

# Small and Medium Enterprise Transformation (South African Manufacturing)

Thesis prepared in partial fulfilment of the degree of Master of Industrial Engineering  
at the University of Stellenbosch



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March 2002

## **Declaration**

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and has not previously in its entirety, or in part, been submitted at any university for a degree.

## Abstract

*“The environment sets many new requirements and SMEs can reactively adapt or they can design themselves to affect and operate in the environment as effective as possible.”* - Trade and Industry Minister Alec Erwin (2000).

The objective of this thesis is to assess how applicable transformation methodologies (essentially a design process) are to South African small and medium manufacturing enterprises (SMEs). Enterprise Engineering was chosen as the reference discipline for this study. Enterprise Engineering is an emerging discipline that draws upon a wide variety of reference disciplines as a foundation. Transformation from an Enterprise Engineering perspective is considered as a rigorous engineering approach through careful planning to transform an enterprise from a current state to desired future state. Two methodologies from the Enterprise Engineering discipline were chosen, and their applicability to serve as transformation methodologies was assessed for South African manufacturing SMEs.

The thesis starts by stating the thesis objective, problem statement, approach followed, limitations of the research and thesis outline. Global competitive trends for nations and manufacturing enterprises are then discussed. The current South African environment for manufacturing SMEs is reviewed in order to better understand the specific needs for transformation. Current literature on the reference disciplines of Enterprise Engineering is introduced to establish a sound foundation for understanding the transformation concepts. Transformation, Enterprise Engineering methodologies and the type of transformation that each methodology presents are defined, and some important concepts of the methodologies are discussed and evaluated against prevailing South African practices. A pre-transformation assessment method is established to help in the decision process of whether a SME should go ahead with transformation at all, and if so, what the extent and type of transformation approach should be.

An application for each of the two transformation methodologies is done. The Transform Enterprise Methodology was applied at a small manufacturer of microwave components for the electronic warfare industry, and the Master Planning methodology was applied to a business unit that specialises in rapid product

development. The results of the applications are included in this report. Lessons learnt and conclusions drawn are presented in the sections following.

## Opsomming

*“Die omgewing stel baie nuwe vereistes en klein en medium ondernemings kan reaktief aanpas of hulle self herontwerp om die omgewing te beïnvloed en om so effektief as moontlik daarin te werk.”* – Handel en Nywerheid Minister Alec Erwin (2000).

Die doewit van die tesis is om te bepaal hoe toepasbaar transformasie metodologië is tot Suid Afrikaanse klein en medium vervaardiging ondernemings. Ondernemings Ingenieurswese is gekies as verwysings disipline vir hierdie studie. Ondernemings Ingenieurswese is ’n opkomende disipline wat gebaseer is op ’n wye verskeidenheid verwysings disiplines.

Transformasie vanuit ’n Ondernemings Ingenieurswese oogpunt kan beskou word as ’n werksintensiewe ingenieurs benadering om ’n onderneming te transformeer van ’n huidige tot ’n toekomstige begeerlike toestand in ooreenstemming met ’n plan. Twee metodologië vanuit die Ondernemings Ingenieurswese disipline is gekies, en hulle toepasbaarheid om as transformasie metodologië gebruik te word is bepaal vir Suid Afrikaanse klein en medium vervaardiging ondernemings.

Die tesis begin deur die tesis doelwit, probleem stelling, benadering gevolg, begrensing van die navorsing en oorsigtelike skema te gee. Globale kompeterende tendensies vir nasies en vervaardiging ondernemings word daarna bespreek. Die huidige omgewing vir klein en medium vervaardiging ondernemings in Suid Afrika word dan beskou. Dit word gedoen om beter te verstaan wat die spesifieke behoeftes vir transformasie is.

Huidige literatuur oor Ondernemings Ingenieurswese verwysings disiplines word bekend gestel om ’n goeie fondasie daar te stel vir begrip van transformasie konsepte. Transformasie word gedefinieer en twee tipes transformasie metodologië word bekendgestel. Die belangrikste konsepte van die twee metodologië word dan bespreek en geëvalueer teen algemene Suid Afrikaanse werkpraktyke. ’n Pro-transformasie evalueerings metode is opgestel om te help met die besluitneming of daar voortgegaan moet word met transformasie in ’n onderneming, en indien wel, watter tipe metodologie gebruik moet word en wat die omvang van transformasie moet wees.

Toepassings van beide metedologië is gedoen. Die Transformeer Onderneming Metedologie is toegepas op 'n klein vervaardiger van mikrogolf komponente vir die elektroniese oorlog industrie, en die Meester Plan metedologie is toegepas op a besigheids eenheid wat spesialiseer in pas komponent vervaardiging.

## Acknowledgements

The author would like to thank:

My God and Father for love, Jesus Christ for life and Holy Spirit for guidance.

My mother for continued support.

Mr. Konrad von Leipzig for guidance during the completion of this thesis.

Prof. Nick du Preez for the opportunities through the Department of Industrial Engineering.

Dr. Louis de Lange for valuable input and external examination of this thesis.

Robert le Clus and Douglas Shadwel for editing support.

Herman Swanepoel and Izelda Swanepoel from H.S.I. Microwave Components CC.

Global Competitiveness Centre.

## **Executive Summary**

### **Introduction**

This document is a thesis written by the author for the completion of his Masters degree in industrial engineering at the Department of Industrial Engineering at the Faculty of Engineering at the University of Stellenbosch. Enterprise Engineering experience was gained from the completion of an Enterprise Engineering Module at the Department of Industrial Engineering and 20 months of part time employment at Indutech (Pty) Ltd.

Indutech is one of three divisions of the Global Competitiveness Centre (GCC) at the Department of Industrial Engineering. Indutech specialises in knowledge management and development of Enterprise Engineering software and application methodologies.

### **Layout of this Document**

The thesis starts by stating the thesis objective, problem statement, approach followed, limitations of the research and thesis outline. Global competitive trends for nations and manufacturing enterprises are then introduced in chapter 2. The current South African environment for manufacturing SMEs is reviewed in chapter 3 in order to better understand the specific needs for transformation. Chapter 4 introduces and reviews current literature on the reference disciplines of Enterprise Engineering so as to establish a sound foundation for understanding the transformation concepts. Transformation is defined and two types of transformation methodologies are introduced in chapter 5. Some important concepts of the methodologies are discussed and evaluated against prevailing South African practices in chapter 6. A Pre-transformation Evaluation Method is presented in chapter 7 to help in the decision making process of whether a SME should go ahead with transformation, and if so, what the extent and type of transformation approach should be. An application for each of the two transformation methodologies is discussed in chapter 8. In chapter 9 the conclusions reached are discussed and recommendations are made. The scoring method for the Pre-transformation Evaluation Method and the two detailed methodology application reports are presented in appendix A, B and C respectively.



## **Transformation by using Enterprise Engineering**

*“The environment sets many new requirements and SMEs can reactively adapt or they can design themselves to affect and operate in the environment as effective as possible”* - Trade and Industry Minister Alec Erwin (2000).

The objective of this thesis is to assess how applicable transformation (essentially a design process) methodologies are to South African small and medium manufacturing enterprises (SMEs). Enterprise Engineering was chosen as reference discipline to study enterprises in general. Enterprise Engineering is an emerging discipline that draws upon a wide variety of reference disciplines as a foundation. Transformation from an Enterprise Engineering perspective is considered as a rigorous engineering approach to transform an enterprise from a current state to desired future state in accordance with a plan. Transformation is a complex process that cannot be undertaken in a reactive ad hoc fashion, or as a separate, component related approach. A methodology is needed to guide this process. Using an Enterprise Engineering methodology in a SME will inevitably result in wide ranging changes that will holistically transform the SME.

## **Transformation Approach**

The author proposes a two-step approach to transformation.

1. Execution of the Pre-transformation Evaluation Method: The Pre-transformation Evaluation Method is not intended to be a complete assessment or a change method. It is a rough-cut enquiry process that guides the process of decision making for three critical questions:
  - Can transformation proceed in the enterprise?
  - What type of transformation is required?
  - What should the scope and extend of transformation be?
2. Application of the transformation methodologies: Two transformation methodologies representing two different types of transformation are defined and used for transformation in this thesis. The Pre-transformation Evaluation Method helps to decide on a transformation methodology and provides starting points for the transformation process.

## **Transformation Methodologies and Implementation**

Two types of transformation methodologies were studied and applied in this thesis, namely alteration transformation and conversion transformation. The results of the applications are included in this report. Alteration transformation is defined as a proactive systematic process of adjusting the subsystems of an enterprise to transform the enterprise through careful planning from its present state to a future desired state. Conversion transformation is defined as a systematic proactive approach to transform the enterprise by making quantum jump changes within certain subsystems by following a predefined plan.

The methodology chosen for alteration is the Transform Enterprise Methodology by Dr. Ruyn Underdown. It was developed at the University of Texas Arlington. The Transform Enterprise Methodology was applied at a small manufacturer of microwave components for the electronic warfare industry.

The Master planning methodology that is based on the Purdue Enterprise Reference Architecture and the Purdue Methodology was the methodology chosen for conversion. The Institute for Interdisciplinary Engineering Studies at Purdue University developed this methodology. The Master Planning methodology was applied to a business unit that specialises in rapid product development.

## **Conclusion**

The need for intervention in the small and medium enterprises (SMEs) is great. Lack of technical and managerial capacity in SMEs remains a high priority aspect that needs to be addressed (Ntsika Enterprises, 2000). Tertiary educational institutions should play their role to help providing services to improve technical and managerial capacity. This is especially because the resource limitations of SMEs place consultants and focused research projects unfeasible for these enterprises.

This research provides several contributions to the South African Manufacturing SME literature. During the course of the author's research he found that no other comprehensive transformation (design) approaches have previously been studied and published for South African manufacturing SMEs. Complete workbooks of the

transformation methodologies and scoring method for the Pre-transformation Evaluation Method are provided on CD ROM with this thesis.

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## Glossary

AIDS	Acquired Immune Deficiency Syndrome
BPR	Business Process Reengineering
CASE	Computer Aided Software Engineering
CIM	Computer Integrated Manufacturing
CNC	Computer Numerically Controlled
CR	Communication Responsibility
DTI	Department of Trade and Industry
EBE	Enterprise Business Entity
EE	Enterprise Engineering
EI	Enterprise Integration
EOM	Efficient Operations Management
ERP	Enterprise Resource Planning
GCC	Global Competitiveness Centre
GDP	Gross Domestic Product
HIV	Human Immune Virus
H.S.I.	Herman Swanepoel Industries
IE	Industrial Engineer
IMD	International Institute for Management Development
IS	Information Systems
ISO	International Standards Organisation
IT	Information Technology
LCOEM	Life Cycle Orientated Environmental Management
LOM	Laminated Object Manufacturing

MFG	Manufacturing
MP	Master Plan
PEC	Product-orientated Environmental Care
PERA	Purdue Enterprise Reference Architecture
R&D	Research and Development
RDP	Reconstruction and Development Program
RPD	Rapid Product Development
RPDD	Rapid Product Development Division
SABS	South African Bureau of Standards
SAQI	South African Quality Institute
SEE	Society of Enterprise Engineers
SMART	Specific, measurable, accountable, resources and time-phased
SME	Small and Medium Enterprises
SMME	Small Medium and Micro Enterprises
SPC	Statistical Process Control
SWOT	Strengths, Weaknesses, Opportunities and Threats
TEM	Transform Enterprise Methodology
TQM	Total Quality Management
UNAIDS	United Nations for AIDS
US	United States
WCY	World Competitiveness Yearbook

# **1 Introduction**

## **1.1 Thesis Objective**

The objective of this thesis is to evaluate how applicable transformation methodologies are to small and medium manufacturing enterprises in the South African environment from an Enterprise Engineering perspective. Transformation from an Enterprise Engineering perspective is considered to be a rigorous engineering approach to transform an enterprise from its current state, to a desired future state by following a plan. Enterprise Engineering is the considered and systematic analysis and design of the enterprise through the business processes it employs to realize business goals.

## **1.2 Problem Statement**

Many small and medium manufacturing enterprises in South Africa require fundamental change to successfully compete in the new global marketplace. Fundamental change is difficult. Transforming an enterprise from its current to a desired state is a complex process that cannot be undertaken in a reactive, ad hoc fashion, or as a separate component related approach.

Literature available, mainly from business schools (social sciences), on the daily management of small business contains descriptive methods that are ad hoc and limited to a single process. To the author's knowledge, transformation methods that incorporate a holistic and goal orientated approach into one structured transformation methodology have not yet been evaluated for the South African SME environment. An evaluation of this nature has been done for SMEs in the USA.

## **1.3 Approach Followed**

This thesis research project was a learning exercise in evaluating and testing two transformation methodologies within the South African manufacturing SME environment. The nature of the problem required the use of a deductive approach to the research, as it involved the evaluation and testing of concepts in a new situation.

Evaluation was based on extensive literature reviews on SMEs and personal experience gained from discussions and implementation of the methodologies. The literature review combined with personal evaluation provided the necessary background to draw up the South

African manufacturing SMEs' requirements and highlighted the need for change. These requirements were evaluated against the existing transformation methodologies to assess the value of these methodologies. By applying the transformation methodologies within two enterprises, their respective advantages and shortcomings were analysed. The evaluation and applications lead to experiences and observations which were explained, and from which conclusions could then be drawn.

## **1.4 Limitations of Research**

This research is limited to SMEs that satisfy the following criteria:

- South African enterprises that are engaged in the manufacturing of tangible value-added goods.
- Enterprises with more than 5, but less than 200 employees.
- Annual turnover of more than R1 000 000 and less than R40 million.
- Total gross asset value of more than R150 000 and less than R15 million.

For the purpose of this thesis an enterprise is defined as a profit-making entity with “management sovereignty” and well-established bounds of ownership and liability. The enterprise is charged with responsibility and control over its own actions.

This research does not consider the best persons or situations required for using the methodologies, but rather considers how these transformation methodologies are generally applicable to South African manufacturing SMEs.

## **1.5 Thesis Outline**

Chapter 1 provides the objective and problem statement for the thesis and the boundaries in which the thesis is written.

Global competitive trends for nations and manufacturing enterprises are discussed in chapter 2.

Chapter 3 reviews SME's in the South African environment. This is necessary in order to understand both the current condition of the SME manufacturing environment, as well as the need for transformation.

Chapter 4 reviews current literature that is relevant in providing a sound foundation for the understanding of the transformation concepts. Systems theory is reviewed in the first part of



the chapter to provide a foundation for Enterprise Engineering concepts. Reengineering is reviewed, followed by Enterprise Integration. This is done in order to reflect on previous transformation attempts and limitations, as well as the evolution of transformation using an engineering approach. Finally, Enterprise Engineering is reviewed in order to understand the context and to describe current research that has been done.

Chapter 5 addresses the scope, timing and extent of transformation. Two transformation methodologies taken from an Enterprise Engineering perspective are introduced, and definitions are given to the type of transformation they convey.

Chapter 6 describes in detail important concepts present in both of the chosen transformation methodologies. The application of these concepts to the South African environment is also discussed.

Chapter 7 introduces a Pre-transformation Evaluation Method that considers management commitment, enterprise readiness and products. This provides the necessary information as to whether a SME should go ahead with transformation. If it is decided to do this, it helps to decide on what methodology to use and the scope of transformation that is required.

Chapter 8 presents the results and lessons learnt from the application of the methodologies in SME's.

Chapter 9 presents conclusions of the research and describes possible future research directions.

The scoring method of the Pre-transformation Method is presented in appendix A.

Appendix B contains the report for the application of the Transform Enterprise Methodology to H.S.I. Microwave Components CC.

Appendix C contains the report of the application of the Master Plan to the Rapid Product Development division of the Global Competitiveness Centre.

Also included in this book is a CD ROM with the complete Master Plan and Transform Enterprise Method workbooks as well as the scoring method of the Pre-transformation Method. Acrobat Reader®, Internet Explore® and Microsoft Excel® are required to view these documents.

## 2 Competitiveness and the Next Generation Manufacturing Enterprise

### 2.1 Introduction

The competitiveness of South African manufacturing small and medium enterprises (SMEs) is dependent on the competitiveness of South Africa in the international arena and the ability to adapt to next generation manufacturing trends. The context of discussion in this chapter is shown in figure 2.1. The first part of this chapter discusses the competitive position of South Africa. The competitiveness rating of a nation is the ability of a nation to provide an environment that sustains global competitiveness of enterprises operating in its borders as measured and compared to other nations. The discussion uses the World Competitiveness Report (2001) produced by the IMD as its basis.

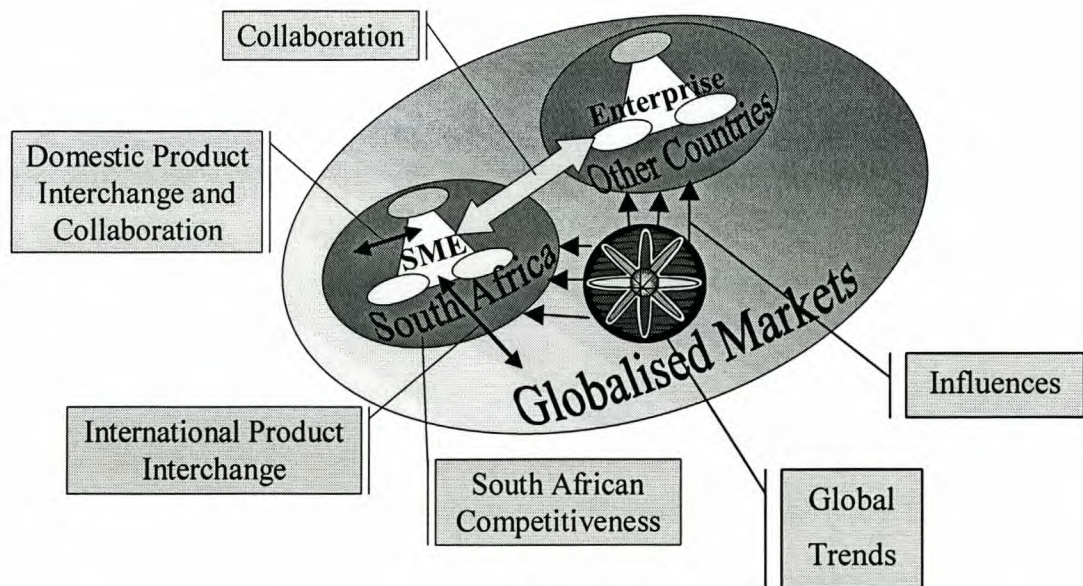


Figure 2.1 – The context of discussion in chapter 2

The second part of this chapter discusses the next generation manufacturing enterprises. It considers the interrelated changes in the global business environment that are creating entirely new success factors for industrial competition. South African enterprises, especially manufacturing SMEs, face new challenges in both the local and foreign markets due to

stronger and fiercer foreign competition. The New-Generation Manufacturing report (1997) by the Agility Forum is used as the basis for the discussion.

## 2.2 Global Trends

The competitive trends of the ninety's were characterized by economic growth whilst still trying to maintain employment growth. Although many western nations experienced economic growth, they were unable to have employment growth. Unemployment in the long-run affects a nation's competitiveness. In general the following three business revolutions played their part in the negative influence on job creation:

- The opening of markets to the so-called global village.
- The technology boom, with the convergence of computers, telecommunications and consumer electronics.
- The management focuses on process development and white-collar productivity.

Currently South African manufacturing SME's (see chapter 3 for detailed discussion) are moving towards jobless growth. Unemployment is a great problem in South Africa, and the new phenomena of jobless growth are only now being added to the problem of unemployment. However, there are new trends (discussed in the remainder of this section) that will have a greater affect on unemployment if they are not effectively dealt with at national level.

Statistical data indicates that international economic performance of the years 1999 - 2001 will be remembered as of the best ever. However, there seems to be an emerging fear of a global economic slowdown. This fear is ascribed to the economic deterioration of the US and structural problems experienced by Japan during 1999 - 2001. This is a threat because the US and Japan represent 46% of the world's GDP. The US ranks 1st in overall competitiveness but 19th in real GDP growth. It seems that the US is reaching the end of a constant 10-year economic expansion. Similarly, Japan is ranked 26th in overall competitiveness but only 48th in real GDP growth. The main impact of global economic slowdown will be negative to regions who are major suppliers to the US and Japan. Economic slowdown, or even a recession in the US and/or Japan, will negatively effect the South African economic environment.

Stock markets are also seen as important players in the competitiveness of nations. Before they were a mirror reflecting the performance and the expectations of companies. They are

however becoming actors in the economy, fuelling growth by injecting capital into an economy, or triggering a slowdown by depriving an economy of equity. In this respect, stock markets act somewhat as a global central bank, but they are much larger and less manageable. In this respect, the strong dollar has influenced most economies in the world and especially the South African economic environment (WCY, 2001). In 2000 the rand averaged R6.94/US\$1, approximately 14% weaker than its 1999 average of R6.11/US\$1. During 2001 the rand has reached up to a 89% weakening to the US\$ compared to 2000.

South African SME's cannot influence economic slowdown, volatile stock markets and the dollar. However, the knowledge of these trends can help to effectively identify the markets to serve and to estimate the influence on manufacturing costs and the potential of export markets.

## **2.3 Measuring Competitiveness**

Although there is no hard and fast rule about how competitiveness is measured, there are some generic characteristics of competitiveness. These characteristics usually consist of a combination of criteria. The following characteristics are used in the World Competitiveness Report (2001):

- Economic Performance - Macro-economic evaluation of the domestic economy.
- Government Efficiency - Extent to which government policies are conducive to competitiveness.
- Business Efficiency - Extent to which enterprises are performing in an innovative, profitable and responsible manner.
- Infrastructure - Extent to which basic, technological, scientific and human resources meet the needs of business.

In the ever changing world market, the difference between success and failure has become ever more important. A competitive nation is able to freely and fairly, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the long term (WCY, 2001).

## 2.4 Next Generation Manufacturing Trends

The global competitiveness of enterprises is dependent on a wide variety of interrelated changes that occur in the marketplace. The factors that determine the success of an enterprise today will not be the same as what is required for success tomorrow.

As manufacturing enterprises prepare for the changing global environment, there are several factors to consider in formulating their strategic responses. Three factors in the Next Manufacturing Report (Next Generation Manufacturing, 1997) that present a forward-looking snapshot in time to identify emerging trends will be discussed here. Enterprises can use this as a benchmark for strategic planning. The three factors are:

- **Global Drivers:** The forces that shape the future competitive environment and exist irrespective of the actions of any one individual, company, or nation.
- **Attributes:** Requirements of an enterprise to effectively respond to global drivers.
- **Dilemmas:** The challenge of managing change with reoccurring paradoxes.

The Global Drivers of the business environment are strongly interdependent, as are the attributes, which an enterprise requires to respond to those drivers. The dilemmas are universally applicable to all enterprises, and resolving these is mandatory to be able to compete in the future. South African manufacturing SMEs are affected by these factors because they can not function independently from the global environment.

### 2.4.1 Global Drivers

The Global Drivers are the forces that shape the future competitive environment and exist irrespective of the actions of any one individual, enterprise, or nation. These key drivers of the 21st Century are:

- **Ubiquitous availability and distribution of information** - With a global communications network becoming a reality, it is now possible to transmit and receive all types of information everywhere. Competitive advantage has shifted from the ability to distribute information, to the ability to filter and act on the information.
- **Accelerating pace of change in technology** - Technology and technological knowledge will continue to experience sustained rates of growth in no small part because of greatly enhanced information and communications technology.

- Rapidly expanding technology access - Technological and scientific education are spreading worldwide. As a result, competitive advantage no longer depends solely on superior technology.
- Globalization of markets and business competition - All of the above lead to a strong driver for true globalization; a drive not only to market globally, but to create wealth, infrastructure, and knowledge workers globally.
- Global wage and job skills shifts - The globalization driver also provides a global pool of industrial workers, causing many job skills to become “commodities” and bringing wage values down. A company’s success is no longer solely dependent on success in any one market or nation. Companies are amplifiers of the technology, human resources, and infrastructure of a geographic region, improving them where they are strong, and avoiding areas where they are weak.
- Environmental responsibility and resource limitations - The importance of strategies to minimize resource use, maximize reuse, and apply environmentally conscious materials and processes in products and manufacturing will continue to grow.
- Increasing customer expectations - Customers’ demands continue to increase as they become more knowledgeable and as competition provides them with ever-better solutions. Supply chain management and closer relations with suppliers have taught the need for joint development of product and process specifications. This trend is extending to relationships with customers, with increasing capability to deliver goods and services tailored for individual customers and small market segments.

## **2.4.2 Attributes**

The manufacturing enterprise of the future will need the following attributes in order to respond to the Global Drivers and to compete successfully:

- Customer Responsiveness – The enterprise will work with customers, and in anticipation of customers, to supply integrated products and services that fit evolving lifecycle requirements of function, cost, and timeliness.
- Physical Plant and Equipment Responsiveness – The enterprise will employ an ever-growing knowledge base of manufacturing science to implement reconfigurable,

scaleable, cost effective manufacturing processes, equipment, and plants that adapt rapidly to specific production needs.

- Human Resource Responsiveness – The entire workforce of the enterprise will comprise highly capable and motivated knowledge workers who can work in a flexible work environment, with substantial independent decision-making.
- Global Market Responsiveness – The enterprise will develop its manufacturing strategy to anticipate and respond to a continuously changing global market, with operations and infra-structure tailored to local requirements.
- Teaming as a Core Competency – The enterprise will team within and outside the company to acquire and focus needed knowledge and capabilities to develop, deliver, and support its products and services.
- Responsive Practices and Cultures – The enterprise will continuously evolve core competencies, organizational structure, culture, and business practices, enabling it to anticipate and respond rapidly to changing customer demands.

### **2.4.3 Dilemmas**

Enterprises attempting to pursue evolutionary paths to achieving next generation manufacturing attributes, will find that the evolving business environment is in apparent conflict. The paradoxes found present dilemmas that leaders in industry, government, and the academic community must join forces to resolve. Some of these dilemmas are how to:

- Have employee security without lifetime employment.
- Simultaneously satisfy all stakeholder needs.
- Practice collaborative knowledge sharing within knowledge-based competition.
- Control core competencies without owning them.
- Manage assets, when the most valuable asset is knowledge.
- Keep domestic jobs whilst developing global markets.
- Reward learning in a reward-for-doing environment.
- Maintain national economic and military security with R&D increasingly being done globally.

- Deal with transnational corporations.

Competitive advantage lies in the successful resolution of these dilemmas and will require innovative thinking to solve.

## **2.5 The South African Technology Perspective for Manufacturing Competitiveness**

Today, South Africa as a nation has been an international player for just over eight years. However, the effects of limited understanding of previous economic advisors on technological factors, years of isolation and minimal trade outside the borders are still affecting negatively on South Africa's competitive rankings.

The apartheid era halted South Africa's ability to effectively and speedily adapt to international requirements for competitiveness prior to 1994. Aspects such as large amounts of money that were spent by Government on certain technologies in order to become self-sufficient whilst neglecting others, enterprises losing their sense of the international markets and a lack of competition can be given as reasons for this.

The South African technology environment and capabilities appear to meet the requirements of a modern economy. However, the South African technology environment and capabilities can be described as a technology colony (de Wet, 1994; FRD & ISP, 1997). Figure 2.2 will be used to explain the meaning of a technology colony. The level of activity (in terms of monetary value) is plotted over the product life cycle. The foreground presents the levels of activity in South Africa as compared to the background, which represents that of a first world country. Predominant industrial business activity is at the manufacturing and "trade-in-final-products" end of the product life cycle, while activities in the industrialized country tend towards a continuum over a whole product development life cycle.



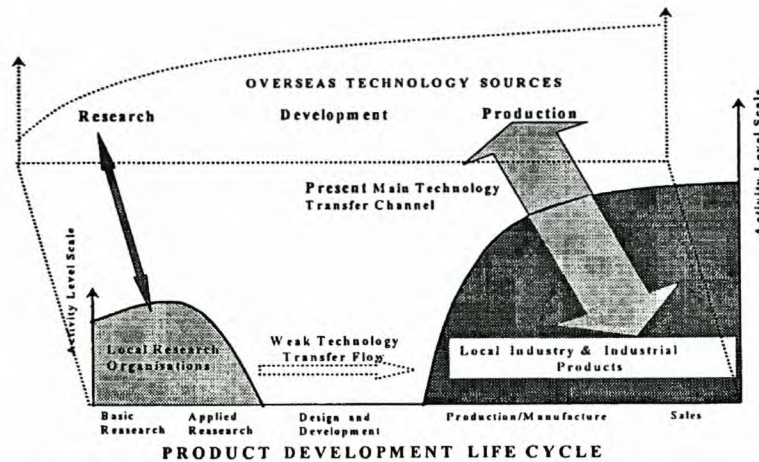


Figure 2.2 – The technology colony (de Wet, 1994)

There is a small group of activities at the research end of the product development life cycle, representing the R&D activities of tertiary education institutions, some R&D done in local industry and some government-funded R&D. South Africa appears to be significantly stronger in science than in technology. South Africa's share of the Science Citation Index is five times larger than its share of patents registered in the USA (Pouris, 1991). South Africa's share of scientific publications is higher by comparison with most newly industrialized countries (excluding Taiwan) and its share of patents lower than the same elsewhere (Joffe, 1995). From this it would seem that South Africa has a problem in exploiting its technological capabilities and effort. Although no direct comparison has yet been made, it could be that South Africa's share of innovations are lower still by comparison with newly industrialised countries.

There is a large flow of technology from first world nations into South Africa, in the form of licensed product designs, processes, subassemblies and final products, often implemented in the form of a subsidiary of a multinational corporation. Only a small number of local enterprises display the capacity to refine imported technology for the particular requirements of South Africa's unique circumstances and markets (FRD & ISP, 1997). Enterprises also have difficulty exploiting local technological capacity, capabilities and effort (FRD & ISP, 1997; Wood, 2000). More than 80% of the value in industrial business activity is done under (foreign) license, and more than 50% of this activity is subject to market constraints (de Wet, 1994). Using Abernathy and Utterback's (1988) study on how product innovation gives way to process innovation and the associated changes that occur in firms/industries provides a picture as to how innovation in South Africa is halted by licensed technology transfer and

imposed market constraints, shown in figure 2.3. Most of the time licensed production introduces mature technology and uses market constraints to satisfy local market demands, rather than increasing local capability to export to the global markets. The combination of licensed production and market constraints limits innovative ability to adapt to new markets. This causes both product and process innovation to be low, allowing only for incremental improvements. This also causes technology transfer (figure 2.2) from the local R&D community of the local industrial sector to be almost insignificant, mainly because the relevant R&D is done “back home”; although there is some communication between the local and foreign R&D communities. Well-resourced science councils and national laboratories, world-class universities and other tertiary research and educational institutions, as well as an established system of technical training, suggest substantial technological capacity, though inappropriately focused and depleted by decades of apartheid (Joffe, 1995; FRD & ISP, 1997).

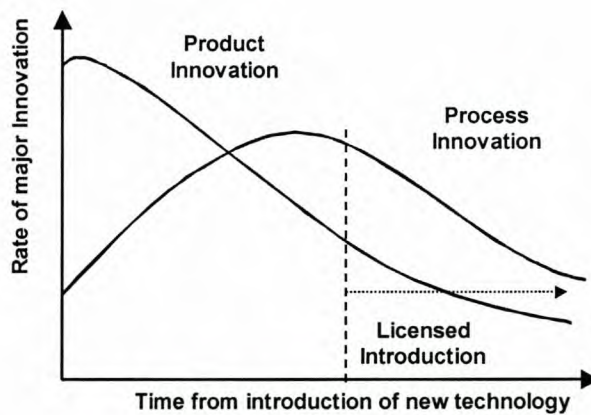


Figure 2.3 – Impact of license introduction on product and process innovation (Abernathy, 1988)

## 2.6 Conclusion

The current competitive situation in South Africa and in enterprises should not be viewed as a shame, discouragement or fate to be suffered. It should rather be seen as an opportunity that requires leadership and management.

Tertiary education should play a role in assisting leaders and managers at both national and enterprise level to lead and manage the way to creating the best possible competitive growth trajectories for their economies. Research into methods that will assist managers and leaders to reconceptualise and move beyond conditioned ways of thinking should be sought. A confidence should be instilled that they are able to become much more of a master of their own future.

