally, the term is understood as a sighting point from which measurements could be made or other positions could be measured.

Benchmarking is defined as a process of rigorously comparing an organisation to the organisations that set the industry standard in order to use the information to surpass these organisations, or quite simply, a standard of excellence or achievement against which other similar things must be measured or judged (Camp: 9).

Camp suggests three basic levels of benchmarking (9):

- Performance benchmarking;
- process benchmarking (best practices); and
- strategic benchmarking.

These types of benchmarking are shown in figure 22.

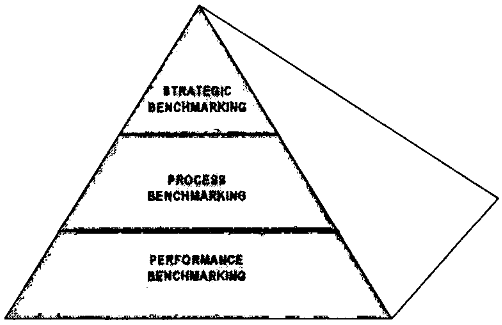

Figure 22 - The levels of benchmarking

It is not a necessity that benchmarking is conducted in an organisation's own industry only. There are many documented cases of successful benchmarking (Camp: 8,9) against organisations in other industries. A word of caution: as much as benchmarking accelerates the learning cycle, it does not necessarily enable an organisation to beat its competition. That will always be achieved through original innovative thinking within the organisation. It is therefore advisable that an organisation benchmarks those processes that it proposes to be comparable to its industry while it develops beyond these benchmarks in those processes that it wants to be world class.

Camp (8) suggests the following process for benchmarking:

- Decide on what to benchmark;
- identify whom to benchmark;
- collect data;
- determine and analyse performance gaps;
- project performance gaps;
- communicate findings;
- revise performance goals;
- develop action plans;
- implement and monitor; and
- recycle the process.

4.2.7 Valuation and investment analysis

The value that is added by an organisation can be expressed in terms of a stream of future income and expenses in the projected income statement of that organisation. This is termed the *net present value (NPV)* of the organisation. McKinsey and Company (Copeland: 6) suggest this valuation process as the key to determining the value adding potential within the organisation. This value is defined as the current value of the future business operations, discounted at an acceptable time value rate. The net present value of an organisation is determined by analysing the projected income statement and applying discounted cash flow methods. By using a search algorithm in the same analysis an *internal rate of return (IRR)*, can also be calculated by determining the discount rate at which the net present value is zero.

Similarly, the assets and liabilities of an organisation can be expressed in terms of the *net asset value (NAV)* of the organisation by analysis of the balance sheet of the organisation.

The total value of an organisation is then determined by adding the net asset value to the potential within the organisation that is based on the net present value. The objective of all improvement initiatives is then to maximise this value of the organisation.

Valuation methods, once established in an organisation, provide for an extremely useful mechanism to evaluate the impact of potential improvement and hence transformational initiatives in terms of the financial performance of the organisation.

4.2.8 Portfolio analysis

An alternative way of analysing organisations is that of portfolio analysis. In portfolio analysis, organisations are viewed as a portfolio of various investments. It is proposed that these investments are analysed in terms of their contribution to the overall organisation by evaluating the following four dimensions:

- Strategic fit;
- organisational capability;
- value creation; and
- life cycle position.

(a) Strategic fit

Any organisation sets for itself a set of long-term aspirations as part of the strategy. These aspirations lead to the definition of its long-term intent and hence, its strategy. In analysing the strategic fit of investments, these long-term aspirations are viewed as the criteria against which the investments are measured. If an investment is then viewed as having a high level of strategic fit, it is because the investment contributes substantially to the achievement of the strategy. If, on the other hand it is viewed as having a low level of strategic fit, it is because the investment does not contribute greatly to the achievement of the strategy.

(b) Organisational capability

In determining organisational capability, a resource-based view is taken of the organisation. By analysing the processes of the organisation, the core competencies of the organisation are determined (those skills that it can use to gain a competitive advantage). Subsequently, the resources that are available to deliver this competence, are determined. These resources are added to the analysis in order to determine the capability of the organisation.

This approach, developed by Prahalad and Hamel (36,37,38) and refined by Stalk, Evans and Schulman (49), is based on the following identity:

Capability = f (processes, core competencies, resources)

The process of capability analysis (adapted from Stalk, Evans and Schulman: 49) is shown in figure 23.

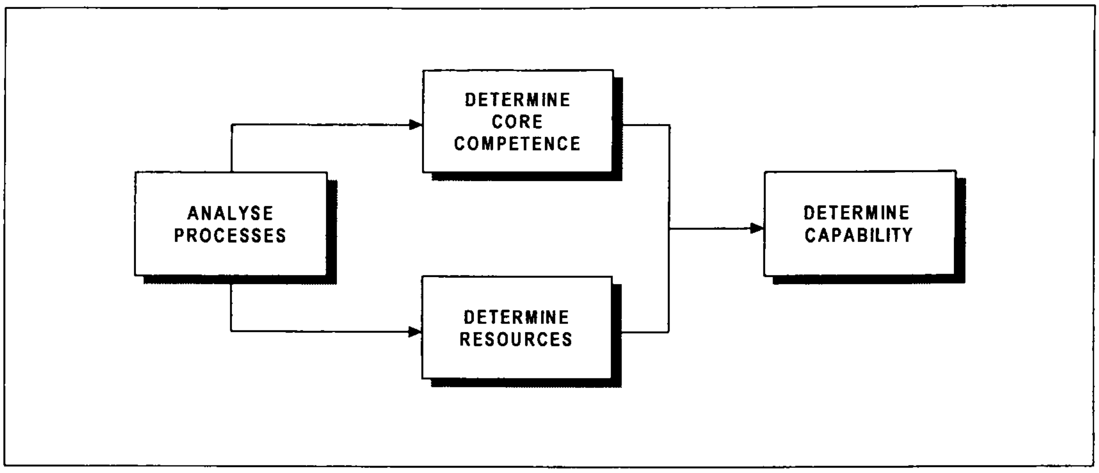

Figure 23 - Capability analysis

The organisational capability is then used as the next set of criteria to evaluate the various investments in the portfolio.

(c) Value creation

Valuation methods (refer to paragraph 4.2.7 of Part Three) are used to determine the amount of value that the various investments within the portfolio creates for the organisation as a whole.

(d) Life cycle position

In viewing an organisation as a portfolio of investments to be managed, the core process of an organisation can be viewed as the acquisition of new investments, extraction of value from existing investments and subsequent disposal of obsolete or non value adding investments.

This process is shown in figure 24.

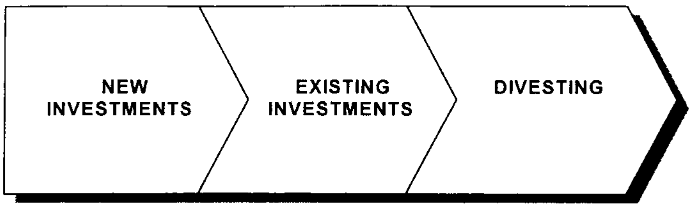

Figure 24 - Life cycle positions in portfolio analysis

By taking this view, the portfolio can be managed and growth or divestment strategies determined for the various investments. For each of these, in turn, there are various options based the various partnership and organisational forms.

4.2.9 Financial analysis

Financial analyses are conducted in order to interpret the financial state of an organisation. This paragraph outlines the most significant financial analyses that should be conducted in an organisation (Horngren: 17).

(a) Profitability

The profitability of an organisation is based on the ratio between the return or margin created by the organisation; and the amount invested. Underlying this approach is the measurement of the profits generated by the organisation in relation to the capital employed.

(b) Solvability

Solvability refers to the margin whereby the organisation's assets exceed its commitments or foreign capital.

(c) Liquidity

Liquidity refers to the ability of an organisation to fund itself on the short-term in order to continue its operations.

(d) Productivity

Productivity refers to the ratio between business output (throughput) and business input, whether financially based or otherwise (see paragraph 5.3 of Part Two). These measures are of specific value in organisations with either low capital or aimed at providing a service based on skills.

(e) Cash flow

Cash flow measurement is aimed at determining and planning for the availability, throughput and direction of financial units.

4.2.10 Value analysis

Value Engineering is the discipline through which capital projects are optimised when still in the design or implementation phases.

Stringer (50) defines Value Engineering as a collection of techniques designed to examine all the cost components of a product or system in order to determine whether any cost item can be reduced or eliminated without detracting from its functional and quality elements.

Because engineering design and capital project implementation are means to achieving business transformation, value engineering as a set of techniques is particularly relevant in business transformation. The analysis phase of value engineering is known as *value analysis.*

Value is defined as the relationship between the functional performance or output of a system, compared to its input or cost (Stringer: 50):

Value = functional performance/cost

Before a value analysis exercise is undertaken, it must be determined what type of value improvement will be pursued. The following improvement alternatives exist:

- Improving functional performance at the same cost;
- reducing cost at the same functional performance;
- reducing cost more than reducing functional performance;
- improving functional performance more than increasing cost; and
- improving functional performance and reducing cost.

The chosen alternative depends upon the constraints or degrees of freedom within a system.

Value analysis is subsequently undertaken. It is based on the following process:

- Identify the constraints within the system;
- define value for the system based on financial valuation methods as discussed in paragraph 4.2.7 of Part Three;
- decompose the system into subsystems;
- decompose the financial plan for the system into controllable variables (capital expenditure and operating expenditure) and uncontrollable variables (revenues based on quantities, exchange rates and pricing);
- determine that value drivers where the biggest improvements can be achieved in the capital, operating and revenue plans;
- determine overall improvement targets for capital, operating expense and revenues (these targets are based on the avoidance of the worst case of the uncontrollable variables);
- decompose the value of each subsystem into function and cost/financial components;
- analyse this decomposition and determine improvement targets for each subsystem and validate them against the overall improvement targets; and
- generate ideas for the improvement of each subsystem.

This process is shown in figure 25.

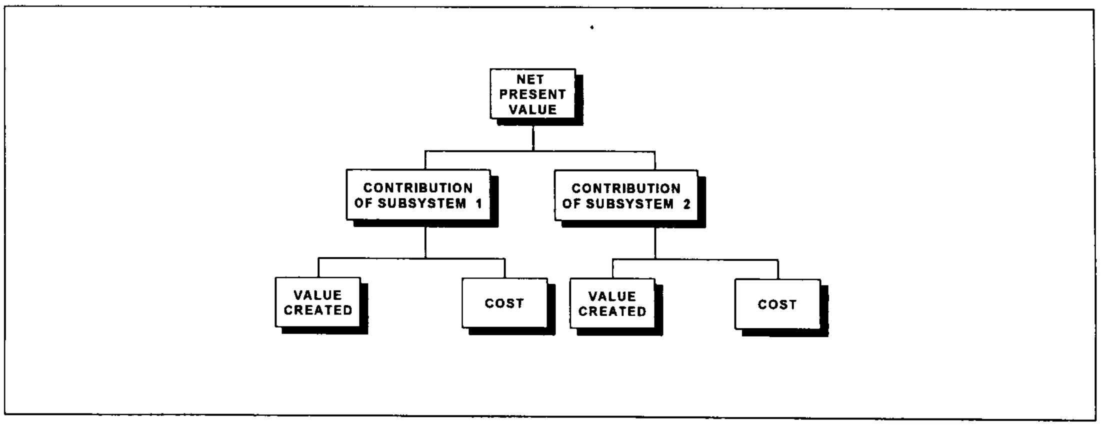

Figure 25 - Value analysis approach

4.2.11 Market analysis

Hammer and Champy (15) refer to the process of listening to the voice of the customer. Cross, Feather and Lynch (11) expand on this notion and propose that, as part of the analysis phase of business transformation, an analysis is conducted of the *voice of the customer* (marketplace). Such an analysis is usually undertaken through market research and is aimed at getting direct feedback from the various market segments about the performance of an organisation. The Boston Consulting Group (Skinner: 48) suggests a method for analysing the various products or services of an organisation based on a comparison of the market share of an organisation, compared to the growth rate within each market segment. This method, known as the *Boston Grid*, is shown in figure 26.

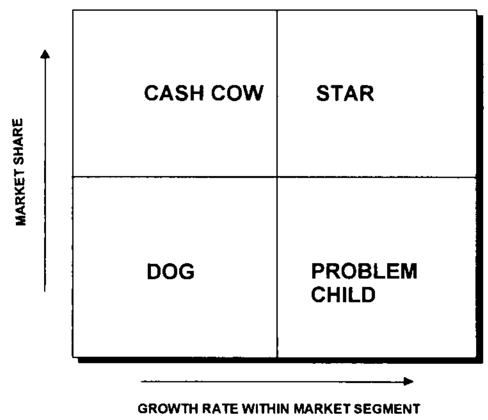

Figure 26 - The Boston Grid

An alternative method of analysing markets is through the Ansoff matrix (4), a method for identifying the current and proposed market strategy. This form of analysis compares the current and future products to current and future market segments as shown in figure 27.

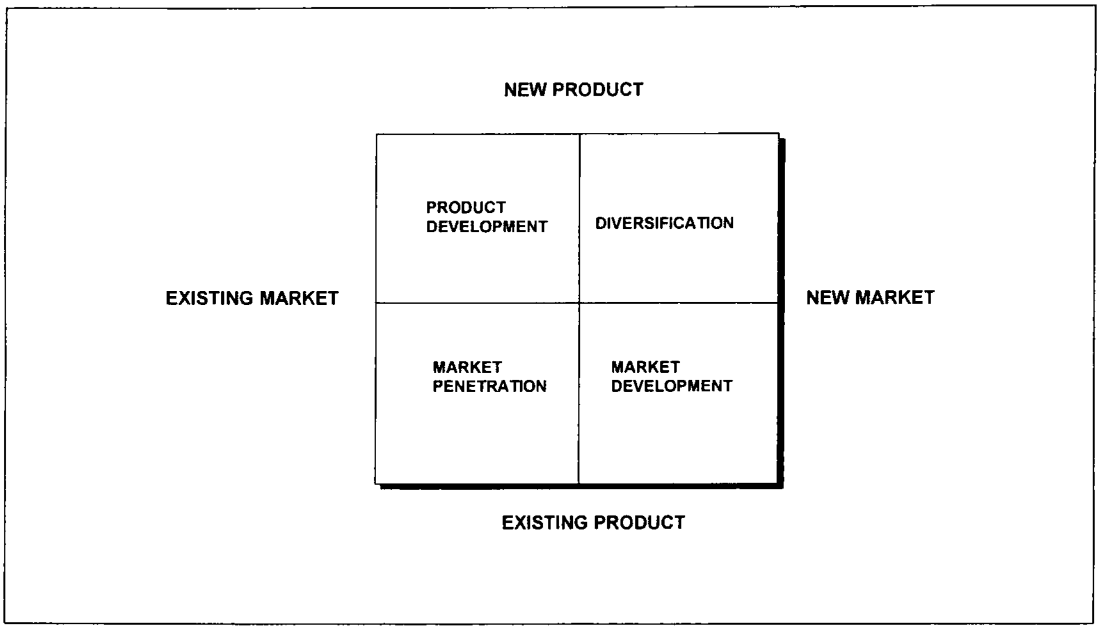

Figure 27 - The Ansoff Matrix

From these, four variants of market strategy are derived, namely:

- Market penetration;
- product development;
- market development; and
- diversification.

4.2.12 Life cycle analysis

Similar to the Boston Grid as defined in paragraph 4.2.11 of this thesis, it is often advantageous for an organisation to understand the relative life cycle position of its various product or service lines. An adapted version of the Boston Grid is suggested in figure 28 for these purposes.

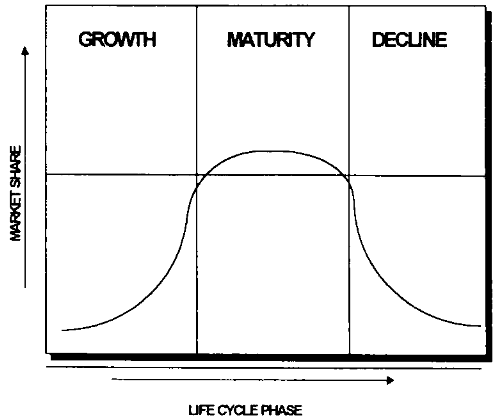

Figure 28 - Life cycle grid

4.2.13 Risk analysis

An organisation is constantly exposed to risks of various natures. An analysis of the risks in an organisation can thus add to an understanding of the state of the organisation.

Risk is defined as the value and probability of loss or failure in a business system (Valsamakis: 57).

Risk analysis is an approach similar to that used in maintenance and reliability engineering where risks are first determined, then grouped in terms of catastrophic, critical, major and minor risks. Subsequently, they are valued based on an analysis of their probability and expected value. The total value that is then determined is an indication of the level of exposure.

4.2.14 Due diligence investigations

A due diligence investigation is a form of analysis that is normally not associated with business transformation itself as it is generally conducted from a technical perspective. In organisations where technical uncertainties exist, due diligence investigations are normally carried out to determine the technical performance of these organisations. By using the value chain approach (refer to paragraph 4.2.4 of Part Three), the due diligence process can be expanded to encompass commercial issues as well.

4.3 Analysis of the internal environment

4.3.1 Current status analysis

The most elementary form of internal analysis is the current status assessment where a qualitative assessment is made of all the information available in the internal environment. This is normally achieved through questionnaires and structured interviews.

The aim of current status analysis is not to serve as a form of analysis by itself, but rather at directing further analysis efforts.

4.3.2 Strategy analysis

Ansoff (3,4) proposes the following definition for a strategy:

An organisation's strategy is defined as the process through which it proposes to interact with the business and external environments.

The organisation learns from its environment and subsequently sets a course for it based on the interventions or strategic initiatives it proposes to launch in order to influence its environment. The strategy is its highest level design (refer to paragraph 3.3.1 of Part Four for an explanation of the strategy development process). An analysis of the strategy of an organisation provides insight into the level of success that the organisation has had in the past in interpreting its environment and the progress that it has achieved in influencing the environment.

According to Prahalad and Hamel (36), the overall strategy of an organisation consists of the following elements:

- *Current reality* – an assessment of the environment by the organisation at a specific point in time;
- *strategic intent* – a description of the long-term vision of the organisation; and
- *strategies or interventions* – the actions that the organisation proposes to take in order to achieve the intent.

These elements are shown in figure 29.

Figure 29 - The strategic framework

4.3.3 Business process analysis

The analysis of business processes in order to find improvement opportunities is one of the most popular business analysis methods (Appleton: 5).

(a) Process modelling

A business process has a name that is semantically defined as a collective noun. Each rectangle in a process model identifies a single process element. In modelling each process element, each rectangle similarly identifies a single activity, which can be decomposed into transactions. The name of a sub-process, activity or transaction always includes a verb. Inputs into a process, process element or activity are represented by arrows entering the rectangle from the left while outputs are represented by arrows leaving the rectangle on the right. A process element may have many inputs and outputs.

In addition to inputs and outputs, a process model specifies the management mechanism (feedback control mechanism) that controls the level to which the process element or activity performs. Management mechanisms are specified as arrows entering the rectangle from the top.

Lastly, the resources required or converted by the process element or activity are specified as arrows entering the rectangle from the bottom.

In terms of model structure, the model may assume any form or configuration, but it is generally recommended that no more than seven rectangles be employed to model a process on any specific level of abstraction.

These generic process elements are shown in figure 30.

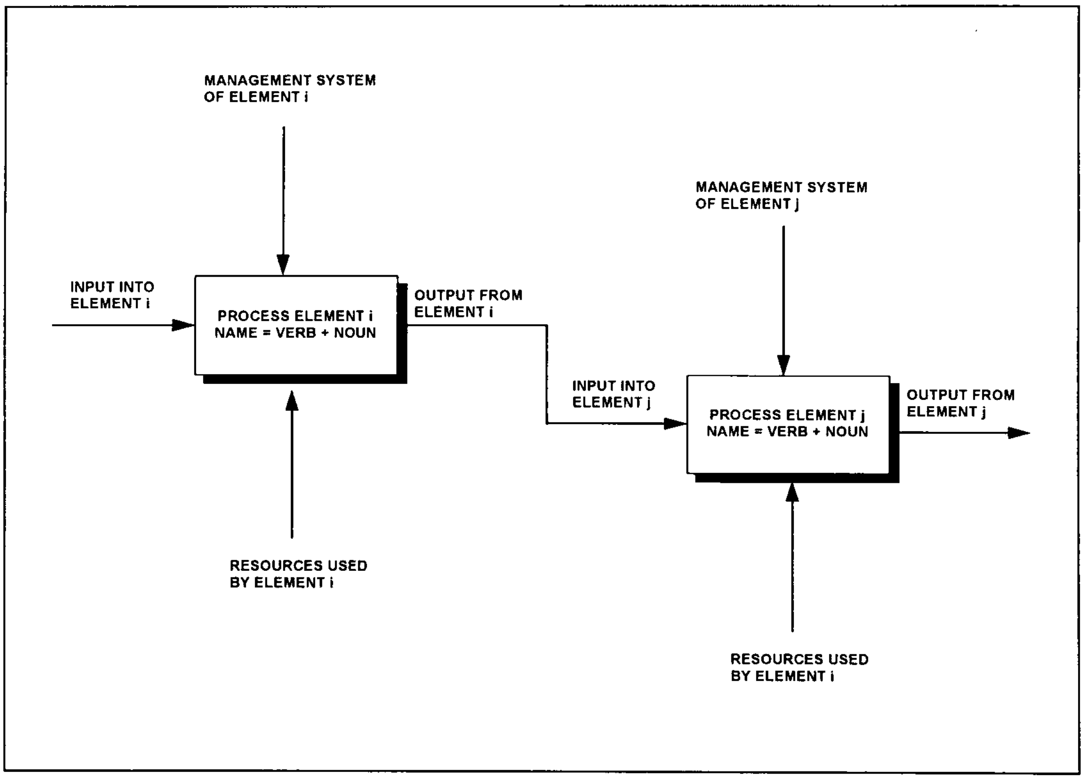

Figure 30 - Generic process elements

(b) Activity modelling

Activity modelling is the lower level of abstraction of process modelling. Activity modelling is often also called *workflow modelling.* There are generally accepted standards that apply to the basic activity model structure, called IDEF[1] that is an approach developed by the United States Department of Defence. This approach is well described by Appleton (5).

There are two versions of IDEF, termed $IDEF_0$ and $IDEF_{1X}$. The former is an approach aimed at pure activity modelling as the next abstraction level of business process modelling, whilst the latter is aimed at displaying the business entities and business rules. An activity model is a set of tasks that convert a set of inputs into a set of outputs, given specific external control parameters and employing resources as specified. A complete activity model on the $IDEF_0$ level consists of the following elements:

- A node tree that displays the hierarchical relationship between activities;
- a context model that displays the highest level activity and its input, output, management and resources;
- a decomposition model of all the transactions within an activity; and
- entity relationship models.

(c) Object modelling

Jacobson (19) suggests an alternative to the approach of business process and activity modelling through the use of object modelling. Objects are nouns, they are elements of the business and are subject to the processes or activities of the business.The approach focuses on the identification of business objects and models activities in terms of the transformation it inflicts upon the various objects.

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[1] *Integrated computer aided manufacturing definition language*

An example of a generic object model is shown in figure 31.

Figure 31 - Generic object model

(d) Dynamic modelling

There are various approaches in engineering for the modelling of the dynamic behaviour of process. System dynamics modelling and simulation modelling (Meadows: 31) are the most significant of these. In essence, these approaches claim that the dynamic nature and the level of turbulence within the business environment require an analysis of the dynamics of a business system.

4.3.4 Leadership assessment

Many organisations believe that the quality of their leadership is a significant factor in the success of the organisation. As a result, various leadership assessment methods exist through which the quality of leadership is determined. In order to define a method for the assessment of the leadership of an organisation, a number of approaches are presented:

- The leadership effectiveness analysis (26);
- the approach of Tannenbaum and Schmidt (52);
- the approach of Blake and Mouton (7);
- the approach of Hersey and Blanchard (16); and
- the approach of Senge (45,46).

In conclusion, a generic model is proposed.

(a) Leadership effectiveness analysis

The leadership effectiveness analysis (26) is a method that was first used for the evaluation of the leadership qualities of military officers. An analysis is conducted of the following dimensions:

- The visionary ability of the leader;
- the ability of the leader to build relationships;
- the ability of the leader to implement the vision; and
- the feedback and control of the leader.

(b) The approach of Tannenbaum and Schmidt

The approach of Tannenbaum and Schmidt (52) is based on the notion that leadership is based on two extremes namely relationship orientation one the one extreme, and task orientation on the other. The relationship orientation is viewed as democratic leadership and the task orientation is viewed as authoritarian leadership. Underlying this approach is the assumption that high performance is associated with low relationship and vice versa, an assumption that was already rejected in the discussion of the value system.

The approach identifies the basic elements required in a leadership model, but these elements should rather be viewed as two separate dimensions with various combinations possible except for the two extremes noted.

The approach of Tannenbaum and Schmidt is shown in figure 32.

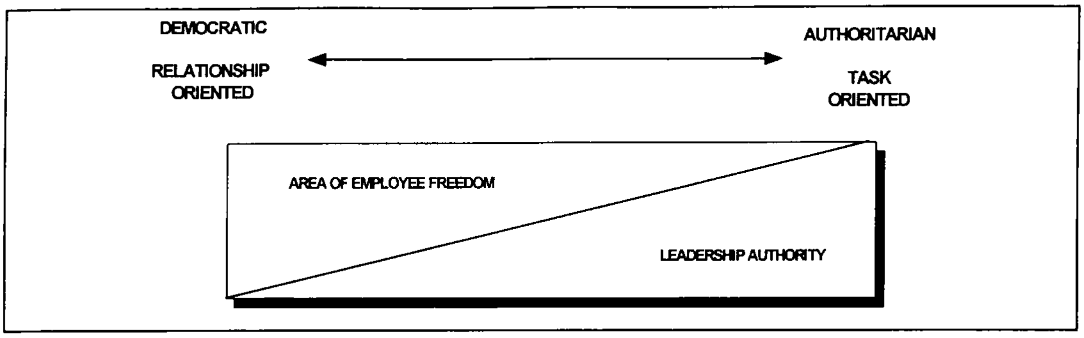

Figure 32 - The leadership approach of Tannenbaum and Schmidt

(c) The approach of Blake and Mouton

Blake and Mouton observe that all leadership approaches are based on the two dimensions of relationship behaviour and consideration, and task orientation and structure creation. They popularised this approach through the definition of their so-called *managerial grid (7).*

The managerial grid is shown in figure 33.

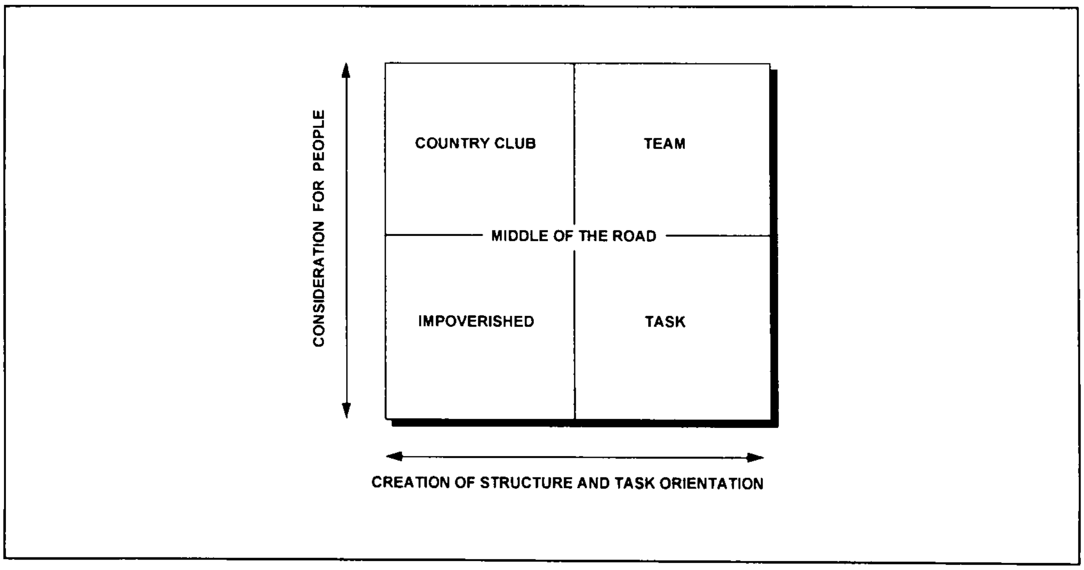

Figure 33 - The managerial grid

Five distinct leadership styles are derived from the managerial grid:

- The impoverished leadership style that is based on the minimum effort required maintaining the organisation;
- the country club leadership style that is based on thoughtful attention being rendered to the social needs of the people and the creation of an atmosphere that is conducive to co-operation;
- the task leadership style that is based on operational efficiency and the elimination of behavioural interference;
- the middle of the road leadership style that is based on a balance between organisational performance and consideration for the people within the organisation; and
- the team leadership style that is based on accomplishment through commitment, organisational performance resulting from interdependence and a common purpose between the people in the organisation.

(d) The approach of Hersey and Blanchard

All of the previous approaches are based on a study of the natural behaviour of leaders. Hersey and Blanchard (16) argue that leadership requires an adaptive or learning model that provides for contingency type leadership. The approach of Hersey and Blanchard is based on the assumption that leadership behaviour is learnt and performed according to the various situations. Effective leadership is thus not only a function of performance and social dimensions, but also of the situation. Leaders should thus assess every situation and the maturity (ability and willingness) of the workers involved in order to determine leadership behaviour.

The situational leadership approach is shown in figure 34.

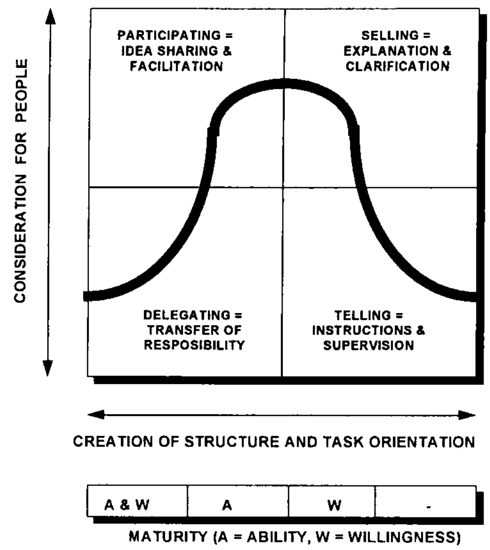

Figure 34 - The situational leadership approach

(d) The approach of Senge

Senge argues that viewing a business system requires feedback and continuous learning (45,46). The presence of the learning disciplines leads to a group sharing the vision of the leader. This serves as the catalyst for action. The leader should thus pay substantially more attention to the creation of a vision rather than acting situational. Situational leadership is a form of reaction, whereas Senge argues for interactive and preactive leadership. When every individual is driven by the pursuit of the vision, little effort is required with the motivation and goal setting of individuals.