The need for intervention into the Small and Medium enterprises (SMEs) is great. Lack of technical and managerial capacity remains a high priority difficulty that needs to be addressed (Ntsika Enterprises, 2000). Tertiary education should play a role to help in the better competitive positioning of SMEs by providing services to improve technical and managerial capacity. This is all the more important because the resource limitations of SMEs put consultants and focused research projects unfeasible for many SMEs.

## **3 Manufacturing SMEs in the Context of the South African Environment**

### **3.1 Introduction**

This chapter considers manufacturing SMEs in the context of the South African environment. The new environment's (globalisation affecting local and foreign markets) requirements for competitiveness and the local response of manufacturing SMEs are reviewed.

This chapter addresses two types of literature that concern SMEs. General themes in literature concerning manufacturing SMEs and specific information concerning manufacturing SMEs within the South African environment are addressed and discussed in parallel. The author chose this parallel approach due to the limited availability of information regarding the manufacturing small and medium enterprise (SME) sector in South Africa. With this parallel approach the author aims to highlight certain perspectives.

### **3.2 SME Classification**

The classification of enterprises into small, medium or even micro and large enterprises is not a simple exercise. In South Africa there is no single, clear, precise and widely accepted classification of what an SME is. Different classifications exist, for various purposes. These would include support policy application, taxation and legislation. Most definitions use the size of the business as its distinguishing feature, presumably because this is easier to measure. Definitions of the size of a SME vary widely. Some use turnover, which can change over time with inflation. Most look at employment, because it provides the rationale for SME business support in South Africa, due to job creation that is desired. Small, micro and medium enterprises (SMME) is the term used by the Department of Trade and Industry (DTI).

The author however excludes micro enterprises from this thesis. This is because micro enterprises mostly represent the informal sector and/or do not require formal business management approaches because of their small-scale operations.

This thesis only considers small and medium enterprises (SME's) which satisfy the following criteria:

- South African enterprises that are engaged in the manufacturing of tangible value-added goods.
- Enterprises with more than 5, but less than 200 employees.
- Annual turnover of more than R1 000 000 and less than R40 million.
- Total gross asset value of more than R150 000 and less than R15 million.

The definitions used until now are quantitative, but manufacturing SMEs in the South African environment tend to share a number of other qualities. They are generally enterprises that serve the local market with a small percentage of these focussing on the export market. These enterprises are usually owned by one person, or by a small group of people, and are managed by their owner(s) who deal with all management issues, usually with little other help. They are independent enterprises and not parts of, or owned by, larger companies.

### **3.3 Enterprise**

Lord Young, when he was the UK Secretary of State for Employment, said that: “We must have an enterprise culture, not a dependency culture”. When he was asked what he meant by “enterprise” he described it as: “Get up and go - not sitting back and accepting it. Think positive and things can happen; if you are passive and think negative then nothing happens. It’s a mental attitude”. The author defines an enterprise as an entity that is successful in its area of business. The author also sees the enterprise as one seeking to grow and develop itself by using innovative holistic methods, which facilitate the process of determining appropriate action and behaviour.

### **3.4 Importance of SMEs**

The recent integration of South Africa into the world economy is both challenging and absolutely necessary. The increasingly globalised economy necessitates South African industry to build competitive advantage and prosperity at local level. The value of the small and medium enterprise (SME) sector is recognized in economies worldwide, irrespective of the developmental stage of these economies. The evidence of small and medium sized enterprise (SME) sectors, particular in Western Europe, Japan and America, contributing to employment growth, economic development and efficiency in serving increasingly segmented consumer markets raises the question of the particular importance of SME’s in the South African environment. Although information regarding the SME sector in South Africa is not

readily available, there are indications that SME's are beginning to play an increasingly important role in the South African economy (Vosloo, 1994; Levy, 1996). The following is a list of important statistics of South African SMEs (excluding micro enterprises) for the year 2000 (NTSIKA, 2000):

- SMEs contribute 28.9% to GDP.
- SMEs contribute 37.1% to employment.
- 30% of establishments are SMEs.
- SMEs contribute 32.6% of salary contribution.

Comparatively, manufacturing is playing an ever-increasing role in South Africa. The following is a list of the contribution of manufacturing to the South African economy (NTSIKA, 2000):

- Manufacturing is the single largest sector, contributing 19.8% to the GDP.
- Manufactured goods are the fastest growing category. It has grown from a 5% contribution in 1988 to a 25% contribution in total export value during 2000.
- Manufacturing is moving from capital-intensive commodity products towards value-added manufactured products with a higher labour content.

The role manufacturing SMEs play in job creation, employment and revenue generation is increasingly been recognised in South Africa (Franz, 2000; Rogerson, 2000; Davies, 1998). The prevailing trends of large enterprises downsizing, outsourcing, privatising, automating and slashing jobs make SMEs all the more important to absorb jobs and improve the economy (Franz, 2000; Rogerson, 2000).

The world over, SMEs play a disproportionately large role in light manufacturing, especially of differentiated products, and a similar pattern prevails in South Africa. South Africa, however, faces the problem in that, relative to international norms, small and medium enterprises are underrepresented in South Africa manufacturing (Levy, 1996; Clancy, 2001). According to a study done by Rogerson (2000) concerning manufacturing change in Gauteng (1989-1999), it seemed that the significance of manufacturing SMEs (<200 employees) is rising. Between 1989 and 1999 the employment contribution of manufacturing SMEs has risen from <22% to 42% (Rogerson, 2000). New signs of vitality, buoyancy and optimism are

present in manufacturing SMEs as apposed to signs of less optimistic moods among established manufacturers (Kesper, 1999; Rogerson, 2000).

The South African government, in particular, has admitted that job creation is the biggest challenge it is facing (Franz, 2000). Indeed, only a small segment of the entire South African SME economy has or will develop the capacity to create employment and/or economic growth at socially desirable levels. These types of SMEs are generally run by highly-educated and experienced entrepreneurs with skilled labour (Levy, 1996; Levin, 1997; Kesper, 1999; Rogerson, 2000). Given the country's history of dualism and discrimination, strong SMEs and highly-skilled labour are unlikely to emerge in substantial numbers, or in the near future, from formerly disadvantaged segments of the population (Levy, 1996; Rogerson, 1999). The phenomenon of 'jobless' growth leads one to conclude that assistance to SMEs (even if effectively implemented and complemented by modifications of related policies) may result in SMEs contributing more to economic growth, but does not automatically translate into employment creation (Kesper, 2000; Rogerson, 2000). Although the South African manufacturing SME sector is an essential element in a successful formula to achieve job creation and economic growth, it should not be seen as the cure to the ills of the South African industrial performance (Vosloo, 1994; Levy, 1996). Statistics indicate that the number of workers employed did not increase to the same extent as the SME share of employment and the rise in unemployment. This implies job substitution of larger enterprises to SMEs. Although SMEs have not created new job opportunities, they have absorbed workers who have been employed at large enterprises and lost their jobs for some or other reason. In this context, SMEs play an extremely important role in job retainment (NTSIKA, 2000). Despite the relative lack in new jobs creation, SMEs are important because they create a much more diverse economy, less vulnerable to shocks and to decisions made outside the local area.

### **3.5 SME Competitiveness Factors**

The competitiveness of SMEs is determined by a whole range of factors, which apply in significantly different combinations in different sectors and enterprises. However, notwithstanding this diversity, the author focuses on a few key factors that determine SME competitiveness in manufacturing, namely;

- The role played by the owner(s) in the competitive positioning of a SME.
- Innovation patterns in South African Manufacturing SMEs.

- The quality of organization and training to ensure profitability and productivity.
- Tangible investments in equipment to improve company productivity and at the same time reduce average production costs.
- Flexibility in SMEs as a competitive advantage in order to offset the economies of scale, as well as the technical and financial resources advantage that larger enterprises have.
- Quality management that conforms to customer requirements.
- Macro-economic implications on SMEs.

### **3.5.1 The Owner**

In the text to follow, the owner will refer to the person(s) in which the decision power is centralized. The owner is also defined as a person(s) whose personality, skills, responsibilities, attitudes and behavior have a decisive influence on company strategy.

#### **3.5.1.1 Owner Types**

The personalised aspects of an SME's strategic behavior can be defined by two extreme types (OECD, 1992).

- The owner who prefers to perpetuate his enterprise and maintain its independence, even to the detriment of its growth; a behavior described as tending to be "reactive". The owner is thus averse to long-term debt, focuses on internal problems and adjusts to changes in the economic environment. He takes a "wait and see" attitude to new technologies, is very careful about soundness of any financing operations, the market outlets suitable for increasing his production, and the availability of internal resources for such an investment.
- The owner, who aims mainly for growth, takes risks and starts up activities in a phase of rapid growth, which is described as "proactive" behavior. This owner seeks new markets or new niches, agrees to work with sub-contractors and joins dynamic networks. Among the first to try out new technologies, he is a leader in this field; he will develop a technology suitable for his needs, often in conjunction with a private or public research center.

For owner characteristics, another useful typology to consider is the distinction between craftsmen and opportunist entrepreneurs (Barkham, 1996). The craftsman entrepreneur is characterized by low levels of formal education, high technical ability, lack of managerial orientation, limited business goals and a disinclination to plan ahead. The opportunist



entrepreneur has a high-level education, a long held ambition to start an enterprise and make it grow, diverse business experience and a high level of managerial capability.

Craftsmen entrepreneurs tend to start enterprises characterized by relatively low growth, small-batch subcontracting type production and paternalistic management, and seek a competitive advantage based on price, quality and company reputation. The opportunist entrepreneur will form a company based on a new product or process - professional management techniques are employed, growth is the explicit objective and competition is based on innovation and marketing effort.

### **3.5.1.2 Owner Paradigms to Management**

The paradigm (assumptions, rules and ideas) of the owner leads to dilemmas that are a disadvantage to long-term or rapid SME growth. Initially the owner paradigm encompasses several successful attributes, but as the organization grows, this paradigm is no longer valid. Up until this stage, the sheer commitment of the owner has enabled the SME to operate successfully. When an SME grows beyond the point that the owner's commitment alone is adequate to manage the enterprise, it often suffers from micromanagement. The owner(s) is required to go from a micromanagement style appropriate for a small staff with simple processes, to a management style appropriate for an organization of greater autonomy and sophisticated processes. Micromanagement is often characterized by slow process cycle times, decision underpowered workforce and the owner working vast amounts of overtime while also suffering financial and emotional stress.

### **3.5.1.3 The Family Owned Enterprise**

Many SMEs are family owned enterprises. The presence of family leadership can lead to ineffective decision-making processes because it is clouded with complicated emotional family issues. Paradigms for the management of the SME are many times built on family history and family based decision making rather than sound business leadership. The unclear chain of command and biased promotions based on family relationship rather than on qualifications often occur in family leadership and can cause resentment, lack of respect and motivational loss among employees.

## **3.5.2 Innovation**

To remain innovative a SME needs to be attentive to the needs of its customers. Combining customer needs with commercial and competition surveillance allows the enterprise to keep

abreast of any new technologies of interest to the SME. This allows the SME to maintain or increase its own competitiveness through innovation in products and manufacturing processes and in management and distribution. It also allows the SME to monitor the trends in markets and amongst the competition. In this text, innovation is defined as the introduction of a new or changed product and/or new or changed production process. To achieve this entails the combination of scientific, technological, organizational, financial and commercial activities.

SMEs, using niche market strategies, are willing to try new ideas for breaking into the market place. This entrepreneurial spirit of SMEs fuels new ideas and products.

### 3.5.2.1 Sources for Innovation

In terms of links with local research institutions, Joffe (1995) found that a tiny proportion of manufacturing companies have research links with local science councils or universities. SMEs do not regard science councils, universities and technikons as very significant or crucial sources of information for innovation activities and see their presence at trade fairs and exhibitions, professional and trade journals and professional conferences and seminars as a more important source of information (FRD & ISP, 1997; Viviers, 1998). The supply chain is seen as a significant limiting factor to innovative performance of SMEs. This is ascribed to limited interaction that exists with suppliers (FRD & ISP, 1997). Consultants are also used as a source for information to help in the process of innovation. As shown in figure 3.1, it is clear that there exists a strong support from consultants to SMEs in South Africa; a trend similar to other more developed countries.

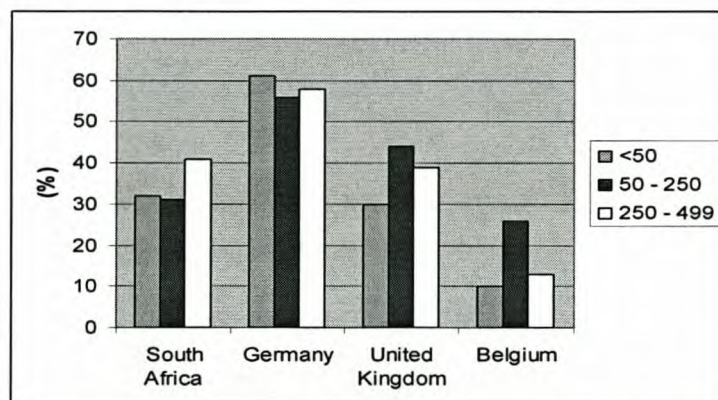


Figure 3.1 – Percentage of SMEs indicating the use of consultants as sources of information (FRD & ISP, 1997)

Figure 3.2 presents a breakdown by percentage of the expenditures that SMEs incur for information or specialist services obtained from the outside. South African SMEs are open to receiving specialized services to facilitate and help with innovation and improvement of their enterprises. The acquisition of patents and licenses does not appear to be an important component of innovation expenditure, except in small enterprises (<50 employees). After R&D, product design and trial production were the most important components of innovation expenditure. R&D and product design are better executed in a formalized environment, and decisions to be made for trial production, training of employees and acquisition of tooling need to be planned for.

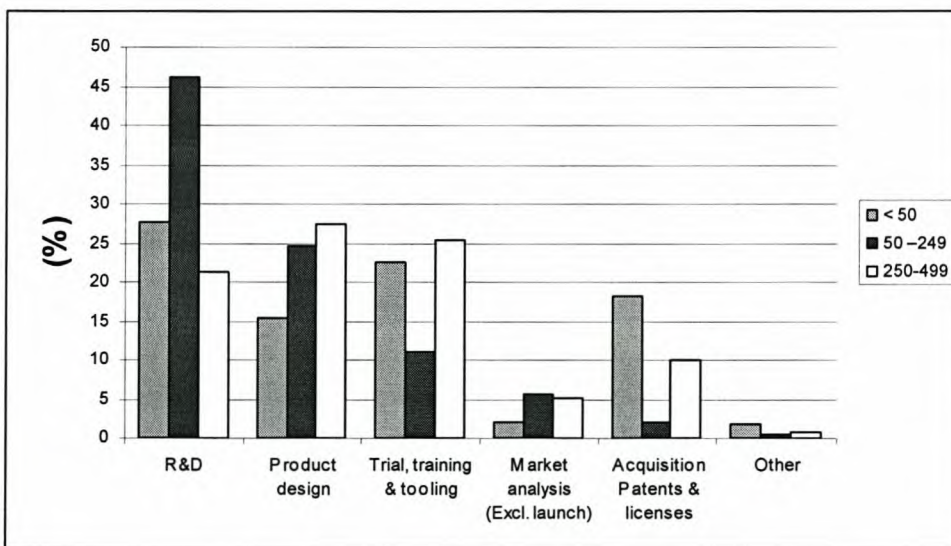


Figure 3.2 - Current expenditure on innovation (%) (FRD & ISP, 1997)

Technological effort is often isolated as a separate R&D function within the enterprise, rather than being integrated within all activities of the enterprise (Joffe, 1995). Figure 3.3 suggests that SMEs regard production, and especially workers, as a far less important source of information than R&D, marketing and management (FRD & ISP, 1997). South African manufacturing enterprises are said to be weak in shopfloor-based incremental innovation because enterprises engaged in R&D generally rank workers as the least important source of information for innovation (Joffe, 1995; FRD & ISP, 1997).

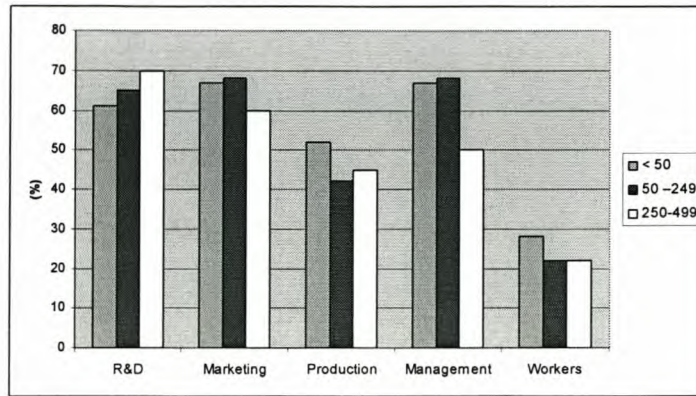


Figure 3.3 - Percentage of respondents indicating that internal sources of information are very significant or crucial for innovation (FRD & ISP, 1997)

As South African manufacturing SMEs compete increasingly against global players in both the domestic and international markets, they can no longer rely on a largely underskilled workforce which is not consulted or expected to take any initiative in enhancing performance. Establishing a competent culture that encompasses the knowledge, attitude, skills, a constant desire to learn and development of critical thinking skills is essential for South African SMEs. A new management approach is required to assist in the process of establishing a competent culture.

The R&D function is often present in one or a few individuals. The individual(s) many times are the founders and driving force in terms of management and innovation within the small enterprise. The small enterprise can have all its “eggs in one basket” when considering innovative growth of products and manufacturing processes.

The ownership taken of established technology and previous innovation within a SME might often blind the SME to better practices. It is a difficult and costly process for small enterprises to transfer knowledge and train people within the enterprise so as to share and acquire competencies, yet it is extremely important.

Table 3.1 represents the innovating scientists and engineers as a percentage of total personnel. According to the authors of the data in table 3.1, a slight error has occurred in the data and the 8.1% is less than indicated and the 2.2 % more.

Size of SME	Innovation scientists and engineers as a % of total personnel.
< 50	8.1
50 –249	2.6
250-499	2.2

Table 3.1 - Scientists and engineers involved in innovation activities (FRD & ISP, 1997)

There seems to be a clear distinction between SME size and the tendency to perform R&D, despite the important effect that industry orientation has on the R&D activity. Figure 3.4 gives an indication that small enterprises are more engaged in experimental development than in continuous R&D. Compared to European countries, relatively few South African manufacturing SMEs perform R&D on a continuous basis (FRD & ISP, 1997). Continuous improvement is made possible by formal processes within an enterprise. Change from informal processes (a characteristic of SMEs, section 5.4) to formal processes is essential for competitiveness, especially as specialization increases and growth occurs. An SME that wants to effectively operate and affect its environment should, through a structured and planned approach, address its migration from an informal to a more formal operation. A formal operation requires the establishing of replicable standards, approaches and methods which minimizes the need for duplication and enhances the capacity to deliver uniform or required quality as a matter of course. The migration from an informal to a more formal operation will enable better and more efficient utilization of resources to ensure continuous improvement in productivity and services. It also identifies the critical competencies that need to be fulfilled in order to ensure that optimum levels of predictable outputs are achieved. This migration will lead to stability, but the SME must be careful not to move towards bureaucracy and red tape in how things should be done, but should remain flexible and innovative in its approach.

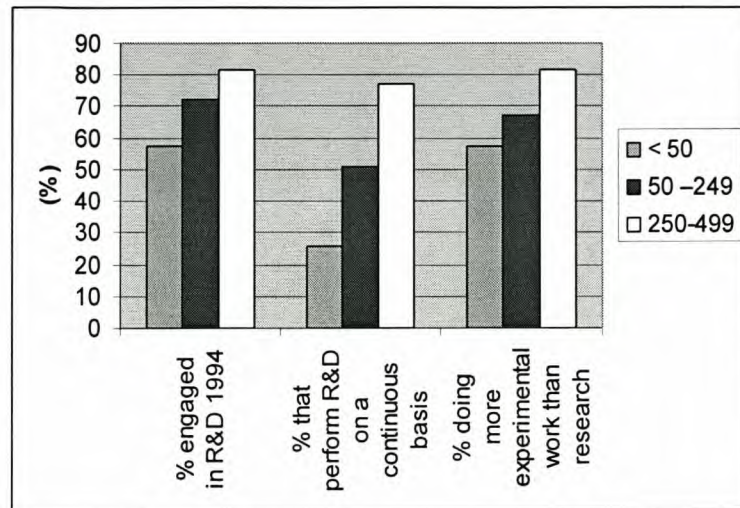


Figure 3.4 - Percentage of SMEs indicating that they are engaged in R&D activities 1994 (FRD & ISP, 1997)

Product rather than process innovation is predominant among SMEs in South Africa (FRD & ISP, 1997). This finding may indicate that many SMEs are overlooking the importance of process innovation in enhancing product quality and productivity, and instead are concentrating on increasing the sales of existing products and/or modifying the products to expand into new markets. It is, however, important for SMEs to be aware of processes developed elsewhere in the world and then also acquire and implement them. A process to help with the effective identification, selection and assimilation of new process technologies are required for SMEs. This is because implementing new processes can be very costly and time-consuming and disrupt production. If however, they result in achieving the objectives of improved quality and increased productivity, they can be considered as major factors in enhancing competitiveness.

Collaboration in R&D activities involves both the generation of new knowledge within the enterprise and the exchange of information and technology between the enterprise and its collaborators. R&D collaboration is therefore closely linked to technology transfer. International data shows that the tendency towards R&D collaboration is increasing rapidly and is of growing importance to the innovation activities of enterprises. R&D collaboration activities often occur within SMEs. Table 3.2 indicates both the percentage of SME's and large enterprises involved in collaboration activities with the levels of satisfactory activities indicated as a percentage in brackets. It is evident from table 3.2 that larger enterprises are more engaged and have greater success with R&D collaboration than smaller enterprises. A

Community Innovation Survey of European countries indicated that enterprises undertaking collaborative R&D are more innovative in terms of the percentage of innovative products in their output mix (FRD & ISP, 1997). It is imperative for SMEs to organize themselves and to establish better formal collaborative structures. This is because of the greater competitive advantage of more effective operation and better products and services that can be obtained through collaboration.

Co-operation arrangement in R&D with:	< 50	50 –249	250-499	>499
Educational establishments	17.8 (40)	21.2 (72)	12.6 (50)	57.8 (60)
Government laboratories	12.7 (22)	12.1 (55)	9.1 (51)	25.0 (47)
Science councils	12.7 (48)	18.0 (69)	18.2 (60)	51.6 (63)
Other enterprises	27.4 (74)	27.9 (71)	50.0 (92)	64.1 (79)

Table 3.2 - Percentage of respondents that had co-operation agreements, the satisfactory level is indicated in brackets (FRD & ISP, 1997)

The innovation within a SME has an impact on the products an enterprise produces. When considering export and import markets and product innovation, export markets seem to be favoured for innovation. In a study done by Viviers, it seems that there is in general a favoring of SME's towards the export market. The requirements of export markets are greater than local markets (Quality, section 3.5.6 and Environmental Sustainability, section 3.8.2). SMEs who want to engage in export will require better financial and operational planning to conform to these requirements. Changes of this nature can be very costly and even detrimental if not effectively managed and planned for.

Tables 3.3 provide a percentage distribution of domestic and export sales products, by degree of innovation based on monetary value as a percentage of export sales. The percentage distribution of new products in 1992 –1994, based on the monetary value as a percentage of sales of significantly changed or newly introduced products is shown in table 3.4. Table 3.4

indicates that more new products for the market (as percentage of monetary value) are produced by the smaller enterprises.

Size of SME	Products essentially unchanged (1992 - 1994)	Products subject to minor or incremental changes (1992 - 1994)	Products significantly changed or newly introduced (1992 - 1994)
< 50	79.1 (89.5)	15.1 (8.0)	5.8 (2.5)
50 -249	65.0 (22.7)	16.5 (68.9)	18.5 (8.2)
250-499	77.4 (75.7)	10.4 (17.2)	12.2 (7.1)

Table 3.3 - Percentage distribution of 1994 domestic (exports in brackets) sales and products, by degree of innovation and size of enterprise (FRD & ISP, 1997)

Size of SME	New products for the SME but not for market	New products for the market
< 50	18.6	81.4
50 -249	54.1	45.9
250-499	61.4	28.6

Table 3.4 - Percentage distribution of new products in 1992 -1994 (FRD & ISP, 1997)

There are many constraints in the translation of new ideas and research into innovative products and processes. This, in turn, requires a clear understanding and appreciation of what determines innovation activities in response to new circumstances. This goes hand in hand with a SME's own experiences and ability to learn. Innovation is a process that requires careful management, along with an awareness of, and interest in, long-term market potential, rather than a concentration on short-term sales targets. Thus, SMEs need to have a good approach to plan for change, which will allow the SME to effectively operate and affect its environment.



### 3.5.3 The Quality of Organization and Training

Developments in information and production technologies have marked repercussions on the nature of labour, its involvement in the changes affecting the SME and on its ability to “fertilize” the acquired technologies. It also affects the SME’s ability to adapt to the new organization systems which combines new with old equipment (OECD, 1992). Scarcity of competent workers and skilled technicians are obstacles to expansion of SME’s within South Africa (Levy, 1996; Viviers, 1998; Rogerson, 2000).

In the use of modern technologies, human resource strategies should be applied to ensure the development and involvement of the workforce in the technology changes. Reorganisation of the tasks and workstation activities that assists with work design and change of job description is also required. In doing so, the profitability and productivity of the enterprise is better ensured.

Barnes’s (1997) study found that non-value adding labour is prevalent in the automotive component SME industry in KwaZulu-Natal. The cause of this can be ascribed to poor physical layout of the plants, human resource development that fail in multi-skilled training of employees and operational management that is not effective in multi-tasking of employees. Most of these SMEs had made changes to their production processes and used on-the-job training for its workers. On-the-job training is most of the time, insufficient. The latest manufacturing techniques such as multi-skilling, multi-tasking, total quality control, team working, cell structures and the utilization of Statistical Process Control (SPC) all require structured retraining of the labour force. It would appear though that only a few of these SMEs are moving towards a structured retraining program when adopting the latest manufacturing techniques. Barnes (1997) also found in his study that the functions of human resource development such as sharing of information, motivation of the labour force and cultivating a common objective among workers fail due to middle management breaking the dynamism between senior management and the factory floor.

A lack of formal systems, as described by Underdown (1997), is a common problem among small manufacturing enterprises. A small business can operate successfully under a set of informal, undocumented, and intuitive processes for a large portion of their early operations. In this stage, the staff is small, and product offerings are narrow and limited. As the enterprise begins to grow, the staff increases, the number of product offerings widens, and the customer base grows. This growth increases process complexity. To compensate for the increased

complexity, the informal processes that were once successful must be improved and formalised. Many small companies do not recognize this need and continue to use informal processes and systems. This leads to inconsistent application of the informal processes and ultimately inconsistent and poor products and services to the customers. Processes and systems that were once executed flawlessly and consistently by a small staff are now rarely performed with the same precision or quality by a much larger staff. As the enterprise grows, process knowledge is not being passed on to the new staff. In addition, growth places new customer demands on the systems. The small business operating in this mode is in a general state of chaos.

### 3.5.4 Tangible Investment

Investment in equipment based on the new management and production technologies is intended to improve enterprise productivity, and at the same time reduce average production costs. It is, however, not certain that an SME's competitive advantage is based on the mastery of a technology; this advantage may be based on other kinds of know-how. Many SMEs have fallen victim to technologies they have not properly mastered, while others have succumbed as a result of obsolete technologies (OECD, 1996). Modernization of SMEs, which is mainly connected with new equipment based on advanced technologies, alone is not a sufficient requirement for the improvement of their competitiveness. However, it cannot be denied that acquiring of technological information to the SME's and the use of new technologies is vital for their competitiveness. Table 3.5 represents the capital expenditure in tangible assets as a percentage of total innovation expenditure in SMEs. The expenditure percentage is greater for smaller SMEs.

Size of SME	% Capital expenditure of total innovation expenditure
< 50	70.2
50 –249	48.4
250-499	57.7

Table 3.5 - Capital expenditure in tangible assets as a percentage of total innovation (FRD & ISP, 1997)

Many automotive component SMEs in KwaZulu-Natal do not use their fixed capital optimally, thus contributing to high production costs. Investment in overly complex

production systems, poor plant layout and inappropriate machinery are some of the problems found among SMEs (Barnes, 1997).

A study done by Rogerson (2000) revealed the following financial issues for Gauteng manufactures (large % of study sample included SMEs):

- High interest rates are a hindrance to modernization.
- High amount of bad debt and cash flow problems.
- Securing finance for working capital.

These problems usually result in the use of substandard equipment. Older equipment is repaired and maintained until a new purchase is inevitable. This can cause SMEs to be placed at a disadvantage in the marketplace, as new technology provides better quality products at lower prices and faster delivery times. Even if cash is available to purchase new technologies, many SMEs avoid this because of an aversion to the risk involved. Risk includes the failure of the technology as well as the training and technical support required.

### **3.5.5 Flexibility**

SMEs need to continuously deal with change in order to remain competitive. Flexibility enables SMEs to offset the major enterprises' advantages which are based on their economics of scale and their technical and financial resources (OECD, 1992). However, today's rate of change is proceeding more rapidly than ever before.

Flexibility is characterized by the ability to respond to frequent and unpredictable change. The ability to respond rapidly to changing market opportunities by utilizing flexible business processes is a key attribute in a flexible SME. In order to establish competitive leadership, manufacturing SMEs are presented with the task of creating flexible business processes, either through enhancing or changing business processes or sheer commitment from the workforce. The advantages of flexible SMEs are centralized management, less specialized factors for production, (intuitive) strategic thinking and flexibility and resilience of the workforce.

Barnes's (1997) study on KwaZulu-Natal's automotive components industry found that excessive inventory holding within SMEs stems from the inflexible operations prevalent within the industry. Certain SMEs operated on outdated scheduling systems, with little thought being given to ways in which to increase the flexibility of the production processes being used. He also found that the combination of the complex production systems utilized

and the outdated procurement systems lead to long lead and throughput times. This adversely affects the ability of the SME to meet customer requirements. The Department of Industrial Engineering at the University of Stellenbosch in collaboration with Q-Muzik has developed an approach for the implementation of the Q-Muzik ERP software package that is cost effective and can be rapidly implemented in SMEs. The Q-Muzik ERP software supports a project-based environment and is locally supported. Applications of this nature place solutions within the grasp of South African SMEs to enable them to be more competitive.

However, the possibility for an SME to adapt to new kinds of production, or anticipating them, depends on their ability to incorporate technological changes and innovation into their competitive strategies. Although flexibility is often thought of as a strategic issue, the SME must be able to realize the benefits of flexibility through actionable plans on a more local level. The use of new management and production technologies in addition to providing an appropriate solution for their use in SMEs can achieve the desired result.

### **3.5.6 Quality Management**

Quality management is receiving increased attention because it plays a major role in improving productivity and competitiveness (van Vuuren, 2001). Competitive positioning within the global markets can be bettered by providing products that have a competitive price-to-value ratio. This global economy requires that South African SMEs must take a big leap forward on the industrial front by producing better quality products, while remaining price competitive.

Quality can be defined as the conformance to customer's requirements. South African SMEs are not known for achieving high levels of quality. Reasons for this could be disparity in purchasing power, differences in scale of production, multiplicity of technologies and inadequacies of identifying customer needs.

An investigation done by Schoeman (1996) gives the following recommendations for quality management within SMEs.

- Commitment of all staff members within the enterprise, and particularly management, should be sought.
- Buy-in to the quality strategy should be achieved through communication, training and motivation of all employees.
- The enterprise should capitalize on the structure created by quality management programs.

- The implementation costs should be traded-off against the significant benefits derived, particularly customer satisfaction.