"Our traditional view of leaders as special people who set the direction, make the key decisions, and energise the troops are deeply rooted in an individualistic and non-systemic world view. Especially in the west, leaders are heroes, great men (and occasionally women) who rise to the fore in times of crisis. Our prevailing leadership myths are still captured by the image of the captain of the cavalry leading the charge to rescue the settlers from the attacking Indians. So long as such myths prevail, they reinforce a focus on short-term events and charismatic heroes rather than on systemic forces and collective learning. At its heart, the traditional view of leadership is based on assumptions of people's powerlessness, their lack of personal vision and inability to master the forces of change, deficits that can be remedied only by a few great leaders. Leadership is ...the start of inspiring (literally to breathe life into) the vision of learning organisations."

Peter Senge in "The Fifth Discipline: The Art and the practice of the learning organisation" (45, page 312)

Senge proposes that leadership is based on the following three elements:

- *Leadership as an act of design.* If an organisation was an ocean liner, what was the role of the leader? Senge argues that the first role and the highest level of influence would be that of designer of the ship. In the business sense, the leader is the architect. Lao-Tzu stated that bad leaders are despised. Good leaders are praised. But about great leader they say *"we did it ourselves."* As a result, leadership as an act of design is often overlooked.
- *Leadership as an act of stewardship.* Leadership is based on a deep and committed relationship between the leader and the organisation. There is a higher purpose for the leader, a deep conviction that drives the leader. This conviction becomes the vision of the leader, and this vision is so powerful that it expands beyond the organisation into society at large. This unique relationship between the leader and his vision leads to the leader assuming the role of steward in the pursuit of this vision.
- *Leadership as an act of teaching.* Leadership is required to define *reality* and *intent* in order to determine the most suitable course of action for an organisation.

(f) Generic model

From all the previous leadership approaches that were studied, the following generic dimensions of leadership are proposed:

Transformational leadership dimensions

- *Architectural ability* based on the continuum between a leader that constantly creates, and one that constantly maintains;
- *visionary ability* based on a continuum between a leader that pursues a higher purpose and guides the business vision (entrepreneur), and one that follows the general tide of events; and
- *teaching ability* based on a continuum between a leader that facilitates the learning and adaptation of the business, and one that relentlessly pursues a certain course.

Institutional leadership dimensions

- *Level of influence* based on a continuum between strategic influence and operational influence;
- *behavioural intent* based on a continuum between structural (goal-oriented) and cultural (value-oriented) behaviour;
- *activity horizon* based on a continuum between an interactive activity horizon and a reactive activity horizon; and
- *governance style* based on a continuum between authoritarian governance and devolution.

Transactional leadership dimensions

- *Performance orientation* based on a continuum between high performance orientation and other objectives that may be pursued;
- *relationship style* based on a continuum between individualistic relationship types and group oriented relationship types; and
- *knowledge base* based on a continuum between generalised and specialised knowledge bases.

4.3.5 Organisational culture

An organisation's culture is largely based on its value system. The presence of values and beliefs forms the basic force that provides legitimacy to any organisation in terms of its stakeholders. The basic framework of Schein (43) is used to understand the culture of an organisation.

Schein defines the culture of an organisation as the combination of all of the artefacts and creations, the core principles and the basic assumptions that underlie the organisation.

The structure defined by Schein in order to define organisational culture is shown in figure 35.

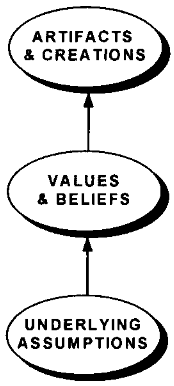

Figure 35 - The Schein framework

Core values and beliefs are identified through observing the rituals and the visible behaviour within an organisation. The underlying assumptions, on the other hand, are fairly vague in terms of definition, but they do exist. They explain the logic of the core business, the relationship with the business environment and the relationship between entities within the business.

The culture describes the behavioural rituals, artefacts, creations and beliefs of a specific race or civilisation.

Environmental change requires new culture as much as it requires new structure. Whenever change leads to different value systems in society, society will expect those new values being reflected in the organisations they are dealing with. An organisation is never forced to adopt new value systems, it chooses those from its own and the environment to which it is willing to adhere.

For a long time, the concept of culture and values seemed to be of little relevance in the business environment, perhaps as a last gasp of the industrial age. The reasoning was that organisations are based on objectives, not value systems. To some, the definition of a value system was purely a list of adjectives that describe the supposedly virtuous conduct of its people.

Peters and Waterman (32) changed this paradigm by demonstrating the importance of value systems in highly successful companies. This resulted in a large amount of literature being compiled in the past decade on value systems.

The author suggests that the framework provided by McDonald and Gandz (29), be used as an approach for analysing the value system of an organisation. For this reason, a conceptual overview is provided.

(a) The McDonald-Gandz framework

Through their research, McDonald and Gandz discovered a generic set of values that underlie any organisation. Through analysis of its preferences in this generic set, an organisation can learn the nature of its own value system.

This generic value system is shown in table 5 through the identification of twenty four generic values:

SHARED VALUE CONCEPT	***MODE OF BEHAVIOUR***
Adaptability	being flexible and changing in response to new circumstances
Aggressiveness	being aggressive and pursuing goals vigorously
Autonomy	being independent and free to act
Broad-mindedness	accepting different viewpoint and opinions
Cautiousness	being cautious and minimising exposure to risk
Consideration	being caring, kind and considerate
Co-operation	being co-operative and working well with others
Courtesy	being polite and having respect for individual dignity
Creativity	developing new ideas and applying innovative approaches
Development	achieving personal growth, learning and development
Diligence	working long and hard to achieve results
Economy	being thrifty and careful in spending
Experimentation	taking a trail and error approach to problem solving
Fairness	being fair and providing just recognition on merit
Forgiveness	being forgiving and understanding when errors occur
Formality	upholding proper ceremony and maintaining tradition
Humour	creating fun and being light-hearted
Initiative	seizing opportunity and taking responsibility without hesitation
Logic	being rational and thinking in terms of facts and figures
Moral integrity	being honourable and following ethical principles
Obedience	complying with directions and conforming to rules
Openness	being straightforward, sincere and candid in discussions
Orderliness	being neat, tidy and well-organised
Social equality	being equal to others and avoiding status differences

Table 5 - Generic values

A value system essentially defines the view that an organisation takes with respect to the two basic dimensions of culture namely:

- Its view on relationships and people; and
- its view on performance and the pursuit of business objectives.

McDonald and Gandz propose that an organisation can position itself on the value system grid according to its preferences for these generic values as selected from table 5.

The value system grid is shown in figure 36.

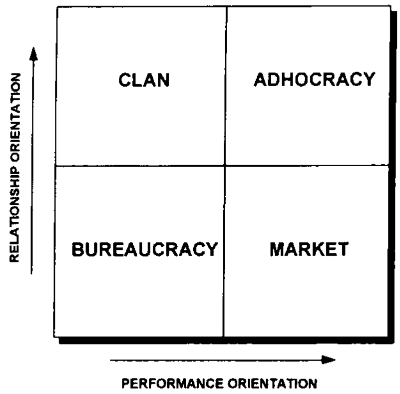

Figure 36 - Value system grid

(b) The bureaucracy

The culture of the *bureaucracy* is based on hierarchy and its purpose is execution and regulations. Its basic values are those of cautiousness, economy, formality, logic, obedience and orderliness.

The bureaucracy achieves its goals through measurement, documentation and computation.

(c) The clan

The culture of the *clan* is based on consensus, and its purpose is group cohesion. Its basic values are those of broad-mindedness, consideration, co-operation, courtesy, fairness, forgiveness, humour, moral integrity, openness and social equality.

The clan achieves its goals through discussion, participation and consensus.

(d) The market

The culture of the *market* is based on rationality and performance, and its purpose is the pursuit of objectives. Its basic values are those of aggressiveness, diligence and initiative.

The market achieves its goals through goal clarification, individual judgement and decisiveness.

(e) The adhocracy

The culture of the *adhocracy* is based on adaptive development, and its purpose is based on the requirements set for it. Its basic values are those of adaptability, autonomy, creativity, development and experimentation.

The adhocracy achieves its goals through visioning, learning and innovation.

(f) The competing values framework

Quinn (39) proposes a similar framework than that proposed by McDonald and Gandz. He identifies four generic groups of organisational values that are similar to those presented by McDonald and Gandz.

These groups are:

- The hierarchy;
- the team (clan);
- the producer (market); and
- the adhocracy.

They suggest that opposite values compete within an organisation. This causes tension. These opposites are:

- The rigid values of the hierarchy versus the free-thinking values of the adhocracy; and
- the goal-oriented values of the producer versus the humanistic values of the team.

4.3.6 SWOT-analysis

Self-assessment methods are generally based on some form of the traditional SWOT-analyses (strengths, weaknesses, opportunities and threats), focusing on the properties of the organisation and its environment that should be addressed (Thompson: 53). These factors are:

- Factors that must be exploited by the organisation;
- factors that must be averted by the organisation;
- factors that must be consolidated by the organisation; and
- factors that must be eliminated by the organisation.

These factors are shown in grid format in figure 37.

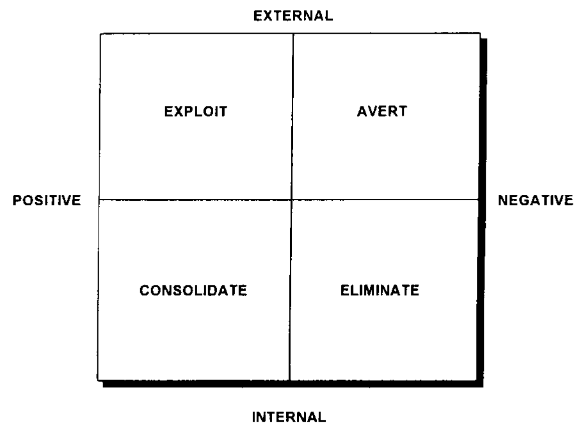

Figure 37 - The self-assessment grid

It is suggested that a SWOT-analysis be carried out in conclusion of the overall analysis and used as a summary of the various analyses of the external, business and internal environments.

5 Conclusion

Part Three presented an approach to business analysis. It used the systemic view of a business as a point of departure. In doing so, it was firstly explained why it was important to analyse an organisation, secondly an overview was presented of the various dimensions of a business system (what) and thirdly the various approaches and methods that can be employed (how) were positioned within this framework.The final output of the analysis phase is a set of requirements, a specification in engineering terms, for the design phase.

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Part Four - Business Design

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to," said the Cat.
"I don't care much where..." said Alice.
"Then it doesn't matter which way you ought to go," said the Cat.
"...so long as I get somewhere," Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, "if only you walk long enough."

Lewis Carrol from "Alice's Adventures in Wonderland"

1 Objective

Part Four of this thesis introduces the reader to the design phase of the Business Engineering Process in terms of the following:

- The basic principles of architecture and engineering design;
- the various elements of business architecture;
- the business design process; and
- a number of examples of best practices in business architecture.

The Business Engineering Process was proposed as a road map for the thesis. Part Four of the thesis is an integral part of this process.

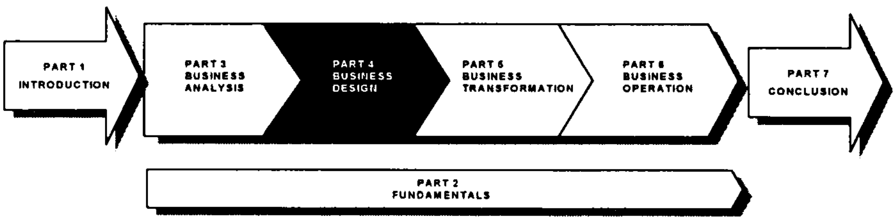

Figure 1 - The design phase of the Business Engineering Process

2 Basic principles

2.1 Design and architecture

Business design is concerned with the definition of the *future intent* of an organisation. This must be viewed in contrast to analysis, which is concerned with the definition of the *current reality* of the organisation. In defining the design process, the concept of architecture becomes relevant. Design is the process, architecture is the output. The input for this process is some form of requirement or specification that was compiled through the analysis of a system. This approach is shown in figure 2.

Figure 2 - The design process

This design process, when viewed independently, consists of two conflicting but necessary sub-processes namely architectural design, concerned with the development of an innovative and visually appealing design, and engineering design, concerned with the development of a cost effective balance between the architectural design and the realities of the real world.

Whilst systems thinking and structured analysis were the core engineering skills required in the previous chapter, innovative thinking and creativity are the core skills required in design. Because architects are extremely reliant on their innovative thinking skills, a study was made of the basic principles applied in the architectural design process in addition to those applied in the engineering design process. Architects are, by nature, dreamers, whilst engineers are realists. It is this combination that makes the design process successful.

In the design of organisations, this process of architectural and engineering design can be applied in a similar way. The output of the business analysis phase, being some form of specification, can thus be used as a starting point for business design. A business design process can subsequently be followed, which leads to a business architecture or blueprint being compiled (a master plan of the required or envisioned business and a plan as to how this can be achieved). In order to define an engineering approach to business design, the basic principles of architectural and engineering design are studied.

Part Four of the thesis introduces the reader firstly to the concept of business architecture and secondly to the design processes involved in defining this architecture. Lastly, like photographs of buildings, generic best practice architectures are presented.

2.2 The principles of architectural design

New or renewed organisations are built. According to Lawler (30) they are built by starting at the foundation and adding the various layers. They are built according to architectural designs, from the ground up.

Architecture is a term established by the Greek civilisation. It means something higher than ordinary *tecture* (construction or building). It is a structure distinguished from the ordinary by its scale, order, permanence and solemnity of purpose. A lasting impression is left by its visual appeal. It forms a unity with its environment and is the result of thorough analysis and innovative thinking.

Janson (25) defines architecture as the art of shaping space to human needs and aspirations.

Architecture is considered a special type of art that confines space so that people can dwell in it. In doing so, it creates the framework within which human beings live.

Architecture is a conceptual framework that defines the various dimensions of a structure. It is based on an analysis of the requirements of the inhabitants and serves as a the output of a design process – a compilation of the blueprints, plans, implementation schedules and resource requirements from which a structure can be created.

There are four fundamental principles of architectural design (Janson: 25):

- Primacy of purpose (the form follows the function);
- architectural fit (the architecture satisfies the requirements set by the architect, the future inhabitants and the engineers at once);
- utilisation of structural materials capable of implementing the architecture; and
- availability of applicable technology.

Throughout history, the most impressive architectural achievements were found in places of religion. If one examines the underlying principles applied to this form of architecture across various architectural eras and cultures, five further principles of architecture become evident (Janson: 25):

- Metaphysical symbolism (architecture does not only satisfy practical requirements but also reflects our values and beliefs);
- historical relevance (architecture conveys the hopes and ideals of a particular generation that takes pride in its architectural achievements);
- perfect mathematical symmetry (the image is one of equilibrium, order and symmetry);
- dependence on culture, time and individual architectural style (it is possible to know the culture, the values, the time frame and the architect from observing the structure although there are some architectures that are timeless); and
- artistic inspiration (architecture is inspired by the vision of the architect).

The fundamentals of business design are derived from these fundamentals of architectural design as shown in table 1.

FUNDAMENTAL OF ARCHITECTURAL DESIGN	*FUNDAMENTAL OF BUSINESS DESIGN*
Primacy of purpose	Structure follows strategy
Architectural fit	Satisfaction of stakeholder needs
Utilisation of structural materials	Recognition of resource constraints
Utilisation of applicable technology	Utilisation of applicable skills
Metaphysical symbolism	Alignment with long term vision and core values
Historical relevance	Adaptability
Mathematical symmetry	Simplicity and logic
Culture, time and architect dependence	Compatibility with organisational culture
Artistic inspiration	Visionary leadership

Table 1 - The fundamental principles of architectural design

In business design, like in architectural design there are stereotypical architectural styles, there are reproductions of original masterpieces and there are artists who made specific architectural styles famous.

2.3 The principles of engineering design

Engineering design is concerned with balancing the innovative thinking of the architect with the rational thinking of the real world.

Engineering design is a process of interpretation of a user requirement and optimisation of the system that was developed in order to satisfy this user requirement.

In doing so, the design engineer applies a number of fundamental principles (Blanchard: 7). These principles of engineering design are:

- Value optimisation (design to cost versus cost to function);
- reliability optimisation (balancing reliability with redundancy);
- a system life cycle approach;
- systems modelling and prototyping; and
- scientific evaluation of various alternatives.

By following a similar approach to that of the previous paragraph, additional fundamentals of business design can be derived from these principles of engineering design. They are shown in table 2.

FUNDAMENTAL OF ENGINEERING DESIGN	*FUNDAMENTAL OF BUSINESS DESIGN*
Value optimisation	Optimisation of value creation
Reliability optimisation	Design for flexibility
Quality	Fitness for purpose
System life cycle approach	Long-term view
Systems modelling and prototyping	Application of business modelling and sensitivity tests
Scientific evaluation of various alternatives	Evaluation of various design options

Table 2 - The fundamental principles of engineering design

Engineering design is a voice of reason. It tests the practical implications of the suggested architecture and modifies it through an iterative process in which the design is reviewed, the configuration changed and tracked and a system specification produced that satisfies the design engineer and the architect at once.

3 Business architecture

3.1 The principles of business architecture

3.1.1 Approach

Organisational behaviour is driven by the needs of the organisation. The driving force of the architecture of an organisation is its hierarchy of basic needs. Like human beings transforming themselves in the pursuit of their aspirations, organisations transform themselves in order to reach new levels of achievement. In doing so, new architectures are required.

The hierarchy of basic needs of organisations (derived from Maslow: 34) is shown in figure 3.

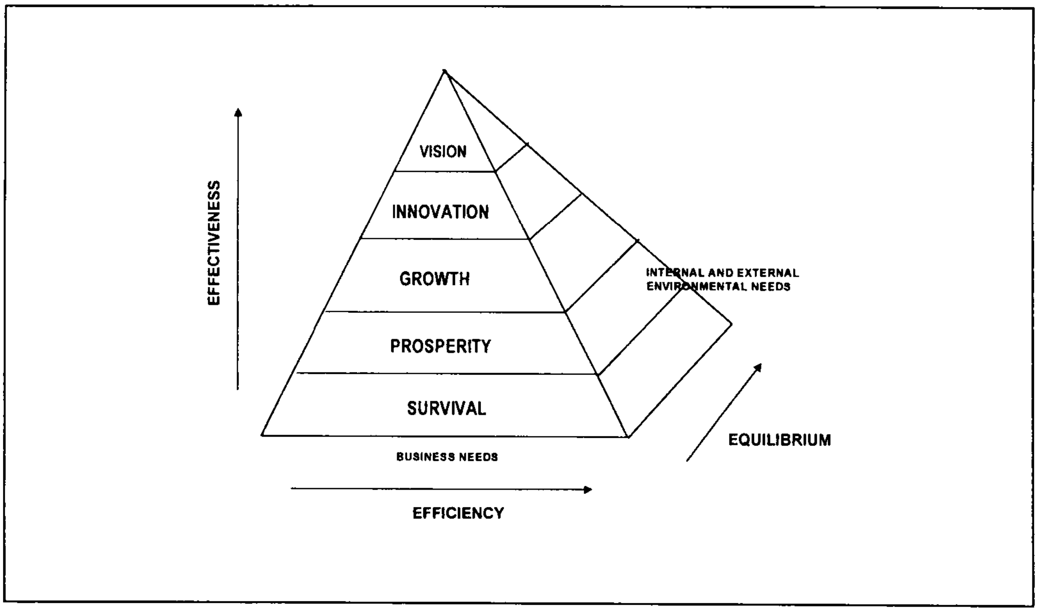

Figure 3 - The hierarchy of basic needs of an organisation

Based on its hierarchy of needs, three fundamental activities are performed by organisations namely *alignment,* in order to maintain equilibrium with the internal and external environment, *transformation* as an act of entropy in returning to equilibrium with the environment and *operation* in order to exploit the equilibrium that exists.

It is suggested that an organisation pursues three ultimate goals in this process:

- Effectiveness (the ability of organisations to improve themselves);
- efficiency (the ability of organisations to improve the way in which they satisfy their basic needs); and
- equilibrium (the ability of organisations to remain congruent with their environments).

In designing organisations as systems within an environment, the following properties are important in defining the architecture of the system (adapted from Nadler: 39):

- Internal interdependence (changes in components of the business architecture affects the total architecture);
- capacity for feedback (information on the performance of the business architecture can be used to manage the system);
- equilibrium (when an event disturbs the balance of the business architecture, the business system will react by reinstating the balance in order to survive);
- dynamism (the system follows environmental patterns in order to maintain equilibrium);
- entropy (all systems move towards eventual disorganisation and death, but business systems possess the ability to renew themselves[1]);
- equifinality (different architectural styles potentially lead to the same results being achieved); and
- adaptability (the system survives through constant measurement of environmental requirements and adapts accordingly).

[1] *In spite of this, very few organisations live longer than fifty to sixty years.*

3.1.2 Architectural style

When examining organisations, one can distinguish between various architectural styles. The term architectural style is used to define the unique characteristics relating to the cultural, historical and individual architectural flair that influence an architect's output. Three architectural styles can be distinguished in organisations (Nadler: 39):

- Bureaucracy or mechanistic architecture;
- expansionism or organistic architecture; and
- adhocracy or systemic architecture.

A comparison of these architectural styles is shown in table 3.

PROPERTY	BUREAUCRACY	EXPANSIONISM	ADHOCRACY
Purpose	Maintain status quo	Growth	Innovation
Method	Programming	Regeneration	Development
Process	Reactive	Preactive	Interactive
Structure	Hierarchy	Hierarchy	Adaptable
Culture	Standardised and centralised	Standardised and decentralised	Value driven
Management	Policy	Objectives	Vision

Table 3 - The three basic architectural styles

(a) Function and form

Architecture, as explained earlier, consists of both form and function. Function relates to the requirements of the various stakeholders. Form relates to the originality and vision of the architecture.

To form a better understanding of the basic architectural styles, the various function-related elements of architectural style and the various form-related elements of architectural style are evaluated.

(b) Function

Function relates to the way in which architecture satisfies the requirements of the stakeholders. Upon investigation, the various approaches to business architecture design all assume some specific functional requirement. Some are built around the optimisation of throughput (Goldratt: 19,20), others are built around the satisfaction of customer requirements (Hammer: 21) whilst others are built around product quality (Juran: 26). The first of these argue that the business architecture should optimise the function of throughput and productivity of an organisation, thereby optimising the organisation. The second of these argue that the business architecture should optimise the function of customer satisfaction, thereby optimising the organisation. The third of these argue that the business architecture should optimise the product quality of the organisation, thereby optimising the organisation.

The value disciplines model (Treacy and Wiersema: 52,53) explained in paragraph 4.2.2 of Part Three, serves as an explanation of the various functional architectures as a result of a strategic position taken by the organisation. These are:

- Relationship-based architecture (customer intimacy);
- product-based architecture (product/service leadership); and
- process-based architecture (operational excellence).

(c) Form

Three basic organisational forms are identified (Hanna: 24):

- The unitary form;
- the multidivisional form; and
- the network form.

The unitary form was created in the model that was used by Henry Ford. A unitary organisation is also called a profit centre. It is based on a situation in which every resource, every process and every output is managed from a single source which can be decomposed into various departments each having to account for the level to which it optimises its cost.

The multidivisional form was based on the General Motors model created by Alfred Sloan. This model consists of various profit centres. Within this model, resources, processes and output are generally managed on a decentralised individual profit centre level. Only those elements of the organisation that prove to be more successful in a centralised form become centralised.

All organisational forms are built from these two basic elements. Many organisations have found that a third form, a network or conglomerate, is emerging. Many of these are virtual organisations, networks of various small enterprises that jointly form a strong and competitive force.

Toffler (51, page 17) describes these organisations as follows:

"To survive today's onrushing changes, we must be prepared to reconsider the very models on which our obsolete organisations are based.

Instead of rigid conventional departments, the form is divided into a highly flexible structure composed of a framework and modules. Instead of being treated as an isolated unit, it is pictured as occupying a position at the centre (and as part of) a shifting constellation of related companies, organisations and agencies. The result, I believe, is a powerful model of adaptive organisation.

The framework is the thin co-ordinative wiring that strings together a set of temporary, modular units. The constellation consists of the company and the independent or semi-autonomous outside organisations on which it relies."

3.2 Business architecture models

In order to compile a proposed business architecture model, the most significant architectural models were studied. There are a number of models that are documented in literature but many of these were developed from an information technology perspective (CSC Foundation: 13,14). Thus, they describe only those elements of business architecture required to develop information technology architecture. The author believes that this notion has led to an amount of confusion and lack of business substance in many of the existing business architecture models. A short overview is presented on the most significant business architectural models that were studied. They are organised in terms of their contribution towards a generic model that is presented in paragraph 3.2.4 of Part Four.

These models are:

- The McKinsey 7-S model;
- the Arthur D Little model;
- the business system diamond;
- the star architecture;
- the MIT 90s paradigm; and
- architectural models that were developed for the computer-integrated manufacturing environment.

3.2.1 The McKinsey 7-S model

The McKinsey 7-S model (Thompson: 50) provides the basic building blocks of business architecture but does not clarify their relationships. The McKinsey model was developed by McKinsey and Company. It proposes that business architecture should be based on the model as shown in figure 4.

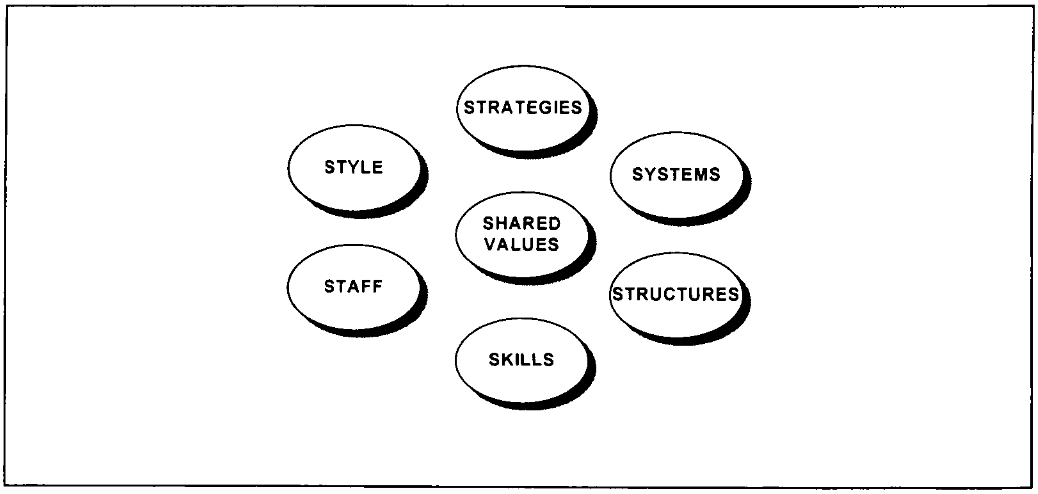

Figure 4 - The McKinsey 7-S model

This model is based on the following elements:

- A strategy that describes the proposed interaction of the organisation within its environment;
- the systems that the organisation uses to guide its activities;
- the structure that organises the processes of the organisation;
- a set of shared values that direct behaviour within the organisation;
- the style by which the organisation is governed;
- the skills through which the organisation performs its function; and
- the staffing that provides the skills.

3.2.2 The Arthur D Little model

The approach followed by Arthur D Little Incorporated (18,31) is primarily concerned with the definition of a performance management framework for organisations. The model is referred to as *the high performance framework*. It consists of three elements:

- A business environment framework;
- a business performance framework in which the relationship between stakeholder requirements, business processes, and business resources are defined; and
- a business management framework.

This model is shown in figure 5.

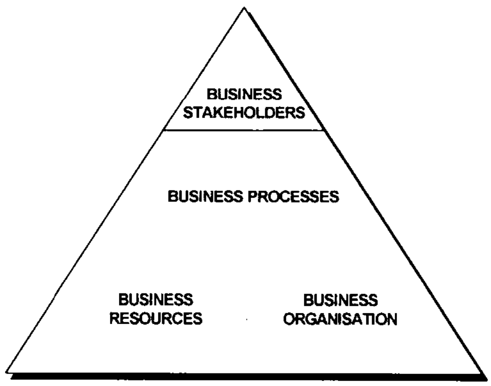

Figure 5 - The high performance model

Organisational performance, according to this model, is based on excellence in the satisfaction of all stakeholder requirements at once. The model thus starts with a definition of stakeholder requirements. Based on these requirements, the processes are designed for the delivery of the required business output to the stakeholders. Based on these processes, resources are acquired and managed in order to operate the business processes successfully.

3.2.3 The business system diamond

Hammer and Champy (13,21) developed the business system diamond. They established themselves as the pioneers of the business reengineering movement. This movement is founded upon the notion of an organisation being some configuration of processes. The architecture is based on the definitions of these processes and related elements. The ultimate aim is to find ways in which to improve these processes.

The *business system diamond* as proposed by Hammer and Champy and is shown in figure 6.

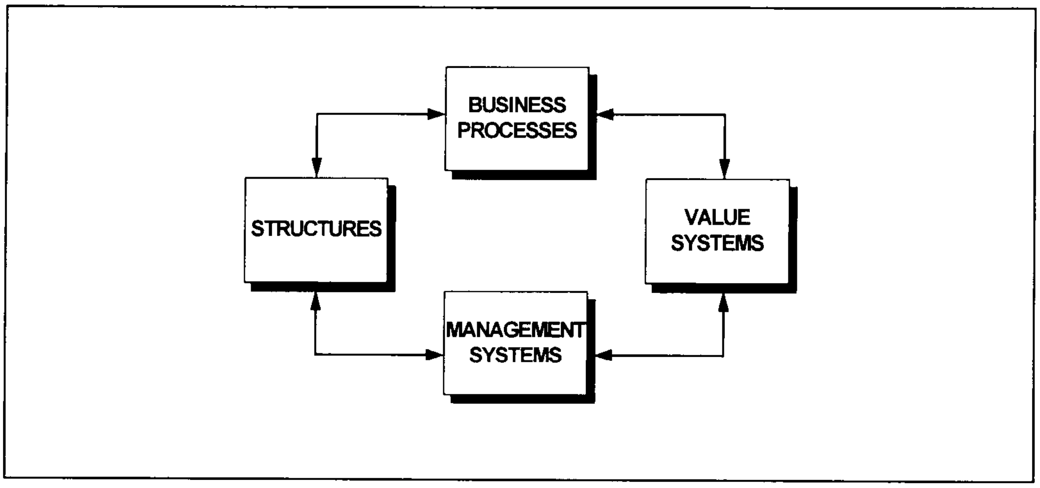

Figure 6 - The business system diamond

The model might be simplistic but it does show the importance of these elements in the architecture of the organisation. They propose that, to apply the model successfully, all points of the diamond must simultaneously be addressed and continuously revisited in the design process.

3.2.4 The star architecture

The star architecture as proposed by Lawler (30) is based on five generic components required in the architecture of an organisation.

This model is shown in figure 7.

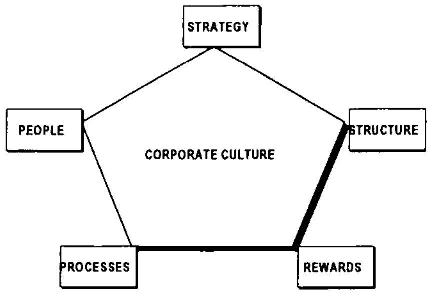

Figure 7 - The star architecture

The five-pointed star model that was developed by Lawler does not identify corporate culture as a determinant of architecture. Lawler argues that culture develops as a consequence of the other elements.

3.2.5 The MIT 90s paradigm

The most comprehensive and logical model that was investigated for the definition of business architecture is the model developed by the MIT Management School (38). It is based on a systems view of the organisation. The model, known as the *MIT 90s paradigm,* was developed as a model for a research programme conducted by MIT into the management and technological challenges facing organisations in the 1990s and beyond. The programme specifically aims to understand the turbulence of the business environment, the globalisation of the world economy and the role of information technology.

The model represents the five fundamental elements of an organisation that should be in dynamic equilibrium (mutually and with the environment). As the MIT 90s research programme specifically aims at understanding the role of information technology within this model, the model presented in this document is based on a generalisation of the original model.

The generalised version of the MIT 90s paradigm is shown in figure 8.

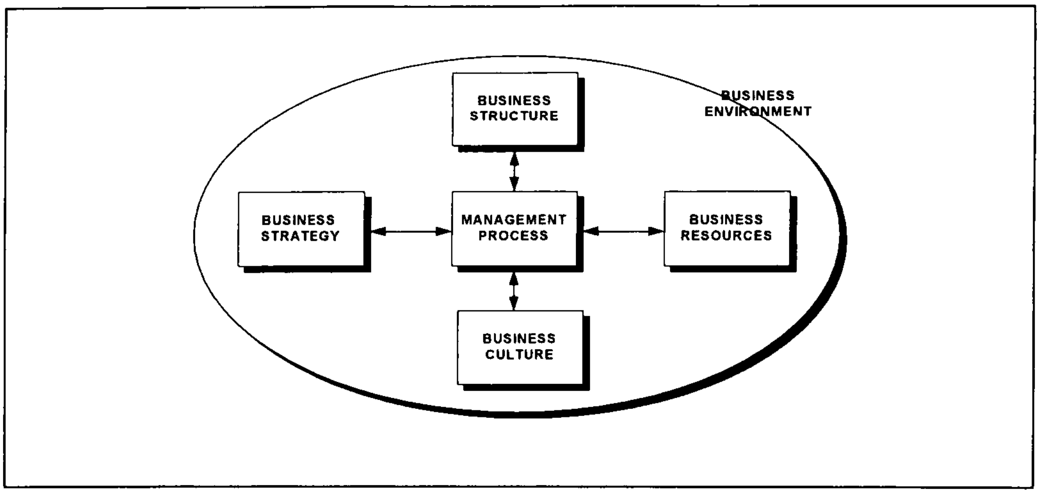

Figure 8 - The MIT 90s paradigm

The model shows that the management process of the organisation serves as the most important link between the business strategy and the resources of the organisation. If an organisation does not have a clearly defined management process, it will not be able to align the resources with the strategy, nor will it be able to align the structure with the culture.

3.2.6 Architectural models from the CIM environment

A number of models exist within the computer-integrated manufacturing (CIM) environment for the development of business architecture (Bernus: 54, Jorysz: 55, Kosanke: 56). These models are all aimed at developing an accurate and comprehensive definition of an organisation for the purpose of defining information systems within a manufacturing environment. These models were mainly developed within the Industrial Engineering domain and, whilst they provide some proof of the involvement of the Industrial Engineering discipline in the field of Business Design, they tend to focus only on the modelling aspects related to computer-integrated manufacturing. Whilst the application of information technology (including the manufacturing environment) remains a major factor in business transformation, this subject area is not included within the main focus of the thesis. Also, these models focus only on the structural elements of the operations of an organisation and neglect the strategic, cultural and managerial elements of architecture. For completeness of the thesis, a brief overview is presented. Additional references are provided in paragraph 7 with regard to these models.

The most significant of these models are:

- The Purdue Enterprise Reference Architecture (PERA) that models the manufacturing activities of an organisation from the functional and physical perspectives;
- the Computer-Integrated Manufacturing Open Systems Architecture (CIM-OSA) that models the manufacturing activities of an organisation from the functional, information, resource and organisational perspectives;
- the Toronto Virtual Enterprise (TOVE) ontology that provides a set of modelling conventions and terminology for the modelling of an organisation; and
- the Generalised Enterprise Reference Architecture (GERAM) and related models developed at Griffiths University.

The main contribution of these models does not lie in their definition of architecture (in other words strategic, structural, cultural and managerial) but rather in the modelling conventions that they provide. Generally, their contribution can be summarised as follows:

- They provide a shared terminology for an organisation;
- they define the meaning of each term in a precise and unambiguous manner (semantics);
- they implement this semantics in a set of axioms; and
- they define a symbology for depicting a term or related concept in a graphical format.

3.3 Generic business architecture model

3.3.1 Dimensions

Three fundamental dimensions of the architecture of an organisation are suggested. They were derived from the models shown previously namely:

- External and internal alignment based on the alignment of the business strategy with the environment on the one extreme, and the alignment of the resources with the organisation on the other extreme;
- mode of behaviour based on the structural requirements of the organisation on the one extreme and the cultural requirements of the organisation on the other; and
- a management system that ensures equilibrium between the other two dimensions.

The relationships between these dimensions are shown in figure 9.

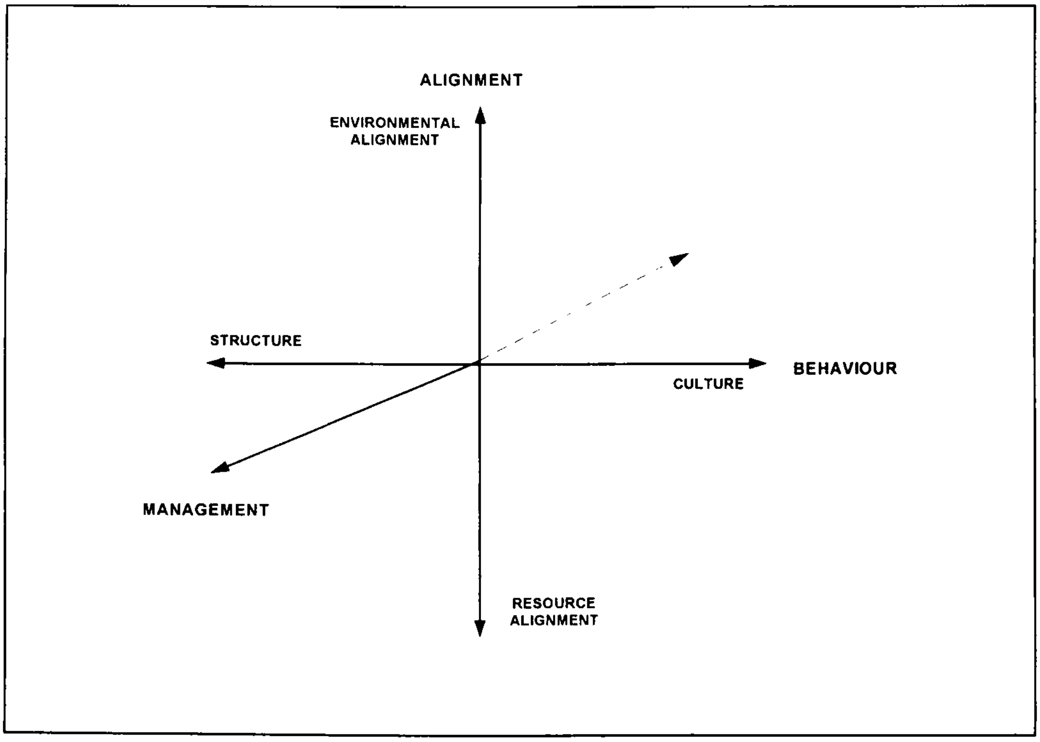

Figure 9 - The dimensions of business architecture

(a) External and internal alignment

Alignment is defined as the relationship between system elements on the various levels of abstraction.

An organisation is part of a higher level system. Within this relationship, it strives to align with the requirements set by the environment. Simultaneously, it also attempts to influence the environment. The organisation does so through its vision and strategies. Similarly, an organisation performs processes in order to achieve these strategies. Lastly, an organisation acquires and manages resources, and these resources must be aligned with the requirements of the organisation. The implication of the alignment dimension is that the generic business architecture should include a definition of the environment (as defined in the analysis phase), a definition of the organisation's strategies, and a definition of the various resources that are utilised in the organisation.

(b) Mode of behaviour

Mode of behaviour is based on two elements:

- The structure within which the organisation performs its function; and
- the culture within which the organisation performs its function.

Together, these elements provide the guidelines within which the organisation operates. It defines the various activities that an organisation undertakes in order to achieve its purpose and specifies the required behaviour while performing these activities.

(c) Management system

The management system of an organisation is the feedback control mechanism of the business system. It firstly sets the general direction for the organisation in respect of strategy, resources, structure and culture. Secondly, it corrects unsatisfactory performance by influencing the strategy, resources, structure or culture.

3.3.2 Generic business architecture elements

The elements of this generic business architecture are derived from the dimensions described in the previous paragraph. These elements are:

- The environment;
- the strategic architecture;
- the structural architecture;
- the cultural architecture;
- the resource architecture; and
- the management architecture.

These architectural elements are shown in figure 10.

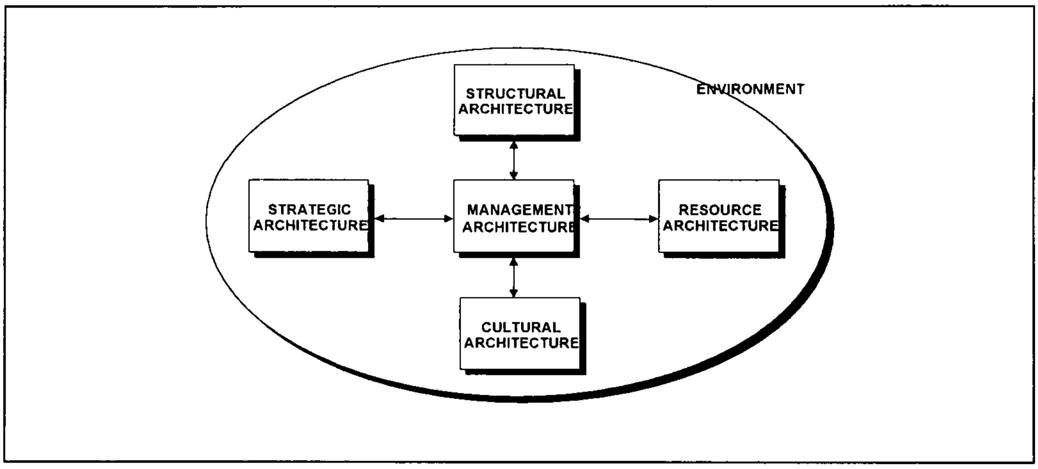

Figure 10 - The generic elements of business architecture

3.3.3 Environment

The definition of the environment of an organisation is based on the output of the analysis phase. It consists of three basic elements:

- The way in which the external environment will influence the organisation;
- the current reality within the business environment; and
- the current reality within the internal environment.

3.3.4 Strategic architecture

Strategic architecture, as the name implies, is all about strategy. A strategy or strategic plan forms the blueprint for the long-term direction of an organisation by defining three imperatives (Prahalad and Hamel: 42):

- How the organisation intends to act upon the influence of the external environment;
- what the future intent is within the business environment and how this will be achieved; and
- what the future intent is within the internal environment and how this will be achieved.

The most important skill that is required in order to pursue these imperatives is that of *visioning*. Vision – a vivid picture of a better future, energises people to overcome adversity.

In order to understand strategic architecture, the term *strategic* is defined.

"STRATEGY - generalship...the art of formulating a series of manoeuvres to obtain a specific goal."

Oxford Dictionary

The term *strategy* or its adjective *strategic*, was derived from the Greek word *stratos*, meaning *army* or *war*. As much as society claims to be civilised, people will always engage in warfare. The reason for warfare is simple - a common goal that is pursued by two or more opposing parties. Although the basis for warfare in the business environment is economic interaction between the organisation and its stakeholders, the philosophies around strategy remains the same as those proposed for warfare by the Chinese 2000 bC (Sun Tzu: 49).

"Warfare is the greatest affair of state, the basis of life and death, the way to survival and extinction. It must be thoroughly pondered and analysed."

Sun Tzu in "The Art of War"

A strategy specifies the thinking of the general, describes the proposed course of action of the different campaigns that compose the war and regulates the battles to be fought in each.

Mintzberg (35,36) warns that there are three fallacies that should be avoided in strategy:

- Forecasting, as it distracts attention from true vision and it does not consider possible future discontinuities;
- detachment, as it allows for the division of strategic thinking into a visioning activity assigned to visionaries, and a planning activity assigned to planners; and
- formalisation, as it removes learning from the strategic process.

A number of strategy theorists have attempted to define the generic strategies an organisation can follow. Ansoff (4) proposes four generic strategy types:

- Market penetration;
- product development;
- market development; and
- diversification.

Porter (40) proposes three generic focus areas in strategy namely cost competitiveness (being as cost effective as possible), product differentiation (focusing on product and service quality) or focused niche (focusing on stakeholder requirements not addressed by other organisations).

These basic focus areas are shown in table 4.

FOCUS AREA	*COST COMPETITIVENESS*	*DIFFERENTIATED COMPETITIVENESS*
INDUSTRY WIDE	cost leadership strategy	Differentiation strategy
MARKET SEGMENT	focus strategy	Focus strategy

Table 4 - Strategic focus areas in an organisation

These models are hardly comprehensive. Ansoff only focuses on extensions of the business strategy whilst Porter only focuses on identifying business strategy in the first place.

The value disciplines as proposed by Treacy and Wiersema (52,53) is a generalised approach based on the notion that an organisation can choose one of three strategies namely customer intimacy, product leadership or operational excellence.

It is proposed that one of the following generic strategies are pursued:

- Vertical integration of the business system through the formation of alliances, mergers and acquisitions;
- consolidation through the outsourcing of investments that can be managed effectively and efficiently elsewhere;
- diversification through the addition or removal of investments;
- development and growth through mergers and acquisitions or expansions of existing investments;
- restructuring through optimising the performance of the organisation; and
- resource optimisation through the improvement of resource productivity.

Mintzberg and Quinn (36) suggest that all strategy types, and indeed those listed here, are derived from the following four possibilities:

- Locating the core business;
- distinguishing the core business;
- elaborating the core business; extending the core business; or
- reconceiving the core business.

3.3.5 Structural architecture

Structure is the combination of all the tangible elements that define the mechanics of the organisation (Chandler: 9).

The structural architecture is a collective term for the various inputs, processes and outputs of the organisation defined in measurable and practical terms.

Chandler coined the well-known phrase in management that structure follows strategy (Chandler: 9). This implies that structure is not created by chance, but rather it is a derivative of the strategy of the organisation. The strategy influences the composition of the structure. If an organisation follows a strategy of vertical integration, the structure will differ from that if the organisation follows a strategy of growth and development.

Structural architecture consists of the following generic elements:

- The goals and objectives of the organisation;
- the value chain of the organisation;
- the organisation's processes;
- the functional hierarchy of the organisation; and
- the shareholding and ownership of the organisation.

When the structure of an organisation is designed, the future intent with these elements must be defined in alignment with the strategy. Because it rarely happens that an organisation is defined from a zero base, they should be defined in comparison with the current reality of the organisation. In any transformation effort, this comparison leads to the definition of a series of *interventions*, transformational actions, whereby the new structure is achieved. When doing so with the processes of the organisation, it is referred to as *Business Process Reengineering (BPR)*.

(a) The goals and objectives of the organisation

The goals and objectives of an organisation represent its highest form of structure. They translate the strategy into value chains, processes and hierarchies. There is a semantic difference between the goals and objectives of an organisation.

Goals are viewed as the sub-components of the strategic intent of the organisation. They can be strategic or operational. Strategic goals are directly derived from strategy. Operational goals are indirectly derived from strategy.

Objectives are viewed as the way in which the pursuit of goals is being measured. They can, similarly, be long-term oriented or short term oriented.

(b) The value chain of the organisation

The *value chain* of an organisation is based on the generic value chain proposed by Porter (41). Any organisation consists of a series of processes, as described in paragraph 4.2.4 of Part Three of this thesis. They collectively add value to the output of the organisation. A unique value chain can be constructed for an organisation that will show a similarity with the generic value chain. The value chain, consisting of these high level processes, is constructed in alignment with the goals and objectives of the organisation.

(c) The organisation's processes

The processes of an organisation are constructed in order to provide the details underlying the value chain.These processes define the intended activities within the organisation as well as the business rules that govern their operation. The processes are developed in alignment with the value chain. They are based on the desired state, that is, derived from the future intent of the organisation.

In defining the processes of the organisation, it is important to determine the level of maturity of any particular process. The Software Engineering Institute (Appleton: 6) provides a framework for defining process maturity levels.

These levels are shown in figure 11.

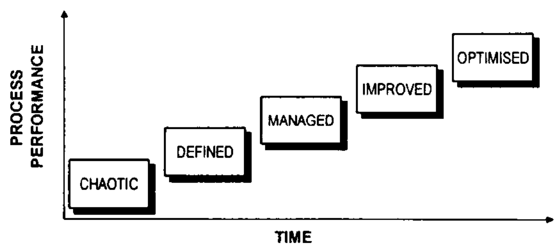

Figure 11- Process maturity levels

(d) The functional hierarchy of the organisation

Using a process model (value chain and processes) to define the structural architecture does not imply that a functional hierarchy can not be compiled. The functional hierarchy is a perspective of the organisation similar to that of the process perspective. Like with any perspective, certain elements are more visible whilst others are less so. Whilst the process perspective clarifies the relationships between processes and hence units within an organisation, the accountability and responsibility structure is obscured. Similarly, if a functional perspective were created without the process view, the accountability and responsibility would have been visible with the systemic relationships obscured. One way of addressing this issue is by two-dimensional thinking about the issue – developing a matrix that reconciles the processes of the organisation with the functional hierarchy. The structural architecture is not complete without a functional hierarchical view of the organisation. The rigid hierarchical relationships have however changed to flatter, leaner and more adaptable structures in recent years.

Handy (22) proposes the following new types of "hierarchies" that will emerge:

- The triple-I organisation based on structures built around intelligence, information and ideas;
- the federal or inverted doughnut organisation based on a core with various peripherals around the core all allied to one common flag; and
- the shamrock organisation based on small groups of specialists, a contractual fringe and a pool of part time workers.

In addition to these, Lawler (30) suggests the following types of hierarchies:

- The project organisation where the assumption of permanence is removed; and
- the team-based organisation where groups are formed around tasks and hierarchical position is determined by the ability to execute the task.

(e) The shareholding and ownership of the organisation

If the organisations of the Industrial Age are compared to those of today, there is one other significant difference apart from those already discussed in this thesis. The ownership structures of organisations have become significantly more complex. Whereas the organisations of the industrial era were based on sole proprietors, partnerships (Rolls and Royce, Daimler and Benz and the like), and large multidivisional public corporations like General Motors, strange variants are being created today. The following are the most significant reasons for these strange variants:

- Globalisation has lead to multinational and global organisations being created and adapted in order to benefit from regional economic forces;
- disparity in trade and fiscal policies between countries have created opportunities to maximise returns;
- stakeholder empowerment has lead to various stakeholders who were previously unimportant acquiring shares in organisations;
- the information technology and knowledge worker industries typically consists of various small enterprises that form conglomerates and networks and are bought and sold daily; and
- change in the economic environment is causing increased turmoil in stock markets which leads to more dynamic trading of stock.

Because of these reasons, organisations are increasingly concerned with their ownership structure as well as the ownership structure of their investments.

3.3.6 Cultural architecture

Schein (45) defines culture as the combination of all the intangible elements that influence the behaviour of people within an organisation.

The cultural architecture is the thus a collective term for the values, beliefs and human interactions in the organisation.

The most important factor in defining the culture of an organisation is the fact that it must be aligned with the structure. Organisations that overemphasise structure above culture are run by robots, which in time will become unhappy with their environment. This in turn will lead to unfavourable performance. Similarly, organisations that over-emphasise culture above structure are run by a group of individuals who are content but achieve nothing. They will over time, become discontent with their situations.

If structure follows strategy then culture follows structure. Similar to the way in which a structure is derived that will enable the strategy to realise, culture is derived from structure in a way that will enable the structure to function optimally.

Deal and Kennedy (15) define two dimensions of corporate culture namely:

- A continuum between slow reaction from the environment and fast reaction from the environment; and
- a continuum between low risk organisations and high-risk organisations.

The dimensions of corporate culture are shown in figure 12:

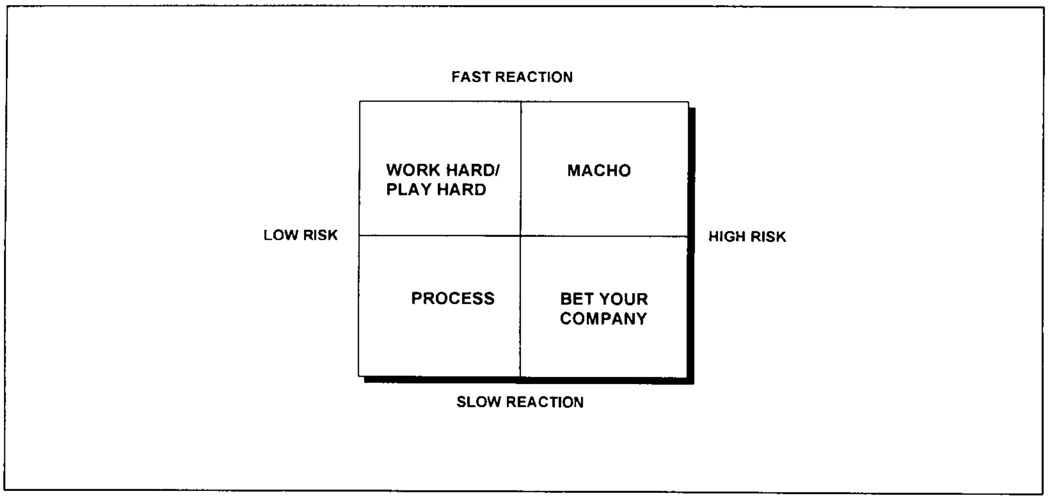

Figure 12 - The dimensions of corporate culture

From these, four basic types of organisational culture are defined:

- The macho or tough guy culture (high risk/quick feedback);
- the work hard/play hard culture (low risk/quick feedback);
- the bet- your-company culture (high risk/slow feedback); and
- the process culture (low risk/slow feedback).

Martin (33) similarly defines three types of culture:

- Informal culture;
- formal culture; and
- technical culture.

It is suggested that cultural architecture consists of the following generic elements:

- The leadership of the organisation;
- the core values of the organisation;
- the collective skills of the organisation;
- reward and recognition systems within the organisation; and
- the organisational climate.

When the culture of an organisation is designed, it is done in order to support the structure. It must however be stressed that the definition of cultural architecture is normally a less formal and less tangible process than that of structure. Similar to the creation of a building, the structural architecture defines the shell, whilst the cultural architecture defines the interior in order to ensure that the inhabitants are able to express their lifestyles while living in it

Although the process of defining this form of architecture is less formal, this does not imply that culture does not evolve from the thinking and the order amongst the individuals who are left within the structure. A formal definition process driven by the leadership of the organisation promotes the establishment of a stable organisational culture.

(a) The leadership of the organisation

The highest form of cultural architecture of any organisation is the leadership style within the organisation (Lawler: 30, Mintzberg: 37, Nadler: 39, Senge: 46). Leaders are not programmed to behave in any specific way, they do what comes naturally. If these are aligned with strategy and structure, they become leaders.

(b) The core values of the organisation

The core values and beliefs (Schein: 45) within an organisation play a similar role to that of goals and objectives in the pursuit an organisation's strategy. Whilst the goals and objectives define the targets that are pursued, the values define the behaviour that is required in pursuit of the strategy. The leadership of the organisation defines them in a formal or informal way.

The values of an organisation are translated into the behaviour that the leadership wishes to promote. By acting out this behaviour, in their role as role models, they influence the behaviour of other individuals.

(c) The collective skills of the organisation

The collective skills of an organisation are defined in order to influence the competence with which the processes are executed (Prahalad and Hamel: 43). They should ideally be aligned with the organisation's processes. If they are not aligned, the organisation is either executing processes without the competence to do so, or it is in possession of certain skills that it does not utilise to its full potential.

(d) Reward and recognition systems within the organisation

Reward and recognition influences the behaviour of the employees within an organisation (Lawler: 30). They serve as incentives for individuals to perform. They also need to be closely articulated with the need for human beings since they are critical in attracting and retaining the right individuals. They are crucial in making all the elements of the architecture operate effectively. Discontented individuals can sabotage the best structure and the worst structure can be operated successfully by contented individuals.

It does not make sense to combine a strategy that calls for teamwork with a reward system that rewards individual performance. Similarly, it does not make sense to develop a strategy and structure that assume the availability of people with certain capabilities if those people can not be hired or developed.

(e) The organisational climate

The organisational climate indicates the level of satisfaction of the individuals within the organisation with the previous elements of cultural architecture. It is based on their contentment with the organisation's leadership, their alignment with the specified behaviour in the core values, their skill levels and their levels of satisfaction from the reward and recognition they receive.

3.3.7 Resource architecture

The term architecture has long been used in the field of information technology (CSC Foundation: 11,12,13). As indicated earlier, this has also lead to a number of approaches being developed to define business architecture that only does so in order to define the information technology architecture. In this paragraph, amongst other elements, this form of architecture becomes relevant.

The strategic alignment model was developed by the CSC Foundation (13,21) in order to define the various levels that are necessary in the development of information systems. This model defines four types of alignment:

- Alignment between business strategy and information technology strategy;
- alignment between business strategy and business processes;
- alignment between information technology strategy and information systems; and
- alignment between the business processes and the information systems.

These relationships are shown in two-dimensional form in figure 13.

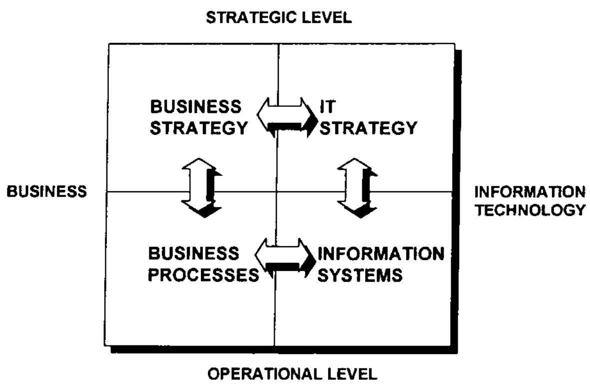

Figure 13 - Strategic alignment model

A generalisation of this model is used to develop a framework for the alignment of business resources in general. This model is shown in figure 14.

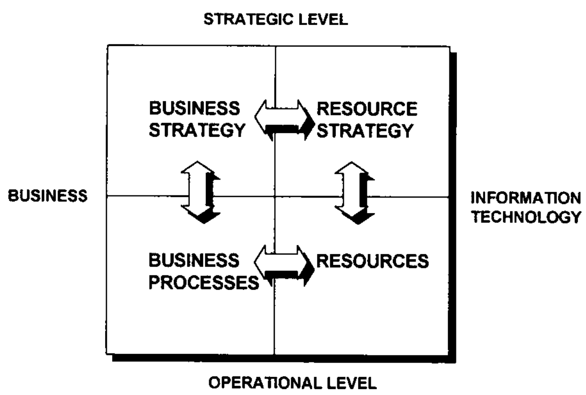

Figure 14 - Generalised strategic alignment model

Resources are all those inputs that are required in order to ignite the business engine. An organisation needs raw materials, money, equipment, technology, people and information. These resources are scarce and expensive and they influence the cost incurred by the organisation, therefore they need to be optimised at levels not exceeding that required by the strategy.

Resource architecture consists of the following generic elements:

- Natural resources;
- capital resources; and
- knowledge resources.

(a) Natural resources

Natural resources are the materials, energy and land that are used to operate the organisation.

An organisation plans its requirements for natural resources through the use of scheduling methods such as master production scheduling, material requirements planning and capacity planning.

(b) Capital resources

Capital resources are the finances and facilities of the organisation.

The finances of an organisation are planned for through the budget of the organisation. This includes the operating, capital and cash flow budgets of the organisation.

Facilities are planned for through various maintenance scheduling, asset management and replacement plans within the organisation.

(c) Knowledge resources

Knowledge resources, or the management of intellectual capital, has become a strategic imperative for many organisations.

Drucker refers to the so-called *post capitalist society* (16), meaning that the focus on resources is shifting from capital resources to these knowledge resources. As we enter the new millennium, the role of the knowledge worker is becoming increasingly important in organisations. This is particularly true for the service-type industries that are growing in numbers. Because of this, the role of the intellectual resources of the organisation can not be over-emphasised. This intellectual capital is the result of the collective learning of the organisation.

Similar to the way in which an organisation collects capital resources and grows through financial prosperity, there are organisations that grow in knowledge. Because of this, this resource has to be protected in a similar fashion than the way an organisation protects its capital resources. Also, for many service organisations, knowledge has become the most significant asset.

According to Agyris and Schon (3), knowledge management consists of the following five elements:

- Knowledge acquisition based on the way in which the organisation acquires knowledge in terms of internal and external sources, and the area of interest;
- problem solving based on the way in which the organisation addresses obstacles in terms of location, procedure, activity and scope;
- dissemination based on the processes and breadth of sharing of information;
- ownership based on the emotional ownership and identity source of the information; and
- memory based on the way in which an organisation stores and retrieves knowledge.

Knowledge resources are based on the human resource, technology and information resources of the organisation. The human resources are planned for through a definition of requirements, technology through technology strategy and information through information architecture.

3.3.8 Management architecture

From the systems perspective, management is viewed as the feedback control mechanism that continuously measures organisational performance and corrects or improves it by influencing the input into a system.

Management architecture consists of the following generic elements:

- Performance measurement; and
- corporate governance.

(a) Performance measurement

"Revolutions begin long before they are officially declared. For several years, senior executives in a broad range of industries have been rethinking how to measure the performance of their businesses. At the heart of this revolution lies a radical decision : to shift from treating financial figures as the foundation for performance measurement to treating them as one among a broader set of measures."

Robert Eccles in "The performance measurement manifesto" (17, page 54)

The performance measurement system serves as the instrumentation in the cockpit of an organisation. They are derived from the strategies and processes of the organisation and serve as a tool whereby management action is activated.

The *balanced scorecard* (Kaplan and Norton: 27,28,29) as described in paragraph 4.2.1 of Part Three of this thesis is the most elementary approach to performance measurement of an organisation. As indicated previously, it simplifies all of the complex theories on business performance measurement. It does so by evaluating the performance of an organisation's processes against the requirements of the four most fundamental stakeholders of the organisation. In compiling a balanced scorecard as part of the design process, the instrumentation is defined against which future performance can be monitored. It is based on performance measures that are compiled for the various perspectives of organisational performance as defined in figure 15.