Barnes's (1997) study highlights that SMEs do not focus on built-in quality and "quality at the source", but rather remain with the traditional final inspection and rework of defect in parts. Many SMEs have little or no idea of the benefits of implementing quality practices and how to employ them (Holness, 2000; Roopnarian, 2000). Establishments like the South African Quality Institute (SAQI) seek to promote the message of quality management to SMEs in South Africa (Holness, 2000). Initiatives from government and private organizations provide assistance and encouragement to businesses to outsource their non-core activities. These initiatives are aimed to raise business awareness and empower entrepreneurs in the SME sector of the economy to be able to continuously produce high-quality products and services and, through this, to become successful sustainable businesses (Roopnarian, 2000).

### **3.6 Macro-economic Implications on South African SMEs**

South African SMEs are vulnerable and dependent on the South African economic environment. Changes in the South African economic environment tend to have a greater effect on SMEs than on larger businesses. This is because SMEs are more vulnerable to changes in their customer base and the influence that government and regulatory agencies exercise. SMEs tend to operate in dynamic niche markets that regularly undergo radical changes. A large percentage of SMEs' products are often designated to a few vital customers. If these customers are affected by external environment changes, the SME is vulnerable to changes they cannot control.

Government and other regulatory agencies have a tremendous effect on the economic environment and have an important intervention role to play in promoting SMEs. In the following section the definition of SMMEs as defined in the White Paper on National Strategy for the Development and Promotion of Small Business in South Africa (1995) will be used.

#### **3.6.1 Intervention from Government**

In his opening address at the President's conference on Small Business, President Mandela sited three reasons for SMME's importance in the South African framework:

- The development of SMMEs is important for the social and economic development of the country, since they increase competitiveness and mobilise idle funds to productive aims.

- SMME development contributes to a more equal distribution of economic powers.
- The stimulation of SMMEs can reduce the level of unemployment.

The White Paper on SMEs, officially known as the National Strategy for the Development and Promotion of Small Business in South Africa, provides the government's policy framework in respect to SMEs in South Africa. The ultimate goal is to make small, medium and micro-enterprises (SMMEs) equal partners in the economy and maximise their contribution to the RDP. The White Paper and subsequent Small Business Enabling Act are instruments from government to facilitate the transformation of the small business sector in South Africa. The Department of Trade and Industry (DTI) is responsible for formulating and implementing national industrial policy in South Africa. The national industrial policy is aimed at the promotion of industrial expansion, employment creation, exports, small business development and black empowerment. It should however be noted that the South African SMME sector is far from homogenous and would require a fine-tuned set of interventions rather than the generic assistance currently provided. A prime example is the fact that none of the policy initiatives are specifically directed toward defence related industries.

In June 1997 the DTI launched a new initiative aimed at improving South Africa's global competitiveness through strategic cluster aligning. They also unveiled a vision which is characterised by a shift from a low wage, low consumption economy dependent on exports of primary products to a higher wage, higher consumption economy that exports value added product and services. Currently South Africa is far behind in successfully implementing a cluster process. The main obstacles to this implementation are secrecy, suspicion and market warfare (Davics, 1999).

Trade and Industry Minister Alec Erwin has confessed to some major deficiencies in government's support for small-business development (Creamer, 2000). He stated that the Department of Trade and Industry (DTI) realises its shortcomings in this area and has, therefore, undertaken a detailed review of its small, medium and micro enterprises (SMME) programmes (Creamer, 2000).

During a recent parliamentary briefing Alec Erwin reiterated government's view that the economy is "poised for growth". Alec Erwin also suggested that with increased levels of investment and saving, gross domestic product growth may rise to 5%. He contended that South Africa is in a privileged position as compared to other developing countries. Firstly because the reduction of high tariff protection has pushed the economy on to a competitive

path and, secondly, because South Africa's "just and democratic dispensation" has inspired increased investor confidence (Martin, 2000). Government has also started to change the legal and policy framework, which stresses the importance of SMMEs as a fundamental part of the growth in the economy and in the creation of employment and wealth distribution. It is, however, important to understand that policy interventions have definite limits to the extent to which they can rapidly accelerate SME participation.

Levy (1996) in his study on the business environment for industrial small and medium enterprises holds the view that the South African business environment is systematically biased against SMEs due to its high levels of industrial and conglomerate concentration. He proposes three areas in which policy and intervention programs should play an important role to enlarge SMEs historically limited role in South Africa.

- Enhance SME access to finance.
- Ease the regulatory inhibitions of SME performance.
- Relax or remove anti-competitive behaviour on the part of large enterprises.

## **3.7 SME Obstacles**

SMEs are about being autonomous yet having limited resources of manpower, time, skills, expertise and finance, and therefore having to be dependent on external support.

### **3.7.1 Finances**

Cash is a scarce commodity to SMEs, and it is valued at a premium. Gaps exist in the South African financial markets for providing finance to SMEs. Typically, small businesses make use of loans and credit to gain working capital and to purchase new equipment. Stifling access to finance from banks are the high interest rates, and the fact that banks demand collateral for any finance that they release (Creamer, 2000; Martin 1999). The venture capital arena is not as dynamic and well established in South Africa as in first world economies. The DTI has acted in order to close this gap by providing fund schemes through several organisations that focus on different enterprise size segments.

The "cash crisis" results in a cash flow focus. Paying creditors as late as possible and receiving money from debtors as soon as possible are mechanisms used to gain necessary funds. This cycle creates a short-term financial planning focus that undermines any long-term planning or visionary goals. The lack of finances also effects adversely on human resources.

### **3.7.2 Human Resources**

Labour problems related to poor work quality, lack of skills, wrong attitudes and low productivity are reasons why SMEs do not want to expand in size in the Gauteng Province (Rogerson, 2000).

The cash-strapped financial situation aggravates these labour problems within SMEs. Qualified people with years of experience can often not be afforded. As a result, unskilled people are hired and trained on the job.

Varying product demand and project-based work environments also contribute to the human resource problems within SMEs. SMEs often operate below the required resource levels. Inexpensive temporary workers are typically used to fill in the gaps. This leads to strain on employees and as a result causes problems such as poor quality, late delivery and poor customer relations.

### **3.7.3 Lack of Awareness**

SMEs generally operate in narrow niche markets that they exploit. Thus the SME develops strong expertise in a very specific area. Resources of an enterprise are deployed to develop specialized products and services that are focused on the niche to facilitate a profitable and growing business. The drive and focus that the SME has towards its niche market may inhibit the awareness of the SME to its environment. This environment includes the market in which it competes, government regulations, government incentive schemes, competitor's activities, available municipal services and customer preferences.

## **3.8 The Future**

Two areas that can affect SMEs negatively are the HIV/AIDS pandemic and Environmental Sustainability. It is important that SMEs are aware of these future aspects and manage it well.

### **3.8.1 HIV/AIDS Pandemic**

It is particularly important for South African (manufacturing) SMEs to appropriately respond to the HIV/AIDS pandemic. An appropriate response is essential due to the important role that SMEs play in the South African economy. The HIV/AIDS pandemic has affected the workforce of South Africa at large. Because the workforce is affected, all aspects of the



enterprise are at risk. A radical mind shift and rethinking should occur within SMEs as to how they will operate in the future.

Therefore, given the impact that HIV/AIDS can have on business costs and productivity, it is essential that SMEs respond and are assisted in generating the capacity to respond to this impact. For SMEs these issues become of even greater importance where workforce numbers are low, in which situation the loss of one worker can be catastrophic. Adopting appropriate HIV/AIDS workplace policies and understanding the legal issues surrounding them should be one of the primary responses of SMEs given the limited working capital that prevents them from responding more broadly to the problem. The reputation gained through such a project is invaluable to the SME. In addition, SMEs are often in a good position to be creative and innovative through small-scale, less costly and less cautious additional projects. This type of projects allows for higher adaptability and is potentially easier to replicate (UNAIDS, 2000).

### **3.8.2 Environmental Sustainability**

“Environment” in this context refers to the biosphere within which all life on earth exists, rather than merely the business environment. Sustainability means that a service or product competes in the market place because it delivers goods or services that reduce energy consumption, pollution and other forms of environmental damage. Sustainability is an economic state where the demands placed upon the environment by people and commerce can be met without reducing the capacity of the environment to provide for future generations (Bradbury, 1999). *“In simple terms, an economic golden rule for a restorative economy would be that sustainability means leaving the world better than you found it, taking no more than you need, trying not to harm life or the environment, making amends if you do”* (Robert, 1997).

As societies develop economically beyond mere subsistence, their people can begin to shift their focus from immediate to long-term survival issues. Adopting a long-term perspective often coincides with increased natural environment awareness and pressure on businesses to be better environmental “citizens”. In most Western societies as well as many developing countries, there is a heightened level of environmental awareness concomitant with pressure on business and government to do a better job of “green” management (Sharfman, 1997). Environmental change philosophies and tools gaining popularity in the business world to support “green” management include the CERES Principles, TQM, Life Cycle Orientated

Environmental Management (LCOEM), Product-orientated Environmental Care (PEC), The Natural Step, ISO 14000, etc.

A small business owner who is engaged in exports gave the following statement to the author when asked what his view was on environmental sustainability; *“It is a luxury that we and the developing countries can’t afford”*. However many larger enterprises have started to require compliance from its suppliers. The challenge for SME suppliers may involve radical transformation, not only of organizational practices, but also in the way of thinking that led to those practices in the first place. The general misconceptions that good ecology and good economics are mutually exclusive are being challenged, and South African SMEs should ensure that they align themselves with global environmental sustainability practices.

### 3.9 Conclusion

The competitiveness of SMEs is determined by a large range of factors, which apply in significantly different combinations in different sectors and enterprises. Key factors relating to SME competitiveness were discussed, and it can be concluded that local and international markets demand SME competitiveness due to the new globalised markets. SMEs still have to develop and improve much upon these key factors.

Government intervention plays a very important role in the facilitation of SME development in South Africa. The South African SME sector is far from homogenous and would require a fine-tuned set of interventions rather than the generic assistance currently provided. Incentive program renewal and improvement by the DTI is expected, however awareness thereof is the SMEs’ responsibility.

Obstacles are multiple and part of “daily life” for SMEs. Finances, skilled labour and lack of knowledge are the greatest obstacles faced by SMEs.

The following statement by trade and industry minister Alec Erwin (2000) establishes that design is required by a SME to be competitive in a environment characterized by many variables of change – *“The environment sets many new requirements and SMEs can reactively adapt or they can design themselves to affect and operate in the environment as effective as possible”*.

Chapter 4 is dedicated to a literature study on various approaches used for enterprise design. These various approaches are discussed with the aim to gain a better understanding of

enterprise design and to lay a foundation to introduce Enterprise Engineering as a discipline. Enterprise Engineering is the foundational discipline used in this thesis.

**4****Literature Review****4.1 Introduction**

Enterprise Engineering was chosen as reference discipline to study transformation in South African manufacturing small and medium enterprises. Enterprise Engineering is defined by Liles (1995) as an emerging discipline that draws upon a wide variety of reference disciplines as a foundation. This literature study serves to present some of the chief foundational reference disciplines and thinking that lead to the establishment of Enterprise Engineering as a discipline.

Enterprise Engineering was chosen because it focuses on the entire enterprise rather than single processes or departments as with Reengineering or traditional improvement efforts. Thus, the scale of improvements is much greater than previous approaches to improving an enterprise.

Figure 4.1 provides a visual representation of how the author placed reference disciplines and thinking in context. The Systems Approach is introduced to provide a foundation for Enterprise Engineering concepts. Reengineering literature is then covered to describe the current attempts to transform business processes within enterprises and their limitations. However, Reengineering does not address the need to continuously engineer the business process. Enterprise Integration is then introduced as an approach that systematically applies management and engineering methods to processes and sequences of events to engineer and sustain the so-called integrated enterprise. The interactions, or interfaces between processes are the source of most systems failures. These failures at different enterprise levels, as well as specific failures ascribed to Reengineering are then discussed. The chapter concludes by introducing Enterprise Engineering as a discipline.

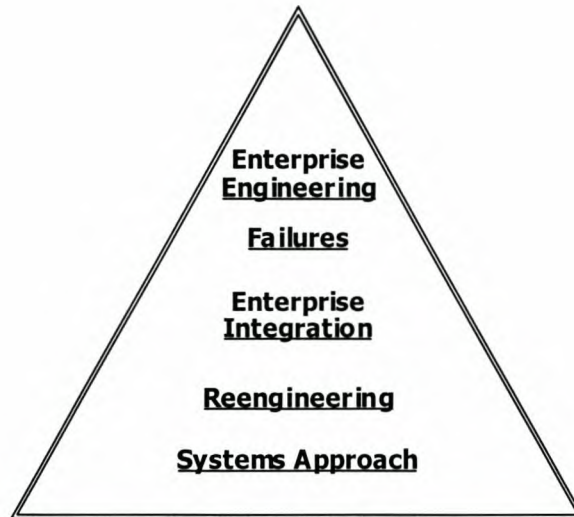


Figure 4.1 – Context of reference disciplines to Enterprise Engineering.

The following definitions were proposed by Underdown (1997) and will be used in the literature study:

- An enterprise activity is a unit of action that is the building block of an enterprise process.
- An enterprise process is a collection of enterprise activities organized to meet a desired goal. Business processes can be in one of three forms: resource gathering, guiding and directing, and transforming.
- An enterprise is a collection of enterprise activities organized into a set of business processes, which cooperate to produce desired results.
- Engineering is a discipline of applied science. Scientific principles are applied to issues of interest for the benefit of humankind.
- A system is a collection of processes designed to reach a desired goal.

## 4.2 Systems Approach

The Systems Approach is a methodology of change embodied in the system paradigm that takes a holistic approach to problems of complex systems. It is a method of enquiry, a way of thinking which emphasizes the whole system instead of component systems and strives to optimise the whole system's effectiveness instead of improving the efficiency of nearby systems. Many problems arising in systems stem from the inability to differentiate between the System Improvement and the Systems Approach (van Gigch, 1991).

## 4.2.1 System Design Versus System Improvement

System Design differs from System Improvement in its outlook, methods and thinking processes. Table 4.1 presents a comparison of these two methods of obtaining change.

	<b>System Improvement</b>	<b>System Design</b>
<b>Condition of the system</b>	Design is set	Design is in question
<b>Concerns</b>	Substance Content Causes	Structure and process Method Purpose and function
<b>Paradigm</b>	Analysis of systems and component subsystems (the science paradigm)	Design of the whole system (the systems paradigm)
<b>Thinking processes</b>	Deduction and reduction	Induction and synthesis
<b>Output</b>	Improvement of the existing system	Optimisation of the whole system
<b>Method</b>	Determination of causes of deviations between intended and actual operation (direct costs)	Determination of difference between actual design and optimum design (opportunity costs)
<b>Emphasis</b>	Explanation of past deviations	Predictions of future results
<b>Outlook</b>	Introspective: From system inward	Extrospective: From system outward
<b>Planner's roles</b>	Follower: satisfies trends	Leader: influences trends

Table 4.1 - Comparison of the system improvement and system design approaches

The concept of improvement carries the connotation that the design of the system is set and that norms for its operation have been established. Design is a creative process that questions

the assumptions on which old forms have been built. It demands a completely new outlook and approach in order to produce innovative solutions with the immense capability of bringing a cure for present-day ills.

When applying System Improvement, one is faced with questions that relate to the proper functioning of the systems, as they exist: The design of the system is usually established, and emphasis is placed on ensuring that it operates according to specifications. On the other hand the Systems Approach is a methodology of design and as such it questions the very nature of the system and its role in the context of the larger system. The first question raised when applying the Systems Approach concerns the purpose for the existence of the system; it requires an understanding of the system in relation to all other systems larger than and interfacing with itself. This outlook is called extrospective because it proceeds from the system outward, in contrast with System Improvement, which is introspective because it proceeds from the system inward. System Improvement is the embodiment of the analytical method, by which the condition of the component systems and their respective elements are studied by deduction and reduction to determine the cause of deviations from the expected or intended results. The System Design approach proceeds from the particular to the general and infers the design of the best system by a process of induction and synthesis (van Gigch, 1991).

## **4.2.2 Systems Approach Elements of Particular Importance to Enterprise Engineering**

From the discussion in the preceding subsection, it is clear that the Systems Approach encompasses a wide variety of concepts. It is the author's opinion that the concepts of holism, goal seeking, challenging of existing boundaries and integration made essential contributions to Enterprise Engineering.

### **4.2.2.1 Holism**

The analytical approach emphasizes reductionism and decomposition. In contrast, the Systems Approach attempts to view the whole with all its interrelated and interdependent parts in interaction. The whole takes on distinctive properties that would be lacking were one to remove a part. The systematic thinking in the Systems Approach does not replace the analytical thinking but supplements it because it would be folly to understand the whole

without specifically knowing the parts. The whole represents an independent framework in which the parts play a distinctive role (Schoderbek, 1990).

A system is a set of objects with relationships between the objects and between their attributes, related to each other and to their environment, in order to form a whole. The analytical approach does not consider relationships, because system parts are separated and studied in isolation. The Systems Approach views relationships as paramount to determining solutions to problems. The relationships are considered the bonds that link objects (objects being identified as subsystems in a complex system) together. In the context of a given set of objects, relationships can be classified as symbiotic, synergistic and redundant. A symbiotic relationship, unipolar when running in one direction or bipolar in other situations, is one in which connected systems cannot continue to function alone. The synergistic principle, “the whole is greater than the sum of its parts”, makes it clear that “whole” and “sum of its parts” are quite different entities. Redundant relationships are those that duplicate other relationships (Schoderbek, 1990).

Hierarchy implies the nesting of systems within other systems. Relationships are the glue that hold hierarchical levels together and determine boundaries for wholeness. Boundaries can be defined as “the line forming a closed circle around selected variables, where there is less interchange of energy across the line of the circle than within the delimiting circle”. In approaching holism, the designer solves the problem by looking at the whole. Determining what constitutes the “whole” is indeed a difficult process. Boundaries provide the level of resolution in determining the whole for problem solving (Schoderbek, 1990).

#### **4.2.2.2 Goal Seeking**

The problem of establishing whole systems and environmental boundaries is inextricably tied to setting the goals and objectives of the system and to agreeing by which criteria the system performance will be judged (van Gigch, 1991). Goals are generally multiple and conflicting, with goal changes possible as the environment and boundaries change. The rational basis for setting boundaries might also influence the determining of goals (Schoderbek, 1990). To alleviate such problems, the Systems Approach defines the goal of a system at the metalevel. The metalevel is defined as the level at which design of methods used at all other levels of inquiry is done. In the traditional management hierarchy, this is called the strategic level of the enterprise. The goal at the metalevel is supported by the goals of the subsystems. A Systems Approach focuses on the optimization of the system. Goal achievement serves to



facilitate the optimization of the system as a whole rather than sub-systems. In order to achieve this, the problem and the goal need to be stated at the metalevel, with each sub-system goal in support of the metalevel goal (van Gigch, 1991). Subsystem goals will undoubtedly not be optimized if the metagoal is optimized.

#### **4.2.2.3 Challenging of Existing Boundaries**

The Systems Approach considers malfunctions in a system with an extrospective outlook that considers malfunctions from the system outwards. *“The extrospective outlook counters the search for malfunctions within system boundaries, by refusing to place outer boundaries on systems and by extending the search for alternative causes beyond the confines of immediate systems. The Systems Approach places the planner in the role of the leader to consider the redesign and system configurations by attempting to eliminate legal and geographical barriers that prevent the internalization of spillover effects”* (van Gigch 1991). The planner in the role of the leader needs to constantly consider the state of the system in terms of processes, assumptions, relationships, and goals. Van Gigch (1991) proposes that the metagoal should align and enable designers to determine the relationships required to meet the metagoal and compare the optimum situation against the current situation. A new set of system boundaries occur due to the change in relationships that is required in order to satisfy the metagoal.

#### **4.2.2.4 Integration**

Integration from a Systems Approach is the quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demand of the environment (Schoderbek, 1990). The state of integration is consistent with the environmental demand for interdependence. However, the organization that seeks to be more differentiated will find integration more difficult. The Systems Approach recognizes the increasing complexity of the world and the increasing significance of interdependencies among systems (van Gigch, 1991). When all of an enterprise’s subparts are integrated within the whole in such a way that the energy used by each is in the direction of total enterprise efficiency and effectiveness, then survival is not only more assured but a more “healthy” enterprise is also established (Schoderbek, 1990; van Gigch, 1991).

The Systems Approach requires that all decision units be integrated to deal with a common problem regardless of their formal organizational level boundaries. When designing a total system, negotiation of solutions between subsystems should occur. When adding localised

control within the system it causes implementation that has solutions that work in a common framework. The common framework provides the power for subsystems to participate in common solutions without relinquishing their power (van Gigch, 1991).

## 4.3 Reengineering

Business Process Reengineering (BPR), Process Improvement, Business Transformation, Process Innovation and Business Process Redesign are terms frequently used interchangeably to represent the phenomenon of "Business Process Change". In the text following, Reengineering will be used to describe Business Process Change.

### 4.3.1 Reengineering Defined

Reengineering is defined as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed" (Hammer, 1993). Hammer points to the four key components of Reengineering: fundamental, radical, dramatic, and process.

- Fundamental means asking basic questions about why the organization performs an activity, and why the organization performs the activity in a certain way. By asking these basic questions, outdated rules and assumptions are exposed. A procedure may have been established under a different set of circumstances than are currently valid, thus obsolete activities are performed. The fundamental component of Reengineering challenges existing rules governing behavior to discover their current validity. Rules and policies ingrained into an organization's culture may have been established to control a different situation than is currently prevalent, thus their existence must be challenged. The fundamental component of Reengineering recommends that a problem be approached without assumptions. Past methods of performing processes should not be considered. Instead, designers ask what is to be accomplished, before they ask how it should be achieved.
- Radical focuses attention on reinvention rather than improvement. Reinvention implies that existing procedures are forgotten and totally new procedures are developed. This encourages the formation of new paradigms and forces designers to challenge existing boundaries of what is considered possible. Thus, designers begin with a clean slate and focus on what could be.

- Dramatic emphasizes the level of change to expect. Reengineering is concerned with large-scale improvements, rather than small, incremental tweaks to a current process. Gains of 10% or less should not be attempted with Reengineering. Processes requiring dramatic change of 50% or more are candidates for Reengineering.
- A process in Reengineering literature is defined as "a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer." A process orientation focuses on results, and developing processes that add value to the customer. A process focus implies looking at the entire process and not the tasks that make up the process. The entire process may cross departmental lines or involve many organizational units. A process focus, however, will disregard these distinctions, and optimize the process rather than the task within each department.

The principles for Reengineering intended to guide organizations who want radical change have been stated by Davenport. His version encompasses the primary ideas also mentioned by other authors (Davenport, 1994).

- A clean slate approach to organizational redesign.
- An orientation to broad, cross-functional business processes, or how work is done.
- The need for, and possibility of, radical change in process performance.
- Information technology as an enabler of change in how work is done.
- Changes in organizational and human arrangements and the accompanying change in technology.

These principles distinguish Reengineering from other process improvement efforts and form the fundamental building blocks from which Reengineering efforts are born. Davenport claims that Reengineering combines familiar concepts into a new synthesis. These key components have never been together before, not in quality nor socio-technical design nor systems analysis nor anything else (Davenport 1994).

### **4.3.2 Determinants for Successful Reengineering**

The (r)evolution of Reengineering broadened the concept of Business Process Change through (Grover, 1995):

- The requirements needed to sustain and integrate process change.

- The need to reconcile alternative process improvement and management approaches.
- The recognition of organisational constraints to implementation.
- The recognition of the radical, the incremental, the continuous and the contingent approach.

Although Reengineering is a powerful change approach that can bring about radical improvements in business processes, the Reengineering approach still needs to adhere to fundamental requirements in large-scale change efforts. A successful Reengineering project thus requires management involvement, training and education, proven methodologies, tools, technology and continuous improvement.

#### **4.3.2.1 Management Involvement**

Management involvement is paramount to a successful Reengineering program. Management involvement should reflect management commitment to the program, effective leadership and facilitation to define roles.

A prerequisite to a successful Reengineering program is senior corporate management's total commitment to the program; therefore, the uncertainty many of these executives have about Reengineering and its benefits to the organization must be addressed. Getting off to the right start by gaining the enterprise support and total commitment of senior management can mean the difference between the success and failure of a business Reengineering program (Freiser, 1992). This statement is supported by Yung (1997) stating that Reengineering has to be driven and supported by the top management of an organization.

Peppard (1995) believes that the characteristics of a process organisation demand a new type of management style. He believes that the manager becomes more of a consultant or coach than has typically been the case. Table 4.2 distinguishes between the old model of the manager and that of the new leader (Peppard, 1995).

Old Manager	New leader
Thinks of self as a manager or boss	Thinks of self as sponsor, coach or internal consultant
Follows chain of command	Deals with anyone necessary to get the job done
Most senior team member	May not be most senior member of team in terms of the enterprise's hierarchy
Makes most decisions alone	Invites others to join in decision making
Hoards information	Shares information
Tries to master one major discipline e.g. marketing	Tries to understand the whole process
Demands long hours	Demands satisfied customers

Table 4.2 – The old versus the new leader model of Peppard

Hammer (1995) distinguishes between the following roles of involvement when implementing Reengineering.

- Leader – a senior executive who authorizes and motivates the overall Reengineering effort.
- Process owner - manager with responsibility for a specific process and the Reengineering effort focused on it.
- Reengineering team – a group of individuals dedicated to the Reengineering of a particular process. Who diagnose the existing process and oversee its redesign and implementation.
- Steering committee – a policy-making body of senior managers who develop the organization's overall Reengineering strategy and monitor its progress.
- Reengineering czar – an individual responsible for developing Reengineering techniques and tools within the company and for achieving techniques and tools within the company and for achieving synergy across the company's separate Reengineering projects.

The relationship among these is as follows: The leader appoints the process owner, who convenes a Reengineering team to reengineer the process, with the assistance from the czar and under auspices of the steering committee (Hammer, 1995).

#### **4.3.2.2 Education and Training**

Many authors agree that education and training is an important component for successful Reengineering implementation (Ulis, 1993; Grover, 1995; Arendt, 1995; Zairi, 1995; Romney, 1995; Hammer, 1999). Change management and project management training and education is considered highly related to success of a Reengineering project (Arendt, 1995; Grover, 1995). Hammer (1993) states that training increases the skills and competence and teaches employees the “how” of a job, while education increases the employees’ insight and understanding and teaches the “why”. He believes that education is more important than training, because in a continuing changing environment people are required that can figure out what a job takes and then do it. Ulis (1993) believes in the utilisation of in-house expertise such as found in training and human resource departments to do the required training and education.

#### **4.3.2.3 Methodologies**

It is common in literature that authors refer to the importance of methodologies and tools to facilitate a well-disciplined and organised way of structuring, assessing and resolving the issues that business process Reengineering raises to assure success (Klein, 1994; Harrington, 1993; Kettinger, 1997; Paul, 1999). Methodologies refer to systematic approaches to conducting a Reengineering project. An effective methodology is like a roadmap. It helps you select your destination and then find the best way to get there (Klein, 1994). A Reengineering methodology should be designed or selected creatively to satisfy the current needs of the organisation (Klein, 1994). Adequate customisation of available Reengineering methodologies determines the level of comprehensiveness and effectiveness that a new customised Reengineering methodology can reach (Kettinger, 1997; Klein, 1994). Not all Reengineering practitioners agree on the use of a methodology, with some proposing the intuitive approach as a means of higher-level understanding. The primary distinction between the intuitive and methodological approaches is this: the intuitive tells you where to go, the methodological approach tells you what to do to get there. There are two different types of methodologies as well: the descriptive, which simply tells you what to do, and the prescriptive, which also tells you how to do it. Hammer (1993) argues that a Reengineering

methodology is not practical since the context for implementation is never the same, “Reengineering is contextual. It’s a function of how an organization behaves, its belief systems, its position in the marketplace, the character of its people. It is absolutely impossible to have a structured approach”. In contrast, Reengineering literature is full of methodologies claiming to be the one solution everyone needs. These methodologies range from simplistic to complex in explanation and from incremental to radical in scope. Methodologies also differ in the emphasis of the approach followed. Examples of this are:

- Harrington’s (1993) method that is a combination of a variety of tools into one logical way of initiating drastic and rapid change in a single business process.
- Klein’s (1994) method that emphasises the cultural aspects of Reengineering. The emphasis on social design in Klein’s method demonstrates the importance of people in the process of Reengineering an enterprise.
- Davenport’s (1994) method that has a strong information technologies component.
- Kettinger’s (1997) Process Reengineering Life Cycle method that uses a life cycle as metaphor for Reengineering.

It is proposed by Vernadat (1996) that Reengineering require business process modelling methods to assess and reengineer enterprise behaviour and functionality in order to create better synergy among business entities.

#### **4.3.2.4 Tools**

Tools are the manual or automated aids to doing the work of the project (Klein, 1994). Several researchers argue that effective use of modern software tools to assist in Reengineering efforts is crucial to Reengineering success (Kettinger, 1997; El Sway, 1997; Klein, 1994; Carr, 1993). Use of software tools contributes to Reengineering success by improving productivity (Klein, 1994), completing projects more quickly (Kettinger, 1997), producing higher quality results (Klein, 1994), measuring process costs (Carr, 1995), and eliminating non value-added work and focusing instead on value-added work (Klein, 1994).

Effective software tools should have specific features, such as:

- Being usable by non-technical people (Klein, 1994; Manganelli, 1994).
- Providing process visualisation (El Sway, 1997).

- Providing interactive and graphical-based demonstrations of process phases (Davenport, 1994).
- The ability to analyse processes (El Sawy, 1997) and show information flows between phases as well as rates of flows and resources usages (Davenport, 1994).
- Enhancing the clarity of the Reengineering team's vision (Klein, 1994; Manganelli, 1994)
- Enabling the running of life simulations to discover bottlenecks and constraints (Davenport, 1994).
- Enforcing consistency in analysis and design (Klein, 1994; Manganelli, 1994)
- Facilitating integration with CASE tools that are widely used in designing Reengineering underlying information systems (Davenport, 1994)
- Permitting iterative and top-down refinement from the Reengineering project goals to solution (Klein, 1994; Manganelli, 1994)
- Producing an acceptable return on investment (Klein, 1994; Manganelli, 1994).

Common office tools such as spreadsheets and project management tools are often used to meet needs, depending on the specialisation and complexity that is required (Manganelli, 1994).

Klein describes six types of tool application categories:

- Project Management – These tools are used for planning, scheduling, budgeting, reporting and tracking projects.
- Coordination – These tools are used to distribute plans and to communicate updated details of projects.
- Modelling – These tools are used to make a model of something in order to understand its structure and workings.
- Business Process Analysis – These tools are used for the systematic reduction of a business into its constituent parts and the examinations of the interactions among those parts.
- Human Resources Analysis and Design – Tools used to design and establish the human or social part of reengineered processes and are mostly standalone, partial solutions for specific, sometimes overlapping applications.



- **Systems Development** – These tools are used to automate the reengineering business processes.

Despite the partial solution to automation that CASE tools provide, it is better to reengineer with CASE tools than without them (Borchart, 1995).

Authors on the potential effects of Reengineering mostly agree that information technology (IT) is fundamental in enabling the innovative redesign of core business processes (Brancheau, 1996; Hammer, 1993). Hammer (1993) proposes that long-standing rules should be identified and then it must be determined if technology can break these rules.

#### **4.3.2.5 Impact Testing of Reengineering**

Pilot testing is considered a primary means of forecasting the impact of Reengineering on the enterprise (Guha, 1993). Hammer (1995) proposes that prototyping is an inexpensive crucible for learning and exposing the shortcomings. Guha (1993) believes that prototypes help people to understand the new designs and management can make judgments about prospective designs before devoting large amounts of resources for implementation. Many authors agree that iterations improvement should precede the prototype before implementation (Hammer, 1995; Guha, 1993; Aiken, 1998).

#### **4.3.2.6 Continuous Improvement and TQM relation to Reengineering**

Continuous improvement is part of several Reengineering methodologies (Harrington, 1993; Kettinger, 1997; Ulis, 1993). Several researchers suggest that using continuous improvement techniques increases dramatic gains (Carr, 1993; Clemmer, 1994). Some authors suggest that Total Quality Management (TQM) is particularly integrated with Reengineering (Kettinger, 1995; Zairi, 1995). Harrington believes that the completion of a Reengineering project is just the beginning. Some authors agree that Reengineering should be used to build a platform for a TQM programme. Reengineering can be used to change the company radically and TQM can be used to continuously improve the company in the years to come (Zairi, 1995). Business processes should be revolutionized and evolutionized to ensure that the business processes continually remain competitive in an ever changing environment.