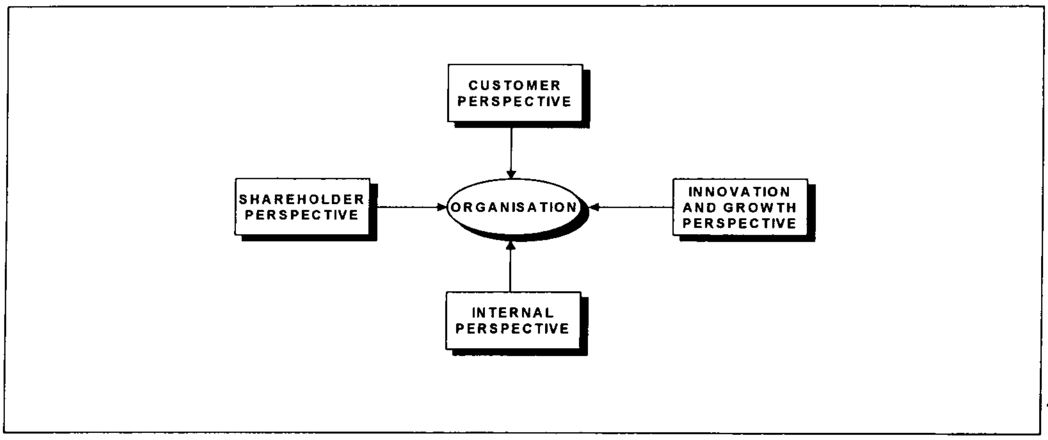

Figure 15 - Balanced scorecard perspectives

(b) Corporate governance

One of the dilemmas of the multidivisional architecture is that of corporate governance. This dilemma can even exist in smaller organisations whenever there are management responsibilities that are shared by a central decision-making entity and decentralised entities.

The dilemma is based on a lack of clarity in respect of the regulating principles between these entities. The word *governance* was derived from the word *governor* which is defined as the entity that governs an area, or the engineering word *governor* which is a mechanism that measures performance and regulates it within certain levels.

It is suggested that corporate governance is based on two dimensions namely:

- The level of governance based on a continuum between strategic governance and operational governance; and
- the governance activity based on the continuum between planning, where the governor takes the leading role and governance occurs before the actual activity, and control, where the entity that is being governed takes the leading role and governance occurs after the actual activity.

These dimensions are shown in figure 16.

Figure 16 - The dimensions of corporate governance

From these two dimensions, four generic governance styles can be determined. These are:

- A strategic planning governance style where the governor is prescriptive in respect of the strategic direction and leaves the rest to the entity that is being governed;
- a strategic control governance style where the governor expects certain specified strategic targets to be achieved and leaves the rest to the entity that is being governed;
- an operational planning governance style where the governor is prescriptive in respect of the short-term activities that are being undertaken; and
- an operational control governance style where the governor expects certain specified short-term targets to be achieved.

By positioning itself in terms of these generic styles the responsibility for the management activities can be clarified in the architecture.

4 Business design processes

4.1 Approach

In architectural and engineering design, various design projects tend to each have its own unique requirements. In some cases, an innovative new building is designed. In other instances an old outdated building is renovated in order to stay relevant. In other instances, an existing building needs expansion and additions and alterations are done. Whilst the end product and the principles are the same, the approach is different in designing these various structures.

Similarly, the design of organisations can be viewed in three groups (Appleton: 6):

- New business design;
- business redesign; and
- business growth.

For each of these, the process of design may differ. However, the quality and contents of the output are generally the same.

4.2 Design processes

Recent management literature describes various new processes that can be used for the design of organisations (Goldratt: 20, Hammer: 21, Juran: 26). Terms such as *Business Process Reengineering*, *Theory of Constraints* and *Total Quality Management* are only a few of these processes.

A useful framework for understanding these various design processes is presented by Martin (33). Martin defines these processes as *the seven disciplines of enterprise engineering*[2].

[2] *It must be noted that, although these seven disciplines all contain the prefix "re" that implies restoration rather than design, the concept remains the same.*

The framework provided by Martin is shown in figure 17.

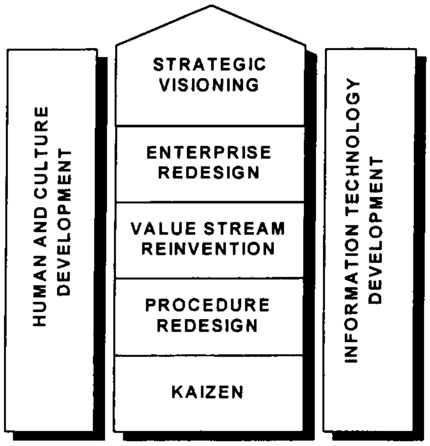

Figure 17 - The seven disciplines of enterprise engineering

These processes are defined as shown in table 5.

ENTERPRISE ENGINEERING DISCIPLINE	***DEFINITION***	***DESIGN PROCESS***
Strategic Visioning	Strategic positioning of the organisation	Strategic planning
Enterprise Redesign	Holistic and revolutionary transformation of the total organisation	Business innovation
Value Stream Reinvention	Revolutionary transformation of one or more end to end processes of the organisation	Business reengineering
Procedure Redesign	Revolutionary transformation of one or more process elements	Process reengineering
Kaizen	Evolutionary transformation of the organisation	Continuous improvement
Human and Culture Development	Transformation of human resource culture	Human resource development
Information Technology Development	Transformation based on information technology introduction	Information technology development

Table 5 - Definition of business design processes

4.3 Generic business design process

An organisation is a system that receives input from upstream systems, processes this input and produces output to downstream systems. The processing that occurs can be viewed as various process elements that are interrelated according to a pre-defined logical configuration. In modelling a system, one at least needs to model the structure of the output of the system, the process involved and the inputs into the process. This can be achieved through applying the various modelling approaches that were discussed.

In order to define a generic design process, the systems approach requires a definition of the input required into the process, the process itself, and its output.

The overall process is shown in figure 18.

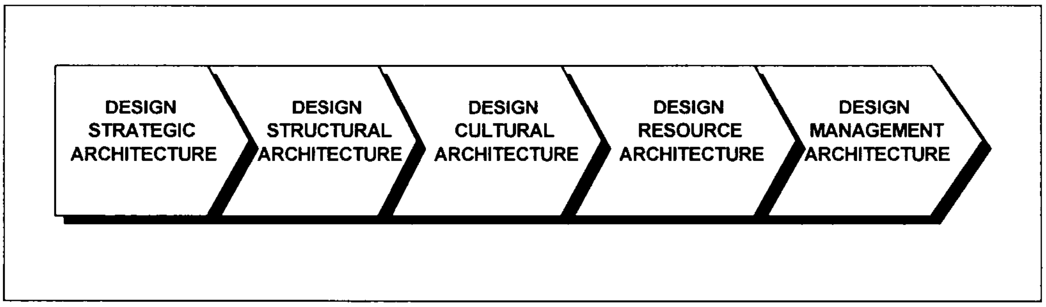

Figure 18 - The business design process

4.3.1 Strategic architecture design process

"A good deal of corporate planning I have observed is like a ritual rain dance; it has no effect on the weather that follows, but those who engage in it think it does. Moreover, much of the advice and instruction related to corporate planning is directed at improving the dancing, not the weather."

Russel L Ackoff in "Creating the corporate future" (2, page 113)

The strategic architecture design process, like the name implies, is focused on strategic planning. When investigating the process of strategic planning, it is necessary to understand the difference between strategic planning as defined by Ansoff (4,5) and strategic thinking as defined by Mintzberg (35,36). The former refers to the formal process in the organisation of compiling long-term and short-term plans and implementing them, the latter refers to the skill associated with the strategic planning process.

Strategic thinking ensures the effectiveness of the strategy design process – that the organisation is focused on the relevant issues. Strategic planning is concerned with the efficiency of the strategy design process – the level of success with the execution of the formal process. It is therefore important to recognise that, while the design process is focused on this formal process, this is not an ultimate measure of success. Mintzberg (36) was the first to recognise these differences. He argues that the core skill required in strategic thinking is innovation, while the core skill required in strategic planning is the application of the structured approach.

He explains this paradox as follows:

"When strategic planning arrived on the scene in the mid 1960s, corporate leaders embraced it as the one best way to devise and implement strategies that would enhance the competitiveness of each business unit. True to the scientific management pioneered by Frederick Taylor, this one best way involved separating thinking from doing and creating a new function staffed by specialists: strategic business planners. Planning systems were expected to produce the best strategies as well as step-by-step instructions from carrying out those strategies so that the doers, the managers of businesses, could not get them wrong. As we now know, planning has not exactly worked out that way.

Business planning is not strategic thinking. Indeed planning often spoils strategic thinking, causing managers to confuse real vision with the manipulation of numbers. And this confusion lies at the heart of the issue: the most successful strategies are visions, not plans."

Henry Mintzberg in "The rise and fall of strategic planning" (36, page 34)

There are two generic approaches that could be followed in the design of the strategic planning process:

- A systems approach based on those of Prahalad, Hamel and Senge (42,44,46,47); or
- a value chain approach based on that of Porter (40).

(a) The systems approach to strategic planning

The systems approach to strategic planning is based on an assessment of the causal relationships within the organisation.

This process is shown in figure 19.

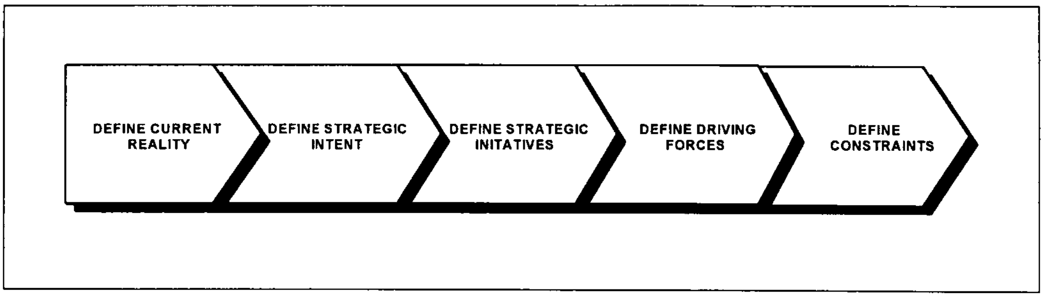

Figure 19 - The systems approach to strategic planning

Inputs required for this process are:

- An analysis of the environment; and
- an analysis of the current performance of the organisation.

The process itself consists of the following activities:

- Definition of the current reality of the organisation;
- cause/effect analyses of the current reality (current reality tree);
- definition of the future intent of the organisation (strategic intent);
- cause/effect analyses of the future intent (future reality tree);
- definition of the required interventions in order to progress from the current reality to the future intent (strategic initiatives);

- definition of the driving forces as a source of energy in achieving these strategic initiatives;
- definition of the constraints that inhibit the achievement of the strategy; and
- an implementation plan for the strategy.

(b) The value chain approach to strategic planning

The value chain approach is based on an assessment of the sequential relationships in the organisation.

This process is shown in figure 20.

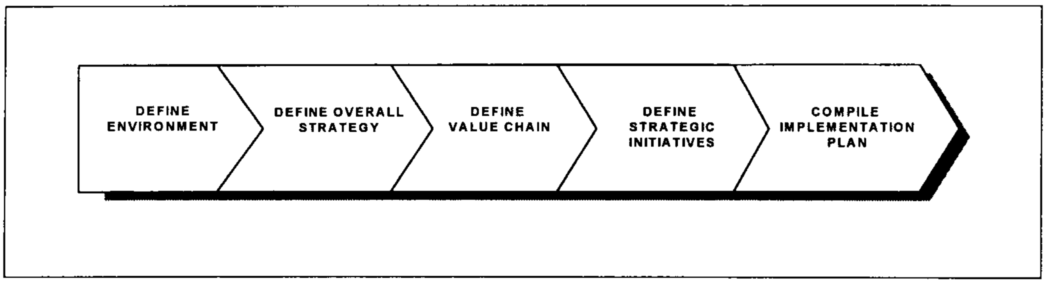

Figure 20 - Value chain approach to strategic planning

Inputs required for this process are:

- An analysis of the environment; and
- an analysis of the value chain of the organisation.

The process itself consists of the following activities:

- Definition of an overall strategy for the organisation;
- definition of the proposed value chain for the organisation;
- definition of the proposed detailed strategies for each element of the value chain (including the environment); and
- an implementation plan for the strategy.

4.3.2 Structural architecture design process

When designing the structural architecture of an organisation, the strategic architecture is used as primary driver. The existing structure is the secondary driver because structure can not always be transformed overnight. The various elements of the structure are subsequently derived from these.

This process is shown in figure 21.

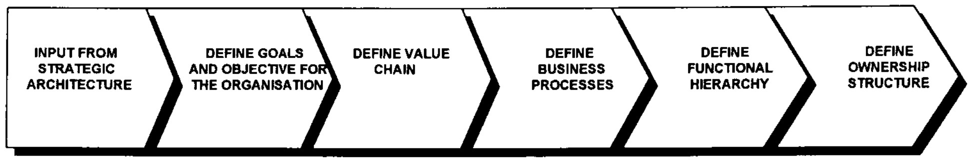

Figure 21 - Structural design process

Inputs required for this process are:

- The strategic architecture of the organisation; and
- the current reality with the existing structure.

The process itself consists of the following activities:

- Deriving the goals and objectives of the organisation from the strategy by defining goals as the sub-components of the strategic intent through a process of goal decomposition, and objectives as the measurable targets derived from the goals;
- definition of the value chain of the organisation in terms of the processes through which the goals are achieved (if the value chain was not already defined as part of the strategic architecture);
- definition of processes as sub-components of the value chain;
- definition of the functional hierarchy of the organisation through a two dimensional matrix approach through which processes and functional units are related; and
- definition of the shareholding and ownership of the organisation.

4.3.3 Cultural architecture design process

Mintzberg and Quinn (37) define culture as the ideology of the organisation. They suggest a three phased process for the development of an ideology:

- Rooting of ideology in a sense of mission;
- development of ideology through tradition and sagas; and
- reinforcement of ideology through identifications.

When designing the cultural architecture of an organisation, the structural architecture, as well as the aspirations that are set in the strategic architecture are used as primary drivers. The existing culture is the secondary driver. There must, however be tolerance for the fact that the design of cultural architecture is often an informal and less tangible process. The formal process shown here thus serves as an explanation of this informal process rather than a formula.

This process is shown in figure 22.

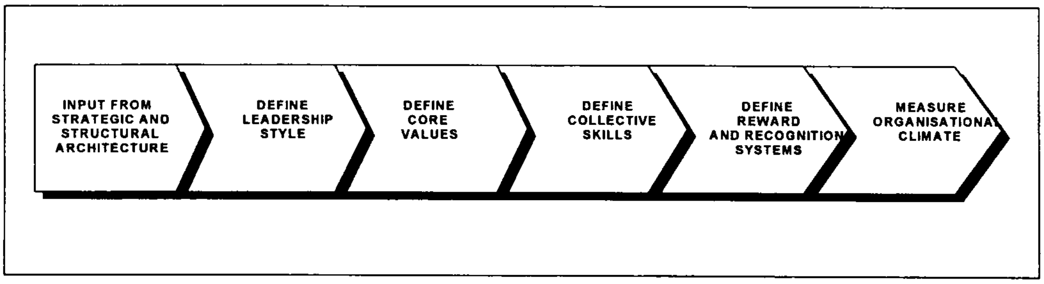

Figure 22 - Cultural design process

Inputs required for this process are:

- The strategic architecture of the organisation;
- the structural architecture of the organisation; and
- the current reality with the existing structure.

The process itself consists of the following activities:

- The leadership of an organisation is considered a given – however, the strategy and structure might induce corrective actions in this regard;
- definition of the core values of the organisation by the leadership;
- alignment of the collective skills of the organisation with its processes;
- definition of reward and recognition systems within the organisation;
- understanding the effect that the cultural architecture will have on the organisational climate.

4.3.4 Resource architecture design process

When designing the resource architecture of an organisation, the previously defined architectures are used as primary drivers. The various business resources namely the natural, capital and knowledge resources, are then aligned with the other architectures.

This process is shown in figure 23.

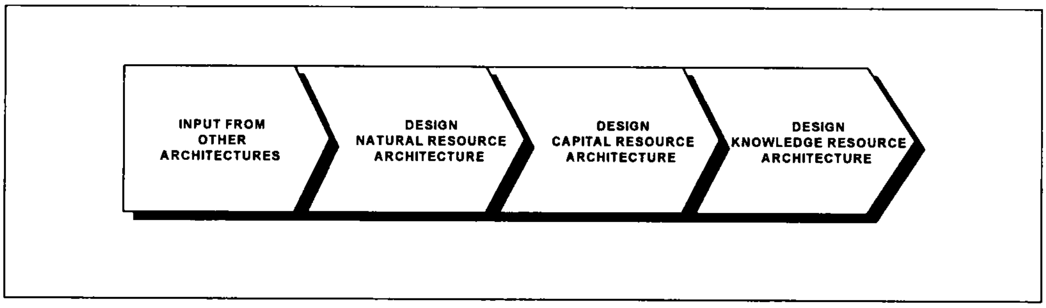

Figure 23 - Resource architecture design process

Inputs required for this process are:

- The strategic architecture of the organisation;
- the structural architecture of the organisation; and
- the cultural architecture of the organisation.

The process itself consists of the following activities:

- Definition of the natural resource requirements of the organisation;
- definition of the capital resource requirement in a capital and operating budget format; and
- definition of the knowledge resources, human resource requirements and information technology strategy of the organisation.

4.3.5 Management architecture design process

When designing the management architecture of an organisation, the basic approach that defines levels of resolution in management is used. The design process should thus view the management architecture from the strategic, tactical and operational points of view. This process should resolve issues such as performance measurement imperatives and corporate governance by defining the levels at which the various activities are undertaken namely the corporate, divisional and business unit levels.

An integrated management architecture focuses on planning, execution, control and feedback and integrates strategic, tactical and operational management.

This process is shown in figure 24.

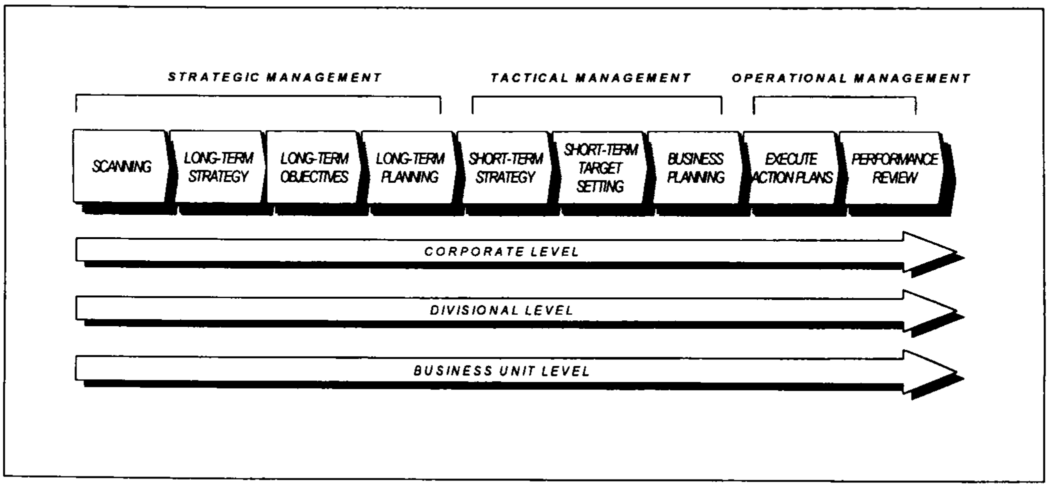

Figure 24 - Integrated management process

Inputs required for this process are:

- Scenario planning information; and
- performance feedback.

The process itself consists of the following activities:

- Scanning of the external, business and internal environments through scenario planning, performance measurement and self assessment;
- definition of a long-term strategy;
- translation of the long-term strategy into long term objectives;
- definition of a long-term plan;
- definition of a short-term strategy;
- translation of the short-term strategy into short term targets;
- defining a business plan and budget;
- execution of the strategy; and
- continuous improvement and performance reviews.

4.4 Modelling conventions

There are conventions through which the design process is simplified. Generally, the design process determines the effectiveness of the architecture, whilst the modelling conventions determine the efficiency of the design process. Modelling conventions are used as a way of communicating the plan of the architect in generally accepted format.

According to Appleton (6) modelling conventions simplify the design process by simplifying three elements of architectural models:

- Semantics;
- syntax; and
- procedures.

A model requires a semantic convention to identify the elements of the model and the possible interrelationships between them. It also requires a syntactic convention in order to standardise on graphics and language. A model also requires a procedure by which the model is compiled.

There are a number of modelling conventions that can be applied namely:

- Mind mapping;
- goal decomposition;
- process modelling;
- activity modelling;
- entity modelling;
- business rule modelling;
- object modelling; and
- relationship modelling.

5 Generic business architecture

5.1 General

The author has, in his practical experience in the implementation of the business design process, encountered a number of generic business architectures that have been implemented successfully. This paragraph aims to present some of the perspectives that were obtained. The *business process* is used as a point of departure, simply because it is at this point where variants start occurring.

5.2 Primary business processes

5.2.1 Marketing

Marketing is viewed as the process through which the requirements of the customer of an organisation are met (Skinner: 48). There are many misconceptions about the marketing process, the best known of these being the difference between marketing and sales. A way of thinking is demonstrated about the marketing process. This perspective is based on the process as shown in figure 25.

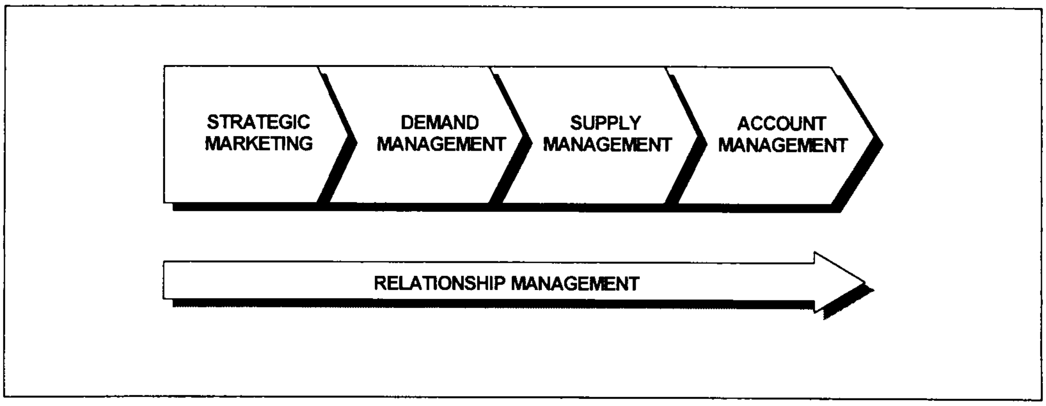

Figure 25 - Integrated marketing process

This process consists of the following elements:

- A strategic marketing process through which the marketing strategy is defined based on product definition, pricing, locality of markets, promotion strategy, people requirements and physical elements of requirement satisfaction;
- a demand management process through which the requirements for products or services are determined;
- a supply management process through which the requirements for products or services are determined;
- an account management process through which customer satisfaction is converted into cash; and
- a relationship management process through which customer service is provided.

5.2.2 Supply chain

The supply chain has become known as a method for understanding the production and logistics processes in an organisation. A way of thinking about the supply chain was developed by Christopher (10). It is presented here. This approach differs significantly from classic materials and manufacturing control principles in five respects:

- It views the supply chain as a single entity rather than a series of functional areas;
- it focuses on the order fulfilment process of an organisation;
- it is a process of strategic importance;
- it provides a different perspective on inventory management; and
- it requires integrated, rather than interfacing information systems.

The process of supply chain management is shown in figure 26.

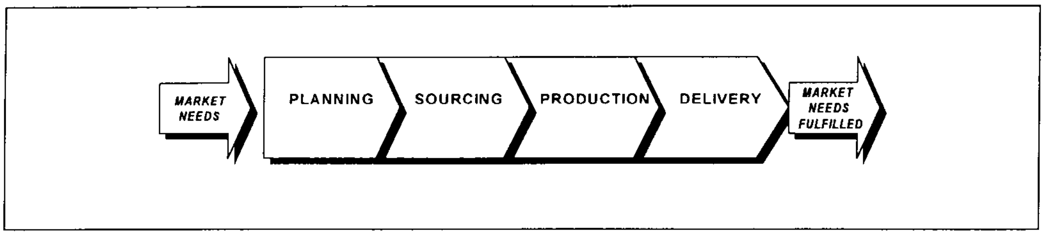

Figure 26 - Supply chain management process

This process consists of the following elements:

- A planning process through which end item forecasts are made;
- a sourcing process through which end item forecasts are converted into raw material requirements;
- a production process through which raw materials are converted into end items; and
- a delivery process through which end items are distributed.

5.3 *Secondary business processes*

One of the organisational processes that has undergone the biggest degree of transformation in the past decade is the information technology management process (CSC Foundation: 11,12,13). Subsequently, various lessons can be learnt and a number of generalisations can be made about the way secondary business processes are treated in an organisation using this base.

The first of these is the role of the secondary process in the organisation. It can be one of the following:

- A role of custodianship through which the resource is managed on behalf of the organisation;
- a role of governance through which policies and guidelines are set and controlled on behalf of the organisation; and
- a service provider role.

The CSC Foundation (12) proposes that, the process through which a business resource is provided, be viewed as three sub-processes namely one that is involved in the definition of the demand or requirement for the specific resource, a second that is involved in the governance of the resource, and a third that is involved in the provision of a service regarding the resource.

These processes are shown in figure 27.

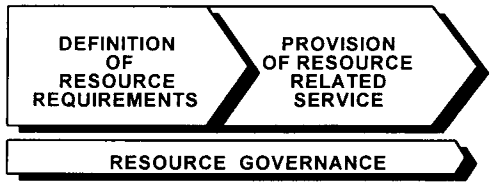

Figure 27 - Resource demand and supply

They suggest that the first and second roles belong to the organisation itself, whilst the last belongs to a resource provider. These processes will retain a specific relationship which could vary from one in which the resource provider (for example the Information Technology or Financial Department) provides a support service on demand, one where they become close business partners, and one where they become the source of competitive advantage of the organisation.

6 Conclusion

Part Four presented an approach to business design. It used the metaphor of architectural and engineering design as a point of departure. In doing so, it was firstly explained why it was important to design an organisation, secondly an overview was presented of the various dimensions of business architecture (what) and thirdly the various approaches and methods that can be employed (how) were positioned within this framework. Lastly, a way of thinking was presented regarding best practices in the organisation. The final output of the design phase is a set of blueprints for the transformation phase.

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Part Five - Business Transformation

"There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune.
On such a full sea we are now afloat,
And we must take the current when it serves,
Or lose our ventures."

William Shakespeare

1 Objective

Part Five of this thesis introduces the reader to the transformation phase of the Business Engineering Process in terms of the following:

- The relationships between change and transformation;
- the business transformation concept; and
- the process of business transformation.

The Business Engineering Process was proposed as a road map for the thesis. Part Five of the thesis is an integral part of this process.

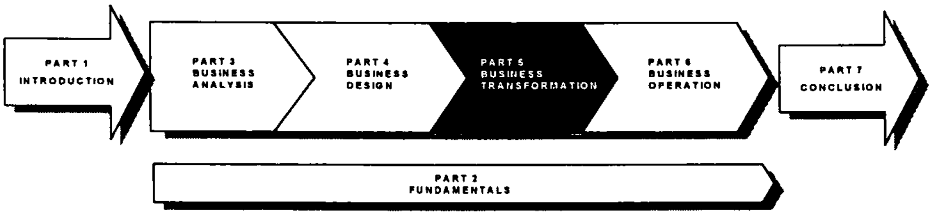

Figure 1 - The transformation phase of the Business Engineering Process

2 Basic principles

2.1 Change and transformation

From a Business Engineering perspective, transformation is concerned with the implementation of the proposed architecture. Transformation and change have also become phenomena of our time. Answers about the nature of transformation should thus be sought far wider than the business environment.

The first and important perspective lies in the definitions of the words *change* and *transformation*. In the field of Applied Mathematics, the words *speed* and *velocity* have been assigned different meanings although linguistically, they have the same meaning. In Management Theory, the words *goal* and *objective* have been assigned different meanings whilst linguistically also having the same meaning.

Similarly, in Business Engineering, it is suggested that, by assigning different definitions to the words *change* and *transformation*, knowledge is expanded.

The term transformation literally means modification, alteration or metamorphosis. Formally transformation is defined as the process of deliberate interventions that alter an entity from one state to another as a result of a change in its environment.

Change is defined as a state of different but unavoidable environmental circumstances. Change is an environmental force; transformation is the way in which an entity reacts to it.

Transformation is the result of environmental change. Any entity reacts to the changes around it. These changes could be external forces (change in the external environment) or internally (realignment of the members of this entity).

More formally, it can be stated that:

Entity state = f (external environmental parameters, internal environmental parameters); and
Transformation = f (change in environmental parameters).

These relationships are shown in figure 2:

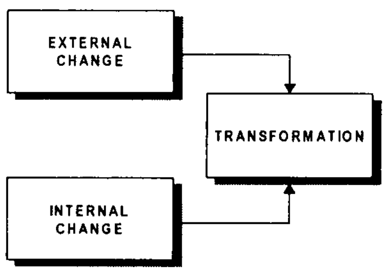

Figure 2 - Relationships between change and transformation

The properties of change and transformation are shown in table 1.

DIMENSION	***CHANGE***	***TRANSFORMATION***
Level of impact	*society*	*entity (organisation or individual)*
Level of control	*low*	*high*
Source of energy	*force majeure*	*intervention as a result of change*
Causal relationship	*change drives transformation*	*driven by transformation*

Table 1 - A comparison between change and transformation

Up to this point it was reasoned that change is the driving factor of transformation, but an entity's transformational actions could be so intense that it becomes the driver of change.

Transformation could be a continuation of an existing trend, referred to as first-order transformation or evolution. Conversely, transformation could be a discontinuity between the past and the future trends referred to as second-order transformation or revolution. Second-order transformation is never achieved without renewal or the mastery of new skills (Ferreira: 14, Nadler: 25).

There is a relationship between the basic needs of the entity and the transformation it experiences. So for instance, mankind has evolved from a lower order Maslow level to a higher one through an evolutionary transformation process. These are the reasons for natural progression in nature and, indeed, for mankind's progress. It is subject to adversity that we excel. The skills that carry us through are our ability to adapt, to learn, as well as our capacity to be dissatisfied with the present state. These skills, combined with a vision of a better future, lead to survival.

The relationships in this learning cycle are shown in figure 3.

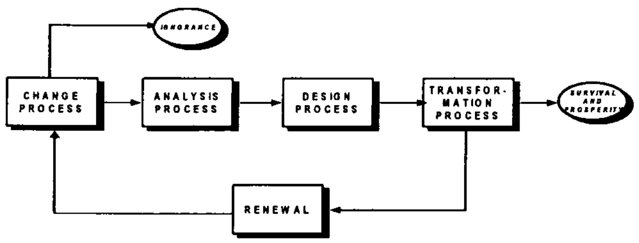

Figure 3 - Transformation as a learning cycle

The term transformation is a collective noun. Transformation is seldom a one-dimensional activity. Transformational actions can occur in all the dimensions of an entity. These transformational actions are known as *interventions*. Thus, transformation is a set of interrelated interventions that all support a common goal.

To understand transformation further, the concept of a *state* must be defined.

A state is defined as a set of parameters that describe the dimensions of a situation.

It is useful to draw an analogy between the state, transformation and transformation level of a system; and the position, displacement and velocity of a particle. In other words:

- A state implies a position which can be expressed in terms of a set of co-ordinates;
- transformation describes translation of the position as the first derivative of the state in respect of time; and
- a transformation rate measures the velocity of transformation as the second derivative of the state in respect to time.

2.2 Transformation levels

Two levels of transformation are distinguished (Nadler: 25):

- *First-order transformation or evolution* where transformation is a gradual, predictable, incremental and manageable process (continuous improvement with a fixed and low transformation rate); and
- *second-order transformation or revolution* where transformation is instantaneous, radical, unpredictable and hard to manage (discontinuous change with variable or high transformation rate).

The aforementioned levels of transformation are shown in figure 4.

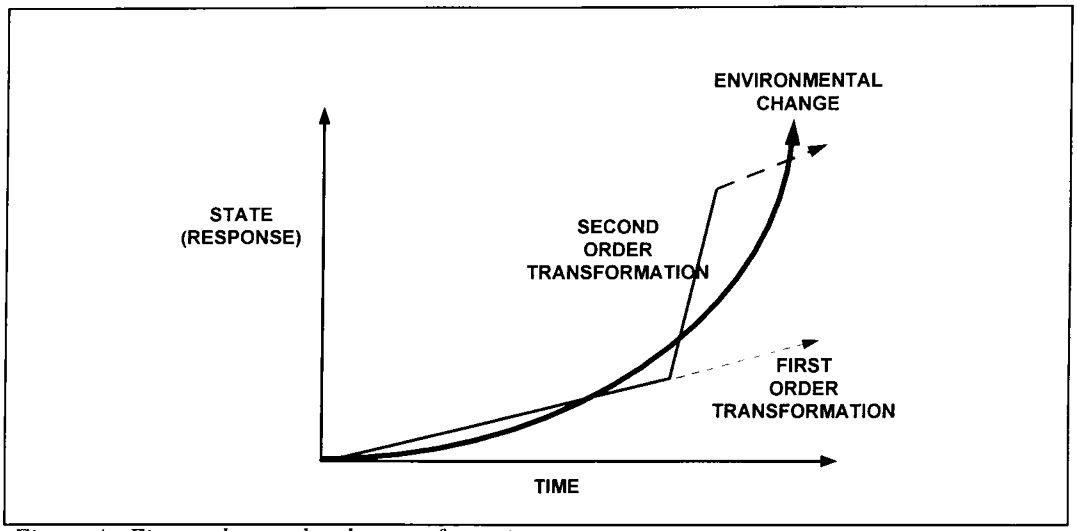

Figure 4 - First and second-order transformation

2.3 *The paradigm shift*

Mankind, like any rigid body, resists change and transformation.

People resist change. They strive towards a state of entropy. When it becomes inevitable that transformation will occur, people will slow the process down and turn revolution into evolution.

A way of understanding people's natural resistance to transformation is through the concept of a paradigm shift, which provides a framework that explains behaviour during the transformation process.

The term *paradigm* was derived from the Greek and means a pattern, model, structure or frame of reference. It was introduced by Kuhn (21) in order to understand a phenomenon amongst scientists in the observation of data not corresponding to current thinking and therefore indicating the existence of a different model that is emerging. Kuhn notes the phenomenon suggesting scientists' inability to perceive data not corresponding to current models and often denoting such data as random-based. He argues that such behaviour is based on the scientists' thinking paradigms.

Under an existing paradigm, the acceptable wisdom becomes increasingly unwieldy and unworkable in new situations. The complexity of its models impedes progress and provokes breakthrough thinking. A new paradigm is eventually invented that matches the new experiences far more effectively than the old model and replaces it quite rapidly. Kuhn suggests that this cycle has taken place continuously throughout scientific history. An example of this is the shift from the Newtonian clockwork paradigm to the Quantum or relativity paradigm in Physics. Barker (3) as well as Covey (7) argue that this principle applies not only to scientific revolutions, but also to transformation in general.

"Being is seeing in the human dimension. And what we see is highly related to what we are. We can't go very far to change our seeing without simultaneously changing our being, and vice versa. Paradigms are powerful because they create the lens through which we see the world. The power of a paradigm shift is the essential power of quantum change, whether the shift is an instantaneous or a slow and deliberate process."

Stephen Covey in "The Seven Habits of Highly Effective People" (7, page 21)

3 External change

3.1 Approach

An entity is always part of a larger whole and interaction exists between the entity and the larger whole. An organisation is an open system that interacts with its external environment as created and influenced by its stakeholders from society. It also interacts with its internal environment when the individuals within the organisation renew their thinking and subsequently contribute to the transformation of the organisation. External environmental changes are caused by changes in the structure of society. It is thus relevant to search for external factors from society affecting organisations. This paragraph deals with these external changes whilst paragraph 4 of Part Five deals with internal change.

The primary external environmental changes are (Nadler: 25):

- Technological innovation;
- changing value systems;
- changing relationships between entities;
- changes in the order and structure of society; and
- exponential growth in population incurring exponential decreases in resource availability.

The secondary external environmental changes are:

- Resultant political and social restructuring;
- resultant economic restructuring and globalisation;
- resultant acceptance of moral responsibility towards resources;
- resultant changing relationships between entities; and
- resultant shorter life cycles.

In order to understand the external changes in the environment, the models of Toffler (35,36,37), Naisbitt (26,27,28) and Martin (24) were studied. A brief explanation of these models follows.

3.2 Future shock

"This book is intended to do more than present a theory however. It is also intended to demonstrate a method. Previously men studied the past to shed light on the present. I have turned the time-mirror around, convinced that a coherent image of the future can also shower us with valuable insights into today."

Alvin Toffler in "Future Shock" (35, page 3)

In *Future Shock (35),* Alvin Toffler investigates the effects of changes in society on individuals and organisations. He defines a state of future shock as the disease caused by the inability to adapt to change as a result of the untimely arrival of the future. The term future shock is derived form the term culture shock that is a condition that a traveller experiences when entering a foreign culture.

Society at large is travelling through time. The past 50 000 years can be divided into 800 generations of 62 years each. The majority of innovations used by society were developed during the 800th generation. This phenomenon illustrates that change is accelerating which leads to accelerated transformation.

Upon further investigation, it becomes clear that what Toffler points out is that change in society, as much as any other change that is driven by reproductive organisms, is increasing exponentially. The exponential function is used to describe the growth or decline in reproductive organisms or growth or decline in entities being driven by reproductive organisms.

This phenomenon is shown in figure 5.

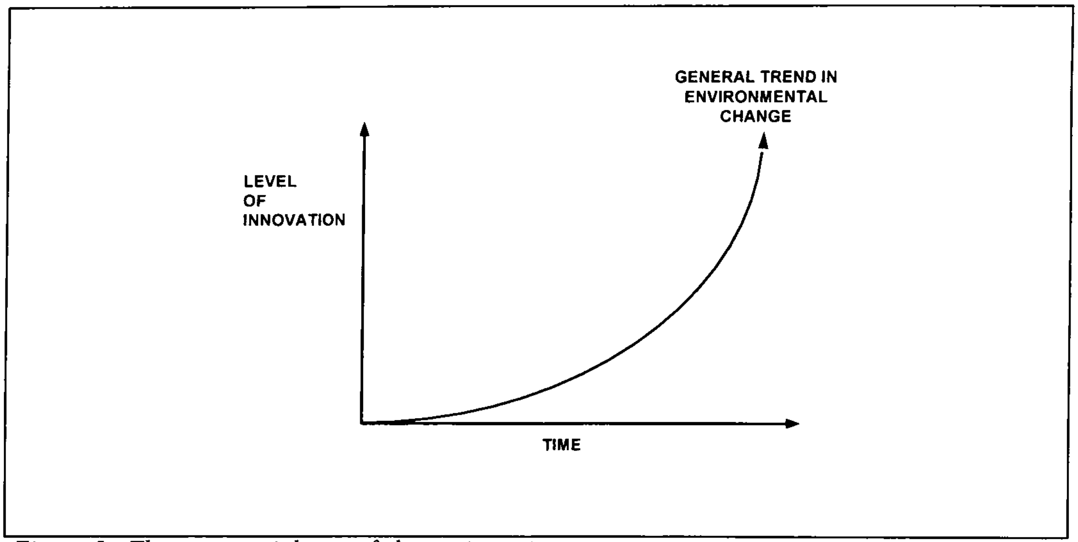

Figure 5 - The exponential rate of change in society

Toffler argues that technology enables more technology, illustrating the reproductive principle underlying the exponential function. The process of technological innovation, as described by Rogers (29) serves as a possible explanation for this, technological innovation being viewed as three distinct phases:

- Invention of the new technology;
- adoption by society; and
- diffusion.

The process of innovation is concluded when the loop is closed from diffusion into society, back to the generation of further new ideas. If society demands more innovation and it is supplied, the rate at which the cycle repeats itself elevates, even more so when at least some of these innovations conceive further innovation.

This process also explains change in the relationships between society, organisations and technology. Initially, this relationship was based on agricultural needs, thereafter on industrial needs and currently on technology and information.

External change is primarily characterised by three attributes (Toffler: 35) namely transcience, novelty and diversity. A brief discussion follows.

3.2.1 Transience

The time frames of relationships between humans and objects and mutually between humans are shortening. An example of this is the fact that the life cycles of products, services and concepts are shortened by technological innovation.

Moreover, the relationship between individuals and organisations has shortened. Toffler proposes transformation from *bureaucracy* to *adhocracy* as the emerging pattern describing the relationship between individuals and organisations. These structures are viewed as opposites on a continuum.

Toffler describes the differences between bureaucracy and adhocracy as shown in table 2.

ELEMENT	*BUREAUCRACY*	*ADHOCRACY*
TRANSFORMATION APPROACH	Rigid	Adaptive
STRUCTURE	Order	Disorder
MOVEMENT	Static	Dynamic

Table 2 - Bureaucracy and adhocracy

In an adhocratic organisation, problem-solving teams are formed and abandoned and this dynamic nature enforces adaptive ability and creative problem solving. In bureaucratic business, the organisation is rigid and orderly and is based on rules and policies.

3.2.2 Novelty

The effect of technological change provokes changes in social behaviour and requires an ability to adapt because of the temporary nature of the environment.

3.2.3 Diversity

Standardised products will disappear and be replaced by custom-made services. This might lead to an abundance of choices that will shift the emphasis to complex decision-making processes.

3.3 The third wave

In *The Third Wave (17,36)*, Toffler proposes a metaphor whereby change in society and its interaction with organisations is described. Toffler suggests that change in society and transformation of organisations are mutually dependent and it is impossible to study them separately.

Toffler's *third wave model* suggests that society and business have historically been influenced by three waves of change:

- An agricultural revolution that led to the Agricultural Age that constituted the bulk of the 800 generations.
- An industrial revolution in the late 1700s that lead to the Industrial Age that lasted for almost 200 years and was characterised by mechanisation in the 1800s and early 1900s.
- A super-industrial revolution that was started in 1955 with the introduction of the computer to commerce. It is also significant that 1955 was the first year that white-collar workers eclipsed blue-collar worker in numbers in the first world industry.

This third wave lead to what is often referred to by other authors (Ackoff: 1,2) as the Systems Age or the Information Age. Although some suggest that these two components are in fact different waves, this thesis treats them as one.

These waves are shown in figure 6.

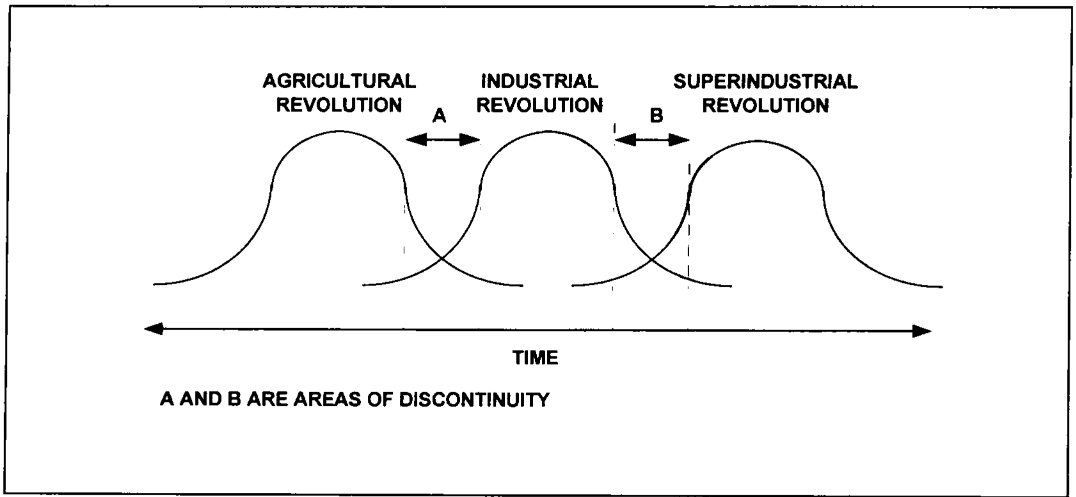

Figure 6 - The third wave

Toffler argues that the practices followed in organisations become practices in society and vice versa. Generally he derives that both the structure and culture of society mutually affects the primary human activities during a particular wave.

Examples of these phenomena are:

- The feudal system during the Agricultural Age, where agricultural activity structured society;
- the principle of specialisation, a functional view of activities (Taylorism) as well as Industrial Engineering during the Industrial Age, derived form the mechanised view of the environment; and
- the use of information technology in all levels of society, adhocratic organisations and knowledge-workers during the Super-industrial Age.

A comparison of the three waves is shown in table 3.

ELEMENT	AGRICULTURAL AGE	INDUSTRIAL AGE	SUPER-INDUSTRIAL AGE
NEEDS OF SOCIETY	Driven by low level needs	Driven by financial rewards	Personal recognition
BUSINESS SIZING	Closed communities (based on the needs of the community)	Growth (success depicted by size)	Rightsizing (recognition of upper limits of economies of scale)
RESOURCES	Natural resources (possession of land and the wealth of the land)	Capital resources (possession of capital and machinery	Knowledge resources (information, knowledge and technology)
PRODUCTS AND SERVICES	Hand made and nature based production	Mechanised and standardised production	Custom-made services based on information, perception and technology
ORGANISA-TION TYPE	Feudal (based on the possession of land and the needs of the community)	Bureaucracy (a clearly defined machine producing standardised decisions)	Adhocracy (indistinctly defined organisational units that are formed and decomposed, producing customised decisions)
TECHNOLOGY	Manual operation	Mechanisation	Information systems
WORK RE-QUIREMENTS	Based on the laws of nature	Standardised, functional and repetitive	Based on multiple skills
OPTIMISA-TION AND ALIGNMENT	Coincidental	Reduce into undividable parts, optimise each separately	Search for the larger whole of which an object is part and optimise on that level
PHILOSOPHY	Laws of Nature	Reductionism and analysis	Holism and systems thinking

Table 3 - A comparison of the three waves

Toffler suggests that these waves overlap. Characteristics of all three waves might be present in a specific society depending on its level of progress, that each of these waves moves forward at its own pace and that each has its own characteristics. In areas where overlapping does exist, confusion and discontinuity arises because the tried and tested approaches normally employed, do not generate the expected returns, affecting both the economy and the socio-political environment.

Organisations are currently experiencing the effects of the overlapping waves. This explains why Taylorism (the functional approach) is fading.

It must be borne in mind that, where industries exist, Taylor's principles (33) will prevail - it is only in the application of these principles outside industry, or in so-called super-industry that it is under suspicion. Current business thinking rejecting Taylorism is therefore not always sound as Taylor's principles were aimed at specialised labour in mechanised industry.

3.4 *The great transition*

Martin (24) argues that the exponential curve that is experienced as a result of the rate of change, is simply a fragment of a much larger process that he calls *the great transition*. This total transition process is shown in figure 7.

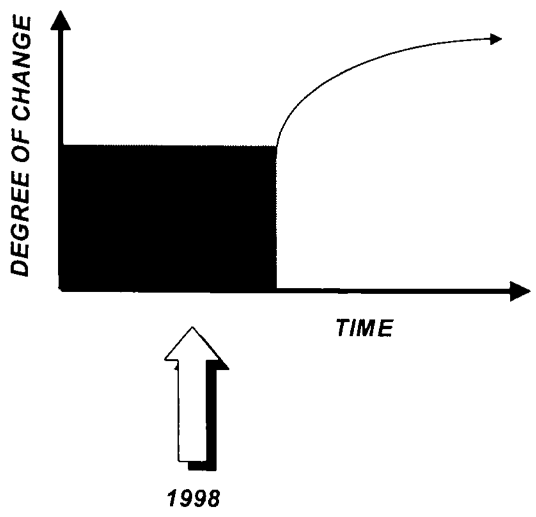

Figure 7 - The great transition

The grey shaded area in figure 7 indicates that limited knowledge of the future leads to the belief that the rate of environmental change, or environmental turbulence is increasing exponentially. Whilst it is not entirely true, the exponential model serves as a good approximation for this trend.

This great transition results in two phenomena:

- The post-capitalist society. The term post-capitalism was proposed by Drucker (12) and does not refer to an end to capitalism as an economic model but rather to a focus on other basic economic resources than fixed or monetary capital. Specifically he refers to knowledge, consisting of human, information and technology resources.
- The cybercorp, as the symbolic business model based on the knowledge resources of the Super-industrial Age.

Martin explains transformation as the collective noun for the actions or interventions that organisations inflict in order to create a cybercorp. He suggests that the effect of change is the same for most organisations. They can not stay aligned with their environmental requirements, but relative to each other, the one might be ahead of the other. This provides a source of competitive advantage.

3.5 Megatrends

Naisbitt (26,27) proposes that the external environmental changes that influence society can be grouped into two generic groups namely:

- *Megatrends,* being those changes that, having occurred, leave a permanent influence on the structure of society; and
- *noise,* being those changes that, having occurred, leave only a temporary influence on the structure of society.

"The more things change the more they stay the same."

Machiavelli

The distinction between megatrends and noise is important because it forces one to identify the real changes that are shaping society and in being able to distinguish these changes, an individual or organisation can profit from a competitive advantage. It also forces one to understand that all changes are not necessarily effecting the way organisations function.

3.6 The global paradox

Naisbitt (28) suggests that globalisation and economic advancements in the world produce a number of interesting paradoxes (a paradox is any situation where two conflicting notions are true at the same time). The global paradox, put simply, is a theory that states that the more an entity grows, the more important its smallest components become. This is a derivative from systems theory, stating amongst others that, the bigger the system, the more efficient must be the parts. So for instance, he explains that the more powerful the world's superpowers become, the more important the smallest nations in the world become. Similarly the bigger an organisation, the more important the smallest stakeholders. The following example explains this trend:

"On the 14th of March 1993, the people of Andorra, perched high in the Pyrenees between France and Spain and numbering 47 000, overwhelmingly passed a referendum granting themselves sovereignty. Now the new country of Andorra – about one-tenth the size of Delaware – can have its own international dialling code, Olympic team, stamps, currency and a seat in the UN (which it got in July 1993 to become the 184th member). But didn't this assertion of independence occur at a time when European countries were marching toward greater union? When Europe was on the verge of adopting a single new currency? When the Maastricht Treaty called for the establishment of a common currency for the 12 countries that make up the European Community? Actually, Andorra is much more in the direction the world is going than the European Union."

John Naisbitt in "Global Paradox"

The following postulates are derived from this theory:

- As the importance of nation-states recedes, more of them are being created. We are moving towards a world of 1000 countries.
- Electronics creates more tribes at the same time as it globalises the world.
- The disappearance of politicians in their current roles. Politics will re-emerge as the engine of individuality.
- Small and medium-sized organisations will increasingly come to dominate.
- China, the last great communist country, will become the world's biggest market economy.

4 Internal change

4.1 Executive reinvention

Goss (15), and to a lesser extent Covey (8) propose that the other factor which causes transformation is the renewal of the individuals within the organisation.' This process is called executive reinvention. Executive reinvention is a process of declaring one's future and making bold promises instead of predicting it. In order to do so, an individual must take a stand. Ghandi, in spite of compelling evidence to the contrary, took a stand that the British will leave India. By acting out this transformational behaviour it energised his people and caused a transformation.

Executive reinvention is an application of the premise that an entity can be transformed through renewal or energising from its members within. Individuals can rethink their lives, their beliefs and their needs. In the process, the collective power of their efforts causes their surroundings to be transformed. In the South African example, the political transformation was not only inflicted by external forces and pressure groups, but also through individuals within the system who elected to change their thinking.

The concept of continuous transformation implies that the individuals within any organisation will have to reinvent their thinking many times whilst they are involved in organisations and because of the exponential nature of change, they should possess the capability to conduct this process faster and better every time. Goss refers to this as transformation becoming a way of being, a part of an individual's universal human paradigm. Individuals who transform their beings become extraordinary.

4.2 Transformational leadership

Transformational leadership is a term used to define internal change as a result of a change in leadership thinking.

According to the Tichy (34), there are various styles of transformational leadership.

This transformational leadership model is shown in figure 8.

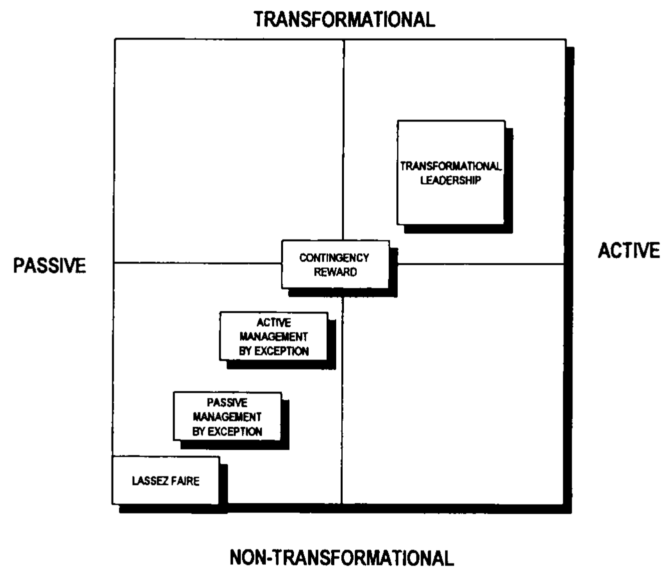

Figure 8 - Transformational leadership model

According to the model, there are five leadership styles of which the highest form is that of transformational leadership:

- A non-transactional or laissez-faire style;
- a passive corrective style;
- an active corrective style;
- a contingent reward based style; and
- a transformational style consisting of the following four processes:
  - individual consideration;
  - intellectual stimulation;
  - inspirational motivation; and
  - idealised influence.

5 Business transformation framework

5.1 The dynamics of business transformation

"I like the story of the Peruvian Indians who, seeing the sails of their Spanish invaders in the horizon, put it down to a freak of the weather and went on about their business, having no concept of sailing ships in their limited experience. Assuming continuity they screened out what did not fit and let disaster in."

Charles Handy in "The Age of Unreason" (16, page 42)

Business transformation is the consequence of a change in the business environment. This concept is shown in figure 9.

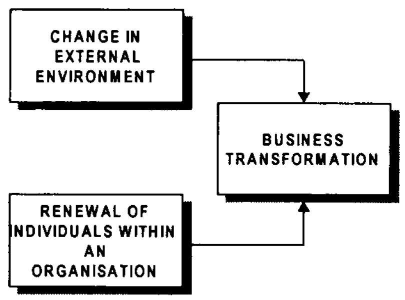

Figure 9 - Business transformation drivers

The concept of a learning organisation is a useful way of understanding the dynamics of business transformation. A learning organisation is an organisation that stays in dynamic equilibrium with its environment (Senge: 30,31). This implies that whenever a change occurs in the external, business or internal environments, the organisation has the ability to adapt.

It is proposed that dynamic equilibrium between an organisation and its environment has two important implications:

- The transformation process continues forever; and
- the time increments between the various interactions between the organisation and the environment become infinitely small.

The exponential nature of change, combined with this dynamic nature of transformation provides for an interesting deduction. If an organisation succeeds in retaining dynamic equilibrium with its environment, the stable periods in the organisation will become shorter and shorter over time, whilst the transformational activities undertaken will require ever increasing efforts. This phenomenon is shown in figure 10.

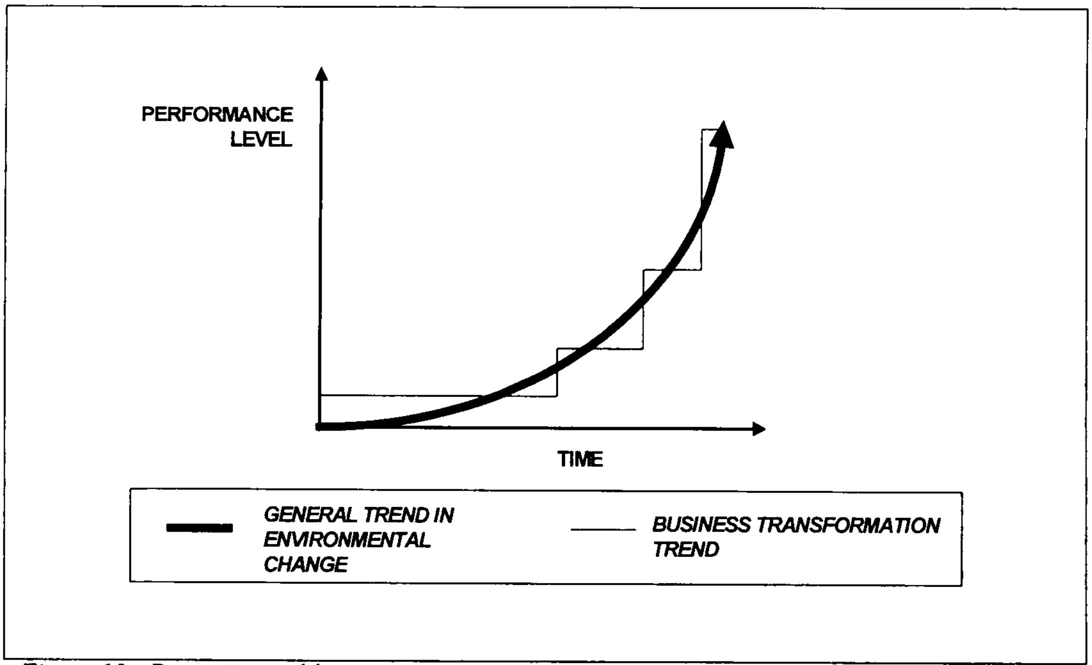

Figure 10 - Dynamic equilibrium

From this relationship, two further deductions can be drawn:

- The magnitude and time frame of business transformation has changed in organisations from initially being a process that was slow with a low organisational impact to one that is fast and has a high organisational impact; and
- there are various modes in which an organisation can act in relation to change.

5.1.1 Business transformation levels

Nadler and Tushman (25) are responsible for research on the various types of business transformation. They elaborated on the basic approach of distinguishing between first and second-order transformation by categorising business transformation in two dimensions.

They categorise business transformation firstly as reactive versus anticipatory (preactive) transformation. Reactive transformation is forced upon an organisation in response to events in its environment. Anticipatory transformation is made because of a belief that initiating transformation in advance of future events will provide competitive advantage.

Secondly, they categorise business transformation in terms of the magnitude of the transformation, based on the strategic versus incremental levels. Strategic transformation has an impact on the business system as a whole, redefining the organisation, its strategy, structure, people, processes and core values. Incremental transformation, on the other extreme, takes place without changing the values, mode of organising and general strategic context.

These levels of business transformation are shown in figure 11.

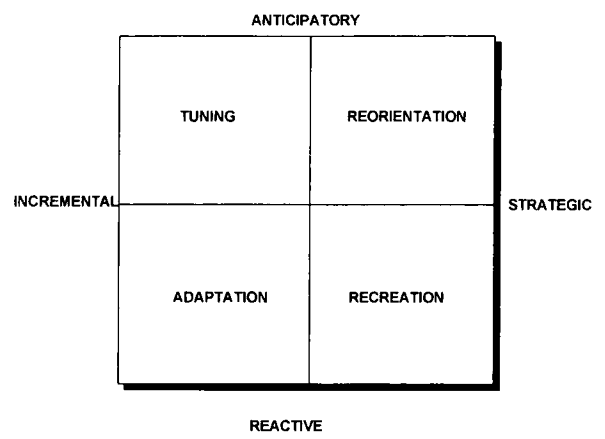

Figure 11 - Business transformation levels

5.1.2 Business transformation modes

Ackoff (1) cites five possible modes of behaviour in the business transformation process as a result of environmental change. These are:

- An inactive mode where no transformational behaviour occurs as a result of environmental change;
- a reactive mode where transformational behaviour follows environmental change;
- an active mode where transformational behaviour and environmental change occur simultaneously;
- a preactive mode where transformational behaviour occurs in anticipation of environmental change; and
- an interactive mode where transformational behaviour induces environmental change.

For any potential environmental change any of these modes of behaviour is possible. An organisation may firstly choose to ignore any specific environmental change because it is decided that the effects of the change are negligible. Secondly, an organisation may choose to respond to environmental change because there is no apparent advantage in adapting faster. Thirdly, an organisation may choose to adapt instantaneously when an environmental change occurs. Fourthly, an organisation may choose to forecast a specific environmental change and act beforehand, or lastly it may choose to be the source of environmental change because it believes that it is able to influence the environment. It is a matter of choice and priority based on the nature of change.

5.1.3 Theories on business transformation

The evolutionary/revolutionary classification of business transformation is well described in literature (Martin: 24, Nadler: 25). This classification originates from the field of evolutionary biology where a distinction is made between Darwinian gradualism and punctuated equilibria. It has found application in a number of diverse fields: single versus double-loop systems in systems analysis, evolution and revolution in industrial development and single versus double loop learning.

Ferreira (14) proposes a classification for the understanding of the various types of business transformation described in literature. He proposes a classification of three types of business transformation namely:

- Incremental business transformation;
- revolutionary business transformation; and
- ecological (systemic) business transformation.

(a) Incremental business transformation

Incremental or adaptation theories on business transformation maintain that organisations assess their changing environments continuously and adapt to threats and opportunities that they perceive. The response to change, under these theories, is always reactive or preactive.

(b) Revolutionary business transformation

Revolutionary theories on business transformation, on the other hand, focus on periodic, discontinuous and metamorphic transformation to overcome inertia or stagnation and to enable better alignment with the environment. They tend to start with a stage of rapid transformation, followed by a return to relatively stable configurations. The response to change, under these theories, can be reactive, preactive or interactive.