#### **4.3.2.7 Reengineering in SMEs**

Hammer (1993) states that all companies, great and small, are candidates for Reengineering. Many small companies have successfully reengineered with the same verve and creativity as larger companies. Small companies reengineer, like their larger counterparts, to significantly

improve performances of their key processes, and thereby compete more effectively in an ever more difficult global economy. Small companies can consider Reengineering as soon as it begins to encounter fragmented tasks, ballooning overhead and internally focused activities. Although small companies follow the same basic approach and principles as larger organisations they have to be innovative because of the lack of resources (Hammer, 1995).

## **4.5 Enterprise Integration**

### **4.5.1 Introduction**

Enterprise Integration (EI) was initiated in the Computer Integrated Environment. As the importance of the human aspect in the enterprise was realised it matured to include organisational design. Enterprise Integration is a rapidly developing field that systematically applies management and engineering methods to processes and sequences of events to engineer and sustain the so-called integrated enterprise.

There is a close cooperation between researchers of Reengineering and EI. What Reengineering does not address is the need to continuously engineer the business process, instead of just Reengineering it once (Nemes, 1996). Enterprise Integration architectures facilitate the continuous engineering of processes by considering that many business process reengineering projects are similar and common to every type of business. Thus, they can be captured, standardised and re-used instead of deploying them again from scratch each time (Vernadat, 1996).

System building principles, modelling, EI methodologies and the architectures on which these are based are important concepts underlying the field of EI.

### **4.5.2 System Building Principles for Enterprise Integration**

EI considers core business processes in an organisation and concentrates on how to perform these tasks better and whether modifications are deemed necessary to achieve this goal. The process that leads to better solutions is considered, instead of only better solutions (Nemes, 1996).

In this context EI captures and describes processes, strategies, organisational structures, resources, goals and constraints of the enterprise. It specifies the business process

requirements, identifies the solution options, presents alternative designs and provides implementation paths at strategic, tactical and operational levels (Nemes, 1996).

The entire business process is studied and described in terms of three inter linking networks (Williams, 1996; Nemes, 1996):

1. Material flow and material transformation together with service provision.
2. Information flow and transformation that is needed to manage and control the enterprise.
3. Supporting organisational structure of people who carry out the non-automated parts of the tasks. This component is essential, since people make decisions based on experience and incomplete information.

### **4.5.3 Enterprise Modeling**

Enterprise modeling consists of an understanding of the essential features of a system and writing these down in a systematic manner. It can be seen as a process of building models of whole or part of an enterprise for knowledge about the enterprise, previous models and/or reference models as well as domain ontologies and model representation languages.

Things to be integrated and coordinated need to be modeled. Enterprise modeling ensures that if an agent, called system A, executing a given business process wants to “talk”, i.e. interact in the form of a dialogue, with an agent, called system B, executing another business process, there is the need for two fundamental components, see figure 4.2.

- An Integration platform and its integrating infrastructure that provides the hardware and software environment that enables systems interoperability and integration (i.e. to allow communication between system A and system B in the form of a flow of information).
- An Enterprise Model or common semantic referential, used to ensure that when system A refers to concept C, system B has the same understanding of concept C as system A. In other words, system A and system B share the same knowledge about concept C.

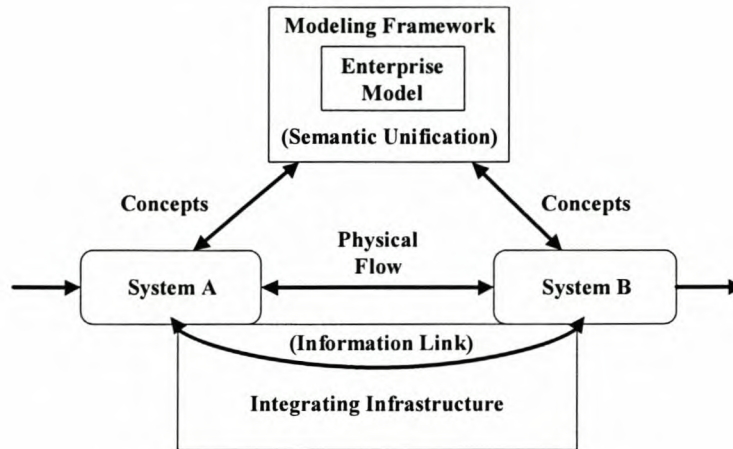


Figure 4.2 – Model-based Enterprise Integration principles

The enterprise model is used as a semantic unification mechanism, or knowledge-sharing mechanism, built by applying principles and tools of a given enterprise modeling method. Semantic concept definitions in the model can be expressed in the form of ontologies. Ontology is a formalisation of some knowledge in terms of abstract concepts (entities made of a list of properties) and axioms (predicates on the properties) (Vernadat, 1996).

#### 4.5.4 Architectures and Methodologies

Methodologies exist in the framework of architectures. The architecture provides the framework showing the interrelationship of all of the parts and/or functions of an enterprise. The architecture forms the basis for development or execution of an Enterprise Integration program (Williams, 1996; Nemes, 1996).

Two types of architectures exist that deal with the integration of manufacturing enterprises (Nemes, 1996):

- The structural arrangement of a physical system.
- The structural arrangement of the development and implementation of a program.

In these two types of architectures methodologies with a consistent set of components are found. These components are:

- A reference model globally and generically showing the structure of the project system to be studied.

- One or more modeling formalisms enabling the build up of the model in order to study and evaluate it.
- A structured approach for the overall program leading step by step from an existing system to a future system taking into account evolution objectives and specific constraints.
- Performance evaluation criteria with which the system can be evaluated in relation to several points of view.

Within the framework of an integrated manufacturing system design methodology, the structured approach must cover all of the life cycle of the integration project which is split into several successive stages.

### **4.5.5 Life Cycles**

The enterprise life cycle and product life cycle are of particular importance in the design and implementation aspects of EI. The life cycle is not purely sequential and generic for either the product or the enterprise. For some of the components of these, life cycles may exist, are in operation, or be in the process of being developed or redesigned. For a competitive advantage the interaction of the product life cycle and enterprise life cycle needs to be considered.

Vernadat (1996) defines the enterprise life cycle as a sequence of phases characterising the entire existence of an enterprise. The enterprise life cycle approach helps the designer break the integration project up into phases and therefore not only adds a structure to the project but also simplifies the project (Reid, 1998).

The product life cycle is a familiar concept and many approaches exist to define it. Much work has been done to shorten the product life cycle in order to provide the enterprise with a competitive advantage. Enterprise Integration recognises that shortened and better product life cycles alone do not provide a competitive advantage but the entire enterprise must work together to achieve competitiveness.

Although the product life cycle and the enterprise life cycle operate on different planes, they do interact at all levels. The product cannot exist without the enterprise, and the enterprise cannot exist without the product. The heart of EI is found in the fact that as an enterprise introduces new products the technology can become obsolete and thus redesign of certain aspect of the enterprise is required.

The enterprise and product life cycles are shown in figure 4.3 below. It is important to realise that the product life cycle is by no means restricted to the operational phase within the enterprise life cycle. The product concept could in fact be the starting point for an entire new enterprise.

The curved arrow that moves back up the enterprise life cycle represents change in the enterprise in order to accommodate changes in the operating environment. One can therefore see that along the enterprise life cycle there is a reiterative process that will only end once the enterprise is terminated.

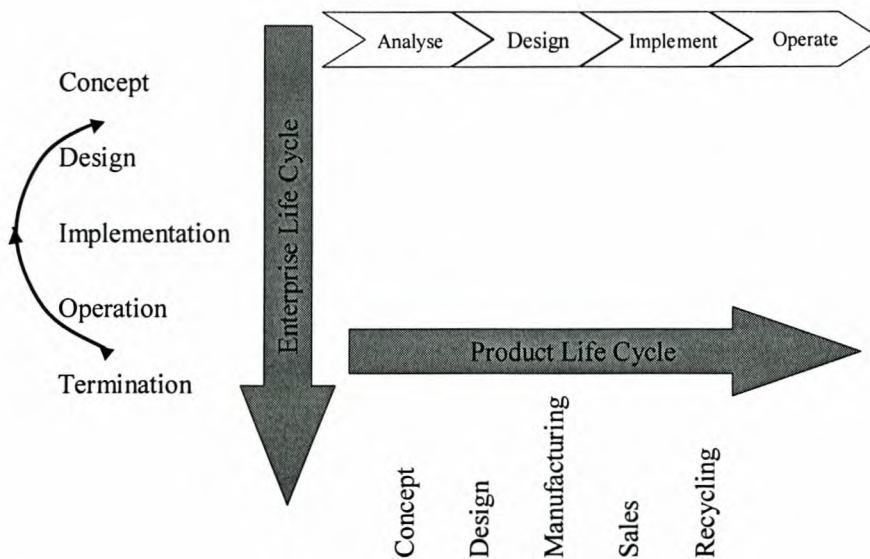


Figure 4.3 – The interaction between the enterprise and the product life cycle

This loop that the enterprise designer executes is one of the key aspects of Enterprise Integration. The designer must realise that the enterprise will continually have to change in order to remain competitive and therefore also to remain functional. Integration makes an enterprise more competitive, giving the enterprise the ability to adapt rapidly to changes in the internal as well as the external environment. This ability to rapidly adapt and change in a proactive fashion is what gives an enterprise competitive advantage in reacting quickly to market demands (Reid, 1998).

### 4.5.6 Integration

Integration consists of putting components together to form a synergistic whole. Integration is a never-ending process, because it is a goal and the enterprise is in a permanent process of

change (Vernadat, 1996). The different types of integration under consideration in the field of EI, as described by Vernadat (1996), are defined briefly in the following subsections.

#### 4.5.6.1 Loose Integration Versus Full Integration

System integration can range from no integration at all, to loose integration, or to full integration (Vernadat, 1996).

- Loose integration exists when systems exchange information, but no guarantee exists that they will interpret the information in the same way.
- Full integration exists when 1) specification of any system is only known by the system itself, 2) systems contribute to a common task and 3) the systems share the same definition of each concept they exchange.

#### 4.5.6.2 Horizontal Integration Versus Vertical Integration

Horizontal integration is concerned with the physical and logical integration of business processes from product demand to shipment, regardless of organisational boundaries. Vertical integration is concerned with the integration between the various management levels of an enterprise (Vernadat, 1996). Figure 4.4 illustrates the two possible types of integration, which can be realised in manufacturing enterprises.

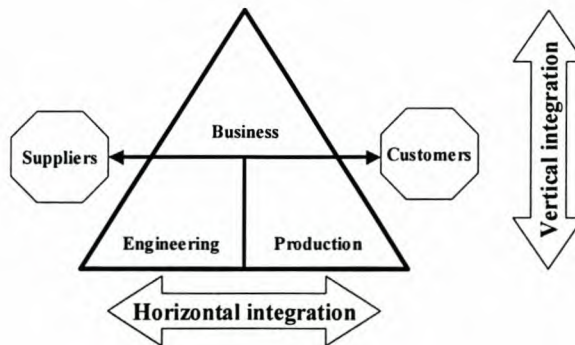


Figure 4.4 – Two possible types of integration for manufacturing enterprises

#### 4.5.6.3 Intra-Enterprise Integration Versus Inter-Enterprise Integration

Intra-Enterprise Integration is concerned with the integration of the business processes internal to a given enterprise. Inter-Enterprise Integration addresses the integration of business processes of a given enterprise with business processes of other enterprises, or even sharing some parts of business processes by different cooperative enterprises (Vernadat, 1996).

#### **4.5.6.4 System Integration Versus Application Integration Versus Business Integration**

Physical system integration is essentially concerned with systems communication while application integration in addition incorporates interoperability of applications on heterogeneous platforms as well as access to common shared data by the various applications. Business process coordination at enterprise level is considered by business integration (Vernadat, 1996).

### **4.6 Failures**

System failures and failures in Reengineering are covered in this section. It helps to identify and avoid common as well as complex type of failures when designing, implementing or maintaining systems, subsystems or processes in an enterprise.

#### **4.6.1 System Failures**

Design of systems strives towards zero failures, but it is impossible to obtain it and thus systems do fail. Van Gigch (1991) defines system failures as “actual, concrete events that occur at the implementation level of systems”. Failures can be physical failures, failures in software design, as well as failures due to neglect of levels of logic in modeling and metamodeling. Considering these types of failures, van Gigch (1991) defined a classification of five categories of failures. The classification is important because it provides a standard system for labeling, coding, counting and measuring failures. A short discussion of the five categories follows.

##### **4.6.1.1 Failures of Structure and Regulation**

Organisational design is a very important factor that contributes to success. Ill-designed organisations usually do not meet stated goals. The design of an organisation can be addressed by domain, structure and regulation. Failures at domain level occur when the domain and the control are ill defined and specified. The domain refers to the scope or field over which each controller or metacontroller exercises regulation on policy and behaviour. Failure in structure occurs when subsystems, aspect systems and phase systems and among their combinations do not perform their assigned functions. Subsystems define the “who” (individuals, groups, departments), the aspect systems define the “what” (issues, topics, problems) and the phase systems define the “when” (to situate events in their chronology).



Regulation problems occur when the organisation cannot harness the emergence of desirable and feasible changes to improve the organisations effectiveness.

#### **4.6.1.2 Failures in Technology**

An organisation needs hardware and software to carry out its functions. Hardware refers to designed hard systems like buildings, machines, facilities and other instrumentals like computer systems. Software refers to the design of soft systems such as managerial information systems, computer control systems, production control systems, scheduling systems, payroll systems and data-processing systems. Systems failure occurs at the technical level of design of system hardware or software. Failure is plausible at technical level because human intervention leaves room for human failure. Within a dynamic environment requiring competitive products and service the technology can fail to deliver the required level of satisfaction to clients.

#### **4.6.1.3 Failures in Decision Processes**

Organisational decision making is based on information and intelligence. The only form of evidence suitable for decision making is intelligence, given that it is the only one containing all four types of rationality (structural rationality, substantive rationality, procedural rationality and evaluative rationality) that can be obtained. Unless these types of rationality are designed at metalevel, malfunctions as described in Table 4.3 may occur.

Logic-versus-Authority Malfunctions – Problems of logic refer to the lack of distinction between control and authority. Control and control levels are related to logic and logic levels, whereas authority is related to organisational levels.
--

Structural Malfunctions – Occurs when the structural rationality does not exist or when it is not formulated in the metacontroller. Organisational design should always be the responsibility of the top levels of the enterprise.
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Teleological Malfunctions – Exists when the evaluative rationality does not originate in the metacontroller. All levels of the organisation should work in concert to meet a common set of goals.
---

Closure Malfunctions – Occurs when decisions are made on the basis of evidence without complete intelligence.
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Disjunction – Occurs when each of the participants in the decision process holds different
--

intelligence or a different set of rationalities.
Compatibility Malfunctions – Occurs when the decision makers hold the wrong intelligence or the wrong set of rationalities for the decision at hand.
Metalogic Malfunctions – Occurs when the structural rationality does not exist or when it is not formulated in the metacontroller.
Morality Malfunctions – Occurs when the evaluative rationality which guides decision making results in system outputs detrimental to clients and recipients.

Table 4.3 - Types of Decision Process Failures

#### 4.6.1.4 Failures of Behaviour

System failure due to behaviour is linked to the human element of the communications channel. This type of failure covers syntactic malfunctions, semantic malfunctions and pragmatic malfunctions. Syntactic malfunctions are related to the perception of signs and symbols. Semantic malfunctions occur when the user experience confusion of the signs and symbols conveyed by the interface of a message to the user. When the message has an influence on the user, pragmatic malfunctions might occur. If the user is not aware of the problem and does not respond with positive and creative action a situation for the occurrence of this type of problem arises.

#### 4.6.1.5 Failures of Adaptation and Evolution

To adapt the organisation is either trying to control the environment or modify internal structures to accord with external changes that drives towards the destruction of the system. Adaptation failure occurs when the organisation is unable to generate the adaptive structures to survive. Systems dealing with changes have variable(s) that have a dimension of fluctuation from stability. Evolutionary malfunctions occur when the system does not take into account past failures that could amplify fluctuation variables to push the system through the threshold of stability toward non-equilibrium.

### 4.6.2 Reengineering Failures

It is estimated that between 50 and 70 percent of Reengineering efforts were not successful in achieving the desired breakthrough performance (Hammer, 1993). Table 4.4 provides a list of possible causes of Reengineering failures. Though this list is not complete, the breadth of failures is evident.

1. Change of management systems & culture factors	<ul style="list-style-type: none"> <li>• Problems in communication</li> <li>• Organisational resistance</li> <li>• Lack of organisational readiness for change</li> <li>• Problems related to creating a culture for change</li> <li>• Lack of training and education</li> <li>• Difficulty of moving to process-oriented thinking and analysis</li> <li>• Pursing a restructuring or downsizing strategy rather than a re-engineering approach</li> <li>• Neglecting people's values and beliefs</li> </ul>
3. Management support factors	<ul style="list-style-type: none"> <li>• Problems related to commitment, support and leadership</li> <li>• Problems related to championship and sponsorship</li> </ul>
3. Organisation structure factors	<ul style="list-style-type: none"> <li>• Ineffective Reengineering teams (best people not allocated to design teams)</li> <li>• Problems related to integration mechanism, job's definition and responsibilities allocation</li> </ul>
4. Reengineering project management factors	<ul style="list-style-type: none"> <li>• Problems related to planning and project management</li> <li>• Problems related to goals and measures</li> <li>• Inadequate focus and objectives</li> <li>• Ineffective process redesign</li> <li>• Problems related to Reengineering resources</li> <li>• Unrealistic expectations</li> <li>• Ineffective use of consultants</li> <li>• Problems with redesign methods and approaches</li> <li>• Re-engineering the wrong processes, without</li> </ul>

	<p>sufficient process improvement</p> <ul style="list-style-type: none"> <li>• Trying to fix a process instead of changing it</li> <li>• Quitting too early.</li> </ul>
5. IT infrastructure problems	<ul style="list-style-type: none"> <li>• Problems related to information technology solutions and sourcing decisions</li> <li>• Improper IS integration</li> <li>• Inadequate IS development</li> <li>• Ineffective Reengineering of legacy information systems</li> <li>• Miscellaneous problems</li> </ul>

Table 4.4 - Reasons for Reengineering failures

## 4.7 Enterprise Engineering

Enterprise Engineering is defined as that body of knowledge, principles, and practices having to do with the analysis, design, implementation and operation of an enterprise (SEE, 1995). Enterprise Engineering has a holistic approach to changing the enterprise. Enterprise Engineering stands at the cross roads of disciplines like Reengineering, Continuous Process Improvement and Enterprise Integration that are concerned with Reengineering and continuous improvement of business processes. It also relates to ergonomics, human resource management, and economics, which are important aspects to consider for structured, systematic manufacturing system and implementation (Vernadat, 1996).

Fundamental engineering principles form the contextual foundation of Enterprise Engineering. The term "engineering" implies a body of scientific knowledge that can be taught, and whose results can be measured and quantified. The context from which EE is approached is shown in figure 4.5.

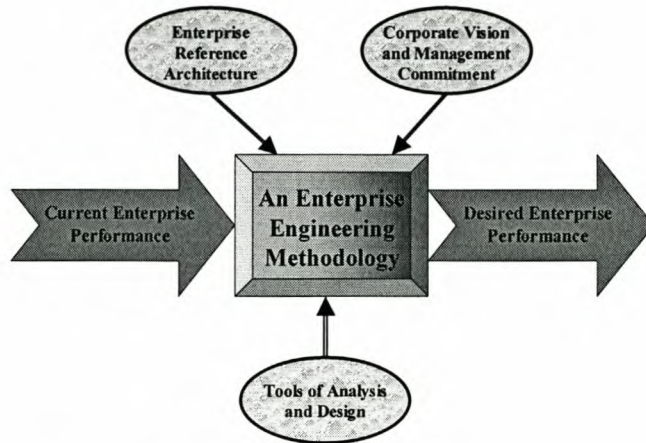


Figure 4.5 - The context of Enterprise Engineering

The Enterprise Engineering Methodology is the application component of Enterprise Engineering. It represents a structured planned approach of changing an enterprise from a current state to a future desired state.

Applying the Enterprise Engineering Methodology is a rigorous engineering exercise that needs to be supported by:

- An enterprise reference architecture that provides a standard that defines how components are put together as a whole in order to achieve change. It serves thus as a generic architecture from which other architectures can be compared or derived.
- Corporate vision to provide the metagoal of what the enterprise aspires to become and management support to sanction and support efforts to achieve the vision.
- Tools that are manual or automated to support analysis and design.

Enterprise Engineering as an emerging discipline can be discussed according to six characteristics (Liles, 1996):

- Focus of study
- Worldview or paradigm
- Set of reference disciplines used to establish the discipline
- Principles and practices associated with the discipline
- Active research or theory development agenda
- Deployment of education and promotion of professionalism

### **4.7.1 Focus of Study**

Enterprise Engineering has a well defined and unique focus of study defined by the Society for Enterprise Engineering's (SEE) fundamental question: "how to design and improve all elements associated with the total enterprise through the use of engineering and analysis methods and tools to more effectively achieve its goals and objectives".

### **4.7.2 Worldview or Paradigm**

In the Enterprise Engineering paradigm, the enterprise is viewed as a complex system of processes that can be engineered to accomplish specific organizational objectives. Enterprise Engineering recognizes the ever-changing organic nature of the enterprise, and therefore has a valid world view or paradigm.

### **4.7.3 Reference Disciplines**

The discipline of Enterprise Engineering uniquely builds upon several reference disciplines in science, engineering, and humanities. Industrial Engineering is an excellent reference discipline, because it provides a holistic view of the enterprise, which is necessary for successful implementation of Enterprise Engineering. Many of the skills required of Enterprise Engineers are those already possessed by many Industrial Engineers (IEs). IEs are well positioned to take the lead role in developing Enterprise Engineering as an emerging discipline.

### **4.7.4 Principles and Practices**

Principles incorporate the worldview and define the philosophical approach to solving problems. Practices are the methodologies, models, procedures, and theories used to apply the discipline's knowledge base. Together, principles and practices form the foundation of a discipline and promote further ordered study. Defining principles and practices needs to proceed if Enterprise Engineering is to become a recognized discipline.

### **4.7.5 Active Research Agenda**

An active research agenda implies that hypotheses are being generated which address the fundamental question of the discipline. The current topics being addressed can be seen as possible lines of research for Enterprise Engineering, including: managing change, supporting

technologies, methods, tools, and environments unique to the enterprise. Because the enterprise is a system of cultural, process, and technology components, all of these areas need to be researched to help answer the fundamental question as stated in section 4.7.1.

#### **4.7.6 Education and Professionalism**

Education and professionalism are essential to the widespread recognition and deployment of a discipline. A discipline should be identifiable with a research community that sustains its own literature. The written record of knowledge and thought progression is valuable for future researchers and practitioners to reference when developing new theories and methodologies. To achieve this refereed journal, university programs and local interest groups need to be established.

### **4.8 Conclusion**

This chapter introduced reference disciplines and relevant literature that have contributed to the establishment of Enterprise Engineering as a discipline. The purpose thereof is to provide a theoretical basis for understanding the methodologies that are used in this thesis within the context of Enterprise Engineering as a discipline. The author encourages the reader to consult this chapter if any questions arise or has difficulty in grasping certain concepts in the chapters following.

## 5 SME Transformation

### 5.1 Introduction

Enterprise transformation is an integral part of Enterprise Engineering. SME transformation viewed in this perspective is defined by the author as the consideration of all aspects of an enterprise and the engineering of various aspects to change the SME from a current state to a future desired condition. Transformation is a complex process that cannot be undertaken in a reactive ad hoc fashion, or as a separate component related approach. A methodology is needed to guide this process. Using an Enterprise Engineering methodology on a SME will inevitably result in wide ranging changes that will holistically transform the SME.

This chapter consists of three sections:

- Firstly, a model representation that describes all aspects of the manufacturing enterprise will be introduced.
- Secondly, transformation types are explained.
- Thirdly, two Enterprise Engineering methodologies are introduced and the coverage of transformation that they represent is explained.

### 5.2 SME Entity Model

Figure 5.1, the SME Entity Model, is a representation of a manufacturing enterprise within its environment. The SME Entity Model represents all the components required to build a comprehensive holistic view of the enterprise for the purpose of transformation. This model will be used as benchmark against which the transformation methodologies will be mapped in order to understand the extent and type of transformation they represent. The essential balance and integration of the components equates to a healthy enterprise. The components are:

- **People:** People are the most important resource of an enterprise. They are the essential acting components that arrange matter, energy and information in order for an enterprise to deliver competitive products and services according to customer desires. People disseminate knowledge through the enterprise to enable innovation and increased productivity. The competitiveness of an enterprise is dependent on the security and



ownership of employees and the returned benefit that the enterprise obtains by capitalizing on the creativity, commitment and discretionary effort of its employees. An enterprise has to continually adjust the numbers and skills required of the people to enable it to compete successfully in the future.

- **Business processes:** Business processes are concerned with the management of the series of activities within the context of the enterprise required to produce anticipated products and services to customers. Management of business processes requires the development of a highly integrated and concurrent environment that incorporates all stakeholders and aspects for the entire life cycle of the products and services it delivers. To ensure the continued competitiveness, the enterprise should apply deliberate continued change to the current state by designing innovative business process solutions and implementing them successfully.
- **Technology:** Technology is a created device, tool, instrument or machine that people, through complex knowledge and skills, employ to create, use, maintain and dispose the enhanced competitive products and services of the enterprise. These devices, tools, instruments and machines are organized within facilities that allow for the quick and efficient reconfiguration of the same to meet changing needs.
- **Integration:** Integration is concerned with connecting and combining of people, processes, systems, and technologies in such a way as to assure that the right information is available at the right location, with the right resources, at the right time. It comprises all the activities necessary to ensure that, whether operating as an independent unit or/and within extended enterprises, the enterprise can function as a coordinated whole.
- **Transactional environment:** The transactional environment is the environment that can be influenced to some degree by the enterprise. Influence is achieved through co-operation or persuasion of stakeholders to bring about change in the environment.
- **Contextual environment:** The contextual environment is the larger environment over which the enterprise has little or no control. The enterprise must have the ability to scan this environment in an ongoing manner to understand the way it changes so that the enterprise can adapt accordingly.

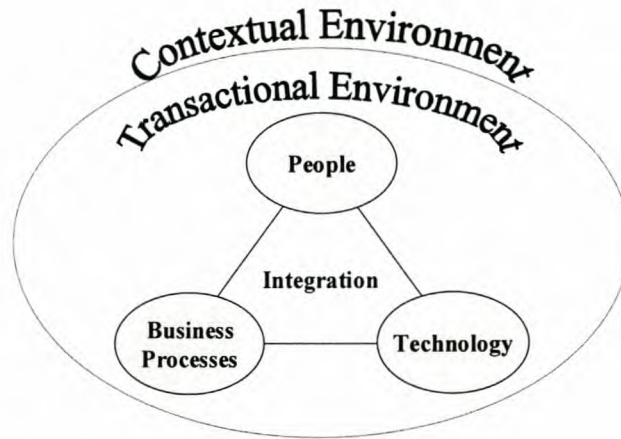


Figure 5.1 – The SME Entity Model

### 5.3 Holistic SME Transformation in Context

SMEs, like their larger counterparts, are complex entities especially when considering their holistic nature. Transforming a SME requires engineering rigor and commitment. With the lack of resources, especially financial resources, and a dynamic environment, the process of transformation must be lean and agile to ensure the most efficient use of those resources. A methodology for transformation is imperative for a lean and agile transformation.

The author found no literature that addresses transformation from a holistic perspective for the South African SME environment. Research has been done on numerous strategies and operational approaches such as strategic planning, Total Quality Management (TQM), ISO accreditation, teams and group technology, etc. to fundamentally change enterprises. These do however not produce a holistic approach that can be applied by SMEs in an ever-changing environment.

The difficulty of a holistic approach is that it does not address a single process or group of processes, but addresses the entire enterprise. The scope of transformation of a single process or group of processes of a SME is limited compared to the consideration of an entire enterprise. A SME is a complex entity that is composed of numerous processes that interact to produce desired future conditions or goals. An enterprise taking an ad hoc change approach to processes without taking interactions, or interfaces between processes into account are at greater risk of failure. The Enterprise Engineering approach addresses the possibility of failure by analyzing, designing and implementing solutions at a higher level of abstraction. The ability to apply engineering principles and practices at higher levels of abstraction

through modeling and metamodeling distinguishes the Enterprise Engineering approach from other enterprise transformation approaches.

## 5.4 Resolution

The highest level of resolution is the SME as a single entity. Levels of resolution can be considered for subunits of the SME. A subunit is defined as an entity that contains the set of functions that carry a product through its life cycle from concept through manufacture, distribution, sales and service.

The resolution used by the author considers the entire enterprise rather than single processes or departments as is done with Reengineering, traditional process improvement and change management techniques. Thus, the scale of improvements is much greater than previous approaches to transforming an enterprise.

## 5.5 Transformation through Incremental Changes

SMEs spend large amounts of time and resources to change many aspects of the enterprise, from strategic to operational. The aim of Enterprise Engineering is to integrate (combine) these small (ad hoc) changes within a larger project with the ultimate goal of more efficient and effective change. In this way, a number of incremental changes can be built upon one another (integrated within the larger context) to achieve better transformation. This concept is illustrated in figure 5.2 (Reid, 1998).

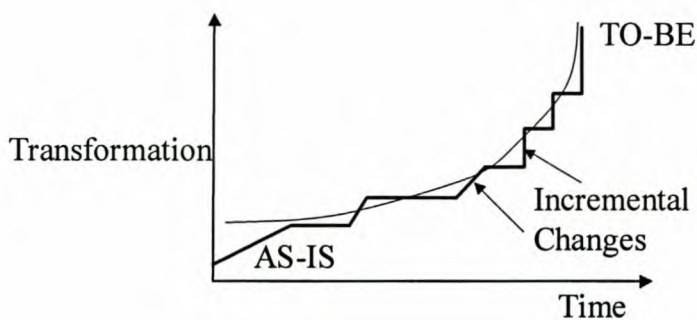


Figure 5.2 – Transformation through incremental changes

## 5.6 Timing of SME Transformation

The timing of SME transformation can be proactive or reactive. Proactive SME transformation is defined as anticipating change or receiving information on trends from the

environment and making systematically planned changes before the SME loses control. The proactive approach allows for an iterative process of design. Enterprise Engineering is essentially proactive in its approach and design, which is in turn based in its application. Reactive SME transformation is defined as changes made by the SME to regain control due to business environmental changes, pressures or dire situations. Control is defined as the ability of management to make decisions that will ensure the best possible operation of the enterprise.

## 5.7 Scope of Transformation

The author classifies the scope of SME transformation as either transition transformation or radical transformation. Innovation is considered as an integral part of both types of transformation. Innovation is defined as an essential process that takes realistic and new intermittent steps to achieve the ideal state envisioned for the enterprise.

Transition transformation is a systematic and iterative process of developing the subsystems (components) of an enterprise so as to remain on a chosen path. The development of subsystems is based upon induction and synthesis. These developments need not be small; they can involve large commitments of time, people and money.

Radical transformation is complex with fundamental shifts that bring about specific changes of performance of subsystems (components) in an enterprise. Radical transformation focuses on re-invention of the subsystems (components) of an enterprise.

## 5.8 SME Transformation Types

An SME Transformation Matrix, figure 5.3, can be determined by combining the timing and scope of transformation. The SME Transformation Matrix represents four types of SME transformations.