(c) Ecological business transformation

Ecological business transformation theories compare the business system to an ecosystem. It is then suggested that this type of business transformation occurs incrementally or revolutionary within a total business system or industry. Similar to the way in which a change in an ecosystem might cause the total ecosystem to be transformed, a whole industry or business system can be transformed, requiring a response from the organisations within that system. In an ecosystem, changes normally coincide with birth or death of members within that system – when infants are born, they possess qualities that are closer to those expected from their ecological environment, similarly, those who did not adapt eventually die. This process of natural progression provides the framework for ecological transformation where the shape of industries change due to new entrants who play by new rules and existing organisations who eventually exit the industry.

Given the structural tenet of ecological theories, it can be argued that it is actually a theory of inertia or lack of transformation as change decreases the survival chances because the time-horizon supersedes the relative position of the organisation. The ecological theories are context-driven, compared to the incremental and revolutionary theories which are activated by managerial choice.

These three types of transformation are viewed in the following two dimensions:

- A continuum between incremental and revolutionary transformation levels; and
- a continuum between environmental and organisational transformation entities.

These dimensions, illustrating the various types of business transformation are shown in figure 12.

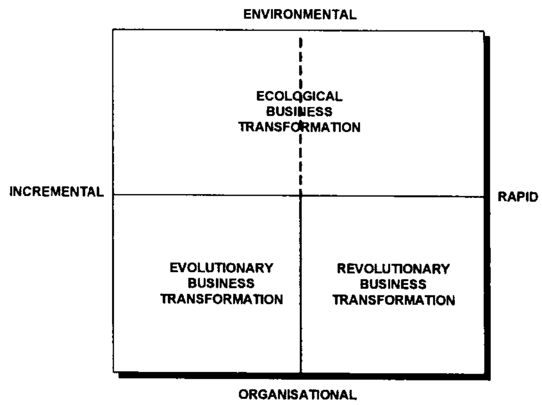

Figure 12 - Types of business transformation

5.2 Business transformation models

5.2.1 Burke and Litwin model

The approach of Burke and Litwin (5,6) is an attempt to define the most significant components of business transformation in order to influence them. These components are grouped together in order to distinguish between transformational and transactional components.

The model is shown in figure 13.

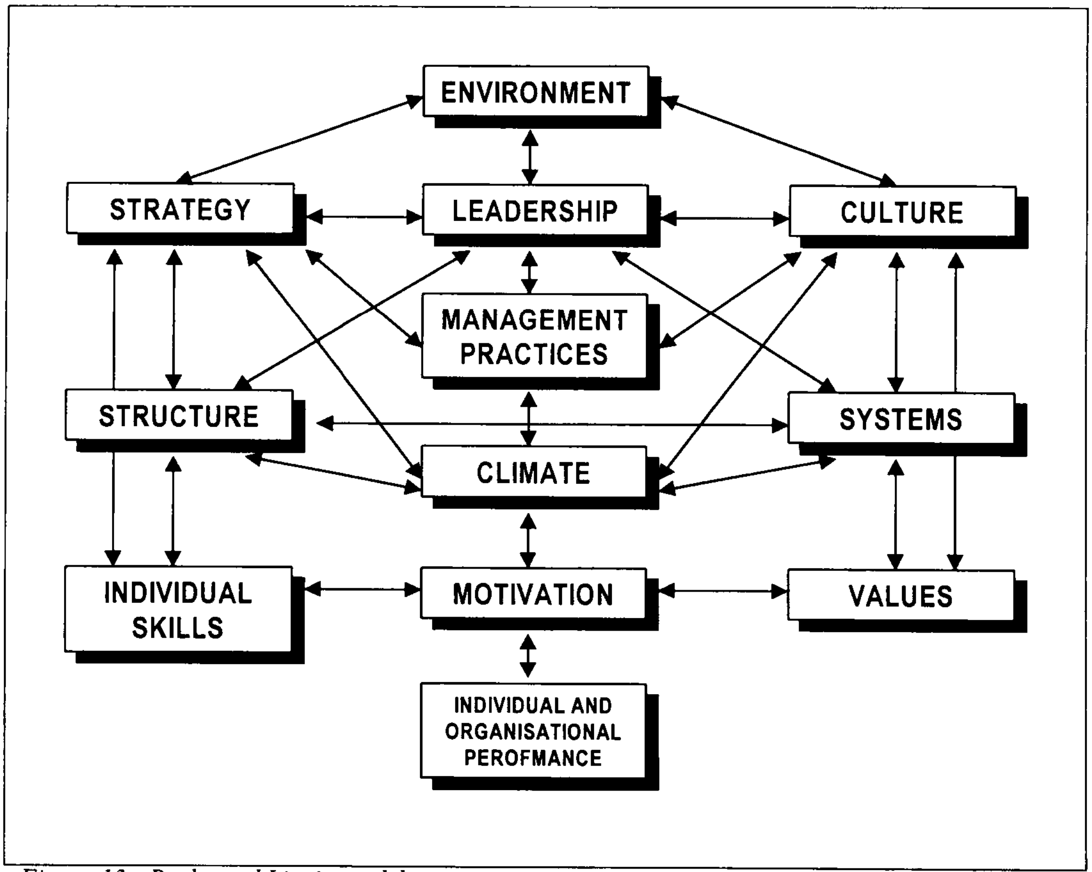

Figure 13 - Burke and Litwin model

A brief description of each component in the model is shown in table 4.

COMPONENT	DESCRIPTION
Environment	External or internal conditions that require transformational action
Strategy	Overall direction of the organisation
Leadership	General direction set by executives
Culture	Behaviour within the organisation
Structure	Arrangement of processes and units in order to achieve the strategy
Management practices	Measurement and improvement actions within the organisation
Systems	Standardised policies and mechanics to facilitate work
Climate	Collective current impressions, expectations and feelings that effect relationships in the organisation
Skills and abilities	Organisational capability
Individual needs and values	The desire and worth required for different people's actions and thoughts
Motivation	The process of creating a performance orientation
Individual and organisational performance	Results

Table 4 - Definitions within the Burke and Litwin model

The model is constructed in such a way that changes made at the top of this model carries more weight than those made at the bottom, which implies that the external environment carries the most weight. The external environment influences the strategy, the leadership and the culture. The external environment thus carries more weight than these do. These in turn carry more weight than the structure and the management practices. The structure, management practices and policies support the previously mentioned components. All of these influence the climate that is based on individual skills and values.

Changes occur in the external environment, which prompt transformation further down in the model. The model is also useful in understanding the difference between first and second-order transformation. Second-order transformation occurs at the top of the model whilst first-order transformation occurs at the bottom of the model.

5.2.2 Generic business transformation model

From the Burke and Litwin model, a generic model is suggested. This model can be used as a framework for understanding the generic components of business transformation.

The model proposes that there are two dimensions of business transformation:

- The magnitude of transformation ranging from strategic transformation and operational transformation; and
- the mode of behavioural ranging from structural to cultural behaviour.

A possible third dimension may be added to these, which is based on the rate of transformation, ranging from a fast rate of transformation to a slow rate of transformation.

From these, the four basic components of business transformation are defined. These are:

- Strategic structural transformation;
- strategic cultural transformation;
- operational structural transformation; and
- operational cultural transformation.

These components are shown in figure 14.

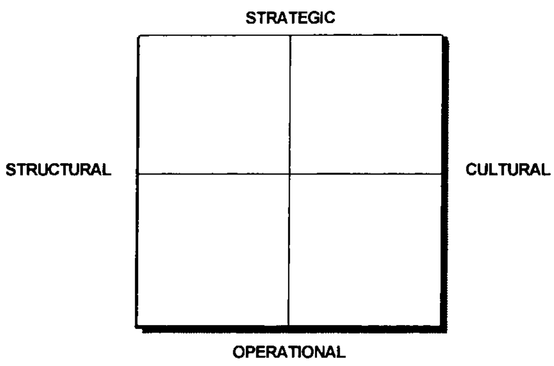

Figure 14 - Generic components of business transformation

From this generic model, the success factors for business transformation can be derived. Business transformation is unsuccessful as a result of misalignment between these quadrants. The most common reasons for unsuccessful transformation are:

- Lack of implementation (the transformation process only focused above the horizontal line and the interventions never became operational);
- lack of strategic focus (the transformation process only focused below the horizontal line and were not aligned with the direction of the organisation);
- lack of cultural alignment (the transformation process only focused to the left of the vertical line and no efforts were made to align the human resources);
- lack of structural alignment (the transformation process only focused to the right of the vertical line whereby a great deal of energy was activated without a structure within which it is focused); and
- a transformation response that was too fast or too slow.

5.3 The human factor in transformation

5.3.1 Resistance to change

To the average employee of an organisation, transformation is an external threat. It is human nature to reject change and continue like before. People tend to strive for some form of entropy. When the people of the organisation are subject to change, they will try to return to their original state. Resistance to change stems from people being uninformed and uncertain why transformation is needed and what the organisation's aspirations are.

According to Stokes (32) people, when confronted by change, react as follows:

- Phase 1: denial;
- phase 2: aggression;
- phase 3: rejection;
- phase 4: acceptance;
- phase 5: collaboration; and
- phase 6: participation.

Kotter (19,20) suggests that a well-structured transformation process that is supported by open and honest communication and concern for the employees, must be followed. People who are comfortable with the status quo do not want to believe the need for change. Transforming organisational culture is compared to transforming one's personality. This is never easy.

Kotter suggests the following focus areas in order to lower their resistance to change:

- Communication;
- education;
- training;
- coaching;
- explaining the benefits of change;
- personal involvement;
- team building; and
- support structures and mechanisms.

The reasons for resistance to change can be reduced by the approach as shown in table 5.

REASON FOR RESISTANCE TO CHANGE	*REACTION*
Reasons for change not understood	Communication about benefits
Fear of loss	Emphasis on benefits
Fear of lack of competence	Training and coaching
Fear of the unknown	Communication and involvement
Changes perceived as forced	Communication
Fear of new social structure	Development of social structure
Impact on their personal value systems	Participation and teambuilding
More responsibility and complexity	Communication
Poor timing	Explain reasons

Table 5 - Overcoming resistance to change

5.3.2 The burning platform

Carr and Johansson (6) introduced the term *burning platform*. The term is used to describe the approach through which radical action is taken to ensure that all the elements of the old reality is destroyed (the platform is burnt) and the reasons for resistance to change are overcome.

The reasons for resistance to change can be generalised into two groups:

- People are focused on all the advantages of the current reality of the organisation; and
- people are focused on the disadvantages of the future intent of the organisation.

The process of creating a burning platform literally means burning the platforms that people cling to. In order to do so, those elements or advantages that they cling to are firstly removed. Subsequently, the disadvantages of the current reality are emphasised, and thirdly, the advantages of the future intent are emphasised. Through this process, it is made impossible for individuals to return to their "platform" of stability and they have to pursue the future intent.

6 Business transformation processes

6.1 Approach

The processes through which business transformation is conducted are described in this paragraph. Business transformation, in this context, is viewed as the implementation of the future intent of the organisation. It consists of three processes namely:

- A formal process concerned with the implementation of the new business architecture;
- an informal process concerned with the management of human resistance to change; and
- a process concerned with the measurement of the performance of the transformation effort.

These processes are termed the generic business transformation process, the transformation management process and the implementation tracking process. They are shown in figure 15.

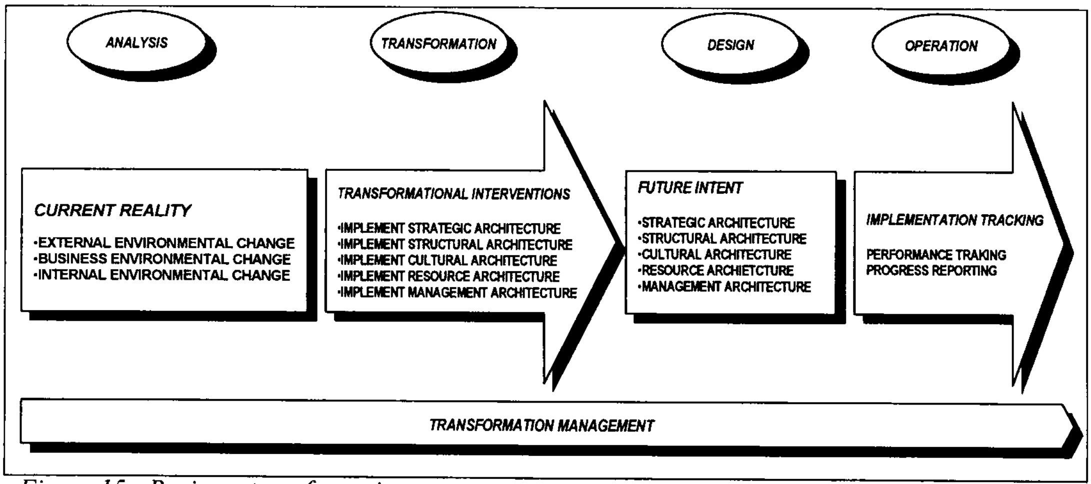

Figure 15 - Business transformation processes

6.2 Generic business transformation process

The first business transformation process is the formal implementation process.

The formal implementation process is concerned with the logical flow of events in order to achieve the future intent of the organisation. In this process the desired business architecture is converted into an implementation plan.

The point of departure in doing so is therefore the business architecture. Each element of the business architecture is systematically analysed in terms of the desired future intent of the organisation and compared to the current reality of that element. From these, the interventions are derived in order to achieve the future intent. These are decomposed into an action plan and responsibilities are determined. The execution of these actions is managed in a similar fashion to that of project management.

This process is shown in table 6.

ARCHITECTURE	***COMPONENT***	***FUTURE INTENT***	***CURRENT REALITY***	***INTERVENTION***	***PRIORITY***	***ACTION PLANS***
STRATEGIC	Overall strategy Strategic initiatives	Define the long term vision of the organisation	Determine current progress	Identify strategic initiatives	Prioritise strategic initiatives	Determine action plans for strategic initiatives
STRUCTURAL	Goals and objectives Value chain Processes Functional hierarchy Ownership	Define proposed structural architecture for the organisation	Determine current structure	Identify initiatives required to implement the new structure	Prioritise structural initiatives	Determine action plans for structural initiatives
CULTURAL	Leadership Core values Collective skills Reward and recognition Climate	Define proposed cultural architecture for the organisation	Determine current culture	Identify initiatives required to implement the new culture	Prioritise cultural initiatives	Determine action plans for cultural initiatives
RESOURCE	Natural Capital Knowledge	Define proposed architecture for resources	Determine current resources	Identify initiatives required to implement the new resource architecture	Prioritise initiatives	Determine action plans for various resources
MANAGEMENT	Governance Performance measurement	Define proposed management architecture for the organisation	Determine current management architecture	Identify initiatives required to implement the management architecture	Prioritise management initiatives	Determine action plans for management initiatives

Table 6 - Generic business transformation process

From these the sub-processes involved in the business transformation process are defined.

6.2.1 Strategic transformation process

The strategic transformation process is concerned with the implementation of the interventions required for the organisation's strategy.

Inputs required for this process are:

- The proposed overall strategy for the organisation; and
- the identified strategic initiatives.

The process itself consists of the following activities:

- Definition of the long-term vision for the organisation;
- definition of the current status regarding the pursuit of the long-term vision;
- identification of strategic initiatives;
- prioritisation of strategic initiatives;
- compilation of action plans;
- assignment of accountability and responsibilities; and
- implementation.

6.2.2 Structural transformation process

The structural transformation process is concerned with the implementation of the interventions required for the proposed structure.

Inputs required for this process are:

- The proposed goals and objectives for the organisation;
- the proposed value chain of the organisation;
- the proposed business processes of the organisation;
- the proposed functional hierarchy of the organisation; and
- the proposed ownership structure of the organisation.

The process itself consists of the following activities:

- Definition of the current status regarding the organisation's structure;
- identification of interventions required to implement the value chain, business processes, functional hierarchy and ownership structure;
- prioritisation of interventions;
- compilation of action plans;
- assignment of accountability and responsibilities; and
- implementation.

6.2.3 Cultural transformation process

The cultural transformation process is concerned with the implementation of the interventions required for the proposed culture.

Inputs required for this process are:

- The proposed leadership style of the organisation;
- the proposed core values of the organisation;
- the proposed collective skills of the organisation; and
- the proposed reward and recognition systems of the organisation.

The process itself consists of the following activities:

- Definition of current status regarding the organisation's culture;
- identification of interventions required to implement the leadership style, core values, collective skills and reward and recognition systems;
- prioritisation of interventions;
- compilation of action plans;
- assignment of accountability and responsibilities; and
- implementation.

6.2.4 Resource transformation process

The resource transformation process is concerned with the implementation of the interventions required concerning the organisation's resources.

Inputs required for this process are:

- The natural resource requirements (land, raw materials and energy);
- the capital resource requirements (capital and operational budgets); and
- the knowledge resource requirements (human resources, information and technology).

The process itself consists of the following activities:

- Definition of the current status regarding the organisation's resources;
- identification of interventions required to satisfy the various resource requirements;
- prioritisation of interventions;
- compilation of action plans;
- assignment of accountability and responsibilities; and
- implementation.

6.2.5 Management transformation process

The management transformation process is concerned with the implementation of the interventions required to implement the proposed management system.

Inputs required for this process are:

- The proposed governance style of the organisation; and
- the proposed measurement system of the organisation.

The process itself consists of the following activities:

- Definition of the current status regarding the management system of the organisation;
- identification of interventions required to implement the governance style and measurement system;
- prioritisation of interventions;
- compilation of action plans;
- assignment of accountability and responsibilities; and
- implementation.

6.3 Transformation management processes

"It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things. For the reformer has enemies in all those who profit from the old order, and only lukewarm defenders in those who profit by the new order. This arises partly from the incredulity of mankind who do not truly believe in anything new until they have an actual experience of it."

Machiavelli

The second business transformation process is that of overcoming the resistance of the human resources of the organisation to the proposed transformation process. This process is concerned with creating alignment and enrolment.

Alignment is achieved when the human resources of the organisation agree that the proposed transformation of the organisation is the right thing to do. Enrolment, however, is achieved when these human resources become an active part of the transformation effort. This is a different matter altogether (Senge: 31).

One might be able to convince an individual that it is humanly possible to walk on a tightrope. Convincing that individual that he himself should walk on the tightrope is another matter altogether.

A number of approaches to this process of overcoming resistance to change were studied. From these, a generic approach is suggested. Organisational transformation has become big business, with organisations spending billions on transformation management consulting services. Firms such as Gemini Consulting, Andersen Consulting, and the CSC-Foundation employ thousands of consultants and have a world-wide reach. This represents a dramatic change from two decades ago when most firms in this field were relatively small. With the advent of total quality management and business reengineering, this industry changed dramatically.

The following approaches were studied:

- Lewin's approach (4);
- Lawler's approach (22);
- Stokes' approach (32);
- Carr and Johansson's approach (6);
- Kotter's approach (19); and
- Martin's approach (24).

6.3.1 Lewin's approach

This approach is based on three generic steps that underlie any successful transformation process (4):

- Unfreezing from the present situation;
- moving to new levels; and
- refreezing the organisation.

6.3.2 Lawler's approach

This approach is based on research conducted by Lawler (22) on the activities to follow in implementing a transformation programme.

Lawler's approach consists of the following activities:

(a) Establish compelling business reasons for change

Literature suggests various ways to justify transformation. Most of these focus on making people feel that there is a need for transformation and the importance of providing a vision of a new and more attractive world toward which the organisation should head. Survival, competition and winning in the marketplace are the kinds of compelling reasons that consistently generate energy around which transformation interventions can be built.

(b) Leaders must guide the transformation process

Organisations can be transformed through one of two alternative processes:

- Top management-driven initiatives; and
- revolution.

Top management-driven transformation has a number of advantages over revolution. Top management has the power to implement transformation in a systematic and focused way. They are uniquely positioned to supply the kind of strategic leadership that is critical to successful transformation.

(c) Take a long-term view of the transformation process

Because transformation is bound to take some time before the results are banked, it is important to take a long-term view. There are the quick wins which can be used to prove to the people the success of the process, but typically a vast number of the successes might, as the result of the exponential nature of change and transformation, only appear at a later stage. When they do, the returns are big. This should be the focus throughout the process.

(d) Create a climate of continuous transformation

A climate of continuous transformation is created using three important steps:

- Creation of positive dissatisfaction with the existing state of affairs;
- delivering on the required transformational interventions; and
- returning to some form of stability by refreezing newly formed architectures.

(e) Avoid fads

There are various time-dependent approaches, fashions, to be followed in business transformation. It is therefore suggested that the total transformation process be focused on fundamentals rather than on these approaches.

(f) Ensure that the transformation process covers the core issues

The full scope of the business design process is broad. In creating a new organisation, it might be necessary to address all of the issues covered in the process. As will be explained in paragraph 2.2 of Part Seven of this thesis, they are building blocks, some of which can be excluded from the process. If this is not done, there is always a danger of executing a superficial transformation process.

(g) Do not wait for heroes

An all too common belief is that transformation can only happen if a single hero emerges to lead the process. This *magic leader* phenomenon is dominant in western mythology. In the business world, success stories are often built around the role of individuals in the transformation of organisations, but they fail to point out the role of thousands of people who contributed to the same level in these organisations.

(h) Avoid corporate anorexia

In the 1970s, many large and successful organisations began to suffer from the so-called dinosaur syndrome (Lawler: 23), something that made them unwilling to adapt to their rapidly changing environments. As a result, downsizing and business reengineering became popular. But this has lead to a form of corporate anorexia. This process makes the organisation lean, but beyond some point, it weakens the organisation and decreases performance. This is especially true for long-term performance.

(i) Replace downsizing with a growth strategy

The challenge for organisations is to understand when it has downsized enough and what growth activities, which will create more value than those that were downsized, can be pursued.

(j) Do not downsize repeatedly

Lawler's research indicates that downsizing is only effective when not repeated regularly. Employees can even perceive an initial downsizing in a positive sense if they feel that excess and poorly performing employees are removed. Continued downsizing leads to loss of capability, commitment and resignations amongst key personnel.

(k) De-layer, do not just downsize

An organisation's short-term financial performance will almost always improve after a downsizing exercise because of cost reduction. In contrast, long term-focused transformation places an emphasis on sustained performance improvement. The challenge here is thus to focus on the elimination of unnecessary work rather than the elimination of cost per sé.

6.3.3 Stokes's approach

Stokes (32) presents a process that consists of seven steps for the management of business transformation. These are:

(a) Creation of pressures to change

Pressures to change are forced upon an organisation from the external and internal environment. The first step is thus to identify this. This creates the framework within which the new vision can be articulated.

(b) Creation of a compelling vision

A clear vision and focus motivates people. They should understand what the currently reality and future intent of the organisation is. If, as a result, transformation is necessary, it should be a logical consequence of this vision.

(c) Strategic planning

Strategic planning, as proposed within this approach, focuses on the strategies required to change the way people think and act within an organisation. In order for this to succeed, the people should be involved in this process.

(d) Scenarios

It is important not to develop a one-sided view of how the transformation process will develop. What is needed in contrast is a set of contingency plans that ensure the success of the transformation strategy.

(e) Communications plan

A communications plan must be developed in order to ensure that all stakeholders are well informed about the transformation process. Continuous communication is required in order to keep people focused and motivated. If people are not presented with the answers to the questions they might have, they will develop their own answers, which will be to the detriment of the transformation process.

(f) Benefits of transformation

The benefits to the organisation and all those affected by the transformation process must be clearly identified. It is important that the affected people understand and believe that transformation is necessary and what the benefit for them will be.

(g) Impact on key variables

The impact of transformation on the organisation's key variables must be assessed. This is necessary to be able to prove the advantages of the transformation process and provides for a common vocabulary in the organisation.

6.3.4 Carr and Johansson's approach

Carr and Johansson (6) compiled a set of best practice activities for successful transformation management. These activities are:

(a) Assessment of the transformation environment

- Determine the organisation's culture and climate; and
- identify the barriers to transformation.

(b) Training

- Identify skill gaps and training requirements;
- develop training material and workshops; and
- conduct training.

(c) Communication

- Identify the audiences;
- translate the transformation interventions into a message;
- develop a communications approach;
- select media and vehicles for communication; and
- communicate developments and status.

6.3.5 Kotter's approach

Kotter (19) investigated the reasons for resistance to change. There are many reasons ranging from fear of loss, misunderstanding the implications of the transformation process, disbelief and a low tolerance for transformation.

He suggests a number of strategies for overcoming resistance to change. These are:

- Education and communication;
- participation and involvement;
- facilitation and support;
- negotiation and agreement;
- manipulation and co-optation; and
- explicit and implicit coercion.

Kotter suggests the use of these strategies in the situations as shown in table 7.

STRATEGY	*APPLICABLE SITUATION*	*ADVANTAGES*	*DISADVANTAGES*
Education and communication	Inaccurate information and analysis	Once persuaded, people will aid the process	Time consuming
Participation and involvement	Transformational leaders do not have all the information they require	Commitment	Time consuming
Facilitation and support	Adjustment problems	Works well with adjustment problems	Time consuming and expensive
Negotiation and agreement	Some group will clearly lose as a result of transformation	Easy way to avoid major resistance	Expensive
Manipulation and co-optation	All other tactics will not work	Quick and inexpensive	Might fail altogether
Explicit and implicit coercion	Speed is essential	Quick and inexpensive	Risky

Table 7 - Strategies for overcoming resistance to change

From these, Kotter proposes a process for transformation management. Kotter used this approach as a basis for research on the determinants of successful transformation management. He suggests that performance in these areas is necessary for successful transformation.

The proposed process consists of the following activities:

(a) Establish a sense of urgency

This is achieved by examining market and competitive realities and identifying and discussing crises, potential crises and major opportunities.

(b) Form a powerful guiding coalition

This is achieved through assembling a group with enough power to lead the transformation effort and ensuring that the group functions as a team.

(c) Create a vision

This is achieved by creating a vision in order to direct the transformation process and developing strategies to achieve them.

(d) Communicate the vision

This is achieved by using every vehicle possible to communicate the new vision and strategies and teaching this new behaviour by the example of the guiding coalition.

(e) Empower others to act on the vision

This is achieved by removing the barriers to transformation, transforming those systems and structure that seriously undermine the vision and encouraging risk taking and non-traditional ideas, activities and actions.

(f) Plan to create short term wins

This is achieved by planning for visible performance improvements, creating those improvements and recognising and rewarding individuals responsible for the improvements.

(g) Consolidate improvement and produce further transformation

This is achieved by using increased credibility to transform systems, structures and policies that do not fit the vision by hiring, promoting and developing individuals who can implement the vision and by reinvigorating the process with new projects, themes and change agents.

(h) Institutionalise new approaches

This is achieved by articulating the connections between the new behaviours and corporate success, and by developing the means to ensure leadership development and succession.

6.3.6 Martin's approach

Martin (24) proposes an approach to transformation management that is based on seven components. These are:

(a) Create a persuasive case for change

Similar to the previous approaches, the reasons why transformation is necessary must be stressed. A persuasive case for change is developed. It includes scenarios, trends and numbers.

(b) Set an exciting vision

Many organisations operate without understanding where it is going. For the vision to direct the success of an organisation, it must be understood. In this way, energy is created in order to reach the vision.

(c) Create a quality team

The following criteria are set for the composition of the transformation team:

- Assign top performers;
- get cross-functional representation;
- empower team members; and
- require full participation.

(d) Plan to fulfil the vision

The following criteria are set in order to plan for the attainment of the vision:

- Involve everyone;
- start with small successes and build upon these;
- communicate constantly; and
- manage expectations.

(e) Transform the culture

The following criteria are set in order to transform the culture:

- Pay for performance and recognise achievements;
- streamline the organisation's structure; and
- empower individuals.

(f) View the work force as a think force

Transformation demands that individuals become thinkers in addition to their typical operational roles. This creates a constant flow of new ideas that will add to the success of the transformation process.

(g) Do not write people off

Martin stresses the importance of not reducing staff unnecessarily as this will lead to negativity about the process. Also, it is important to avoid unnecessary loss of valuable skills.

6.3.7 Generic transformation management process

In Part Four of this thesis, it was shown that the word *strategy* was derived from the Greek *stratos*, meaning war. If strategy means war, then *transformation*, in the same analogy, means *revolution*. The author thus proposes that the analogy of a political revolution be used as a basis for understanding the transformation management process.

This analogy is shown in table 8.

POLITICAL REVOLUTION PROCESS	BUSINESS TRANSFROMATION PROCESS
Creation of discontent with the current political circumstances	Creation of positive dissatisfaction with the current reality of the organisation
Creation of a compelling and simple doctrine or policy to replace the current reality	Articulation of a compelling business vision
Emergence of a leader with stature	Ensuring that the organisation's leadership drives the transformation process
Development of the right generals	Assigning major responsibilities to carefully selected individuals
Propaganda is spread to all	Communication
Followers of the leader are rewarded	Ensuring reward and recognition processes are aligned
Opposition to the revolution is eliminated	Ensuring exit strategies are establish for potential exits
The leader becomes a role model	The leadership of the organisation must, through their behaviour, demonstrate the values they expect from their subordinates

Table 8 - Generic transformation management process

6.4 Implementation tracking process

The third business transformation process is that of implementation tracking.

This process is concerned with the measurement of the success of the transformation process.

From a systemic perspective, three elements must be measured. These are:

- Whether the output of the business transformation process is satisfactory;
- whether the transformation process performs satisfactory; and
- whether the input into the transformation process is satisfactory.

6.4.1 Business transformation output performance

This process is concerned with the measurement of the business results achieved as a consequence of the business transformation process. The actual business performance is therefore measured. This measurement, based on the generic dimensions of business performance, is shown in figure 16.

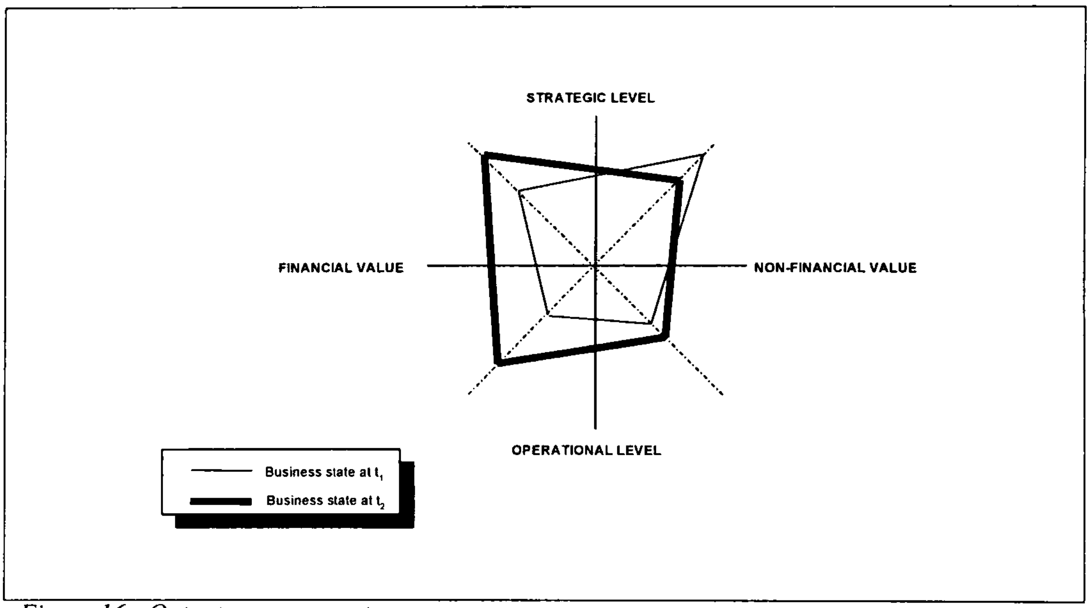

Figure 16 - Output measurement process

6.4.2 Business transformation process performance

This process is concerned with the measurement of the progress with the various transformational interventions. It is measured against the *transformation agenda* of the organisation by using project management principles.