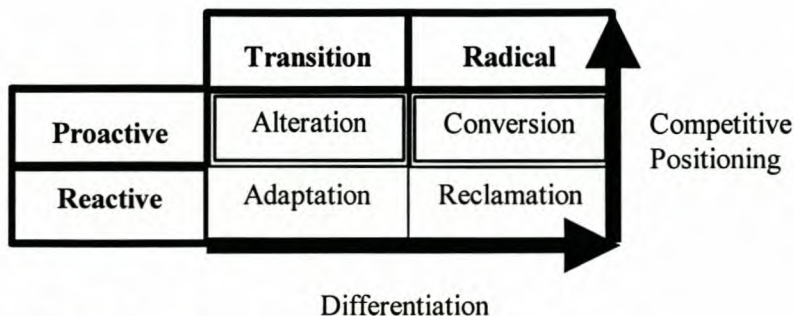


Figure 5.3 – SME transformation matrix

Alteration is defined as a proactive systematic process of adjusting the subsystems of an enterprise to transform the enterprise from a present state to a future desired state by defining a plan. SMEs engaged in alteration are able to implement constant innovative changes in subsystems to develop and maintain a competitive advantage in their environment.

Conversion is defined as a systematic proactive approach of planning to transform the enterprise by making quantum jump changes within certain subsystems. The conversion process is innovative and follows a realist approach to making quantum jumps in subsystems to transform the enterprise from a current state toward a desired future state. SMEs engaged in conversion are able to offer better quality and cost effective products with greater perceived performance differentiation, while still maintaining a competitive manufacturing advantage.

Adaptation is reactive in its approach to improve the enterprise to cope with a common call for changes from the environment. The adaptation process seeks the best and most cost effective ways to adapt the enterprise to deliver the required results to the environment.

Reclamation is defined as a radical ad hoc adjustment of subsystems in the enterprise. The reclamation process is initiated when the enterprise approaches difficulty due to the fact that it cannot effectively compete with its products or/and has manufacturing disadvantages in its environment. Ad hoc adjustments to subsystems are made by whatever means deemed necessary to again place the enterprise into a position where it can compete in the environment.

## **5.9 The Two Chosen Enterprise Engineering Methodologies**

The two types of transformation studied in this thesis are alteration and conversion. The methodology chosen for alteration is the Transform Enterprise Methodology by Dr. Ruyn Underdown. It was developed at the University of Texas, Arlington.

The Master planning methodology that is based on the Purdue Enterprise Reference Architecture and the Purdue Methodology was chosen for conversion. The Institute for Interdisciplinary Engineering Studies at Purdue University developed this methodology.

The methodologies to some extent overlap the transformation types to which they were allocated. The definitions will however be maintained, because the mapping against the SME manufacturing model will give an indication of these overlaps.

### 5.9.1 Alteration - Transform Enterprise Methodology

The Transform Enterprise Methodology (TEM) was developed with the main purpose of planning the transforming of an enterprise from a current state to a future desired state. The enterprises considered for this transformation are manufacturing SMEs with a size of 50 to 500 people. It is an organized collection of activities that describes "what" must be done to change the entire enterprise. IDEF0 was used as modeling scheme, because it allowed activities to be presented in a structure of dominance and to be placed in a recommended sequence.

The methodology integrates cultural, process and technology strategies to transform an enterprise. The method is decompositional in nature and iterative in application. Figure 5.4 presents a first level model view of the IDEF0 methodology.

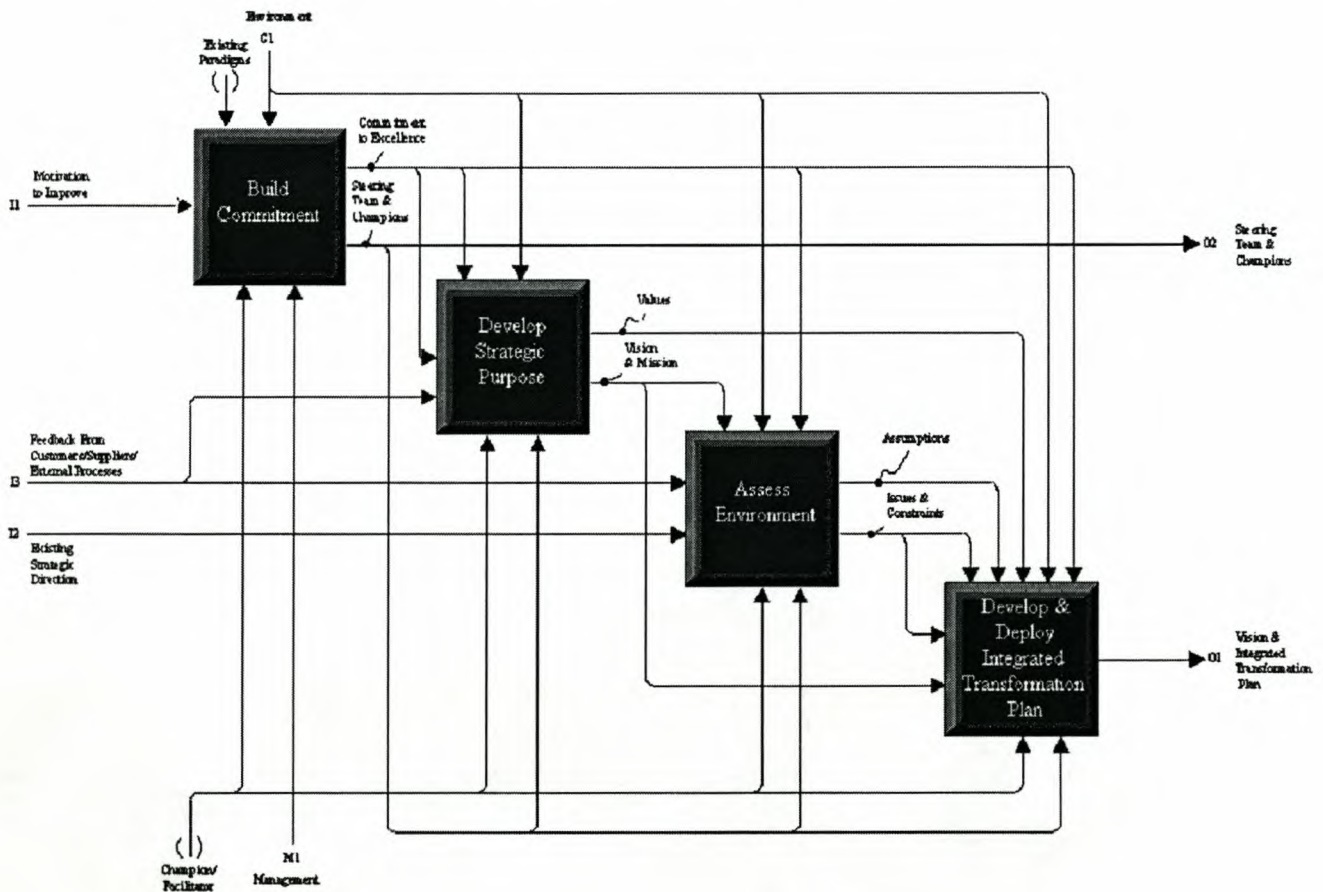


Figure 5.4 – Transform Enterprise Methodology level 1

The methodology starts with the vision that describes what the enterprise aspires to become in the distant future. A transformation plan, called strategy, is then compiled to achieve the

vision. The transformation plan is composed of cultural, process and technology strategies as represented by the activities: Create Desired Culture, Integrate & Improve Enterprise and Develop Technology Solutions.

The TEM is written with a process paradigm, where all activities are considered as processes. Under this paradigm, the vision is achieved through processes that have cultural, process and technology components. Cultural components are the norms, attitudes and beliefs exhibited by the people involved in the process. Process components are those organized sequences of activities that transform an input into an output, provide direction for the enterprise or gather resources for the enterprise to operate. Technology components are the scientific devices that enable processes to be performed.

Figure 5.5 presents the mapping of the TEM to the SME Entity Model. The mapping represents the author's view of the coverage the methodology has of SME Entity Model. The TEM partially covers the components of the SME Entity Model. The TEM enables strategic influence on the transactional environment and scanning of the contextual environment. The TEM can be considered to be a comprehensive holistic transformation methodology.

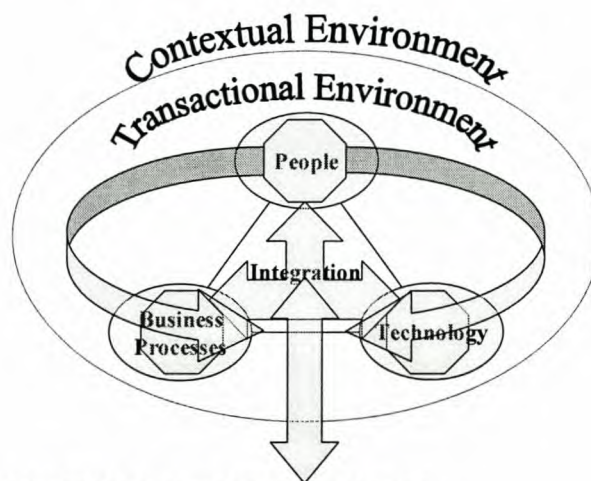


Figure 5.5 – Mapping of the TEM to the SME Entity Model

## 5.9.2 Conversion - Master Planning

The Purdue Enterprise Reference Architecture (PERA) and Purdue Methodology provide the fundamental principles from which Master Planning was developed. Master Planning is defined as the “key” to the Purdue Methodology.

PERA is characterized by a layering structure that describes the full enterprise life cycle from inception and mission definition, down to operational level and finally obsolescence. The PERA is a finite set of interrelated components put together to form a consistent whole,

defined by its functionality. The PERA views only two basic types of tasks that can be carried out in a manufacturing facility:

1. Those related to the physical manufacturing operations themselves.
2. Those related to information concerning the manufacturing operations and their control.

The two task streams are converted into three implementation streams namely; Information Systems Architecture, Human and Organization Architecture and Manufacturing Equipment Architecture.

The Master Plan enables an enterprise that contemplates implementing integrated manufacturing systems to cover all anticipated effort required to integrate the whole of the enterprise. It then proceeds to initiate smaller projects that can be supported by the financial and personnel resources of the enterprise. The sum of the smaller projects, if executed according to initial planning, will result in a final total integration of the enterprise's activities.

The Master Plan provides the enterprise with the necessary preliminary planning and operational guidance to be able to take full advantage of the technologies available. Master Planning serves to illustrate the magnitude of a project before work is started. The objective of the Master Plan is to serve as a vehicle for final evaluation and approval of the overall program by management and to provide those who are responsible for detailed analysis with the data they need.

Master Planning adopts a top down approach that proceeds from mission definition to one of the following: complete system specification or detailed implementation description. Whether complete system specification or detailed implementation description is used depends on the level of analysis required by the business user as illustrated in figure 5.6. It is a top-down approach that describes "what" should be done in order to obtain specifications for an integrated master plan (transformation plan). The approach allows for renewal that is initiated by redefining and reusing the master plan.

Figure 5.7 indicates the mapping of the Master Plan methodology onto the SME Entity Model. From this figure, it can be seen that the Master Plan essentially pushes for automation and radical improvements using technology. It also has linkages to the people in the organization and business processes. These linkages ensure the supportive alignment of people and business processes to the new technological system. Scanning of both the transactional and contextual environment is initiated by the Master Plan methodology.



Scanning has as its purpose the identification of trends and opportunities. These trends and opportunities are then used by the enterprise to identify appropriate technology and action plans.

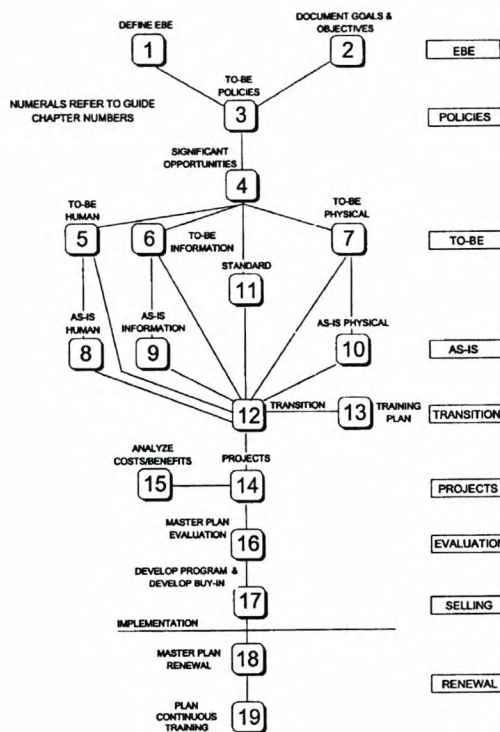


Figure 5.6 - The Master Plan

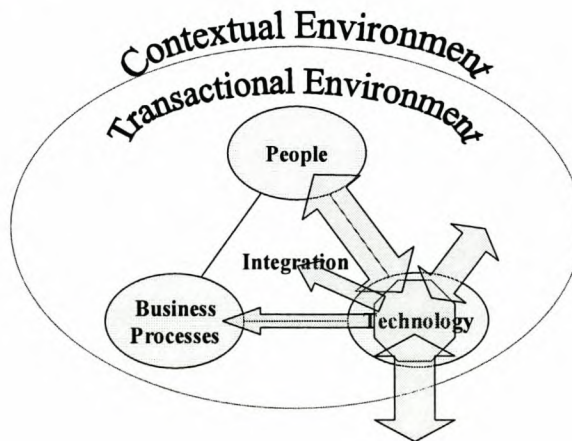


Figure 5.7 – Mapping of the Master Plan to the SME Entity Model

## 5.10 Comparison

A comparison of the two methodologies to various criteria is presented in table 4.1, to highlight the difference in approach.

Criteria	TEM	Master Planning
Condition of the enterprise	Strategic positioning of the enterprise in terms of culture, process and technology strategies is in question.	Enterprise specification in terms of manufacturing capability and information quality is in question.
Concerns	Strategic alignment of culture, processes and technology. Methodology of execution.	Specification of current and future technology capabilities. Methodology of execution.
Paradigm	Design of activities that represent the transformation of the whole enterprise.	Design of enterprise networks to meet specification of the whole enterprise.
Thinking processes	Induction and synthesis	Induction and synthesis
Output	Enterprise that strives to implement and become operational according to a predetermined plan.	Enterprise that strives to achieve best possible integration with available resources.
Method	Activities and purpose. Method to facilitate new strategy creation through a structured approach of dominance and recommended sequence. Activity modeled structure and systematic and iterative process for execution.	Method of providing specification of material, information and human organizational networks and projects requiring realization of these specifications. Method is a specified systematic sequence that is iterative.
Emphasis	Strategic aligning of enterprise to anticipated future.	Application of best practice in technology to achieve integration.
Outlook	Extrospective	Extrospective
Planner's roles	Influence and exploit trends in	Leader in application and

	competitiveness.	differentiation to exploit trends in competitiveness.
Application	Any manufacturing enterprise.	Any manufacturing enterprise.

Table 4.1 – Comparison between TEM and Master Plan

## 5.11 Conclusion

Both the Transform Enterprise Methodology and Master Planning can be seen as complete documented Enterprise Engineering methodologies. Their view of transformation is extrospective and holistic in nature.

The Transform Enterprise Methodology was not written with any specific technology in mind. Technology is addressed in “Develop Technology Solutions”, but it is seen as the least dominant activity. The Transform Enterprise Methodology focuses on the functions and activities that need to take place in a transformation. It is written in IDEF0 format to emphasize the dominance of one activity over another.

Master Planning is written with manufacturing and information technology as primary drivers. Human involvement serves to determine the extent of automation. Unlike the strategic dominance approach of the Transform Enterprise Methodology, the Master Planning is a more scientific, systematic top down approach to determine required specification. Master Planning is a systematic process to determine an overall program by which an existing system can be transformed to a future system by taking into account evolutionary objectives and specific constraints. The Master Planning process identifies the meta-conditions or strategic intent, analyses the environment for opportunities and benchmarks, develops alternative solutions and translates them to executable projects that will ensure program completion.

Both the methodologies have proven to be successful for foreign medium manufacturing enterprises. In this thesis, the scope of application is also tested on smaller enterprises (5-50 people). This is important because many high technology advanced and high value added manufacturing SMEs are present in the 5-50 employee category. These SMEs also require transformation methods to transform in order to become more competitive and grow economically. To ensure that the change required in relation to the extent of transformation that these methodologies present is not disproportionate, the author chose two high value added and technology advanced enterprises in the 5-50 people category to test the

methodologies against. The relevant discussions and results are presented in chapter 7, appendix B and appendix C.

## **6 Important MP and TEM Principles and Practical Considerations for Application**

### **6.1 Introduction**

This chapter considers the four concepts, as discussed in section 3.2, as important principles of the two chosen methodologies. The practical considerations of these principles for application in South African manufacturing SMEs are reviewed. The four principles are:

- Holism.
- Goal seeking.
- Challenging existing boundaries.
- Integration.

The discussion of this chapter seeks to inform and empower the application team for the typical situation they will face when executing the methodologies. The literature study of chapter three and SME review done in chapter two should be considered as a reference for this chapter.

Tools that can be used in the transformation process are discussed at the end to the chapter

### **6.2 Holism**

The two essential ingredients of the methodologies that should be understood in order to achieve a holistic approach are:

- A methodology is an independent framework in which man, machines and equipment, and information systems of an enterprise play a distinctive role.
- An analytical approach for man, machines and equipment, and information systems is required to ensure successful outcomes. These outcomes should be related to the methodology's set standards of relation.

Three guidelines to holism that the application team should keep in the back of their minds when using the methodologies are:

- Which activities or aspects of an enterprise are critical and cannot function independently?

- Which activities or aspects of an enterprise when put together have a dynamic influence on each other?
- Which activities or aspects of the enterprise are redundant or are duplicated in some form or another?

It is not how the process is started but how it is finished that counts. Too much excitement at the start of the process should not be encouraged, but rather a belief in continued endurance should be instilled. The methodology is a roadmap of how to reach a certain destination. The destination is determined, all the requirements for the journey are considered, key points to be reached are established and the correct routes are taken to reach the key points.

This systematic approach of the two chosen methodologies allows for the interrelated parts of the enterprise to be coordinated, therefore avoiding suboptimisation of parts at the expense of the whole. It also permits management to focus attention on the major issues relevant to the survival of the enterprise.

The lack of resources (time, money, people, equipment and machines, materials and information) is the greatest constraint to a holistic approach. This is because all aspects of an enterprise are considered. It requires a great deal of resources to identify, analyze and find a solution to every aspect of an enterprise.

The transformation “time” is composed of the work time invested and the period required for execution. The time that the execution process takes requires strong commitment and endurance for everyone involved, especially management. The execution time should be kept to a minimum. An unnecessarily long process causes people to lose focus and people start to feel that the planning process is a time wasting exercise that costs unnecessary money (Le Roux, 1998). Cost is directly related to the “time” transformation takes. Cost consists of the money per hour paid for work done and the profit opportunity lost to the enterprise.

The work should be broken up into appropriately sized segments in order to best utilise resources, especially time. The size of the work segments is dependent on the work team and the type and condition of the enterprise under consideration. These work segments should be understandable, workable and executable in the required period of time. The importance of work done on each work segment is not to do in-depth analysis, but rather to explore and raise issues of importance.

## 6.3 Goal Seeking

Every SME exists in order to achieve a goal. This goal inevitably is what the SME aspires to become. The methodologies help the SME to determine what its goal is. It does this by determining at metalevel what the SME envisions to become and then use specific strategies in order to achieve the transformation from the current state to the future envisioned state.

The methodologies provide an organized collection of activities that describe “what” must be done to change the entire enterprise. The methodologies are not how-to step-by-step approaches to transforming an enterprise. A how-to step-by-step approach implies that transformation can be successfully accomplished with a single solution or a prescribed sequence of events. When considering the entire change of a SME, this is a false assumption. The methodologies allow each enterprise that attempts to transform to follow a different path to their individual desired futures.

In this section, strategic planning refers to the actions an enterprise plans and executes in order to exercise influence on the transactional environment and on itself due to influence from the contextual environment in order to achieve the enterprise’s goals.

A study conducted by Le Roux (1998), “The Influence of Strategic Management on Successful Small and Medium Businesses in the South African Context”, was used as a valuable source of information for this section.

Strategic management does have the potential to benefit and improve the odds of success for SMEs, although it cannot be stated as a precondition for success. SMEs that do not plan strategically run a greater risk of ending up in serious financial problems than those SMEs that do engage in strategic management and planning. Older SMEs have a history that gives them the necessary foundation to launch their strategic thinking and planning from. Younger or newly established SMEs do not have that advantage. It is more difficult for small SMEs to manage and plan strategically, while it is easier for larger SME’s to do the same (Le Roux, 1998).

Strategic planning is negatively affected by a lack of resources, size, mindsets and the operational history of the SME. The “crises mindset” is characterized by a vicious cycle of month-to-month financial planning that undermines any long-term planning or visionary goals. This vicious circle causes processes that are not critical to the bottom line being overlooked in favour of those that deliver direct money. This mindset is further aggravated by daily operations and these problems lead to a reactive approach to running the SME. This

mindset sees issues that emerge during the planning stage of transformation as important and want to take immediate action to address them through allocated tasks. These tasks however fade away during tight stress situations and daily operations. This is because the tasks are not as SMART – Specific, Measurable, Accountable, Resource Consuming and Time Phased – as the projects produced through the execution of a transformation methodology.

During the execution of the methodology, it is important not to enter into any crisis management or execution of projects before the final execution plans are determined. This is because chaos is created by projects that are not tightly controlled. Le Roux (1998) states that the failure that results from well intended plans that are not successful, results in strategic management and planning receiving the blame where it could actually have been of great benefit.

When strategic planning efforts are considered, the process is many times unfocused and informal. This can lead to unsuccessful allocations of already tight resources (Le Roux, 1998). It is not the purpose of the methodologies to generate much documentation or to establish a highly formal process. The methodologies are to help the application team to facilitate the process and ensure that all the issues are explored and considered within the methodology structure to ensure completeness.

Young or newly established SMEs are very risky from an investment point of view. This is because their chances of surviving are much less than those SMEs who have been successful in bridging those first few uncertain years. Newly established SMEs do not give much attention to strategic planning, because they literally have to worry about a large number of “other urgent problems”, and they do not have the necessary historic information or knowledge of their internal and external environments to base strategic decision making on.

Most owner(s) do not have the knowledge and skills necessary to properly implement and manage strategic planning. The outcome of a transformation process should not only be the transformation of the SME, but also the educating and enabling of the owner(s) to renew the program.

Strategy frameworks like “The Portfolio Approach in Strategy Decision-making” by Kotler (1996) and Porter's (1980) “Framework of three generic strategies” are familiar. These and many like them are many times adapted for use by SMEs. These frameworks were implicitly designed for large enterprises with large pools of resources. These are popular solutions to SMEs. However, the adoption of these frameworks for SMEs fails to recognize that SMEs



have their own unique characteristics and is not mere miniature versions of bigger enterprises. The most important differentiator characteristics of SMEs that cause the inapplicability of these strategic frameworks are their resource limitations and levels of strategic planning expertise.

## **6.4 Challenging of Existing Boundaries**

The challenging of existing boundaries opens the door to innovation within a SME. The methodologies challenge existing goals, paradigms, enterprise structure and processes of the SME in order to bring about innovative alternatives. Innovative alternatives are new creative approaches that enable the transformation of the enterprise towards its desired condition.

It is sited in literature that innovation is a more informal than formal activity in SMEs (FRD&ISP, 1997). Innovation in this context refers to new or changed products and/or new or changed production processes. Innovation as mentioned here only constitutes a part of innovative alternatives, but it serves to support the view of the informal process and informal paradigm that resides in SMEs.

Informal paradigms and informal processes are great hurdles to cross in order to come to innovative alternatives. Informal paradigms blind the enterprise (owner(s), managers, employees) to the range of innovative alternatives that reside in the realm of new paradigms. Informal processes present an obstacle to the process of exploring alternatives.

The following approach represents the author's view on how informal paradigms and informal processes can be overcome by using the methodologies.

1. The Pre-transformation Method (see chapter 7) is used to assess the SME first hand. This is done through direct observation, interviews and study of files and records. The application team gains from this an understanding of the situation and the main forces at work in the enterprise.
2. Based on the application team's understanding, a methodology is chosen and the first phase of execution starts. The first phase of the methodologies views the enterprise from a metalevel (meta in this context means above or controlling). A "metaview" is established by using techniques such as brainstorming and lateral thinking to establish innovative thinking and to explore new paradigms. The metaview determines the goal of the enterprise, thus, what the enterprise aspires to become. Environmental scanning accompanies this process to stimulate new paradigms of thought.

3. The “metaview” is used in subsequent meetings, to stimulate reactions from the enterprise. Participants voice their criticism, objections and feelings about this view. The participants are now unknowingly engaged in a dialectic process, already initiated in step 1 and 2, which reveals resistance and approval of certain aspects of the future desired state of the SME.
4. The dialectic interaction creates a learning process that brings to light the current paradigm and its limitations. Some support of the current paradigm will follow through justifications and rationalizations. It is important to understand that this is not bad, because the current paradigm could only have been formed through experience. Because of the interactive mode, the participants have gained an understanding of the limitations of the current paradigm.
5. The second phase of the methodologies is now engaged by exploring innovative alternatives to supplement the limitations of the current paradigm. It is however, inevitable that certain “sacred things” will have to be eliminated. The production of new innovative alternatives paves the way of enterprise transformation.

It is beneficial to have member(s) on the application team who are not affiliated to the SME. These hold an unbiased view and can have new ideas that can influence positively on the process. The process can be seen as a counter to the informal approach. It is the author’s opinion that the intervention of an application team equipped with the work of this thesis will cause stimulation that will provide rational solutions. The process is however more important than the results. The interactive learning process leads to several iterations that result in the reconceptualisations of both problem and innovative solutions.

## 6.5 Integration

When applying the methodologies, two types of integration are achieved:

- The effort of the application team and those involved during the application of the methodologies are integrated.
- Man, machine and equipment, and information systems are related and integrated to successfully transform the SME.

The methodologies are frameworks that are essential for integration of work done during the transformation process. As already mentioned, the methodologies provide an organized collection of activities that describe “what” must be done to transform the enterprise. The

work done in order to fulfill the “what” activities is related to the framework through direct association. The work done and the dialogue process enable the negotiation of solutions between different aspects of the enterprise. This however relies on the control that participants have over the process of finding solutions. This required control is greatly enhanced by the direct association of the “what” activities with the transformation methodologies. This brings about integration of solutions and prioritisation of projects (solutions) for implementation.

The methodologies are also set up in such a way that they allow for partial integration at enterprise level. The integration at enterprise level represents business process coordination and modelling business operating rules. This is achieved by gaining a understanding of the enterprise and its processes, knowledge base, information sharing in the enterprise and the technology requirements. The TEM achieves this through the Integrate and Improve strategies and Develop Technical Solution strategies (refer to the TEM on the attach CD for detail). By extending the work of the Master Plan to include the Purdue Reference Architecture, full integration can be achieved.

## 6.6 Tools

Tools are the manual or automated aids to doing the work of the project. Office tools such as word processors, spreadsheets and project management tools are familiar and should effectively be used during the transformation process. Use of software tools improves productivity, helps to complete projects more quickly, produces higher quality results, measures costs and eliminates non value-added work by focusing instead on value-added work.

A tool that serves as an integrating platform of work documents produced in common office tools, typically those that are run on a Windows® based environment, which also possesses the following properties are of great value for transformation efforts:

- The integration of the methodologies into the tool.
- The visual representation of the methodologies and the ability to easily navigate through the methodologies.
- The ability to integrate documents produced in other programs into a documented management tree present in the tool.
- The ability to link three levels of information to the different stages of the methodologies, namely; 1) General information describing the phase and action to be taken, 2) Partial

information such as templates, best practice information and other useful information and  
3) Specific documentation produced during the transformation process.

- The ability to create different databases for the specific documentation of each project undertaken.

Such a tool will contribute to facilitating a well-disciplined and organised way of structuring, assessing and resolving of issues that are raised with a transformation process. However, its application is limited to situations of larger and more complex type of SME transformation programs or management of a variety of smaller transformations at different SMEs.

## **6.7 Conclusion**

The methodologies provide a systematic approach for the application team to follow to bring about the holistic transformation of the SME. The most important aspect to take into consideration when applying the methodologies to SMEs is the resource constraints of the particular SME. The application team must understand and manage transformation in the light of the resource constraints that the SME has in order to ensure the best possible transformation within these resource constraints.

SMEs exist to achieve a specific goal. The application of the methodologies facilitates the process of understanding this goal and determining the actions required to achieve that goal.

The intervention accomplished by using the methodologies leads to stimulation, and stimulation to innovative and creative alternatives. This enables the SME to break free from its mould and to follow a path to become a dynamic operation.

The structured approach of the methodologies helps to integrate effort by enabling the negotiation of solutions and prioritization of projects for implementation. Partial integration at enterprise level is also achieved by modeling business operating rules and representing business process coordination.

Effective tools add value to, and support the application of the transformation methodologies.

**7****Pre-transformation Evaluation Method****7.1 Introduction**

SME transformation is a complex process that requires the correct people, processes and technologies to work together as one. Attempting SME transformation prematurely will have negative consequences on an enterprise. These negative consequences are related to the amount of valuable resources (time, money, people, equipment and machines, materials and information) that are wasted and the negative perceptions that are formed. Not only can wasted resources bring an enterprise to an operational deficient state, but negative perceptions about transformation can also impair future innovation in the enterprise.

The author recommends the execution of the Pre-transformation Evaluation Method as an essential first step in the transformation process.

Three questions need to be answered before the transformation process can start in an SME:

1. Can transformation proceed in the enterprise?
2. What type of transformation is required?
3. What should the scope and extend of transformation be?

For this purpose, the author has prepared a Pre-transformation Evaluation Method. The Pre-transformation Evaluation Method is subjective in nature, because the interpretation and analysis of information are subjected to the persons and situations involved. The Pre-transformation Evaluation Method is an eight phased ranked process that requires the completion of phases according to their ranked positions.

The Pre-transformation Evaluation Method is not intended to be a complete assessment or a change method. It is a rough-cut enquiry process that guides the process of decision making for the three critical questions raised above. The Pre-transformation Evaluation Method is not a set of rigged questions with simple right or wrong answers. The questions itself present criteria that are difficult to measure due to their subjective nature. The questions are aimed at helping the evaluator gain an understanding of certain dynamic aspects of the enterprise and to facilitate discussion and debate with management and personnel. The evaluator must use his/her own discretion and initiative in scoring the answers to the criteria where necessary.

The information gained by executing the Pre-transformation Evaluation Method must be documented. This documented information will be used as a starting point during the application of a specific transformation methodology.

## 7.2 The Pre-transformation Evaluation Method Phases

The completion of different phases of the Pre-transformation Evaluation Method facilitates the decision process to the following three questions (as mentioned above).

1. Can transformation proceed in the enterprise?
2. What type of transformation is required?
3. What should the scope and extend of transformation be?

The three questions raised above represent the phases of the Pre-transformation Evaluation Method. Each of the phases consists of subsections that will ensure the completion of the phase. The phases and relevant subsections are as follows:

1. Proceed with transformation.
  - a. Facilitator.
  - b. Management Behavior.
  - c. Internal Stability.
    - i. Business Process Stability.
    - ii. Cultural Stability.
2. Type of transformation.
  - a. People related questions.
  - b. Business processes related questions.
  - c. Technology related questions.
  - d. Integration related questions.
3. Scope of transformation.
  - a. Resource Requirements.

Figure 7.1 presents the phases, subsections and outcomes.

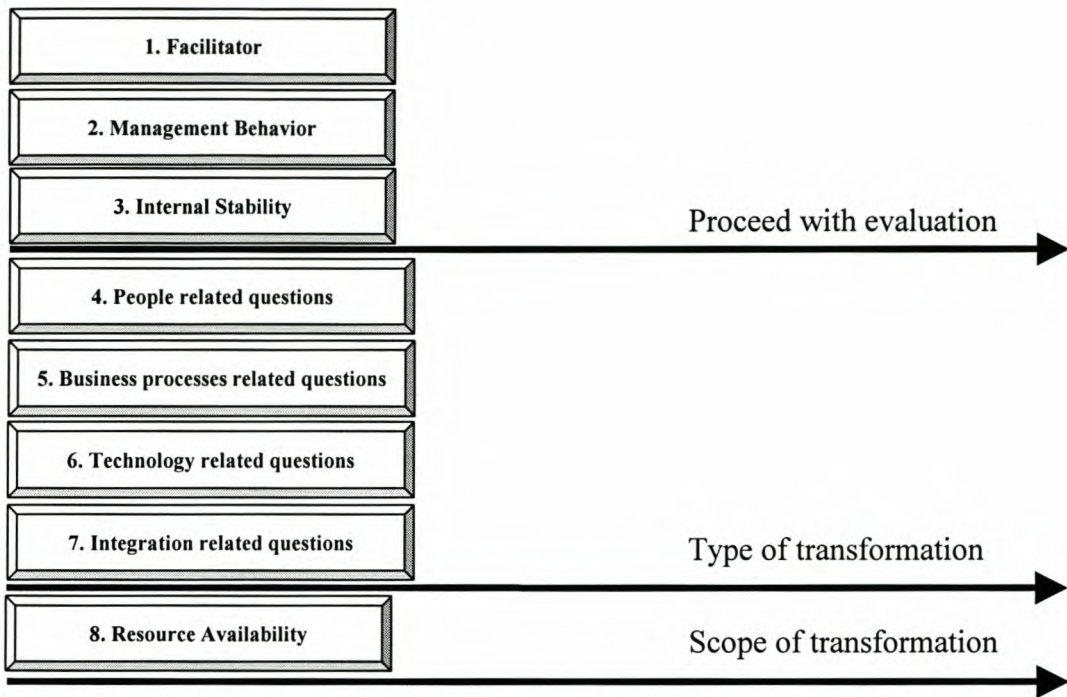


Figure 7.1 – Phases and subsections of the Pre-transformation Evaluation Method

## 7.3 Proceed with Evaluation

Although the transformation methodologies are powerful transformation methods, the process will fail if critical elements required for transformation are not present. These critical elements provide the successful enablers for change. If these elements are not present, the enterprise will struggle to gather the motivation for the transformation program let alone completing it.

In order to proceed with the evaluation phase the following criteria need to be successful:

- Adequate facilitator.
- Correct management behavior.
- Internal stability.

### 7.3.1 Evaluator and Facilitator

The completion of the assessment criteria requires an experienced and knowledgeable evaluator(s) who understands the dynamics of the SME environment.

A facilitator is also required to facilitate the transformation process. The facilitator must be familiar with the transformation methodologies and be knowledgeable in the field of Enterprise Engineering.

The evaluator and facilitator should have the following characteristics:

- Team coaching abilities.
- Working well with other people.
- Encourage participation.
- Technical knowledge.

These characteristics are essential to the successful completion of the assessment and transformation application. Ideally, the evaluator and the facilitator should be the same person. Such a person(s) could typically be an external consultant or a person from the enterprise. The evaluation process cannot continue until at least a suitable evaluator has been appointed.

### **7.3.2 Management Behaviour**

This phase does not seek to build commitment or organize management for the transformation process. Its purpose is to help the evaluator in the process of understanding if the management behavior for successful transformation is present. This phase as a secondary objective seeks to gain an initial commitment from management to collaborate in the completion of the Pre-transformation Evaluation Method.

Understanding of concepts, commitment, leadership and continuing support from management are the foundation elements for the transformation process. The evaluator needs to determine if the required management behaviors are adequate and can be trusted upon for the transformation process.

The following questions need to be positively fulfilled before the next component of this phase can be addressed:

1. Does management perceive training and understanding of concepts as an important component to the successful completion of change programs?
2. Does management communicate effectively with staff, viewing it as a two way process by providing feedback channels?
3. Did management provide commitment to other projects that it has undertaken?
4. What were the problems experienced with previous projects? Was management clear in its objectives and strategic application?



### 5. Are sound co-ordination and communication mechanisms for projects in place?

The transformation process should not continue if it is evident that management does not have or could not be relied upon for these behaviors (Understanding of concepts, commitment, leadership and continuing support).

## **7.3.3 Internal Stability**

Internal stability seeks to know if both the necessary discipline and planning that enable business processes to function effectively, as well as a low “stress” level are present in the organisational culture.

### **7.3.3.1 Business Process Stability**

The day-to-day operations of any enterprise should normally be carried out in a disciplined and thoughtfully planned way rather than in a crisis mode. If expeditors abound, deliveries are late, inventories are bulging, and rework is common, this means that problems in discipline and/or planning exist that impact negatively on the prospects of enterprise transformation. Discipline and planning are foundational to the operation of business processes. The evaluator needs to determine the source of these problems and assess if it can be adequately addressed in an enterprise transformation program. If problems are due to lack of discipline and planning, then transformation should not be attempted until it is resolved.

### **7.3.3.2 Cultural Stability**

Enterprise transformation will demand a cultural change in the enterprise. Any cultural change will have an effect on the internal stability of the enterprise. Enterprise culture is composed of formal (departments, teams or workgroups) and informal (particular shift, race or profession) group cultures. The evaluator needs to gain insight into the group cultures and the “tension” that will be created if a transformation process were to be undertaken. The “tension” is related to the self-interest factors of personnel. The factors to be considered include the general employees' morale, satisfaction levels and employees' belief in reward, benefits or penalty structures.

In general, those employees who view change as enhancing their individual interests and physical rewards tend to be more co-operative and will work to support and not thwart the efforts of a transformation program. If a high “tension” - inertia, fear, self-interest and lack of enthusiasm – for change exists in the different group cultures, then likely members of the application team together with the evaluator should first determine what the “tension” is and

afterwards consider if the transformation process should continue. People-oriented problems could prove to be more difficult to resolve than technical problems and could have serious consequences on a transformation program.

## 7.4 Type of Transformation

In this section, the SME Entity Model will be used as a framework to help identify the type of transformation that is required. Scoring will be used to identify the focus areas for transformation. Four sets of questions based on the four components of the SME Entity Model will be used. A maximum score of 100 is allocated to each of the four sets of questions. Appendix A provides a standard question list and scoring method. The scoring is calculated by allocating a weight to each question, so that the sum of the weights for each section equals 100. The score for each question, calculated as part of its weight, is then summed to determine its score out of a hundred. A low score indicates that the question is not being fulfilled. This score, when plotted on the SME Entity Model, figure 7.2, and compared with chapter 5, will provide an indication of what type of transformation method to use. Typically, a low score on technology and average scores on the other three components will probably require the Master Plan (conversion). A score that is almost the same across all four sections, or low in either business processes and/or people will indicate the use of the Transform Enterprise Model (alteration). When integration has a low score, it must be decided if technology should be the driver or a combination of technology, people and business processes. If technology is the driver, the Master Plan (conversion) must be used or the Transform Enterprise Methodology (alteration) for general integration efforts. The final decision will still rest with the facilitator of the transformation process.

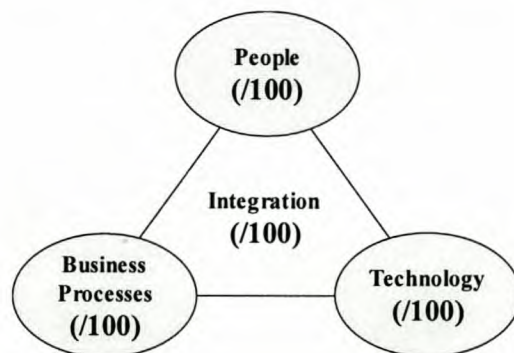


Figure 7.2 – Score mapping on the SME Entity Model

The four sets of questions are concerned with:

- People related aspects.
- Business processes related aspects.
- Technology related aspects.
- Integration related aspects.

### **7.4.1 People Related Questions**

The following questions focus on the importance of the individual to act in a mature and responsible way to benefit the enterprise:

- Do employees at different levels of the enterprise pursue their jobs beyond mere job descriptions?
- Do employees take ownership of their responsibilities?
- Are employees treated as an asset, rather than an expense?

The following question focuses on the development of employees to ensure that they will add value to the enterprise in the long term:

- Is skills training prevalent in the enterprise?

The following questions focus on the ability of employees to be shared partners and leaders to be innovative and achieve the objectives of the enterprise:

- Do employees trust each other?
- Do employees share responsibilities and credit each other when they have done well?

The following question focus on the ability of the employees to collaborate with non-members of teams:

- Do employees collaborate and work positively with outsourced employees, part time employees or consultants?

The following question relates to the importance of people being knowledgeable in their area of business.

- Are there prevailing trends of good productivity due to employees having the required skills and knowledge?

## 7.4.2 Business Processes Related Questions

It is important that the processes of the enterprise produce products and services at a rapid pace and flexible options:

- Are customers seen as an essential component in the development process?
- Are there standard systems or guidelines for producing products or services?
- Are the systems, tools, machinery and equipment responsive compared to newer models?
- Are multidiscipline work styles encouraged in the workplace?
- Are the processes of the enterprise measured for success?

It is important that processes be changed and renewed so as to stimulate productivity and innovation.

- Are processes supportive of productivity?
- Do processes motivate and stimulate innovative behavior from employees?
- Have some processes been reviewed and improved during the past year?

The enterprise must undertake changes in order to remain competitive.

- Is the enterprise re-prioritising and coordinating high leverage processes on a regular basis?
- Does the enterprise reflect a healthy balance between different activities?

## 7.4.3 Technology Related Questions

When a customer recognizes quality, it is reflected in customer satisfaction. Customer satisfaction can lead to increased revenue, making customers economic assets. This is because satisfied customers are likely to buy and buy more often. After all, a satisfied customer is the least expensive way to generate revenue and profit. They are not on the balance sheet, but indirectly they influence the figures. It is the customer's perception of the product and service that is important and nobody else's. If the customer views the quality and value for money as being good, then it is good.

- Does the enterprise have processes in place to measure customer satisfaction?

- Are customers satisfied with the current features, quality and technology used in products and services?

The technology in terms of artefacts (equipment, tools and machines) used is essential for the long-term survival of the enterprise.

- Is the enterprise aware of changing customer needs and the need for new artefacts (equipment, tools and machines)?
- Do the employees understand manufacturing processes and how these processes affect the quality, productivity, reusability and disposability of products?
- Have the process configurations been reviewed for optimum use?
- Is sufficient automation (replacement of human tasks) in place in the enterprise?
- Are human tasks being done better and faster with new technology?
- Does the enterprise use technology that is above industry standard?
- Is software and hardware in place to securely communicate, store, organize, retrieve, and process manufacturing information?
- Does the enterprise have a framework in which to plan technology requirements and manage technology?

The abolition of trade sanctions has enabled South African SMEs to compete in the global markets. It is this important for SMEs to implement sound business practices, especially a good Quality Management System. Compliance to international standards has become important for SMEs. Internationally recognized standards not only give the enterprise guidelines for quality, safety, facilities and procedures, but also provide international recognition for the enterprise. For most world-class manufacturers, compliance to international standards (ASME, ISO, DIN, SABS, ANSI, other) is a prerequisite when performing vendor appraisal. Some international standard requirements can require change of the whole Quality Management System of an enterprise.

- Does the enterprise have quality standards in place for the future requirements of customers?
- Will current systems assure that consistency and high quality standards will be maintained in the future?

- Are suppliers and customers also engaged in the quality management process?

#### **7.4.4 Integration Related Questions**

An enterprise needs to become better internally integrated and externally integrated with other enterprises and suppliers (industrial, educational, investment, and governmental) in order to support timely and cost-effective services and products.

- Does the enterprise understand its position in the value chain?
- Does the enterprise present skills of partnering and teaming?
- Does the enterprise have a consistent set of strategies, concepts and values that guide the ongoing business and product-related processes?
- Are strategies, concepts and values consistently monitored and implemented throughout the enterprise's workforce, technology, and management practices, and in alignment with the enterprise's specific performance objectives?
- Does the enterprise have well-managed physical, financial, and people assets, with information infrastructures that bind the processes together?

### **7.5 Resource Availability**

Resources from the SME will be required for the transformation process. This section seeks to know if resources are available for the transformation process. The amount of resources available will give the evaluator an indication if the resources are enough for a feasible transformation process. The understanding gained by previous sections must be incorporated into this section in order to determine the extent and scope of the transformation process.

Resources considered in this section are:

- Time
- Money
- People

Resources are a great limiting factor in SMEs. It must be determined if the resources that are available will be sufficient to undertake the transformation process. The most critical aspects of resources are the available time from management and the financial support that the enterprise has available. A rough estimate of the schedule of management for a period of six

months ahead must be made. Hours per week (typically 3-4 hours per week for management) available must be calculated. A rough budget must also be set out for the transformation process. The combination of these and information from previous phases will give an indication to the scope of transformation that can be undertaken.

## **7.6 Conclusion**

The aim of the Pre-transformation Evaluation Method is to prevent the SME from running blindly into a transformation process. The transformation process requires resources (time, money, people, equipment and machines, materials and information) to be completed successfully. Improper allocation of these vital resources can be detrimental to the SME. Negative perceptions towards change are also possible and this will impair future innovation.

Essential to the Pre-transformation Evaluation Method is the evaluator. The evaluator(s) and facilitator(s) of the transformation process should be familiar with the SME's manufacturing environment, have relevant technical and people skills, have a subjective approach, be familiar with the transformation methodologies and be knowledgeable in the field of Enterprise Engineering. Ideally, the evaluator(s) of the Pre-transformation Evaluation Method and the facilitator(s) of the transformation process should be the same person(s).

The outcome of the Pre-transformation Evaluation Method provides a good starting point for the application of a transformation methodology. It also provides a global view of those issues that require stronger emphasis during the methodology application process.

The specific experience of application of the methodologies and the lessons learnt from both methodologies are presented in the following chapter.

**8****Application of the Transformation Methodologies****8.1 Introduction**

This chapter relates the specific experience gained by the author through the application of the Transform Enterprise Methodology and Master Plan in two SMEs that represent the 5-50 people category. As mentioned in chapter 6, the methodologies have proven successful for SMEs in the 50-200 people segment, and application in the 5-50 people segment still needs to be done. The applications represented here are important because they shed some new light on the applicability of the methodologies to the smaller SMEs. Although smaller, these SMEs planning and transformation needs are just as critical, important and complex. This segment is important due to the many technologically advanced and high value added SMEs that are present in the 5-50 people segment.

The Transform Enterprise Methodology was implemented at H.S.I. Microwave Components (Pty) Ltd, a technologically advanced and high value added enterprise where microwave related components to the electronic warfare industry are developed, designed, manufactured and distributed. The Master Plan implementation was done at the Rapid Product Development division of the Global Competitiveness Centre. The Rapid Product Development division specializes in the rapid development of component prototypes for industry at large.

It is the author's experience that the application of the methodologies is done in the context of what the requirements and constraints of the enterprise are. The methodologies are not to be seen as rigid unchangeable approaches, but rather as workable approaches to what the specific enterprise situation demands. In both the applications discussed in this chapter, the methodologies were not completed in their entirety. These partial applications did not affect the worth and desired outcomes, but rather presented a custom application to what the enterprise situation demanded. This workability of the methodologies enables them to be pliable to a specific enterprise situation and the general "gut feel" and knowledge of the owners and application team. The workability of the methodologies is however dependent on the experience of SME change and knowledge of the methodology's concepts held by those contemplating application.



## **8.2 Transformation of H.S.I. Microwave Components CC**

This section reflects the specific experience and lessons learned by the author during the application of transformation methodologies at H.S.I. Microwave Components CC. Appendix B contains the detailed execution documentation of the transformation process at H.S.I. Microwave components CC.

### **8.2.1 The Establishment History**

In 1992, Herman Swanepoel was awarded the contract of developing a motor shock test trolley for a major shock absorber company in South Africa. H.S.I. Microwave Components CC was formed in 1995 to accommodate the proprietary manufacturing contract for the motor shock test trolley and the development and manufacturing of suspended stripline filters. The profits generated from the motor shock test trolley were used to extend the resource and development capabilities of the microwave technology. Products were designed and built for the military as well as the commercial markets and include attenuators, microwave filters, equalizers, microwave test units and duplexers. The primary business focus of H.S.I. Microwave Components CC is to develop, design, manufacture and test suspended strip line filters for the Electronic Warfare industry. Appendix B section B.2 provides a timetable of H.S.I. Microwave Components' CC expansion since inception.

### **8.2.2 History of the Author's Involvement at H.S.I. Microwave Components CC**

The author was introduced to the owners in early 2000. The owners later approached the author to establish a project management structure and new pricing structure for the shock test trolleys. As the relationship grew, the author was asked to be an external advisor for management decisions that were made.

The establishment of a project management structure was unsuccessful. This can mainly be ascribed to:

1. Not breaking the project up into specific objectives to be reached over a period. Critical to this was an understanding of the complexity required for each objective.

2. The old “from the top of the head” approach for managing projects was returned when pressure started to rise. This caused the implementation efforts for a project management structure to die a slow death over a few months of recurring pressure situations.
3. Most importantly was the lack of owners’ involvement to motivate and control the process.

The pricing structure was very successful, because it provided a clear breakdown of how much the product actually cost and what their profit margins were. It was found that their product was not as profitable as thought. Action was taken by raising prices, negotiating for bigger batch sizes and better payment plans in order to increase profitability.

Decision making processes were usually determined by intuition and reactive pressured situations. Decisions in which the author was involved during the second semester of 2000 included the following:

- Manufacturing operations moved to an industrial area while design and testing remained at house premises.
- A CNC-machine was purchased and operator was hired.
- An extra electronic assembler was hired.
- Electric plating operations were outsourced.
- New equipment for soldering was purchased.
- New profitability margins for products were developed.

Decisions and action taken always put everyone in a state of confusion for a period until the impact of what had been decided was fully realized.

The Enterprise Engineering experience gained through course work in partial fulfillment of Msc.Eng and part time employment at Indutech Development (Pty) Ltd brought about a better understanding of Enterprise Engineering. The particular confusion that reigned at H.S.I. Microwave Components CC brought the question of the applicability of the Enterprise Engineering discipline to manufacturing SMEs to the fore. The scope and approach of the Enterprise Engineering discipline allowed the application of the methodologies to go beyond mere operational or financial planning. It allows the enterprise to holistically consider and plan all aspects of the enterprise required to reach the desired aims of the future. The

Enterprise Engineering methodologies enable transformation as defined in chapter 5 on SMEs.

### **8.2.3 Master Plan Application at H.S.I. Microwave Components**

The author compiled a proposal to H.S.I. Microwave Components CC for the implementation of the Master Plan. The proposal was accepted and a short discussion meeting and presentation were held as a first step in the process. An industrial engineering student was hired for a period of three weeks to assist with the process. Appendix B section B.3 provides a detailed list of the enterprise structure and employees of H.S.I. Microwave Components CC.

The author and student were allocated as the champions and facilitators of the process. The designer (major shareholder) was allocated as the steering member of the transformation and employees were allocated tasks as needed.

The Master Plan was chosen because the author was familiar with it, and it seemed fit for application to the specific situation. The Pre-transformation Evaluation Method had not yet been developed, and little pre-evaluation was done prior to the application.

After the first three weeks it was felt that the Master Plan was not an appropriate methodology for the situation at H.S.I. Microwave Components CC and that the Transform Enterprise Methodology should be considered for application. The reasons for this were as follows:

- The MP has a technology push focus. It focuses on specification of machines, equipment, information technology and employee requirements for a future desired state. The anticipated effort for all the requirements are then compiled and deployed according to projects that are within monetary and personnel capability. H.S.I. Microwave Components CC had just acquired new employees, machines, equipment and facilities. It was not the concern to specify, for the capabilities were already present. The challenge was to obtain strategies and develop specific plans for utilising the newly acquired employees, machines, equipment and facilities and to move from the informal to more formal processes to ensure operational requirements for expected future growth.
- No formal vision, mission, goals, values etc. were present at the start of the process. Determining these is a process in itself. It needed to be a clear and easily presentable process. The TEM provided just that as opposed to the Master Plan that considers the vision, mission, goals, values, etc. as givens that simply needed revision.

- Due to the transformation inexperience of both the author and H.S.I. Microwave Components CC, the TEM was also perceived a much simpler and clearer process.
- The technical ability and experience of the designer (major shareholder) enabled a strong technical and technological base in the enterprise. The owner being strongly technically orientated did not see the purpose of a technical specification. This was valid, because of the small size of the enterprise and the newly acquired equipment and personnel that were exceeding current requirements. The MP, being technically orientated, and coupled with the one sided input that it facilitates from the designer, was deemed not feasible.
- There was little enterprise structure, human resource management, procedures, project management, strategic planning, etc. in place. It was required that a manageable first cut planning process should be established that especially addresses the operations and product focus. This integrated transformation plan should not be complex and require few givens in terms of previous information requirements. Taking into account the existing capabilities it was critical to ensure the success of the enterprise. The TEM posed a better solution than the MP, because the TEM provided a transformation plan and three basic strategy developments to choose from, as opposed to the specification method of the MP.

### **8.3 Implementation of the Transform Enterprise Methodology**

The TEM steps used, together with a short discussion to the specific application at H.S.I. Microwave Components CC follows. Not all the steps in the workbook were used. In some cases a combination of steps were used, while some were disregarded entirely. As already discussed in section 6.3 this was possible because the TEM is not a step-by-step approach to transforming an enterprise. A step-by-step approach implies that transformation can be successfully accomplished with a single solution or a prescribed sequence of events. The TEM provides a recommended dominance of activities to transform, but does not prescribe a strict sequence of events or time frame. This allows each enterprise to follow its own path towards transformation.

### **8.3.1 Re-organizing and Building Commitment for Transformation**

The first step, in order to continue with the application of the new methodology, was to effectively re-organize for the new process. The re-organizing required for the application of the TEM methodology was as follows.

- A few informal discussions were held to emphasize the dangers of just keeping the status quo and the potential that transformation has. The owners, with some skepticism, agreed.
- A formal presentation and discussion was held to increase understanding of the TEM methodology and how it would be applied. A commitment to proceed was reached.
- The author was allocated as the champion and application team member. The author's duties included the leading of meetings, strongly promoting transformation, capturing of work in documents at different stages, and making them available for review. The designer together with the author had to give management guidance, help, and delegate work to employees in the process of analysis and information gathering.

The constraints to gaining commitment were the designer's paradigms of how the business should be run. Because of this, it was difficult for the author to present the concepts of the enterprise transformation process. The owners were also not interested in spending time to understand the transformation concepts. Their reasons were that too much time would be required and that the concepts would be learnt as the process proceeded.

During this step of application, the author identified that commitment was correlated to the success, perceived value of the transformation process, and especially the paradigm of the owners to how the enterprise should be run.

### **8.3.2 Develop Vision & Strategy**

“Develop vision and strategy” is the process of developing a desired future condition and a practical means of achieving it. Vision is a clear and concise statement which defines what the organization aspires to become. Strategy is the transformation plan to pursue the vision (Underdown, 1997).

### 8.3.2.1 Develop Strategic Purpose

Develop Strategic Purpose is the process of transforming the Steering Team's commitment to improve the vision of what the enterprise aspires to become (Collins, 1996), the values by which it will operate, and the mission of what the enterprise will do. Collectively, the vision, values and mission are referred to as the strategic purpose (Underdown, 1997). The process of determining the vision, values and mission was not difficult. This can be ascribed to the intuitive feel and thought already given by the owners concerning these issues and the TEM process that provided clear guidance. Some disagreement and problems due to the uncertainty of H.S.I. Microwave Components CC's future were resolved because of clear verbalization of the intuition and thoughts of the owners and operational manager and gaining of an agreement to a common vision.

#### Conceive Desired Future

Conceive Desired Future converts the Steering Team's commitment to improve into a vision of what the enterprise aspires to become (Underdown, 1997).

*"Resolute pursuit to become the first choice of local and international EW companies for EW Filters by supplying superior designed and manufactured products, with short lead times and better electrical performance than international product offerings."*

The Suspended Stripline Filter design capability at H.S.I. Microwave Components CC have better electrical performance, are smaller and are more stable than any other product offering. Alternative filter offerings are designed to close proximity of specification and then tuned with tuning screws to meet specification. H.S.I. Microwave Components CC has developed a unique design capability that enables filters to be designed to meet and exceed specifications without using tuning screws. This was brought about by experimentation, alternative design software and experience.

#### Values

Values (Underdown, 1997):

- Provide guidance to the participants during the transformation process.
- Set standards of behavior that communicate to the enterprise what is acceptable.
- Represent the fundamental beliefs on which all future decisions will be based.
- Limit the range of possible strategies.

- Are developed through a brainstorming session of the Steering Team.

The owners made it clear that they believe in high moral standards of doing business. The author presented the values of a well-respected enterprise as a starting point and these were adjusted in subsequent meetings to reflect H.S.I. Values.

*The values to which H.S.I. Microwave Components CC subscribes are as follows.*

- *Relating with integrity and excellence.*
- *Promoting teamwork.*
- *Practicing loyalty at all levels.*
- *Commitment to professionalism and quality in every area of service and trade.*
- *Keeping to honest and open communication.*
- *Being financially perceptive and responsible.*
- *Being accountable and transparent about any action taken as far as it benefits the enterprise.*
- *Not to discriminate against anyone or anything based on gender, sexual orientation, religious beliefs, political affiliation, physical disadvantages, opinions, cultural background, etc.*

### **Mission**

The mission is a transformation of the vision of what the enterprise aspires to become, into a statement that defines what the future business of the enterprise is.

*Quality and expertise reflects the team's pride and pleasure in producing excellent products. To achieve this, our mission is threefold.*

- *We wish to serve local and international companies specialising in EW systems.*
- *Providing electronic warfare filters for their systems and subsystems.*
- *Insuring enterprise flexibility, innovative custom made products and satisfied customers.*

### 8.3.3 Assess Environment

Assess environment is the process of assessing the external and internal environment of the enterprise and determining a set of issues and constraints and a set of assumptions that will influence the transformation plan (Underdown, 1997).

This assessment of the environment proved to be of enormous value to the enterprise. The amount of effort required was small compared to the insight that was gained.

#### 8.3.3.1 Assess External Environment

Assess External Environment is the process of converting the existing strategic direction into an external assessment and a set of threats and opportunities (Underdown, 1997). The information for the external environment assessment was gathered from the Internet, magazines and clients. The Internet results produced particularly “mind-blowing” information to the market openness for H.S.I. Microwave Components CC ‘s products.

Information such as the following were gained (See appendix B, section B.5.2 for more details):

- *The world’s biggest producer and H.S.I. Microwave Components CC’s biggest competitor of the EW filters has announced that no new R&D in the electronic warfare division will be undertaken for the year 2001, but support of production runs will continue. Prices and payment structures were also changed to a less competitive package.*
- *All companies who produce EW filters have set the Far East and wireless communication as their primary focus.*
- *No aggressive marketing for EW filters could be found.*
- *South African EW system producers are growing in popularity internationally.*

### 8.3.4 Discontinuing of the TEM Application Process

At the completion of the environmental assessment, the application process of the TEM was discontinued. This was due to an enormous workload that H.S.I. Microwave Components CC had to cope with. The participants had little and infrequent time available, thus it was decided to stop the TEM application process. Uncertainty with regard to the value of the process was present at its discontinuing. The author’s proposal was that H.S.I. Microwave Components CC should contact him if they wanted to proceed with the process.



The owners contacted the author after three months to resume the TEM application process. They felt that the TEM process was critical to the success of their enterprise. The first part of the application proved to help in the alignment of H.S.I. Microwave Components CC. Growth was on the verge of exploding and H.S.I. Microwave Components CC did not have the capability to cope with it.

### **8.3.5 Re-organizing for Continuing the TEM Application Process**

Organising to continue with the TEM application took on a different form. This new organization of people to enable transformation proved to be much more effective and efficient.

Organisation was done as follows:

- Firstly, the author stressed the importance that greater priority should be assigned to the TEM application. The response was to allocate three hours per week of two people and keep to scheduled meetings whatever the cost.
- The author was assigned to facilitate the meetings and help with the integration of the information. The designer was allocated to lend direct management guidance and support. The financial manager (co-owner) and project manager were allocated to do analysis and preparation of the integrated transformation plan under the guidance of the author and designer.

This new approach to transformation was driven by internal motivation and work continued with rapid pace. The owners at this stage trusted the guidance of the author as to what they needed to cope with expected growth.

### **8.3.6 Prioritized List for Transformation**

The first and second meetings were used to review the work that was already done. Changes were made and consensus was reached. The third meeting was used to set up a prioritized (high leverage) list of all the issues, gained from environment assessment, that was deemed important and critical to the transformation of H.S.I. Microwave Components CC. Refer to appendix B, section B.5.5 to view the list.

### **8.3.7 Develop & Deploy Integrated Transformation Plan**

Develop & Deploy Integrated Transformation Plan is the systematic process of translating the vision, mission, issues and constraints into a practical means of achieving the vision of the enterprise and disseminating it to subordinates within the enterprise (Steiner 1979).

#### **8.3.7.1 Goals**

Goals were developed to motivate the enterprise in the context of what the future holds. The method the author used for developing goals was to focus on the activities that the participants had identified for transformation. This was achieved by using the prioritized list. This was done in order to reduce the complexity and produce a set of transformation goals that were relevant and tangible to the transformation team and other employees. Critical success factors were allocated to each goal to give an indicative measure as to when the goal has been reached.

#### **8.3.7.2 Deploy Objectives**

The transformation team saw the deployment of objectives as very important and exciting. The author followed a rapid process to determine the objectives to be deployed. The TEM followed a much more detailed process to analyse and review objectives. However, the author saw a first cut of workable objectives that could be improved through one or two iterations as more important for the particular situation. The author perceived the enterprise situation as demanding a more rapid process. The process followed was as follows:

- The transformation team voiced the constraints and issues that would halter the goals of being successful.
- Notes were taken, changes were made and goals with their critical success factors were consolidated.
- The specific actions to ensure the successful completion of each goal were then identified.
- The SMART (specific, measurement, accountability, resources and time requirements) process as proposed in the workbook was used to set-up the objectives.
- The objectives were then reviewed to gain insight to its completeness.
- The objectives were then deployed.

Table 8.1 is a representation of a typical goal, critical success factor, deployed objective, accountable person and review. Appendix B, section B.5.7 provides all the deployed objectives.

<b><u>G. Goal:</u></b> Customer relations defined.	
<b><u>CSF:</u></b> When any employee is asked what good customer relations are, he should be able to name the main points.	
<b><u>G.1. Customer satisfaction documented</u></b>	1.1. Every one in H.S.I. needs to have clarity to how customers should be treated, in terms of product satisfaction and customer interaction.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Identify the things companies praise H.S.I. for and document it.  1.a.2. Present on Monday (3 September 2001) and receive inputs from employees.  1.a.3. Prepare a list of customer relations attitudes that the employees should adhere to. Present on Monday (10 September 2001).
<b><u>1.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>1.c. Review:</u></b>	Review 1 should be held on (17 September 2001) to see if it is complete and if improvements can't be added.  Review 2 should be held on Monday (15 October 2001) to monitor success of employees ability to execute.

Table 8.1 – Complete goal for execution

A program plan for all the execution and review dates was compiled on an Excel sheet (see end of appendix B).

## 8.4 Create Desired Culture

Create Desired Culture is the process of creating a culture that has the competencies to transform the enterprise (Flanagan, 1995). Culture is the glue that binds people, processes and technology together to form an enterprise. It is the single most important component of the

enterprise transformation process. Therefore, it is essential to develop a culture that is aligned with the vision of the enterprise (Underdown, 1997).

It was decided that a culture that is built on shared interest and individual specialisation that thrives on cooperation and friendship should be pursued. This was done in order to create a responsible and creative environment where employees can work together as a team.

### **8.4.1 Sell Vision, Plan & Performance Expectations**

Sell Vision, Plan & Performance Expectations is the process of winning support for the vision and the transformation among people throughout the enterprise. It involves developing an understanding of transformation and what is required to achieve it (Underdown, 1997).

The selling of the vision, plan and performance expectations was decided upon as the most important aspect in establishing a desired culture at H.S.I. Microwave Components CC. It was assumed that the desired enterprise culture will not originate by doing detailed design, but instead will evolve over time through effective facilitation. H.S.I Microwave Components' small size enables close cooperation to exist between employees. It was decided that providing the transformation plan (the seeds) combined with commitment from owners and operation manager (the ground) and effective leadership through planning and example (the water) would be sufficient for the healthy culture that would be able to facilitate in the transformation of H.S.I. Microwave Components CC.

A five-point communication plan was followed to sell the vision, plan and performance expectations to the employees.