The transformation agenda is shown in table 9.

INTERVENTION	*ACTIONS*	*PROGRESS*
STRATEGIC TRANSFORMATION	Identified actions	Progress to date
STRUCTURAL TRANSFORMATION	Identified actions	Progress to date
CULTURAL TRANSFORMATION	Identified actions	Progress to date
RESOURCE TRANSFORMATION	Identified actions	Progress to date
MANAGEMENT TRANSFORMATION	Identified actions	Progress to date

Table 9 - Transformation agenda

6.4.3 Business transformation input performance

This process is concerned with the measurement of the inputs provided by individuals in the transformation process. It is based on an individual contract that was negotiated with the various responsible individuals. This contract is based on their particular focus areas and the results they achieve.

7 Conclusion

Part Five presented an approach to business transformation. It explained the driving forces of transformation as external and internal change. In doing so, the reasons why transformation of organisations is important, were provided, secondly an overview was presented of the most important elements of business transformation (what) and thirdly the various approaches and methods that can be employed for business transformation (how) were positioned within this framework. The final output of the transformation phase is the implementation of the transformed organisation. From these, the operational phase is initiated.

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Part Six - Business Operation

"I have walked that long road to freedom. I have tried not to falter; I have made missteps along the way. But I have discovered the secret that after climbing a great hill, one finds that there are many more hills to climb. I have taken a moment here to rest, to steal a view of the glorious vista that surrounds me, to look back on the distance I have come. But I can rest only for a moment, for with freedom come responsibilities, and I dare not linger, for my long walk is not yet ended."

Nelson Mandela in "Long walk to freedom"

1 Objective

Part Six of this thesis introduces the reader to the operation phase of the Business Engineering Process in terms of the following:

- the Industrial Engineering role in business operations;
- a value perspective on business operations; and
- the Operations Management processes.

The Business Engineering Process was proposed as a road map for the thesis. Part Six of the thesis is an integral part of this process.

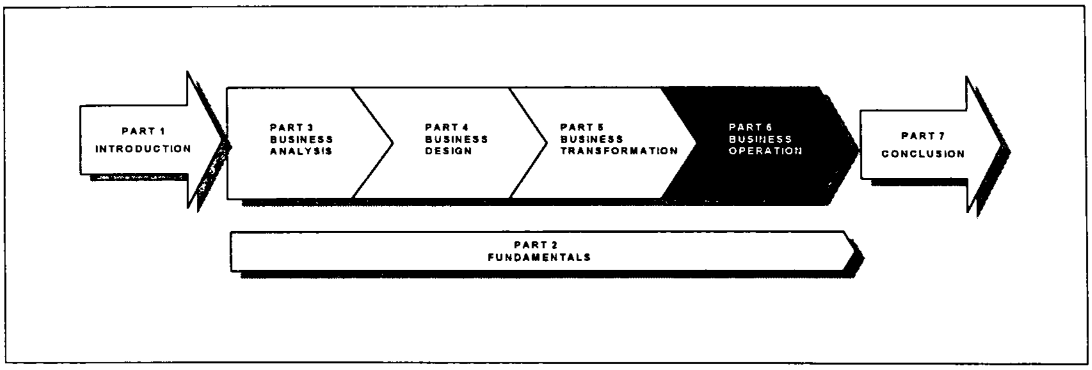

Figure 1 – The operations phase of the Business Engineering Process

2 Basic principles

2.1 *Industrial engineering perspective*

"Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning."

Winston Churchill

Assuming that an organisation has been successfully analysed, architecture was designed and the organisation was transformed to the new architecture, the focus shifts towards the successful operation and improvement of the new architecture. The journey does not end here, it *begins* here.

Industrial Engineering, because of its roots, has often been viewed as the discipline responsible for operational analyses and improvements.

This is mainly the result of three reasons:

- Industrial Engineering was borne out of the Industrial Age and, as such, is rooted in the field of Operations Management.
- It was convenient for the discipline to be classified as such. The problem however, is based on the relationship between change and transformation. For a long period, Industrial Engineering stayed ahead of the requirements set by the environment. But, like with any form of stability, a lag developed over time because of the exponential rate of change. As time progressed, this lag became increasingly obvious.
- Industrial Engineers are good at operational improvements, firstly because they are bred to improve existing things and secondly a large proportion of all Industrial Engineering curricula focuses on operational improvement.

As a result of these reasons, the author did not attempt to reconceptualise Industrial Engineering or Operations Management but rather used these as a basis for Part Six. Part Six is thus an organisation of existing knowledge from a Business Engineering perspective rather than a redefinition of these. Part Six is necessary because of its contribution to the whole. The most important perspective that can be added to the existing knowledge is the *value perspective*, which provides a sound basis for the organisation of this knowledge. A synthesis is thus presented of classical Industrial Engineering within the Business Engineering approach presented in this thesis.

2.2 Value addition

The main objective of the operational phase of the Business Engineering Process is the maximisation of the value of the operations of the organisation. Value was *created* for the organisation through the new architecture, but value can be *added* through the continuous improvement of the architecture. This is the difference between value creation and value addition (Copeland: 3).

The value chain (Porter: 17), as the name indicates, is an approach through which the added value of the various processes within an organisation can be modelled. It is a perspective of the operations of the organisation, showing the contribution of these processes to the overall value of the output of the organisation. The approach of focusing on the added value of each element of the value chain is also known as *economic value added (EVA)*.

This value chain is used as the main point of integration between the business operation phase and the previous phases of the Business Engineering Process. The value addition of each of the processes that were identified on the value chain of the organisation can be improved continuously.

The value addition perspective is shown in figure 2.

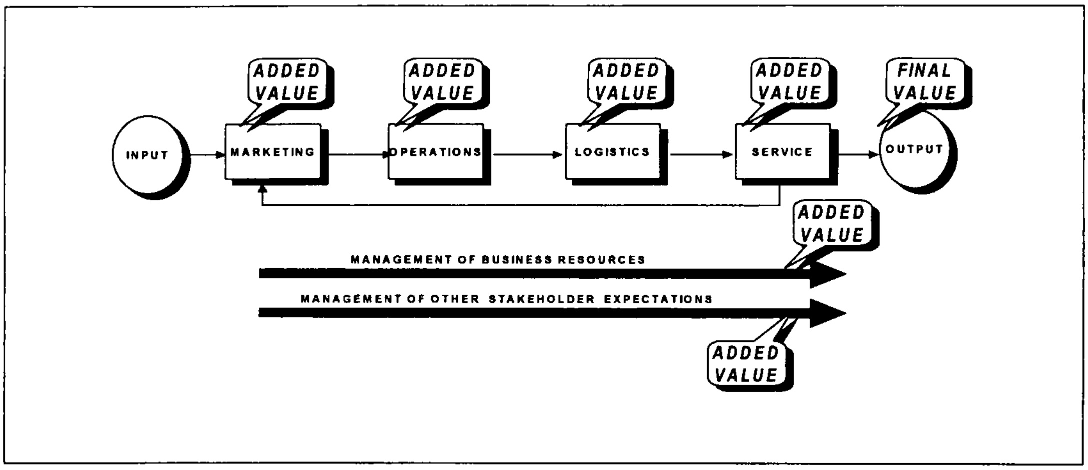

Figure 2 - Value addition in the value chain

Operational value is difficult to define because there is an element of subjectivity embedded therein. What is considered value to one is not considered value to another. The purest way to define value is therefore to take a customer perspective on the concept. In doing so, Melnyck and Denzler (15) define value as the customer's subjective evaluation, adjusted for cost, of how well a product or service meets or exceeds expectations.

From the value chain approach, operational value can be divided into elements:

- Possession value, determined by the marketing process of the organisation;
- functional value, determined by the operations of the organisation; and
- time and place value, determined by the logistics process of the organisation.

It must be noted that there is a significant difference between value and cost. Cost is one *driver* of value, but as will be shown, is not the only driver. This different point of view was initiated by Goldratt (8,9,10) and has since become a corner-stone of modern Operations Management (Chase and Aquilano: 2, Melnyck and Denzler: 15, Schonberger and Knod: 18).

2.3 *Operational value drivers*

Proctor and Gamble initially developed the value equation (Thompson: 21) as a mathematical expression of value as the ratio of performance or output, to cost or input.

In the field of Value Engineering (Stringer: 19), value is similarly defined as the ratio of function or output to cost or input.

In mathematical notation:

Value = Functional performance/cost.

In order to influence this equation, two types of responses are needed. Firstly, a numerator response can be made through which the functional performance is improved. Secondly, a denominator response can be made through which cost is reduced. The factors that can be influenced in order to achieve the desired response are termed the value drivers of operational performance.

The first fundamental definition of value drivers was compiled by Goldratt (10), defining the following as the most significant drivers of operational performance:

- Throughput (numerator response);
- inventory levels (denominator response); and
- operating expense (denominator response).

The one obvious omission from these drivers is the actual quality or customer satisfaction level achieved with the throughput. The other one is the fact that operational expenditure is addressed whilst capital expenditure is omitted. Melnyck and Denzler (15) define a more comprehensive and generic set of value drivers that was adapted for use in this discussion.

These drivers are:

- Quality (numerator response);
- speed (numerator response);
- flexibility (numerator response);
- risk (denominator response);
- waste (denominator response); and
- cash flow (denominator response for expenditure and numerator response for revenues).

From the above, the following basic identities can be derived:

Functional performance = f (quality, speed, flexibility); and
Cost = f(expenditure, risk, waste)

The approach followed in this definition is based on the assumption that throughput is equitable to speed (speed is the measurement of units per time), which is identical to the measurement of throughput (units per time). For definitional purity, the term speed is used because it is defined from a customer perspective. Throughput does have the added perspective of capacity, but if one assumes that speed can only be achieved through available capacity, the definition stands.

The influence of these value drivers will now be discussed in further detail.

2.3.1 Quality

In order to define the role of quality in the value equation, the concept needs to be defined within the context of this thesis. Garvin (7) identifies five perspectives from which quality can be defined:

(a) Transcendental perspective

From this perspective, quality is viewed as something without a clear definition that will be recognised when seen. From this perspective, quality is a condition of excellence from which fine quality can be distinguished from poor quality. Quality is achieved by reaching for the highest performance standard in products or services as opposed to being satisfied with unacceptable performance.

(b) Product-based perspective

From this perspective, quality is viewed by differentiating between differences in quality based on differences in the attributes of products or services.

(c) User-based perspective

From this perspective, quality is viewed as the capacity to satisfy customer requirements. Quality therefore depends upon the performance of the products or services in relation to customer preference. Quality is then defined as fitness for use.

(d) Manufacturing-based perspective

From this perspective, quality is viewed as the level of conformance to requirements. This is based upon the degree to which a specific product or service conforms to design specifications.

(e) Value-based perspective

From this perspective, quality is viewed as the degree of excellence of products or services at an acceptable price and the control of variability at an acceptable cost.

By focusing on quality as a source of value, the following benefits are achieved:

- Improved reputation for the organisation;
- easier selling because customers are increasingly focused on suppliers with an acceptable quality reputation;
- reduction in legal implications;
- reduction in lead-times because of less rework;
- enhanced flexibility because of reduced lead-times;
- improved productivity because things are being done right the first time;
- reduced cost on the long-term; and
- establishment of employee pride.

2.3.2 Speed

In focusing on speed as a component of the value equation, the *lead-time* must be reduced.

Lead-time is defined as the interval between the start and end of an activity or series of activities (Vollman: 23).

Lead-time reduction is achieved through four basic approaches:

- Decreasing the mean value of the lead-time distribution;
- decreasing the standard deviation of the lead-time distribution;
- decreasing the range of dispersion, indicating the open-endedness or closed-endedness of the lead-time distribution; or
- changing the shape of the lead-time distribution.

There are various types of lead-time. These are:

- Design lead-time;
- sourcing lead-time;
- production lead-time;
- physical distribution lead-time;
- order lead-time; and
- customer service lead-time.

The total lead-time is composed from these elements. There are however, various configurations of the processes responsible for the lead-times. They are:

- Engineer-to-order;
- make-to-order;
- assemble-to-order; and
- make-to-stock.

In order to reduce lead-time, various generic strategies exist. These are:

- Simplification of the process through the identification of process steps that can be eliminated, combined or repositioned;
- integration of the process through bringing together related activities, processes and information flows;
- standardisation of the process through the use of standard processes or parts and allowing people to focus on unique steps within the process;
- simultaneous operation of elements of the process that are not part of the critical path;
- increasing the predictability of the process through the identification and elimination of activities that create variance within lead-times;
- automation of the process through the utilisation of technology; and
- developing resource flexibility in order to accommodate fluctuations in process throughput.

By focusing on speed or lead-time as a source of value, the following benefits are achieved:

- Faster delivery at the market; and
- faster response to market demand.

2.3.3 Flexibility

Flexibility describes the ability of the operations of an organisation to respond to external and internal changes. It is measured in relation to range and time.

There are various types of flexibility within an organisation's operations (Melnyck and Denzler: 15):

- Product/service mix flexibility based on the ability of the organisation to present a wide range of products or services and variants of these with fast set-ups;
- changeover flexibility based the ability of the organisation to introduce a large variety of major design changes quickly;
- modification flexibility based on the ability of the organisation to implement minor product or service design changes;
- volume flexibility based on the ability of the organisation to accommodate variances in production quantity;
- programme flexibility based on the ability of the organisation to reduce uncertainty of equipment availability by changing the process flows in the production process;
- material flexibility based the ability of the organisation to adjust for unexpected variations in input; and
- strategic flexibility based on the ability of the organisation to transform its strategic focus in response to change.

The generic strategy of focusing on flexibility as a source of value is called mass-customisation. By focusing on mass-customisation (flexibility) as a source of value, the following benefits are achieved:

- Consistency with shorter product life cycles;
- niche marketing opportunities by producing small quantities for specialised markets;
- premium prices achieved of flexibility;
- reduction in lead-time is achieved;
- quality improvements are achieved; and
- cost reduction is achieved.

2.3.4 Return on invested capital

The term return on invested capital might be slightly misleading within this context because it refers to some elements for which improvement are not controllable. Return on invested capital is defined as follows (Horngren: 11):

Return on invested capital = Operating income/Invested capital
= f(revenues, operating expense)/g(fixed capital, working capital)

When focusing on these value drivers, it must be noted that revenues, from an operational perspective, are largely uncontrollable, whilst operating and capital expenditure are largely controllable. In the discussion here, it is thus advisable to focus on operating and capital expenditure as the value drivers. Expenditure describes the monetary value of the input into the operational process. It is an obvious focus area in operations.

By focusing on operating expenditure as a source of value, the following benefits are achieved:

- Greater market penetration because of lower pricing;
- larger profits because of bigger price differentials; and
- competitiveness because of a better relative cost curve position.

2.3.5 Risk

The operational risk of an organisation is defined as the level of financial exposure of the operations of an organisation as a result of the possibility of failure or loss within the process. Risk is ultimately a cost for an organisation (Valsamakis: 22).

By focusing on risk as a source of value, the following benefits are achieved:

- Predictability of operational results;
- contingency planning is promoted within the organisation; and
- action is directed at the prevention of avoidable events.

2.3.6 Waste

Waste is viewed as any activity or process that adversely affects the value equation. Suzaki identified the following categories of waste (20):

- Waste of overproduction;
- waste of waiting time;
- waste of transportation;
- processing waste;
- inventory waste;

- waste of motion;
- waste from product or service defects;
- waste of time;
- waste of human capability; and
- administrative waste.

By focusing on waste reduction as a source of value, the following benefits can be achieved:

- Higher throughput;
- reduced inventories; and
- reduced cost.

2.4 Value engineering principles

Value engineering was defined in Part Two as the discipline concerned with the optimisation of the value of an organisation. It provides a set of principles to be followed for the optimisation of operational value.

Value improvement, as indicated earlier, can be achieved through increasing the numerator of the value equation or through decreasing the denominator of the value equation.

The following improvement alternatives are suggested:

- Improving functional performance at the same cost;
- reducing cost at the same functional performance level;
- reducing cost more than reducing functional performance;
- improving functional performance more than increasing cost; and
- improving functional performance and reducing cost.

The approach taken in choosing one of these alternatives depends upon the constraints or degrees of freedom within a system.

2.5 Dynamic nature of value

Customers' perceptions of value change continually. What was innovative yesterday might be acceptable today and inadequate tomorrow. There are several reasons for a change in perception of value (Schonberger: 18):

- Familiarity;
- income and education;
- economic conditions;
- competition; and
- industry regulation.

A brief discussion of these reasons follows,

2.5.1 Familiarity

Familiarity is the notion that exposure to something leads people to take it for granted. As a result, familiarity reduces the effect of a product or service attribute as an order winner.

2.5.2 Income and education

As income and education increases, customers' needs become more sophisticated and hence require different and higher quality products or services.

2.5.3 Economic conditions

Changes in economic conditions affect people's perceptions of value. During a period of depressed economic conditions, customers focus on products or services vastly different from those in a period of economic prosperity.

2.5.4 Competition

In its pursuit of competitive advantage, organisations develop different ways of doing things - products and processes that are unique. Some of these, like the Pentium processor, the VHS format and others become industry standards. This leads to an immediate devaluation of non-complaint products or services.

2.5.5 Industry regulation

Government actions establish standards or minimum requirements for products and services. Acceptable performance levels are defined – they become criteria for the determination of value.

2.6 Operational strategy

The term *operational strategy*, at first glance, looks like a contradiction in terms. How can a strategy be operational? What looks like a semantic error is in fact a way of describing the approach taken in terms of the optimisation of value addition from operations.

Melnyck and Denzler (15) define five possible operational strategies for an organisation:

- The time value strategy;
- the place value strategy;
- the relationship-based strategy;
- the mass-customisation strategy; and
- the risk reduction strategy.

A brief discussion of these strategies follows.

2.6.1 Time value strategy

The time value strategy option focuses on the time to add value for a customer. Time influences the actions of the customer as a resource, not a constraint. An organisation can enhance value by reducing lead-time for the customer in many different ways:

- Reducing means and variances;
- managing both design and delivery lead-times;
- reducing total system lead-times; or
- focusing on lead-times for specific activities that interest the customer.

2.6.2 Place value strategy

The place value strategy option focuses on the reduction of the distance between the customer and the supplier. An organisation can enhance value by reducing the distance between the customer and the supplier in many different ways:

- Relocating as much as possible of the activities as close as possible to a customer;
- bringing suppliers and customers as close as possible together; or
- developing customer/supplier partnerships.

2.6.3 Relationship-based strategy

The relationship based strategy option focuses on a change in the way a customer views the organisation's products or services. Suppliers no longer sell and customers no longer buy physical goods. Intangible product and service characteristics such as security, goodwill, information and service are playing an important role in the satisfaction of customer requirements.

2.6.4 Mass-customisation strategy

The mass-customisation strategy option focuses on a system that can customise products or services on a mass scale. Instead of producing products or services for markets, they are produced for individuals. In order to achieve this, the organisation must deliver products or services to these customers at prices not higher than they would pay for standard products.

2.6.5 Risk reduction strategy

The risk reduction strategy option attracts customers by offering to eliminate or reduce the risks of doing business. With organisations increasingly moving towards systems that rely on less inventory and shorter lead-times, suppliers can charge premium prices if they expose their customers to less risk. Typically, these systems are highly visible and under strict control. They are designed to instil customer confidence by demonstrating control that assures on-time delivery of products that satisfy customer's quality and quantity needs.

3 Operations

3.1 Approach

From the Business Engineering perspective, three fields of study are important in the operation of organisations. The first one, *Operations Management,* is concerned with the maintenance and continuous improvement of business operations. The second one, *Operations Research,* is concerned with the use of scientific, mathematical and statistical methods in the Operations Management process. The third one, *Value Engineering,* is concerned with the optimisation of operational value.

The core engineering skill required in operations is the use of scientific methods in the execution and improvement of operations.

3.2 Operations Management

Melnyck and Denzler (15) define Operations Management as the field of study that tries to understand, explain, predict and improve the operations of the organisation.

Operations Management integrates the three major components of operations into a cohesive and mutually supporting entity. These are (Chase and Aquilano: 2, Melnyck and Denzler: 15, Sconberger and Knod: 18):

- Customers;
- processes; and
- capacity.

Customers are the entities that consume the output of the operational system of the organisation. The customer is both critical as departure point, as well as ending point for the Operations Management process. Processes define the sequence of activities through which customer requirements are met. Capacity defines the level of replications that can be achieved within these processes.

A suggested approach to value improvement in operations is shown in figure 3.

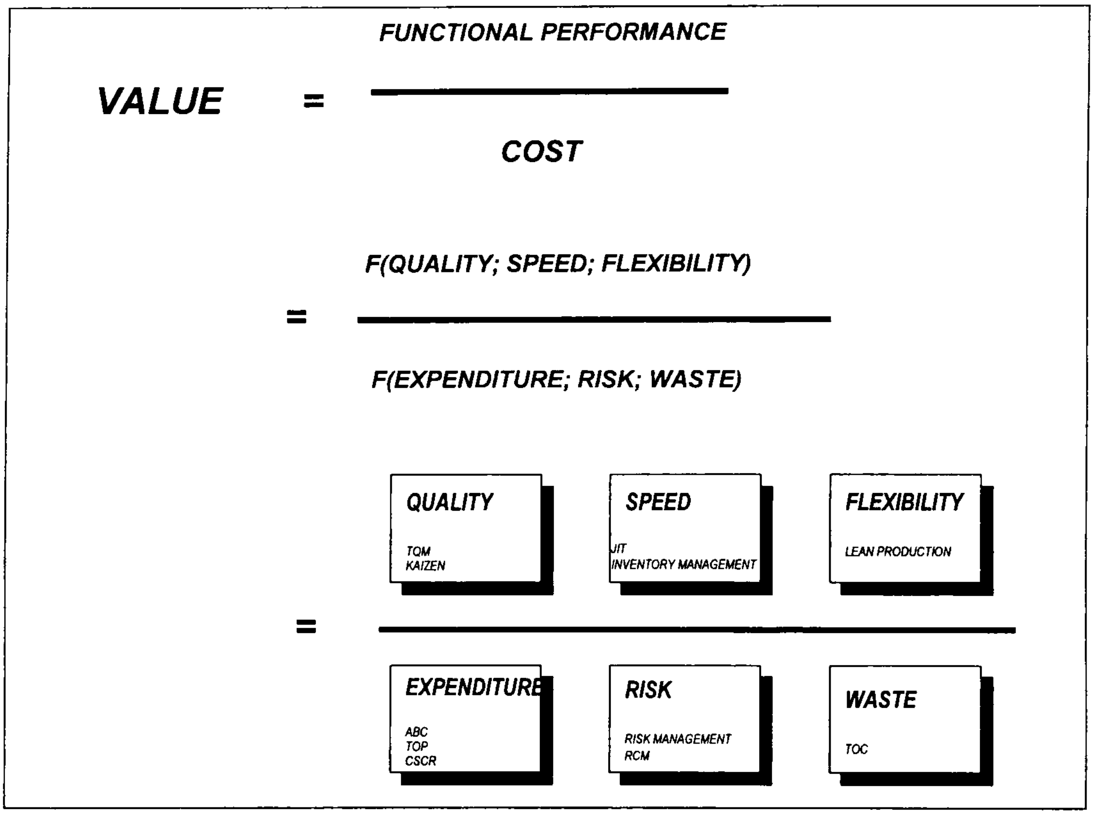

Figure 3 – Operational value drivers

In order to improve operations, one of the value drivers should initially be selected and used as an anchor point for operational improvement. The various components of value are interdependent, therefore, having selected one value driver as focus area, improvement or decline normally follows in other areas which can be addressed as they arise or as separate issues. A brief theoretical overview of improvement approaches for the various value drivers follows.

3.2.1 Quality improvement

Quality improvement is achieved through two basic approaches namely total quality management and kaizen. A brief discussion follows.

(a) Total quality management

The total quality management approach to operational improvement was founded by Deming (6) who defined the fourteen principles of quality, the theory of variance and the role of management. Juran (13) followed and outlined the habit of quality and quality trilogy. Crosby (4) enumerated the absolutes for quality management.

Logothetis (14) defines total quality management as a culture; inherent in this culture is a total commitment to quality and attitude expressed by everybody's involvement in the process of continuous improvement of products and services through the use of innovative scientific methods.

Total quality management is based on four fundamental principles (Garvin: 7):

- Commitment to quality;
- total involvement in the quality undertaking;
- continuous improvement; and
- extensive use of scientific tool and techniques.

Deming (5) defines fourteen principles of quality management. These are:

- *Create consistency of purpose for continuous improvement of products or services;*
- *adopt the philosophy of economic stability;*
- *cease dependency on inspection to achieve quality;*
- *end the practice of awarding business on price tag alone;*
- *improve the system of production and service consistently;*
- *institute training on the job;*
- *adopt and institute modern methods of supervision and leadership;*
- *drive out fear;*
- *break down barriers between departments and individuals;*
- *eliminate the use of slogans, posters and exhortations;*
- *eliminate work standards an numerical quotas;*
- *remove barriers that rob the hourly worker of the right to pride in workmanship;*
- *institute a vigorous programme of education and retraining; and*
- *define top-management's commitment to ever-improving quality and productivity.*

The quality cycle, as proposed by Deming, is a way of determining and managing quality. It is shown in figure 4.

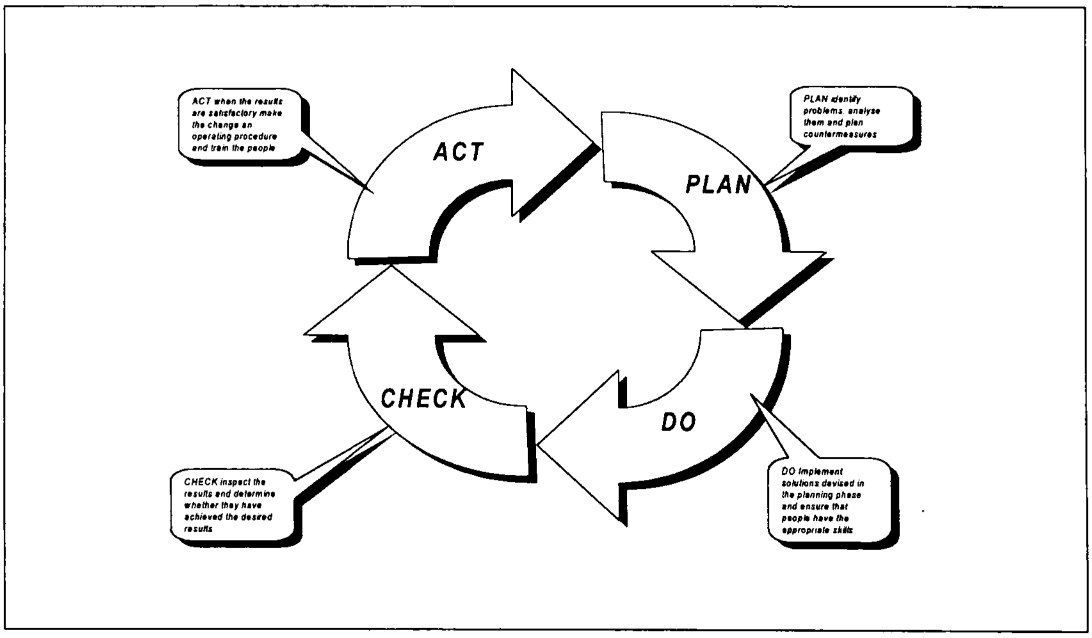

Figure 4 - The quality cycle

(b) Kaizen

The Kaizen approach, the Japanese for continuous improvement, was pioneered by Imai (12) as an application of Japanese philosophy to quality.

"The kaizen concept is crucial to understanding the differences between the Japanese and Western approaches to management. If asked to name the most important difference between Japanese and Western management concepts, I would unhesitantly say that Japanese kaizen is a process oriented way of thinking whilst the West has an innovation and results-oriented thinking."

Masaaki Imai in "Kaizen" (12, page 4)

Kaizen begins with the notion that an organisation can assure its long-term survival and success only when every member of the organisation actively pursues opportunities to identify and implement improvements every day. Kaizen sets no conditions for the size op these improvements. In fact, it often favours incremental improvements over large innovations. Incremental improvements keep people focused on thinking about the process and its current operation.

Kaizen is based on three fundamental principles:

- A process-view of the system because kaizen analysis is based on process improvement;
- success comes from people, because the kaizen approach relies on people's knowledge of the organisation's processes and their insights and intuition to conceive improvements; and
- a constant sense of urgency because a successful kaizen programme depends upon an unceasing awareness of the need for improvement.

3.2.2 Lead-time reduction

Lead-time improvement is achieved through two basic approaches namely inventory management and just-in-time. A brief discussion follows.

(a) Inventory management

Inventory is viewed as a physical resource that an organisation holds in stock with the intent of selling it or processing it to a more valuable state (Vollman: 23).

Inventory management is a classical Industrial Engineering approach aimed at optimising the cost of inventory through various scheduling and analytical approaches.

The best known of the scheduling approaches are manufacturing planning and control (MPC), master production scheduling (MPS) and material requirements planning (MRP) (Vollman: 23).

The best known analytical approaches are the economic order quantity (EOQ), product lot size, quantity discount, reorder level and dynamic demand models.

(b) Just-in-time

Just-in-time is an organisation-wide quest to produce output within the minimum possible lead-time and at the lowest possible total cost by continuously identifying and eliminating all forms of waste and variance (Vollman: 23).

The just-in-time approach is used for the following:

- Inventory reduction;
- quality control improvement;
- lead-time reduction;
- vendor control and vendor performance improvement;
- continuous improvement;
- total preventive maintenance; and
- strategic gain.

The just-in-time philosophy pursues smooth, integrated production flows and eliminates waste. The basic goals of just-in-time are:

- Products only produced on demand;
- products produced according to customer time requirements;
- products produced with perfect quality;
- products produced at minimum lead-time;
- products produced to customer specification;
- waste elimination; and
- production processes apply the best possible methods.

3.2.3 Flexibility improvement

Flexibility improvement is achieved through the lean production approach. A brief discussion follows.

(a) Lean production

Lean production is an organisation-wide approach to design and develop higher value products while consuming fewer resources for both direct costs and overhead costs (Melnyck and Denzler: 15).

Lean production focuses on aggressive efforts to satisfy customers, lean operations throughout the entire delivery system and tight integration of resource networks. Lean producers attack the two major components of costs: variable or direct cost, and overhead. Drawing heavily on just-in-time principles, they focus on producing the output that customers want with the minimum possible direct costs for labour, materials and tools. Lean producers also question the need for any activity that either creates overhead or is unnecessary. Through just-in-time techniques, they reduce overhead costs. In this process, they recognise the limits of their own abilities and do not perform every activity to produce a product.