- An image of what the enterprise desires to become was discussed and a short story, appendix B section B.6.6, to bring this image alive was compiled and presented to employees.
- The gap, appendix B section B.6.7, between the vision and current condition was compiled in a short statement.
- The performance expectations, appendix B section B.6.8, required to fulfil the vision were determined. This provided the necessary discontent that employees needed to feel in order to recognize the need for change.
- The communication philosophy was to: 1) assure the employees that a formal organised planning process was undertaken, 2) bring across that everyone is affected in the long run,

3) build trust, excitement and hope for the future and 4) make sure that everyone understood the vision, values, mission, existing gap, performance expectations and policies.

- A document, appendix B section B.6, composing the vision, values, mission, short story, existing gap, performance expectations, policies and communication plan was compiled.
- The information of this document together with aspects of the transformation plan were sold to everyone in accordance with the communication plan. General weekly meetings and personal interaction was used as the basis of communication.

### **8.4.2 Align Administrative Systems**

Align Administrative Systems implements an organizational structure that will encourage desired decision making, efficiency and effectiveness. Administrative Systems are policies, procedures and structures that govern the operation of the enterprise. Organizational structure defines the chain of command within an enterprise (Underdown, 1997).

At H.S.I. Microwave Components the administrative system and organisational structure were informal prior to the start of the transformation program. It was the author's opinion that careful consideration should be taken of the components that could change from informal to formal processes. The reason for this was that too many formal processes would undermine the dynamism of the enterprise and unnecessary resources could be spend on efforts that do not contribute value to the enterprise. Formal procedures were already put in place for some of the deployed objectives. Refer to deployed objectives section B 5.7.

A new organisational structure was determined. Key to the new organisational structure was the break-up of the enterprise into two main units:

- Design, testing, financial and administration tasks that are run from original premises.
- Manufacturing that is run from the new premises.

The project manager was appointed as operational manager to manage testing and manufacturing. Key responsibilities and authority were formally assigned to him. This allowed more free time for the designer (main share holder) to complete designs, see Figure 8.1.

The organisational structure emphasizes the mutual commitment and support from all parties and that the emphasis is not on authority and command but on teamwork that will allow the

enterprise to thrive. This is emphasised by the following performance measure (appendix B section B.6.7); *Renewed commitment from management to employees, employees to each other and all to the company.*

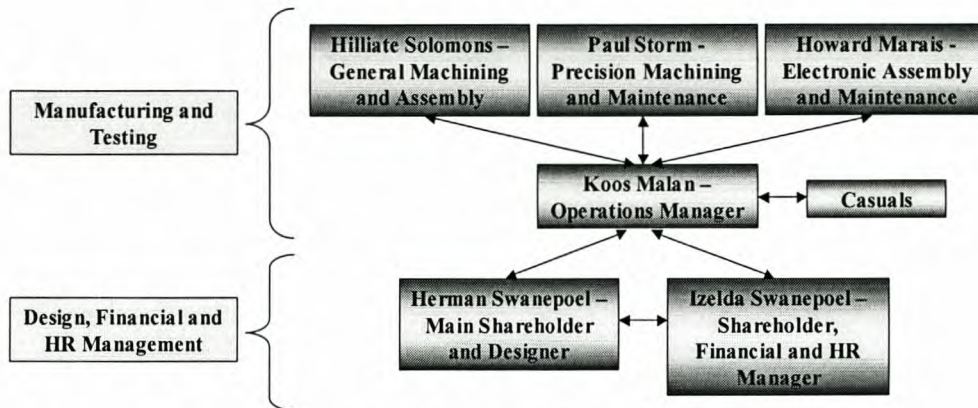


Figure 8.1 – Organisational Structure of H.S.I. Microwave Components

Next, setting standards for appropriate and inappropriate behaviour were felt as a very important part in establishing the desired culture. The setting of standards was done, not to be a “peak over the shoulder” approach, but to provide alignment for employees on issues such as quality, performance, flexibility, output levels and conflict resolution. The previous informal policies of the company were discussed with employees and written down for everyone to refer to. These policies are to be updated on a continual basis to reflect new requirements that are brought about by the transformation of H.S.I. Microwave Components. Section B.6.5 presents the set of policies.

## 8.5 Ending TEM Application at H.S.I. Microwave Components CC

It was decided by the author in agreement with the owners and operational manager that application of the TEM will be discontinued after the “create a desired culture” section of the TEM was completed. The work and planning already done required careful management in order to ensure success. In effect, the management and execution of the planning would serve as a time for testing the value of the TEM application and to consider if it is viable to continue with renewal and further application of the TEM. The author then met with the owners and operational manager every two weeks for two months in order to monitor and give advice to management during the implementation phase. The two sections that were not completed were:

**Integrate and improve enterprise:** Integrating and improving the enterprise is the process of analysing, designing, implementing and controlling enterprise processes to support the vision. Existing processes are analysed using structured engineering techniques to determine current and desired performance. Customers, products, and competitors are examined to develop requirements for new processes, which support the vision.

**Develop technology solutions:** Developing technology solutions is the process of transforming defined technology needs into specific solution requirements to accomplish higher level strategies outlined in the transformation plan. As technology needs are identified during the integration and improvement of enterprise processes, plans are developed to determine appropriate solutions.

## **8.6 Master Plan Application at the Rapid Product Development Division of the Global Competitiveness Centre**

The author was involved in a project of doing a Master Plan application as partial fulfilment for completing an Enterprise Engineering course at the Department of Industrial Engineering at the University of Stellenbosch. A team of five people were designated to the Master Plan application to the Rapid Product Development Division of the Global Competitiveness Centre (GCC) in Stellenbosch. The purpose of this project was to use the Master Plan to develop a reporting document of the TO-BE situation for the Rapid Product Development Division (RPDD) of the GCC. Only the first eight steps of the Master Plan process were executed, as these fulfilled the objective of the project. Two previous Master Plan application cycles for the GCC had been done in their entirety. This information was used as a starting point for the renewal application of the Master Plan to develop the TO-BE situation for the Rapid Product Development Division (RPDD) of the GCC.

### **8.6.1 Background Information**

The Global Competitiveness Centre, otherwise known as the GCC, was founded in January 1998 by the Department of Industrial Engineering at the Faculty of Engineering at the University of Stellenbosch. The GCC was founded to promote international competitiveness in the Republic of South Africa by providing world-class education and training, research, and products and services to the industry. The GCC strives to promote competitiveness via three business units and a support unit:

- Enterprise Engineering (EE).
- Efficient Operations Management (EOM).
- Rapid Product Development (RPD).
- Support unit.

The Rapid Product Development Division (RPDD) is responsible for the delivering of high quality service in the agile manufacturing field. It delivers these services by introducing products with a shortened cycle time, and of superior quality. The products provided by the RPDD are supported by a metrology laboratory, CNC milling machines and rapid product development machines.

The sections following provide a short discussion on the methods used and lessons learnt in applying the Master Plan steps to reach the specified objectives. Refer to Appendix C to view the detailed report.

### **8.6.2 Step 1 - Defining the Enterprise Business Entity and Establishing Feasibility**

This step highlights the prerequisite of having the support and backing of management before embarking upon any project as multifaceted and complicated as a Master Plan. The definition of the Rapid Product Development Division of the GCC as an entity and the establishment of its feasibility are also presented in this step.

The author learnt that the activities that occur in this step were of extreme importance to further application efforts of the Master Plan. Although some of these activities seem rigorous, it should be done with utmost care so that the correct “contract” between the owner(s) (see definition on owner(s) section 2.5.1) and the application team can be established.

### **8.6.3 Step 2 - Goals of the Program**

The goals of this program are to ensure that expectations are understood by the application team and employees. This is done by the owner(s) clearly defining what the enterprise aspires to become and to determine the manner in which this should be achieved. The author deemed it important that careful consideration is taken to the level (degree of abstraction, logic and authority) at which the work of this step is done. It should be done at a level out of reach of



the employees for manipulation and serve as a guide for the application team during the remainder of the program.

### **8.6.4 Step 3 - TO-BE Business Process and Manufacturing Policies**

Before the Master Plan progresses too far, it is important that the business process and manufacturing policies be prepared by the application team and be reviewed by the owner(s) for the enterprise and enterprise entity. These policies should be complete and without contradictions or ambiguities. It is also important to be sure that the developing Master Plan stays consistent with these policies throughout the Master Plan application cycle.

An important aspect to be noted is that these policies need periodic review throughout the application cycle. The application should be responsible for review, and consent of the owner(s) before changes are made.

The different policies that were addressed and reviewed for consistency, validity and completeness are:

- Business policies.
- Manufacturing/service policies.
- Corporate policies.
- Regulatory policies.
- Policies for interfacing with external entities.

### **8.6.5 Step 4 - Initiatives and Opportunities**

This step offers a major opportunity to take a fresh look at several potential sources of economic and technological benefits for the RPDD.

The experience of personnel, assessment of current systems, trend identification, Internet searches and benchmarks were used in this step to identify new initiatives and opportunities. The author has experienced that a tremendous amount of valuable information can be gained through intelligent Internet and publication searches. The benefits of these searches outweigh the cost and time involved in doing them.

The opportunities were documented and prioritised according to the following criteria:

- Achieve critical mass.

- Actively participate in education and training.
- The client must perceive a clear benefit from the RPD division's services.
- Focus on core competencies.
- Remain up to date with world-class manufacturing principles.

## 8.6.6 TO-BE Architectures

As already stated, the purpose of Master Plan application was to use the Master Plan to develop a report documenting the TO-BE situation for the Rapid Product Development Division (RPDD) of the GCC. The author deems it important to give a brief description to the concepts involved in determining the TO-BE situation for the RPDD. The TO-BE envisioned period is roughly two years from the date of creation of this Master Plan.

Figure 8.2 is a visual representation of the concepts as defined by Williams (1996). The lines are grouped into two groups, namely:

- Information lines, and
- Manufacturing lines.

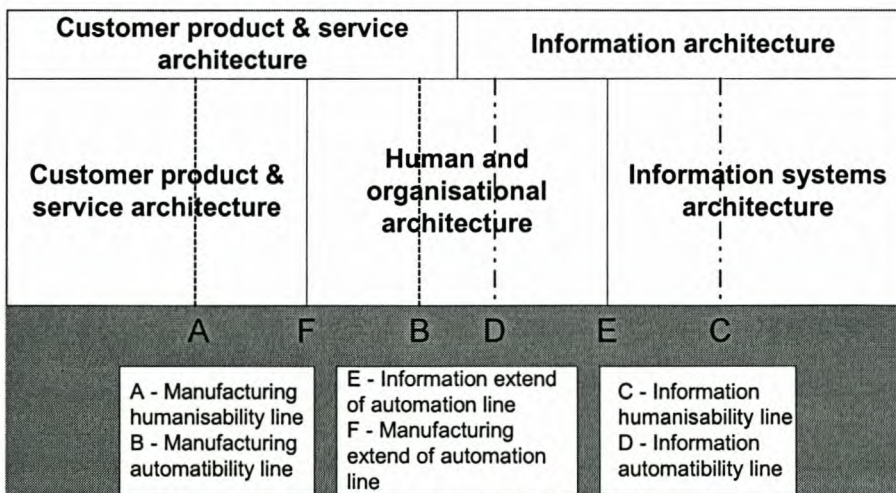


Figure 8.2 - Definition of the different information and manufacturing lines

Employees are considered as the enterprises' greatest asset and central to operation. It is to be determined which of the tasks in manufacturing and information systems should be done by employees. The combination of these tasks will form the human and organisational architecture. Lines A and C determine the maximum extend to which employees can execute

manufacturing and information functions. Lines B and D indicate the maximum extend by which technology in manufacturing and information systems can substitute the employee functions. It is to be determined where line E and F should be allocated for the most effective solution.

The design of the TO-BE architectures is an iteration process of finding the best solutions between automatibility and humanisability.

#### **8.6.6.1 Step 5 - TO-BE Human and Organisational Architecture**

This step consists of determining the functional design of the employee and organisational architecture. Determining the structure of the enterprise with respect to the employees involved, and interaction of employees with equipment and information systems is required.

The organisational structure, employee requirements and training requirements were done and can be viewed in appendix C, section C.5.

#### **8.6.6.2 Step 6 - TO-BE Manufacturing Equipment Architecture**

This step outlines the equipment to be acquired and the relevant changes it will bring to the RPDD. This involved discussion of the types of process equipment, capabilities, operational procedures, materials of construction, processes, etc. involved.

The RPDD is mainly concerned with becoming specialised in the area of rapid product development, quality control and reengineering. It was agreed that this is achievable through multidisciplinary competencies. It was determined that the envisioned growth of the RPDD would primarily require expansion in the field of rapid product development equipment, computer aided engineering equipment and reverse engineering equipment. The required equipment for the expansion can be viewed in appendix C, section C6.

#### **8.6.6.3 Step 7 - TO-BE Information Systems Architecture**

The goal of a successful information network is to support the operational and administrative functions of its enterprise. In order to design an appropriate information system, it has to be known where and how data is collected, where information is needed and processed, and which of these tasks should be automated.

The TO-BE Information Systems Architecture is defined in this step with respect to the TO-BE Manufacturing and Human/Organisational Architectures. It was identified that the RPDD had to explore new ways to capitalise on the new opportunities provided by the Information

Age. This was because the goals and objectives of the RPDD are to make use of the most up to date information technologies available.

## 8.7 Conclusion

The methodologies are very powerful approaches and much can be achieved by applying them. However, the following three points should always take prevalence when SME change or transformation is concerned.

1. “When a screwdriver will do, do not use a variety of power tools”. The Pre-transformation Assessment Method will provide guidance to whether it is appropriate to use one of the transformation methodologies proposed in this thesis. If so, careful consideration should be taken to determine if it is appropriate to use the full transformation methodology or a partial section of it. The choice mainly depends on the enterprise situation and what the enterprise’s needs are. When a methodology is applied to a SME, especially in the case of a small size SME, careful consideration should be given to complexity and level of detail. Too much complexity and detail remove the value and usefulness of the application from the owner(s) and employees.
2. “Listen and see”. It is important to listen to the owner(s) and employees and assess situations carefully before any action is prescribed or taken. An understanding of a situation and appropriate action is required instead of molding a SME to a best practice or to use brute force to make the SME conform to a certain approach.
3. “Ownership”. The owner(s) and employees must always feel that it is their solution and that they were the ones who came up with it. Without ownership, transformation will not realize.

It is the author’s opinion that the methodologies identified, described and applied in this thesis did add value and influenced positively on the two enterprises. The conclusions in chapter nine give reasons to why the author holds this opinion.

The author is also of the opinion that application of the methodologies will be viable for selected South African manufacturing SMEs.

## 9 The Summary Chapter

### 9.1 Summary

*“The environment sets many new requirements and SMEs can reactively adapt or they can design themselves to affect and operate in the environment as effective as possible.”* - Trade and Industry Minister Alec Erwin, 2000.

The objective of this thesis was to assess how applicable transformation methodologies (essentially a design process) are to South African small and medium manufacturing enterprises (SMEs). Enterprise Engineering was chosen as the reference discipline for this study. Enterprise Engineering is an emerging discipline that draws upon a wide variety of reference disciplines as a foundation. Transformation from an Enterprise Engineering perspective is considered as a rigorous engineering approach through careful planning to transform an enterprise from a current state to desired future state. Two methodologies from the Enterprise Engineering discipline were chosen, and their applicability to serve as transformation methodologies was assessed for South African manufacturing SMEs.

The thesis started by stating the thesis objective, problem statement, approach followed, limitations of the research and thesis outline. Global competitive trends for nations and manufacturing enterprises were then discussed. The current South African environment for manufacturing SMEs was reviewed in order to better understand the specific needs for transformation. Current literature on the reference disciplines of Enterprise Engineering was introduced to establish a sound foundation for understanding the transformation concepts. Transformation, Enterprise Engineering methodologies and type of transformation that each methodology presents are defined, and some important concepts of the methodologies are discussed and evaluated against prevailing South African practices. A pre-transformation assessment method was established to help in the decision process of whether a SME should go ahead with transformation at all, and if so, what the extent and type of transformation approach should be.

An application for each of the two transformation methodologies was done. The Transform Enterprise Methodology was applied at a small manufacturer of microwave components for the electronic warfare industry, and the Master Planning methodology was applied to a

business unit that specialises in rapid product development. The results of the applications are included in this report. Lessons learnt and conclusions drawn were presented in the previous sections and conclusion in section 9.5.

## 9.2 Contribution

This research provides several contributions to the South African Manufacturing SME literature. The first contribution is two comprehensive methods that allow for two types of transformation of South African manufacturing enterprises. Literature, available from mainly business schools (social sciences), on the daily management of small business is descriptive methods that are ad hoc and limited to a single process. During the course of the author's research, he found no other comprehensive transformation (design) approaches had previously been studied and published for South African manufacturing SMEs. Some work on the transformation of SMEs has been done in the USA.

The methodologies exhibit the following characteristics:

- The methodologies address the entire enterprise, but can be used on business units within the enterprise.
- The methodologies integrate man, machine and equipment, and information technology into one comprehensive approach.
- Other approaches focus on the management of specific aspects of SMEs and not on the change or total transformation of SMEs.
- The methodologies give specific consideration to SME conditions and resources constraints and are not mere miniature versions of large enterprise practices.
- Partial application of the methodologies is possible if concepts are correctly applied and the situation lends itself towards it.

Secondly, the methodologies are not “how to” approaches but “what activities” approaches. The “what activities” approach exhibits the following characteristics:

- Flexibility in the level of detail and period of application.
- Facilitates creative thinking and enables different paths to be followed that enable custom designs.
- Allows for iteration, renewal and continuous improvement.

Thirdly, complete workbooks that guide the transformation process are presented with this thesis for both methodologies. Lastly, a pre-transformation evaluation method was set up to help determine if application should continue, what type of methodology should be used, and what the extend of the application should be.

### **9.3 Recommended Future Projects**

The level of complexity and detail of the methodologies are too high for widespread use by South African manufacturing owners (see definition of owners in section 2.5.1), especially when smaller and less specialized SMEs are considered. A possible simplification of the approach with less detail, combined with examples from South African industry, and templates to improve the ease of use could be a viable project.

An extension and improvement of the Pre-transformation Method (chapter 6) for use of assessment and overview of an enterprise's competitive position is also viable. The assessment part could include an indication of the extent of transformation required, the time-frame in which it should be conducted, the enterprise's readiness for change, and the enterprise's capability to transform.

A student's involvement with an enterprise like Indutech Development (Pty) Ltd to develop a software tool specifically aimed at SMEs that serve as a platform of design is another option worth investigating.

### **9.4 Recommendations**

It is recommended that this thesis work be compiled into training material that can be used to train consultants, SME owners and students in the field of SME transformation.

It is also recommended that small business support organizations and tertiary education institutions form close collaborative partnerships. These partnerships should be a launching base for the following initiatives:

- Professional assistance for global competitive improvement of SMEs.
- Student assistance in various improvement, change and management approaches to SMEs as part of educational training.
- Workshops, seminars and diploma training courses for SME owners and consultants.

## 9.5 Conclusion

The objective of this thesis was to assess the applicability of transformation methodologies to small and medium manufacturing enterprises in the South African environment from an Enterprise Engineering perspective. The author came to the following conclusions concerning the application value that these methodologies can have to the transformation of South African manufacturing SMEs:

- The methodologies help the owner(s) to make the paradigm shift from a reactive to a proactive business approach. It places the owner(s) in a position to promote and design orderly growth, instead of letting it happen or bearing the results without influencing the forces that shape it.
- The holistic approach of the methodologies allows breakthrough in management for companies that suffer from micromanagement.
- It allows enterprises to organize themselves more effectively to cope with change, invest better in equipment and training, and do better planning for quality management and continuous improvement.
- The extrospective view allows enterprises closer attentiveness to the environment (commercial, available technology and competition) so that the SME can maintain or increase its own competitiveness through innovation in products, manufacturing processes and distribution.
- The methodologies are essential to help enterprises systematically migrate from informal systems to formal systems. This is important, because formal processes improve productivity of employees and better efficiency and effectiveness of enterprise processes, especially when viewed in the light of growth and greater specialization.
- The methodologies help in creating internal balance by helping the application team to see the functions of different aspects of the enterprise in the context of the larger enterprise. They help the application team to counter unwanted effects and repercussions that a solution in one aspect of the enterprise might have on other aspects of the enterprise. This is achieved by choosing from different generated alternatives and by providing incentives.
- The methodologies facilitate in the process of obtaining creative and innovative design solutions. The application of the methodologies facilitates an intervention process that



leads to stimulation, and the stimulation to several innovative reconceptualisation iterations of both the problem and solution.

- Partial application of the methodologies can provide custom solutions. This is achieved through proper knowledge of the methodologies and properly defining the desired output required.
- The author also concludes that the process of application is more important than the immediate results that are obtained, because of learning and experience that are brought about.

The author identified the following limitations to the application of the methodologies:

- Doing an application of a methodology is costly and time-consuming. However, well pre-planned outcomes, experience and flexibility in using the methodologies can place application within reach of most SMEs.
- The complexity and knowledge required of underlying concepts of the methodologies prohibits simple “read and do” application. A person knowledgeable in Enterprise Engineering and the methodologies is required during the application process.
- SMEs often lack competent management to execute planning and to implement transformation plans successfully.
- Enterprise Engineering and the methodologies are new to the South African environment.

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## A

## Appendix

**Pre-transformation Evaluation Mehtod****Total Score****People Related Questions**

Do employees at different levels of the enterprise pursue their jobs beyond mere job descriptions?		
Do employees take ownership of their responsibilities?		
Are employees treated as an asset, rather than an expense?		
Is skills training prevalent in the enterprise?		
Do employees trust each other?		
Do employees share responsibilities and credit each other when they have done well?		
Do employees collaborate and work positively with outsourced employees, part time employees or consultants?		
Are there prevailing trends of good productivity due to employees having the required skills and knowledge?		
<b><u>Total</u></b>		100

Comments:

**Business Processes Related Questions**

Are customers seen as an essential component in the development process?		
Are there standard systems or guidelines for producing products or services?		
Are the systems, tools, machinery and equipment responsive compared to industry standards?		
Are multidiscipline work styles encouraged in the workplace?		
Are the processes of the enterprise measured for success?		
Are processes supportive of productivity?		
Do processes motivate and stimulate innovative behavior from employees?		
Have some processes been reviewed and improved during the past year?		
Is the enterprise re-prioritising and coordinating high leverage processes on a regular basis?		
Does the enterprise reflect a healthy balance between different activities?		
<b><u>Total</u></b>		100

Comments:

**Technology Related Questions**

Does the enterprise have processes in place to measure customer satisfaction?		
Are customers satisfied with the current features, quality and technology used in products and services?		
Is the enterprise aware of changing customer needs and the need for new artefacts (equipment, tools and machines)?		
Do the employees understand manufacturing processes and how these processes affect the quality, productivity, reusability and disposability of products?		
Are the process configurations of the enterprise optimised?		
Is sufficient automation (replacement of human tasks) in place in the enterprise?		
Are human tasks being done better and faster with new technology?		
Does the enterprise use technology that is above industry standard?		
Is software and hardware in place to securely communicate, store, organize, retrieve, and process manufacturing information?		
Does the enterprise have a framework in which to plan technology requirements and manage technology?		
Does the enterprise have quality standards in place for the future requirements of customers?		
Will current systems assure that consistency and high quality standards will be maintained in the future?		
Are suppliers and customers also engaged in the quality management process?		
<b><u>Total:</u></b>		100

Comments:

**Integration Related Questions**

Does the enterprise understand its position in the value chain?		
Does the enterprise present skills of partnering and teaming?		
Does the enterprise have a consistent set of strategies, concepts and values that guide the ongoing business and product-related processes?		
Are strategies, concepts and values consistently monitored and implemented throughout the company's workforce, technology, and management practices, and in alignment with the company's specific performance objectives?		
Does the enterprise have well-managed physical, financial, and people assets, with information infrastructures that bind the processes together?		
<b><u>Total</u></b>		100

Comments:



## **B** Appendix

### **B.1 Business Establishment**

H.S.I. Microwave Components CC

4 Tongaat Street

Papegaaiberg

Industrial Park

Stellenbosch

7600

Tel: (021) 887 6554

Fax: (021) 883 8066

### **B.2 Business Activity Timeline**

Table B.1 represents an activity timeline of H.S.I. Microwave Components (1992-1994 activities not formally traded under H.S.I. Microwave Components).

1992-1994	Development of Motor Shock Test Trolley. Manufacturing of Motor Shock Test Trolleys start.
1995	Manufacturing of Motor Shock Test Trolley.
1996	Development and manufacturing of Microwave Signal Test Unit. Manufacturing and maintenance of Motor Shock Test Trolley.
1997-1998	Development and manufacturing of commercial cellular filters. Manufacturing and maintenance of Motor Shock Tester Trolley.
1999	Manufacturing of Military Filters and Amplifiers. Development, design and manufacturing of Suspended Stripline Filters. Manufacturing and maintenance of Motor Shock Tester Trolley.
2000	Manufacturing of Military Radar Filters. Development, design and manufacturing of Suspended Stripline Filters. Maintenance of Motor Shock Tester Trolley.

2001	Development and design of Suspended Stripline Filters
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Table B.1. – Timeline of H.S.I. Microwave Components CC’s Activities

### B.3 Enterprise Structure

H.S.I. Microwave Components CC is a private company owned and managed by Herman Swanepoel and Izelda Swanepoel. No formal hierarchy exists among employees, except when authority is inferred from owners.

Specific project based relationships do exist. These relationships can be defined in two categories:

- Products according to customer requirements.
- Partnerships in the completion of specific projects. These type of relationships share risks and profit according to predetermined agreements.

The functions (p = permanent, pt = part time) fulfilled by the management and personnel are as shown in Table B.2.

Mr. Herman Swanepoel (p)	Development and design
Me Izelda Swanepoel (p)	Finance, marketing and human resources
Mr. Koos Malan (p)	Project management, procurement and assembly
Mr. Paul Storm (p)	Precision machining and maintenance
Mr. Howard Marais (p)	Electronic Assembly
Mr. Hilliate Solomons (p)	General machining and assembly
Me. Collinia Singanga (p)	Cleaning
Miss. Janine Barnard (pt)	Assembly
Mr. Bouwer van Niekerk (pt)	External Advisor

Table B.2. – Management and Personnel of H.S.I. Microwave Components CC

### B.4 H.S.I. Microwave Components CC’s Relationships

H.S.I. Microwave Components CC has no other partners except the two partners as identified in section B.3. Specific project based relationship does exist. These relationships can be defined in two categories:

- Products according to customer requirements.
- Partnerships in the completion of specific projects. These type of relationship shares risks and profit according to predetermined agreements.

## **B.5 Develop Vision and Strategy**

### **B.5.1 Develop Strategic Purpose**

#### **B.5.1.1 Desired Future**

Resolute pursuit to become the first choice of local and international EW companies for EW Filters by supplying superior designed and manufactured products, with short lead times and better electrical performance than international product offerings.

#### **B.5.1.2 Values**

The values to which H.S.I. Microwave Components CC subscribe are as follows.

- Relating with integrity and excellence.
- Promoting teamwork.
- Practicing loyalty at all levels.
- Commitment to professionalism and quality in every area of service and trade.
- Keeping to honest and open communication.
- Being financially perceptive and responsible.
- Being accountable and transparent about any action taken as far as it benefits the company.
- Not to discriminate against anyone or anything based on gender, sexual orientation, religious beliefs, political affiliation, physical disadvantages, opinions, cultural background, etc.

#### **B.5.1.3 Future Business**

Quality and expertise reflects the team's pride and pleasure in producing excellent products. To achieve this, our mission is threefold.

- We wish to serve local and international companies specialising in EW systems.
- Providing electronic warfare filters for their systems and subsystems.
- Insuring enterprise flexibility, innovative custom made products and technically satisfied customers.

## **B.5.2 Assess Environment**

### **B.5.2.1 Market Situation**

- Stagnation in growth for electronic warfare systems.
- Focus in the microwave component market is on commercial wireless communication. Turnover for commercial wireless communication is greater by a factor 10.
- Whole range of SSS filters are readily available worldwide, but all of them use tuning screws.
- Prices and payment structures are changed to become less competitive packages.
- Customers are content with poor electrical performance product offerings.
- The Far East is the current focus of competitors.
- Customers are willing to buy H.S.I. products at the same price than overseas offerings. This is because H.S.I. products have better electrical performance and it will increase the level of operation of their systems in which components are used. H.S.I. also do not have to produce end user licenses in its products.
- No aggressive marketing for electronic warfare systems or SSS filters are done by any of the competitors.
- The focus of international competitors is to let established competencies sell themselves.
- The biggest producer of the SSS filters (Filtronics) has announced that no new R&D in the electronic warfare division will be undertaken for the year 2001, but support of production runs will continue.
- H.S.I. products are superior in electrical performance to any of the other products that are offered.
- Distribution of products through established networks of companies and enterprise subsystems are possible.

- The local market share of SSS sold in South Africa is considered to rise substantially.
- Collaborative product development and manufacturing are of the order of the day.

### **B.5.2.2 South African Situation**

- No formal government support for SME defense related industries.
- All the required materials are readily available.
- South African EW system producers are growing in popularity internationally.
- Government has incentive schemes for SMEs that seem very compelling.
- Capabilities required in the production of SSS filters are locally available.
- Producing better electrical performance products at the same price is considered important in engineering circles.

### **B.5.2.3 Performance of H.S.I. Microwave Components CC**

- Filters have produced very satisfied customers like Defense Tech. and Avitronics. Satisfaction was due to electrical performance that was superior to alternative products and no tuning was required for filters. Clients were satisfied with the open and collaborative structure of H.S.I. to the status of product during production and after sales service that was provided.
- The major markets do not know about the available product offerings of H.S.I.
- Non-microwave products, shock test trolley was successful, although profit margins were not as good.
- The company has a history of financial problems. The employee turnover history of H.S.I. has been high.
- Sales are not consistent and financial management cannot effectively address quite times.
- Financial support usually rested on one or two products.
- Products with incomplete data packs were taken on for manufacturing; these projects did not prove to be a success.

## **B.5.3 SWOT Analysis**

### **B.5.3.1 Threats**

- Lack of finances.
- Employees leaving H.S.I.
- Employees breaking the morale through negative behavior.
- Growth too fast with a lack of resources to support growth.
- Explosive growth (Planning structure, resource shortage, labour laws)

### **B.5.3.2 Opportunities**

- Research in the field of SSS filters has been limited since the early 80's. Many improvements can be made to product's performance using better design and manufacture.
- R&D would improve electrical performance and packaging format providing many benefits.
- Market is wide open for a technical entrepreneur, that is a leader in the field of SSS filters, to establish a niche.
- R&D capabilities of previous market leaders in the field of SSS filters are released for the development of products for the wireless communication industry.
- SSS filter market is stagnant and thus unattractive for previous established market leaders. These type of companies focus on the highly profitable and growing wireless electronic market.
- Market does not receive good client customer interaction and customised solutions. Collaborative product development is of essence.
- Markets are focused on the Far East. H.S.I. is in the position to provide good customer care of local and European markets.

### **B.5.3.3 Strengths**

- Collaborative product development.
- H.S.I.'s SSS filters have better electrical performance than competitors' product offerings.

- H.S.I.'s SSS products are exactly to specifications and do not require tuning.
- H.S.I. is flexible and in a position to adapt to customer needs.
- Quick development and manufacturing cycle.
- Customer relations.
- Variety of non-filter products that H.S.I. can manufacture

#### **B.5.3.4 Weaknesses**

- Financial resources are not yet being managed and communicated to an optimum level. Strategies for applying resources are lacking.
- Project management structure is not in place to handle large amounts of work at a given time.
- Limited capacity; this capacity has not yet been fully determined.
- Lack of experience.
- Human resource structure lacking.

### **B.5.4 Internal Environment Assessment**

#### **B.5.4.1 What Resistance Might Arise Against Transformation?**

There might not be agreement between the owners.

Operational manager or individuals from the employees may object because:

- They feel threatened because they do not understand the changes that occur and may feel that they are not needed.
- They feel underpaid.
- They feel they will work too much.
- They feel that someone is being promoted unfairly or is getting too much recognition.