As a result, lean production significantly affects an organisation's break-even point in two ways – by increasing the contribution margin and by reducing overhead costs. The contribution margin grows as the organisation charges a higher price to deliver a better product faster while it reduces direct costs at the same time. Together, these changes drive the break-even point downward, enhancing the organisation's flexibility. A lean organisation can afford to produce smaller quantities, allowing niche marketing and it can change outputs faster in response to changes in customer demand. Compared to mass producers with lower contribution margins and higher fixed cost, the lean producer is more agile.

3.2.4 Expenditure reduction

Expenditure reduction is achieved through three approaches namely activity-based costing, total operational performance and clean sheet capital redesign. A brief discussion follows.

(a) Activity-based costing

Activity-based costing is a method of allocating costs to specific products based on breakdowns of cost drivers.

Activity-based costing as defined by Horngren and Sundem (11) tries to trace operating expenditure to specific products or services rather than arbitrarily allocating them according to some predefined basis. To do this, activity-based costing identifies appropriate cost drivers or quantifiable indicators of activities that reveal the sources of costs for products or services. Activity-based costing helps organisations respond to changes in product mixes, technologies and processes.

The danger of activity-based costing and the related cost-driven value improvement approaches comes from the potential abuse and excessive emphasis on cost reduction. They tend to stress short-term savings while ignoring long-term implications.

(b) Total operational performance

Total operational performance is an approach that was develop by McKinsey and Company (Copeland: 3) and is based on the principles of activity-based costing.

Its basic aim is the reduction of operating expenses in the organisation. It breaks down the operational goals of the organisation into activities and products, and allocates the operating expenses of the organisation to these activities and end products. It does so by distinguishing between compressible and incompressible operating expenditure. Compressible expenditure is a term used to describe those expenses that are related to activity throughput, whilst incompressible expenditure is a term used to describe those expenses that are not related to activity throughput. It then sets improvement targets based on industry benchmarks for the compressible expenditure. In order to achieve these targets, ideas are generated and implemented.

(c) Clean sheet capital redesign

Clean sheet capital redesign is a similar approach to the total operational performance approach but focuses on capital expenses. McKinsey and Company developed the approach (Copeland: 3). It is an application of Value Engineering principles.

The clean sheet capital redesign process is aimed at the improvement of the value of capital projects through breaking the net present value of the capital project down into a set of detailed value drivers. These value drivers, based on capital expenditure, operating expenditure and revenues, are decomposed to a level where improvement targets can be set for cost reduction and revenue improvements, whilst maintaining the same output for the capital project as specified in the design phase. Similar to the previous approach, ideas are then generated and implemented in order to achieve these targets.

3.2.5 Risk improvement

Risk improvement is achieved through two basic approaches namely risk management and reliability centred maintenance. A brief discussion follows.

(a) Risk management

Risk management is an approach that focuses on the identification of operational risks, quantification of these risks and the design of a management plan in order to manage these risks (Valsamakis: 22).

From a value perspective, it might be necessary to be preactive towards an organisation's exposure to operational risk because of the impact it will have on operations. For this reason, an organisation should focus on the management of risks.

(b) Reliability-centred maintenance

Reliability-centred maintenance is an application of the risk management approach (Blanchard: 1).

A programme of reliability-centred maintenance focuses on the evaluation and improvement of the reliability characteristics of the physical equipment of the organisation.

3.2.6 Waste improvement

Waste improvement is achieved through the application of theory of constraints principles.

(a) Theory of constraints

The theory of constraints is an approach to value improvement aimed at the identification and elimination of bottlenecks in the organisation's operations.

The approach developed by Goldratt (8,9,10) begins with the premise that operations primarily exist to make money by delivering value to the customers. This process is inhibited by various types of waste, a result of *bottlenecks or constraints* in the system. In order to improve value, these constraints have to be identified and either eliminated, or accepted as fact and used as a ceiling for the throughput through the process. Non-bottlenecks, on the other hand, can easily overproduce and generate waste as a result of the rates at which bottleneck produce. There is thus no justification for this waste accumulating.

The second premise is the argument that variability occurs naturally within any process. These variations have the potential to disrupt the operations of the organisation.

Goldratt (8) proposes the following principles as a basis for the theory of constraints:

- *Balance flows, not capacity;*
- *an hour lost at a bottleneck is forever lost;*
- *time at a non-bottleneck resource has a negligible marginal value;*
- *the level of utilisation at a bottleneck depends on some other constraint within a system;*
- *bottleneck govern throughput, inventory and quality;*
- *utilise resources, don't just activate them;*
- *the size of a bath that moves between work centres need not equal the size of the processing batch;*
- *processing batch sizes may vary along an order's route and over time; and*
- *schedules should simultaneously accommodate all constraints and lead-times are the result of processing schedules.*

3.3 Operations Research

Operations Research is a field of study concerned with the application of mathematical, statistical and scientific methods in the improvement of operations (Winston: 24).

Its contribution to the business operation phase of Business Engineering is based on its ability to support operational management decisions with quantitative tools.

3.3.1 Statistical analysis

The first group of Operations Research methods is aimed at determining the statistical parameters of an operational system (Winston: 24). In the improvement of operations, statistical process control, significance testing and analysis of mean and variances are used to determine whether a process is under control or to measure improvement.

3.3.2 Optimisation

The second group of Operations Research methods is aimed at optimising the inputs into the operational system, subject to the influence of various constraints (Winston: 24). In the improvement of operations, linear, integer and non-linear programming methods are often applied to determine product-mix, to eliminate waste in the distribution chain and to minimise cost.

3.3.3 Modelling

The third group of Operations Research methods is aimed at modelling the dynamics of the operational system in order to determine the bottlenecks and evaluate the consequences of various proposed operational improvements (Winston: 24).

3.3.4 Decision analysis

The fourth group of Operations Research methods is aimed at the creation of models that support decisions that are made in the operational system. In the improvement of operations, multi-criteria and analytical hierarchical decision making processes are often applied in the evaluation of improvement alternatives (Winston: 24).

3.4 Value Engineering

Value Engineering is a study field concerned with the optimisation of operational value (19).

The contribution of Value Engineering to the business operation phase of Business Engineering is based on its ability to analyse, improve and optimise the value of operations through the application of a set of principles.

These principles are:

- Value analysis, through the decomposition of a system into its elements and analysing functional performance in relation to cost;
- value improvement, through the development of improvement ideas;
- evaluation, through the determination of the new value; and
- implementation of the value improvement initatives.

4 Operations management processes

4.1 Approach

Operations Management, from the Business Engineering perspective, can be viewed both as a discipline with its own unique components, as described in the previous paragraph, and as a process of supporting the value chain operations of an organisation. There is no real difference between the management and improvement of a system. As shown in paragraph 2.3.8 of Part Four of this thesis, the management of an organisation is primarily concerned with performance measurement and improvement. For this reason, the focus of the Operations Management process is focused on the improvement of the added value of the operations. This is achieved through the use of Value Engineering methods, through the continuous improvement of operations, as well as through the scientific support-base created by the discipline of Operations Research.

These processes are shown in figure 5.

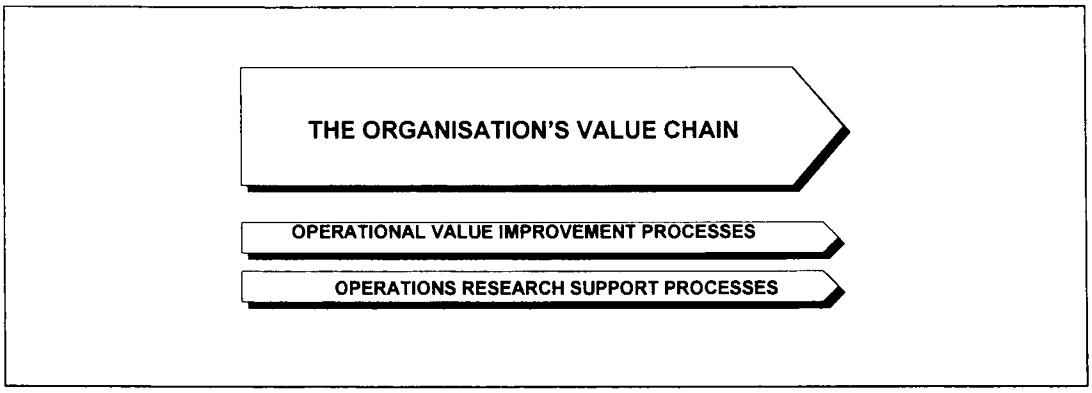

Figure 5 - Operations management processes

The concept of value addition that was defined in the previous paragraph is the cornerstone of the Operations Management process. All improvement is aimed at adding value by focusing on at least one of the identified value drivers of the organisation. This is achieved essentially through three processes for which the boundaries are seamless. These are:

- The value engineering process;
- the continuous improvement process; and
- operations research support processes.

The first two of these are termed the operational improvement processes whilst the last process supports the previous two.

These processes are shown in figure 6.

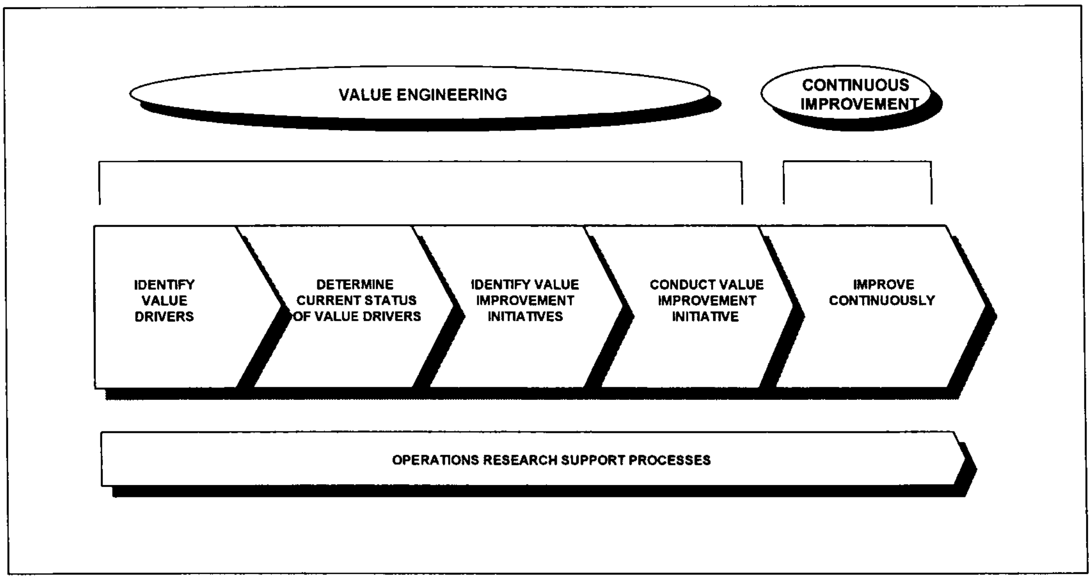

Figure 6 - Operational improvement processes and operations research support

4.2 Value engineering process

The value engineering process is based on an identification of the current status of the various operational value drivers of the organisation and the development and execution of an improvement initiative to close the identified gaps.

This process is shown in figure 7.

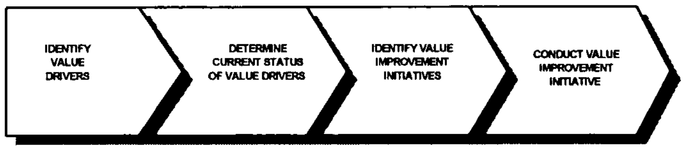

Figure 7 – Value Engineering Process

Inputs required for this process are:

- An analysis of the operational value drivers of the organisation; and
- a strategic decision on value improvement focus.

The process itself consists of the following activities:

- Identification of the various value drivers within the operations of the organisation;
- determining the current status of the various value drivers within the organisation and an assessment to gaps with respect to these value drivers;
- identification of improvement initiative(s) for the selected value drivers based on the identified gaps; and
- implementation of the improvement initiative(s).

4.3 Continuous improvement process

The continuous improvement process follows in sequence with the value engineering process and is based on incremental improvements on an ongoing basis over and above those achieved with the operational improvement initiatives.

This process is shown in figure 8.

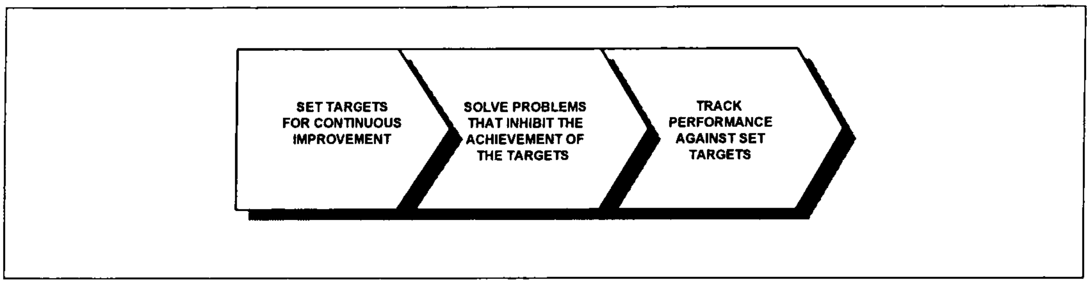

Figure 8 - Continuous Improvement Process

Inputs required for this process are:

- The new performance levels achieved for the various value drivers; and
- forecast industry benchmarks in order to improve continuously beyond current improved operational performance.

The process itself consists of the following activities:

- Setting targets for the various value drivers over and above performance improvements already sustained and over and above industry trends;
- removing problems or exploiting opportunities in order to achieve the targets that were set; and
- tracking performance continuously in order to revitalise the improvement cycle and to position the organisation for possible further interventions.

4.4 Operations Research support

Operations Research support is provided in order to give scientific substance to the operational performance improvement initiatives. Operations Research is not a process by itself, it is a set of tools available to the other initiatives.

The Operations Research support activities are shown in figure 9.

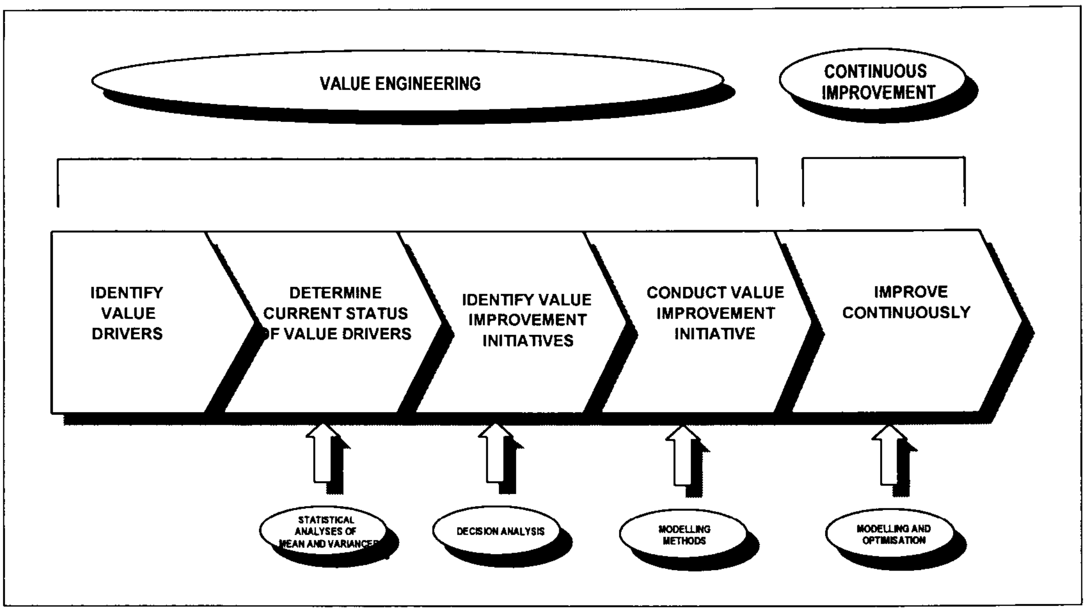

Figure 9 - Operations Research support activities

The following Operations Research activities support the operational improvement processes:

- Using statistical analysis of means and variances in order to analyse value drivers;
- using decision analysis methods to determine improvement initiatives required;
- using modelling methods in order to determine the current state for the various identified value drivers; and
- using modelling and optimisation methods in the execution and continuous improvement of operations.

5 Conclusion

Part Six presented an approach to business operation. It integrated the classical Industrial Engineering and Operations Management approaches within the framework of business transformation. In doing so, it was firstly explained why it was important to optimise the operations of an organisation continuously by defining the value perspective on operations. Secondly an overview was presented of the various approaches to the improvement of this value (what). Thirdly the processes involved in operational improvement (how) were defined and positioned within this framework. The operations phase is not the end of the Business Engineering journey, rather it is the beginning:

- Firstly it is the beginning of a journey towards the continuous improvement of the organisation;
- secondly it is in operations where the value that the organisation creates or adds for its stakeholders originates; and
- lastly it is from signals that are detected in the business operation phase that the Business Engineering process is initiated.

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Part Seven - Conclusion

"We must not cease from exploration and the end of all our exploring will be to arrive where we began and know the place for the first time."

TS Elliot

1 Objective

Part Seven of this thesis provides a summary of the most significant conclusions derived from the thesis in terms of the following:

- An overview of the approach that was presented;
- the theoretical contribution of the thesis;
- the applicability of the approach that was developed; and
- insight into the future value of the approach.

The Business Engineering Process was proposed as a road map for the thesis. Part Seven provides an overview of the most significant conclusions that were derived in this thesis.

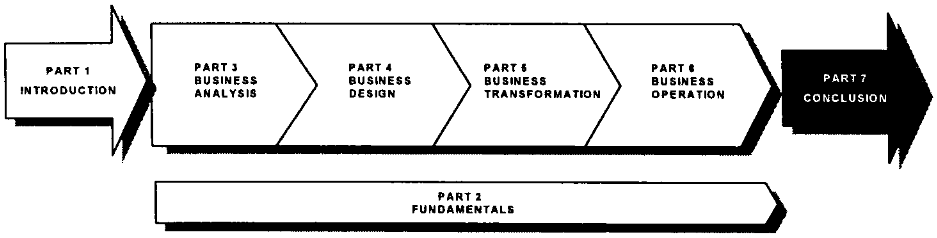

Figure 1 – Conclusions from the Business Engineering Process

2 Overview

2.1 Points of departure

In initiating the research that lead to the completion of this thesis, the following points of departure were taken:

- Various approaches currently exist towards the transformation of organisations. They are however discipline-based and tend to neglect the multidisciplinary nature of business problems.
- A vast number of transformation efforts fail, mainly because of two factors:
  - implementation never occurs or the alignment in the various dimensions of the organisation's architecture are neglected; and
  - single-disciplinary solutions are provided.
- The author believes that the Industrial Engineering discipline has lost some of its relevance in industry because of the shifts that have occurred. Whilst it is still ideally positioned to deliver solutions for the business problems of the day, this opportunity has not been fully exploited.
- Being an Industrial Engineer exposed to various other disciplines, the author had the opportunity to develop an engineering-based approach to business transformation.
- It has become a personal crusade for the author.

2.2 Contribution of the thesis

In the field of Mathematics, students' knowledge is built from fundamentals, complex theories being constructed from these. However, when the phenomenon of business transformation is considered, a vast number of complex solutions are available in literature, without addressing the fundamentals underlying these methods. The most significant contribution of this thesis must therefore be viewed as its contribution to the fundamentals of business transformation and its efforts to bridge the gap between these fundamentals, and the complexities of current methods. This analogy is shown in figure 2.

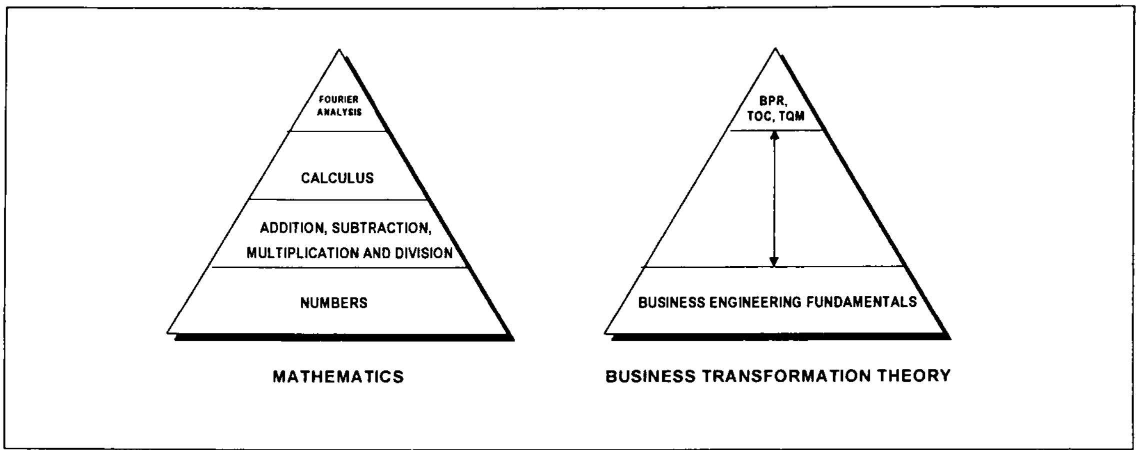

Figure 2 - The fundamental approach

From this point of view, the thesis contributes in the following ways:

- It shows how an engineering approach can be used to develop an integrated and comprehensive approach to business transformation that successfully addresses the issues at hand in current approaches.
- It contributes to Industrial Engineering and Management Theory by redefining their intersection and re-organising their contents.
- It shows how the fundamental engineering skills can be applied to business problems.
- In this process, various methods were adapted, refined or developed.

2.3 *Overall conclusions*

The following overall conclusions were derived from the study:

- Change and transformation is a reality for all organisations today, exacerbated by increased turbulence.
- Change is the result of shifts in society and new ways of thinking amongst individuals.
- Organisations tend to follow fragmented approaches to transform themselves, resulting in increased complexity.
- Organisations do not focus on the fundamentals of transformation.
- An engineering approach can add significant value to the transformation process in two dimensions namely:
  - providing an integrated process; and
  - providing fundamental skills.
- Because engineers run many organisations, adoption of the proposed approach in organisations is highly feasible.
- The Industrial Engineering discipline is ideally positioned to provide a theoretical home for the proposed approach.
- An engineering approach to business transformation is based on a process consisting of the four mentioned phases. This process is based on a set of fundamental principles.
- A systemic view of an organisation can be used in order to analyse the business and develop a design specification.
- The metaphor of architectural and engineering design can be applied successfully to design a blueprint for an organisation.
- External and internal change causes transformation. The transformation process, in turn, is viewed as the implementation of the proposed design.
- A value perspective can contribute significantly to the traditional view of Operations Management.

2.4 Specific Conclusions

The Business Engineering Process is an engineering approach to business transformation.

It was explained in the foreword that the development of knowledge is based on three fundamental cornerstones namely:

- Theory;
- application; and
- insight.

These elements are revisited in figure 3.

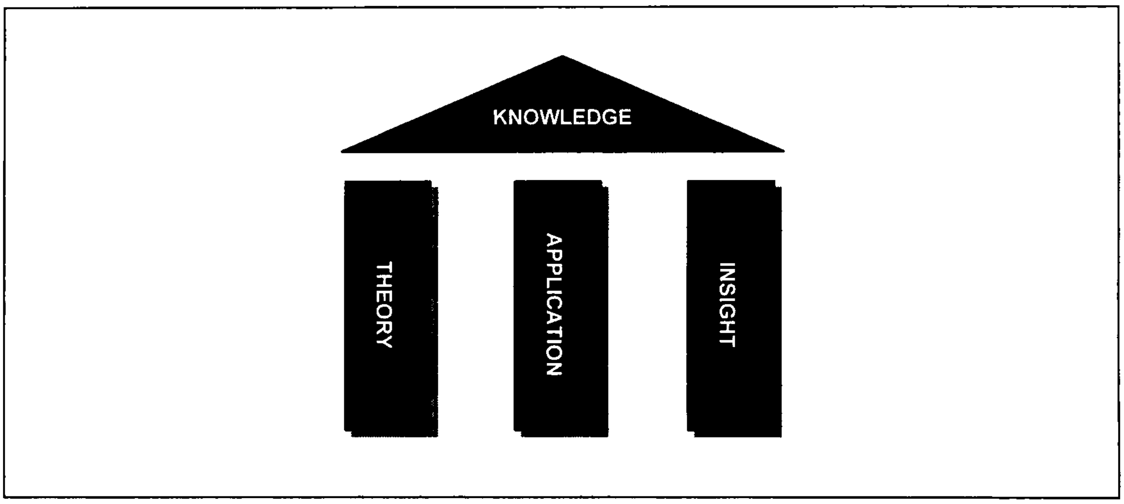

Figure 3 - The cornerstones of the development of knowledge

In order to evaluate the success of this thesis, it must therefore be assessed to what extent the proposed approach contributed to current theory; to what extent can it be practically implemented and what additional insights are there about the future use of the approach. The primary contribution of this thesis is the approach or framework that was presented and the secondary contribution the contents within this framework.

3 Theory

3.1 Aims of the Business Engineering Process

The proposed approach as presented in this thesis, focuses on the pursuit of the following aims:

- To develop a better understanding of the critical issues that an organisations faces;
- to design organisation the are responsive to these issues;
- to implement these organisations; and
- to manage, maintain and continuously improve these organisations.

In order to achieve this, it follows a structured and integrated approach.

3.2 Properties of the Business Engineering Process

The proposed approach has the following three properties:

- The approach is *object-based.* Objects are the building blocks that are used to develop specific approaches to specific problems. It is not suggested that the complete process, as described in this thesis, be applied to every specific business transformation initiative. Rather, in conducting a business transformation initiative, the scope of the problem and the requirements at hand will necessarily have to be determined, leading to a subset of the Business Engineering Process being constructed from the various objects that are available within the process.

- The approach provides for *cross-functional* business transformation models because it is an integrated approach. Therefore, various related approaches and processes that are aimed at business transformation can be derived by using specific configurations of the objects. Examples of these are the strategic planning process, business process reengineering and value engineering. These cross-functional approaches are shown in figure 4.

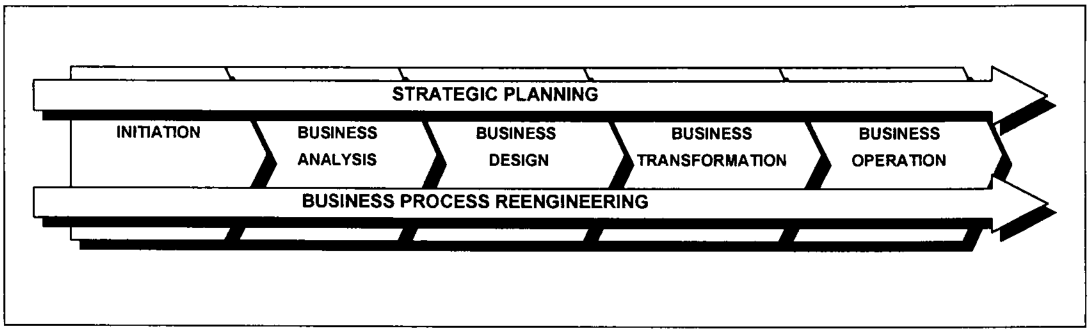

Figure 4 - Cross-functional Business Engineering

- The approach is *fundamental*. The approach was constructed from basic principles. The application of these principles provides a generic framework that can be applied to various problems and can be used to develop specific approaches to problems not addressed in this thesis.

3.3 Application of an engineering approach

In determining whether the proposed approach did in fact use the fundamental skills of engineering, the elements of the Business Engineering Process are correlated with these skills.

The correlation between the elements of the Business Engineering Process, and the fundamental engineering skills is shown in table 1.

ELEMENT/SKILL	***BUSINESS ANALYSIS***	***BUSINESS DESIGN***	***BUSINESS TRANSFORMATION***	***BUSINESS OPERATION***
INNOVATION	Development of a model that describes the current state of the organisation	Development of business strategy	Management of transformation	Value creation initiatives
STRUCTURED AND SYSTEMATIC	Utilisation of analytical and systems thinking in business analysis	Architectural and engineering design processes	Transformation processes	Operations Management process
APPLIED SCIENCES	Application of economic sciences	Application of management sciences	Application of behavioural sciences	Application of Operations Research methods

Table 1 - Application of engineering skills in the Business Engineering Process

4 Application

The author has applied the proposed approach successfully in the following areas at his employer:

- The development and implementation of a strategic management process for the company;
- the development and implementation of an approach to the optimisation of capital projects through business case improvements;
- the development of an organisation that developed and markets a world class new processing technology;
- the development and implementation of a turnaround strategy for a marginal subsidiary of the company;
- the development and implementation of a transformation programme for the in-house information technology provider of the company; and
- the development of a Business Engineering organisation for the company.

5 Insight

"Then said a Teacher, Speak to us of Knowledge.
And he said:
No man can reveal to you aught but that which already lies half asleep in the dawning of your knowledge.
The teacher who walks in the shadow of the temple, among his followers, gives not of his wisdom but rather of his faith and lovingness.
If he is indeed wise he does not bid you enter the house of wisdom, but rather leads you to the threshold of your own mind."

Kahlil Gibran in "The Prophet"

The author believes that the approach that was developed in this thesis can make a contribution to organisations as a fundamental way of thinking. It is, in many ways, a different way of thinking. The engineering approach adds a new perspective to business transformation. Similarly business transformation as a field of study adds a new perspective to engineering.

The originality of this thesis is primarily based on the approach that was suggested and secondarily on the contents of the various elements of the approach.

The thesis is a contribution to Industrial Engineering and it is hoped that the thesis will in some way expand the boundaries of Industrial Engineering. But most of all, it is hoped that this thesis will contribute towards the discipline of Business Engineering being recognised as a field of study that finds a rightful place somewhere in the intersection between Industrial Engineering and Management Theory as shown in figure 5.

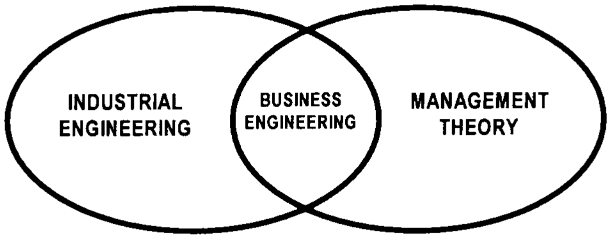

Figure 5 - The intersection of Industrial Engineering and Management Theory

The organisations of the next millennium will be exposed to various new challenges. The author hopes that the theory that was developed in this thesis will in some humble way contribute to the success of organisations in facing these challenges. There are the challenges of creating world class South African organisations; restructuring of the legacy organisations of South Africa and the development of growth prospects. In all of these there is scope for further development and application of the proposed approach.

The ultimate test for the success of this thesis will be when a better theory is developed one day and the question is asked whether this approach has contributed towards the world being a better place or whether it merely added to the complexity and chaos that surround us. Until then, it stands.