It is perceived that resistance from employees will be in the following manner:

- Identified persons will have raw, impulsive, dishonorable and guiltless behavior to dominate situations.
- Slow to accept change.

- Rewards might be too little for change required.

Financial resources might not be enough to support the required change.

Machinery and equipment might be insufficient to support the product performance requirements. The etching process does not deliver the tolerances required.

Inability to deliver and execute a workable plan for transformation.

#### **B.5.4.2 What Yields/Strengths are Present?**

Personnel have positive attitude towards change. They view change as a situation that creates a win-win situation.

Clients can see future position as strategic for own operations.

Designs and general machining is sufficient to effectively support the medium term requirements for products that are superior in design and machining.

Collaboration work agreements with bigger, more established enterprises on components.

#### **B.5.4.3 What Areas Might be Most Critical or Vulnerable?**

Employees are the most critical aspect of the enterprise and any employee that leaves or is absent from the enterprise is considered to be a critical case. Instability that is created through wrong motivations and expectations is also considered critical and needs to be stabilised to sustain morale and employee performance.

Financial resources that fail.

#### **B.5.4.4 What Areas are Stable or Positively Concrete?**

Designs are stable and sound.

Financial Management is consistent and up to date.

Positive commitment from employees to improve the enterprise.

#### **B.5.4.5 What Changes will be Required to Encourage a Corporate Culture that will Support and Promote or Foster Continuous Improvement?**

Job descriptions that evolve with the employee. Employee will effectively see this as recognition and promotion to higher place in enterprise.

Organisational structure with rules and lines of authority.

Decision making that brings ownership.



News and motivation that leads to enthusiasm that will provide focus and productive levels of work.

Acknowledgement and rewards must be given for work well done. The group must be encouraged rather than just the individuals.

Effective communication and allocation of tasks to individuals.

Development of employees.

#### **B.5.4.6 Intensity and Consistency of Norms and Expectations?**

Norms are not yet properly fixed.

Intensity and manipulation of individuals breaks consistency that norms bring.

Expectations are blown out of proportion.

Too much expectation and too little emphasis on consistency and diligence.

Must be careful about the values and assumptions that people allocate to their environment, jobs and responsibilities.

#### **B.5.4.7 Current Performance Measures, Expectations, Benefit and Reward Systems?**

Employees are encourage to work because they perceive the future benefit for their efforts.

No specific benefits other than future financial benefit is provided for employees.

Employees follow the example of the owners.

No belief in incentive systems.

The intensity of survival determines the level of performance.

Employees have an expectation that the enterprise will grow and produce superior products.

#### **B.5.4.8 Communication Channels?**

Communication channels are not a major problem presently.

Certain rules have been defined on how communication must take place.

Communication coupled with coordination is still seen as a major problem by employees.

#### **B.5.4.9 Management Style?**

Management style is still centered on the owner/designer. This management style must however evolve to the place where a culture and structure is established where productivity is at its highest.

#### **B.5.4.10 Existing Levels of Control?**

Control of work is not structured and leads to insufficiencies. Control is not extensive, but rather reactive and partial. Control is being implemented in the production of products, but this process is incomplete.

Control and other aspects of how work is performed are still islands that have not yet been integrated into a sufficient whole.

Control is seen as an action/function that must be done rather than just be seen as integral part of the product. Acceptance for responsibility of control and the structure have not yet been defined.

#### **B.5.4.11 Company Policies?**

Company policies are being developed, but it is only based on the cultural aspect to control problems, rather than a designed whole that empower and help to improve insufficiencies.

#### **B.5.4.12 Education and Skill Levels?**

Employees are able to do their work effectively, but a desired emotional need is present to become formally qualified.

### **B.5.5 Prioritized List for Transformation**

Workload lessening of designer (owner) – (10)

Delivery times (late) – (9)

Financial management – (9)

Human resource management – (9)

Measurement case studies – (9)

Project control – (9)

Overtime – (8)

Government schemes – (7)

Capacity planning –(7)

Norms – (4)

Customer relations – (4)

Pricing structure – (3)

Marketing – (2)

Non-EW products – (2)

## **B.5.6 Goals**

Workload lessening of designer (owner) – The designer must have maximum amount of quality time to do development and design. CSF – Interaction with one person concerning operations.

Financial management –General financial management upgrade is required, in order to better finance structure and finance planning. CSF: Finances must be in place to buy required equipment.

Human resource management – To establish a human resource structure that will support the following aspects. CSF: Should integrate all the following aspects and must prove to be cost effective and efficient.

- Training and career path for employees.
- New employees recruitment.
- Payment policies. Performance incentives.
- Performance appraisal.
- Job designs and descriptions.
- Contingency planning for sickness, death, ect.

Project control – Complete data pack, manufacturing and quality information need to be established for each project. CSF: Knowledgeable external evaluator must rate project control as good.

Continuous Improvement - Measurement case studies that bring forth a clear understanding of previous projects and the problems that occurred. This is then analyzed and projects for improvement are established. CSF: Improvement projects have successfully been completed.

Capacity planning – A clear understanding must be gained of the capacity to produce. CSF: Template project plans from case studies are available. The aim is to:

- Reduce the lateness of projects drastically.
- To reduce the amount of overtime worked.
- To accurately plan and manage projects within the capacity structure.

Customer relations defined – Every one in the company needs to have clarity as to how customers should be treated, in terms of product satisfaction and customer interaction. CSF: When any employee is asked what good customer relations are, he should be able to name the main points.

Pricing structure – System needs to be in place to professionally, accurately and effectively produce prices and quotations for potential customers. CSF - Test run for a quotation must be executed through a standard procedure

Due to continual updating of objectives the dates of the role out plan and reviews are not included

## B.5.7 Deployed Objectives

<b><u>A. Goal:</u></b> Workload lessening of designer (Herman)	
<b><u>CSF:</u></b> Interaction with one person concerning operations.	
<b><u>A.1: Appoint project manager as operations manager. Koos Malan</u></b>	<b>1.1</b> Should be in control of all manufacturing operations at the factory. This should however be a process of steps rolled out over a period.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Become facilitator of general Monday meetings. 1.a.2. Be delegated the responsibility of all purchasing of materials. 1.a.3. Be officially delegated as the only person to be contacted if problems occur at factory. This includes any complaints and manufacturing problems experienced by employees. 1.a.4. Specific buying power for operations manager must

	<p>be agreed upon.</p> <p>1.a.5. Plans must be in place as to how operations will be run in the case of absence.</p>
<b><u>1.b. Accountability:</u></b>	Izelda Swanepoel is responsible to monitor the role out plan. Herman and Izelda are responsible for delegating authority.
<b><u>1.c. Review:</u></b>	Review 1 is to be held on to assess the employees response to new situation and to determine if new appointment is working.
<b><u>A.2. Establish clear reporting structure</u></b>	2.1. Channels of reporting should be established by the new operations manager and designer.
<b><u>2.a. Role out plan</u></b>	2.a.1. Operations manager should address the situation according to own discretion.
<b><u>2.b. Accountability:</u></b>	Operations manager: Koos Malan
<b><u>2.c. Review:</u></b>	Review 1 should discuss if communication is effective and if changes must occur.

<b><u>B. Goal:</u></b> Financial management stability.	
<b><u>CSF:</u></b> Finances in place to buy equipment. (Test equipment and CNC)	
<b><u>B.1. Profit Driven bookkeeping</u></b>	1.1. Manage finances in such a way that profit will be present as soon as possible.
<b><u>1.a. Role out plan:</u></b>	<p>1.a.1. Contract professional to give advice to the financial situation and the indicators necessary to improve on in order to show a profit.</p> <p>1.a.2. Present a plan to Herman Swanepoel and staff to how profit will be achieved.</p> <p>1.a.3. Continually communicate with Herman Swanepoel and Koos Malan concerning the financial situation.</p>

<b><u>1.b. Accountability:</u></b>	Izelda Swanepoel is responsible for it.
<b><u>1.c. Review:</u></b>	Review 1 must be held as to how well H.S.I. is performing in order to show required profits.
<b><u>B.2. Government Incentives Schemes</u></b>	2.1. The schemes and incentives that government provide should be monitored on a continual basis.
<b><u>2.a. Role out plan:</u></b>	2.a.1. The schemes that government provides should be reviewed.  2.a.2. Keep continual track when it would be possible to apply for a government incentive.
<b><u>2.b. Accountability:</u></b>	Izelda Swanepoel is responsible for it.
<b><u>2.c. Review:</u></b>	Review and discussion about advancements and when business plan must be updated.

<b><u>C. Goal:</u></b> Human resource management proposal	
<b><u>CSF:</u></b> Solution is cost effective and complete	
<b><u>C.1. Compile a HR proposal</u></b>	1.1. The proposal should be complete in the following aspects: <ul style="list-style-type: none"> <li>• Training and career path for employees.</li> <li>• New employees recruitment.</li> <li>• Payment policies. Performance incentives.</li> <li>• Performance appraisal.</li> <li>• Job designs and descriptions.</li> <li>• Contingency planning for sickness, death, ect.</li> </ul>
<b><u>1.a. Role out plan:</u></b>	1.a.1. Gain indirect insight in to the needs of the employees and company responsibility.  1.a.2. Search all the options.  1.a.3. Prepare proposal.

	1.a.4 Determine second phase of the project. This could include a second proposal or execution of reviewed proposal. Decision to this will occur on review 1.
<b><u>1.b. Accountability:</u></b>	Izelda Swanepoel
<b><u>1.c. Review:</u></b>	Review 1 and proposal will occur on the same day.

<b><u>D. Goal:</u></b> Project control	
<b><u>CSF:</u></b> If knowledgeable external evaluator rated project control as good.	
<b><u>D.1. Prepare data pack</u></b>	1.1. A complete data pack of the whole process should be completed. This data pack should include quotes and all faxes and communication during the project. This should be integrated into the project control pack.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Prepare short outlay with headings of activities required for the data pack.  1.a.2. Present the short outlay and open it for discussion at Monday Personnel meeting.  1.a.3. Start on current project with implementation.
<b><u>1.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>1.c. Review:</u></b>	Review 1.  Review 2 will be held with Linde.  Review 3 (final review) will be held with Johan and Dave.
<b><u>D.2. Quality control documentation</u></b>	2.1. The complete quality documentation for the project should be present and be integrated into the project control pack.
<b><u>2.a. Role out plan:</u></b>	2.a.1. Prepare short outlay with headings of activities required for the quality data.  2.a.2. Present the short outlay and open it for discussion at Monday Personnel meeting.

	1.a.3. Start on current project with implementation.
<b><u>2.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>2.c. Review:</u></b>	Review 1.  Review 2 will be held with Linde.  Review 3 (final review) will be held with Johan and Dave.
<b><u>D.3. Case study information for project</u></b>	3.1. A case study should be prepared for each project. This should be integrated into the project control pack.
<b><u>3.a. Role out plan:</u></b>	3.a.1. Prepare short outlay with headings of activities required for the case study data.  3.a.2. Present the short outlay and open it for discussion at Monday Personnel meeting.  1.a.3. Start on current project with implementation.
<b><u>3.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>3.c. Review:</u></b>	Review 1.  Review 2. This should discuss the success of case studies.

**E. Goal:** Continuous improvement

**CSF:** Improvement projects have successfully been completed.

<b><u>E.1. Prepare Improvement projects</u></b>	1.1. Improvement projects are prepared from information contained in the project control packs.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Case study information is reviewed.  1.a.2. Proposal for possible improvement is prepared and proposed at management meeting. If agreed project is defined for execution.  1.a.3. Project is executed.
<b><u>1.b. Accountability:</u></b>	Koos Malan is accountable for execution.
<b><u>1.c. Review:</u></b>	Review 1. It should be held to assess possible projects.



	Review 2
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<b><u>F. Goal:</u></b> Capacity planning	
<b><u>CSF:</u></b> Template project plans from case studies are available.	
<b><u>F.1. Template project plans for different products</u></b>	1.1. The template project plans should specifically focus on time requirements for each person in the enterprise, typical overtime of each employee and project lateness.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Information from case studies should be used to set up the plan.  1.a.2. Template project plan should be presented for discussion and decision-making.
<b><u>1.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>1.c. Review:</u></b>	Review for status of project should be held on.

<b><u>G. Goal:</u></b> Customer relations defined.	
<b><u>CSF:</u></b> When any employee is asked what good customer relations are, he should be able to name the main points.	
<b><u>G.1. Customer satisfaction documented</u></b>	1.1. Every one in H.S.I. needs to have clarity as to how customers should be treated, in terms of product satisfaction and customer interaction.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Identify the things companies praise H.S.I. for and document it.  1.a.2. Present and receive inputs from employees.  1.a.3. Prepare a list of customer relations attitudes that the employees should adhere to.
<b><u>1.b. Accountability:</u></b>	Koos Malan is responsible for execution.

<b><u>1.c. Review:</u></b>	Review 1 should be held on (17 September 2001) to see if it is complete and if improvements can't be added.  Review 2 should be held on Monday (15 October 2001) to monitor success by workers to execute.
----------------------------	--

<b><u>H. Goal:</u></b> Pricing structure setup.	
<b><u>CSF:</u></b> Test run for a quotation must be execute through standard procedure	
<b><u>H.1. Prepare price structure</u></b>	1.1. System needs to be in place to professionally, accurately and effectively produce prices and quotations for potential customers.
<b><u>1.a. Role out plan:</u></b>	1.a.1. Prepare presentation to the requirements for the pricing structure and review it at management meeting.
<b><u>1.b. Accountability:</u></b>	Koos Malan is responsible for execution.
<b><u>1.c. Review:</u></b>	Review 1 should be held on (22 October 2001) to assess current situation and to determine action.

## B.6 Sell Vision, Plan & Performance Expectations

### B.6.1 Policies

We at H.S.I. take pride in our workplace and in the products we produce. In order to become the first choice of local and international EW companies, we shall not compromise on any aspect of work ethics and product quality.

- No smoking in the factory or office area.
- Time may be taken to smoke outside.
- Half hour lunch is allowed.
- Employees are responsible for a clean kitchen and office area.
- Work starts at 8h00 and no more than 12 hours will be worked per day, unless agreed upon by employees and management.

#### Communication:

- All problems and grievances of employees should be referred to the operational manager (Koos Malan). If the operational manager cannot solve it, there should be agreed to refer it to the owner (Herman Swanepoel).
- It is the responsibility of the employee to understand their allocated work tasks and ask for help if they do not understand what is required of them.
- It is the responsibility of the employees to communicate clearly to one another and raise the issue if communication is not understood.

#### Finances:

- Leave is unpaid.
- Arrangements need to be made for any days taken off or when extending leave (to be reviewed later).
- General buying must be in conference with the operational officer when the purchase does not exceed R200. If any purchase greater than R200 is done, the financial manager should be informed.

#### Compensation:

- There will be a quarterly social gathering on H.S.I.'s account.
- After the delivery of projects greater than R50 000 there will be a "happy hour" between 17h00 and 18h00 at the place of choice for the employees.
- Production bonuses will be paid after the delivery of products.

### **B.6.2 The Story of the Desired Enterprise (2-4 years from now).**

The Head of Saab's Engineering Department, Terry Johnson, presents a couple of functionally similar EW filters to their Head of Military Systems Design, Dr. Scab. The large, relatively heavy filter bears the label "Filtronics" - the small and light one that of H.S.I.

Dr. Scab: (Excitedly he handles the H.S.I. filter) I have seldom seen such precision - a real work of art! Let me have a look at the test results, please!

Tery: Here you are, Sir. We specified a loss of 12db.

Dr. Scab: I can't believe this! H.S.I. achieves an 18db loss! They don't even use tuning screws! This is unprecedented quality.

Terry: Can you believe, Sir, they promise to develop and deliver, at a competitive price, several weeks earlier than anyone else?

Dr. Scab pauses, seemingly transported in thought, then looks directly at Johnson.

Dr. Scab: Johnson, I think you know which of the two I prefer...

Terry: I agree, and think it worthwhile to put all EW filter orders on hold.

Dr. Scab: Please do, and contact H.S.I. to arrange a visit. Before you do, let me first have a look when I have my earliest opening. I cannot wait to explore ventures with this kind of application possibilities.

### **Stellenbosch a few weeks later**

A neatly dressed and well-spoken secretary receives Dr. Scab and Johnston. She immediately ushers them into the boardroom where numerous components and their performance analyses are displayed in glass cabinets.

Dr. Scab: A neat place isn't it.

Herman and Izelda Swanepoel, the owners, enter and introduce themselves. A tour is undertaken of the premises. What Dr. Scab and Johnson observe is a company that operates to world-class standards.

Izelda: The requirement we have for hiring someone is that the person exhibits excellence in his field of expertise.

The design office is impressive with multiple computers lined up against the walls.

Herman: We use only the latest chips and computer technology. The machines are programmed and run 24 hours a day. We have close links to Germany where the software is developed. Actually, we helped them develop the software over the past 5 years. This led to the greater performance from the computers.

The Mechanical Design and Precision Machining workshop is spotless and working environment is evident. Ten operators and five programmers are lined up next to one of five CNC Machines and computers are ready for inspection. The Manager, Paul Storm, meets the SAAB delegation.

Paul: Please ask anyone in this workshop questions you may have. Part of their job is to know as much as myself or more.

The Assembly and Testing Department is run by Howard Marais who takes the visitors past the spectrum analysers, microscopes, precision assembly equipment and jigs.

Johnson: These jigs remind me of the anecdote of Alexander Graham Bell whose policy it was that if someone needed to measure something he had to make the measurement equipment himself – else he was fired.

Howard: We are all multi-skilled here and I personally ensure that our quality is of the highest order. We solder to an accuracy of 0.03mm.

In the General Machining Department Hilliat Solomons and his team of machinists greet the visitors with characteristic good humor.

Hilliat: As you can see our workshop is organised, our machines are in excellent working order (regularly serviced). We supply the CNC Department with Blanks that are accurate to 0.01mm.

The General Manager, Koos Malan, is busy with a call when the delegation enters his office.

Koos: Yes Paul, thanks.

He turns to Dr. Scab.

Koos: Sir, here is a complete inventory of products we have developed thus far. If you would like to test any of them we can have it in Sweden within 24 hours, or else your man may use our facilities right here.

I know as well that, in this industry, one can't snooze, else one loses. To this extent I have just placed H.S.I. on 24 hour notice to manufacture, immediately, a batch of existing filters for you, should you require any of them. Furthermore, should you need a special filter developed right now we could, realistically, have one developed in two weeks from the date of the order.

### **B.6.3 The Gap**

Four aspects represent the gap between current state and vision:

- Pride
- Communication Responsibilities (CR)

- Precision
- Cleanliness

### **B.6.4 Performance Expectations**

Pride in work and product:

- H.S.I. is a “High Tech” company.
- No compromise on any aspect of work or product.
- Every aspect of product quality is important.
- The spotlessness of the factory reflects excellence.

Communication Responsibilities (CR) – Everyone must be responsible for clear and accurate communication by making doubly sure.

To be best in class a 110% precision is required, 100% commitment from everyone and 10% added by teamwork.

Commitment is from management to employees, employees to each other and all to the success of H.S.I.

### **B.6.5 Align Administrative Systems**

Figure B.1 provides the new organisational structure that represents the new culture that is pursued at H.S.I. Microwave Components CC.

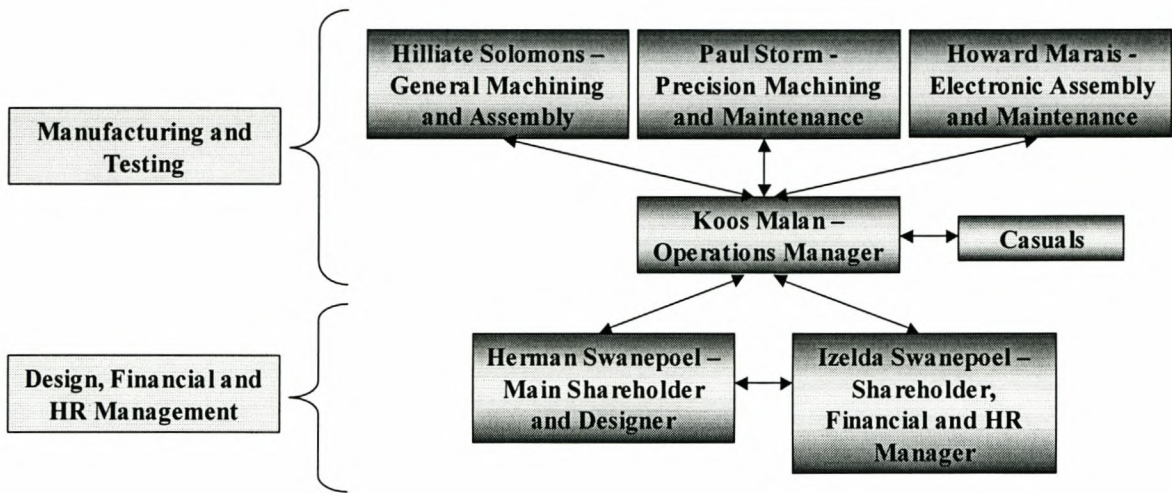


Figure B.1 – New H.S.I Microwave Components organisational structure

**C Appendix****Master Plan Application at the Rapid Product Development Division of the Global Competitiveness Centre**

Richard Goussard

Georgina Hall

Bouwer van Niekerk

Rian van der Merwe

Joubert van Eeden

July 2000

**Background information**

The purpose of this project was to use the PERA Master Plan in order to develop a report documenting the TO-BE and AS-IS situation for the Rapid Product Development Division of the GCC. The group found that the Master Plan has been developed for use in companies or projects on a much larger scale than what was used on this occasion.

There are more than a few steps in the Master Plan that were left out due to the fact that they were not relevant to the scope of the RPDD.

Time constraints prevented the group from documenting the AS-IS situation of the RPD Division.

The postal address of the Rapid Product Development Division (RPDD for this document) of the GCC is the same as that of the GCC itself. This address is as follows:

Global Competitiveness Centre in Engineering : RPDD

Department of Industrial Engineering

Faculty of Engineering

University of Stellenbosch

Private Bag X1

Matieland

7602



Tel (021) 808 4133

Fax (021) 808 4245

All key personnel discussed below can be contacted at this address.

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## **C.1 Defining the Enterprise Business Entity and Establishing Feasibility**

**Definition of the Rapid Product Development Division of the GCC as an entity and the establishment of its feasibility**

### **C.1.1 The Champion**

The champion for the RPDD is identified as Mr. James Reid. His personal contact details are as follows:

Cell: (083) 635 6166

E-mail: jreid@eng.sun.ac.za

### **C.1.2 Initiating Sponsor**

The Initiating Sponsor for the GCC, including the RPDD, is identified as Prof. N.D. du Preez. His personal contact details are as follows:

Cell: (082) 807 2833

E-mail: nddp@eng.sun.ac.za

### **C.1.3 Sustaining Sponsors**

The GCC has many sustaining sponsors, of which the following institutions are specifically involved with the RPDD:

Automated Reasoning

Aztech

Ciba Specialty Chemicals

CMS

Compaq

Epaq

MPC.Hekk

Polifin

SA Leisure

The following are associates of the GCC:

Altech

Barlow Limited

ESi

Indutech

Iscor

Qmuzik

Reumech OMC

SAP

### **C.1.4 Steering committee**

The steering committee consists of a representative of each of the sustaining sponsors, with the addition of Mr James Reid as Champion and Prof. N.D. du Preez as initiating sponsor.

### **C.1.5 Project Manager**

The project manager of the RPDD depends on who takes responsibility of the specific project undertaken. For each project therefore, the project manager can be one of three persons, namely Mr. James Reid, Mr. Zandile Millie or Mr. Ian Smith.

### **C.1.6 Enterprise Planning Team**

This is the group responsible for the development of the RPDD's Master Plan. This team consists of the following members:

- Richard Goussard
- Georgina Hall
- Bouwer van Niekerk
- Rian van der Merwe
- Joubert van Eeden

This group is involved in the analysis and preparation of the plan under the guidance of the Steering Committee.

## **C.1.7 The RPDD of the GCC as Enterprise Business Entity**

This document refers to the RPDD of the GCC as an Enterprise Business Entity. A detailed description of the GCC as a whole can be found in last year's Master Plan for the GCC.

### **C.1.7.1 Name and address of the Enterprise Business Entity (EBE)**

The RPDD has been defined as both the Enterprise Business Entity and the Enterprise Business Unit due to the fact that the goal of the RPDD is to become a self-sustaining business.

The RPDD is one of the four functions of the GCC, defined in section 1.2.2. It has the same physical address as the GCC, as identified in section 1.1.

### **C.1.7.2 Major business activity of the EBE**

The GCC endeavours to boost international competitiveness in the Republic of South Africa by providing world-class education and training, research, and products and services to the industry. The GCC consists of three main business units, namely Rapid Product Development (RPD), Efficient Operations Management (EOM), Enterprise Engineering (EE) and a support function.

RPDD is specifically responsible for the delivering of high quality service in the agile manufacturing field. It delivers these services by introducing products with a shortened cycle time, and of superior quality. The metrology laboratory, CNC milling machines and rapid product development machines, support the services and products offered by the RPDD.

### **C.1.7.3 Other business activities at the same address**

RPDD shares its facilities, such as milling machines, with other departments in the Engineering Faculty, for example the Department of Mechanical Engineering. This means that use of the facilities must be scheduled in conjunction with other parties.

Furthermore, the RPDD also shares its facilities with the other three functions as defined in section 1.2.2.

### **C.1.7.4 Strategic purpose of the EBE**

The RPDD exists in conjunction with the other legs of the GCC for the following reasons, which can also be seen as its strategic purpose:

- To bring funds and practical expertise into the department of Industrial Engineering.



- To enhance the global competitiveness of South African companies by providing them with Rapid Product Development services.
- To be self sustaining

### C.1.7.5 Management Structure of the EBE

An organigram of the GCC and its management structure is shown in figure 1.1. From this diagram the RPDD is seen within context of the GCC as a whole.

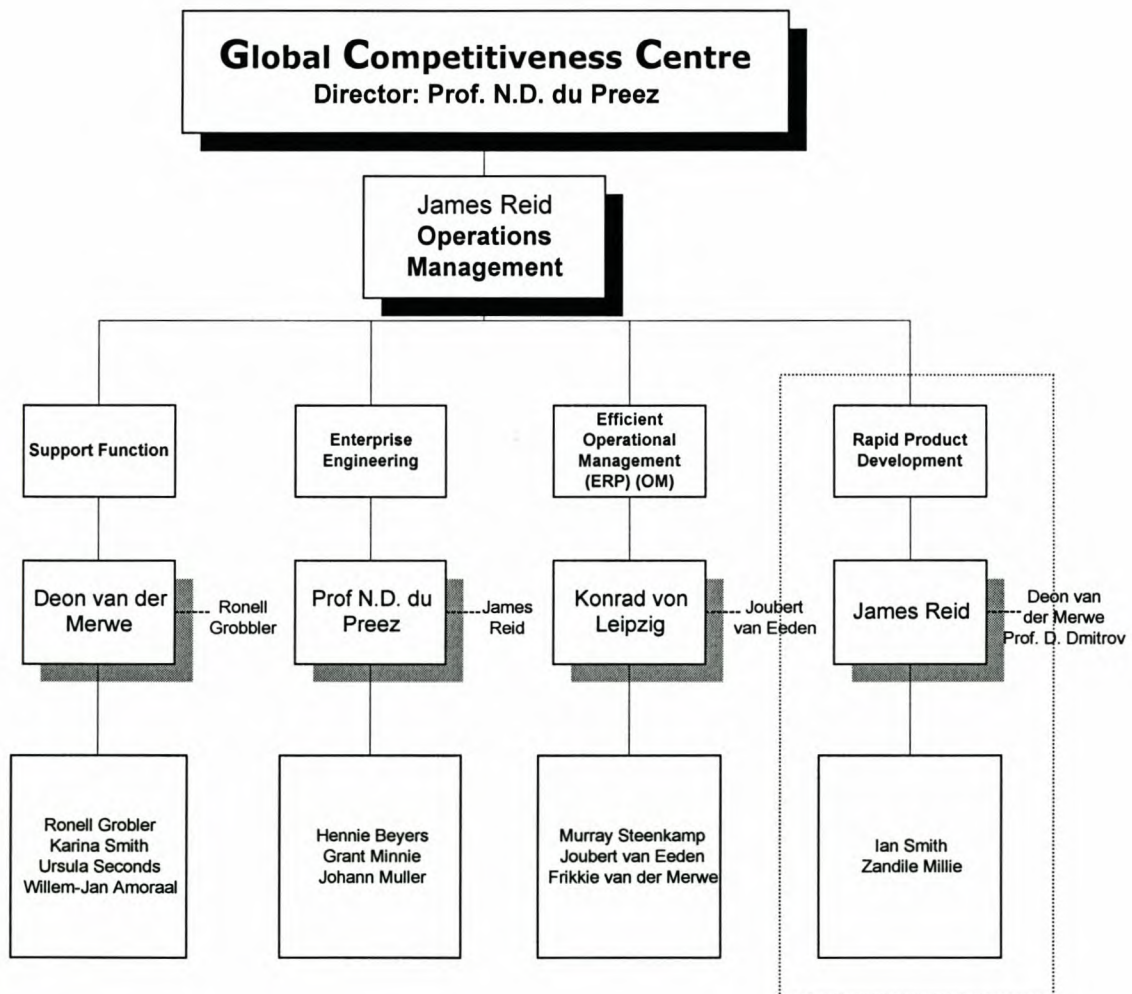


Figure 1.1 - Organigram of the GCC

### C.1.7.6 Physical and Functional boundaries of the EBE

The RPDD is situated in different parts of the Engineering building of the University of Stellenbosch, according to the different functions it fulfils. These different offices are used for

administrative duties and the actual machining functions. It must be noted that many of the RPDD facilities are also used for the other divisions of the GCC.

The following **physical boundaries** exist:

- At present activities are limited to the laboratories provided by the University of Stellenbosch and the GCC.
- They have limited production capabilities because of limited time, personnel and machine constraints.
- As far as **functional boundaries** are concerned, the following apply for the RPDD:
- It cannot function outside the knowledge/areas of expertise of staff members.
- Policies and laws dictate what may or may not be manufactured.
- No product ideas are generated; it only develops prototypes of concepts submitted by clients.
- It does not facilitate mass manufacturing, only prototypes of products.

There is a strong link between the functional capabilities of the RPDD and the Engineering faculty. This is because the resources are commonly available to staff of the department. It is necessary for the RPDD management to ensure that this expertise is used efficiently and economically.

### **C.1.7.7 Capital commitment to the EBE**

The department of Industrial Engineering and the GCC partners are committed to enhancing global competitiveness in South Africa. It is felt that for as long as the GCC can be effective in its role, it will be funded.

It is hoped that the RPDD will become self sustained in the near future. One of the purposes of this document is therefore also to provide guidelines to make the RPDD a profitable entity.

## **C.2 Goals of the Program**

The goals of this program are set out in this chapter to ensure that expectations are understood by both employees and the Enterprise Integration Planning Team

### **C.2.1 The mission, vision and values of the RPDD**

#### **C.2.1.1 Mission of the RPDD**

The RPDD's mission is to provide quality products and services in niche markets in the medium-sized manufacturing sector that requires rapid product development technologies. In order to accomplish this the RPDD will focus on:

- Industrial and academic services and products for South African companies and in the field of Rapid Product Development.
- Continuous quality education and training to students and members of industry, by formal means (e.g. seminars) and informal means (application of theory).

#### **C.2.1.2 Vision of the RPDD**

The RPDD will strive to achieve long term growth for all its combined stakeholders by enhancing its role in the South African consulting and manufacturing business. Areas of critical importance will be to identify new technologies, acquire these technologies, master them, and then also to teach others how to use them, thereby transferring the new technologies to industry sectors.

#### **C.2.1.3 Values of the RPDD**

The RPDD commits itself to the following ethics:

- To extend and encourage South Africa's industrial competitiveness locally as well as globally.
- To use environmentally friendly processes at all times.
- To establish and maintain a professional practice with professional and dedicated employees and partners.
- To use the latest and most suitable technologies in serving clients.

- To offer secure employment for its employees
- Not to discriminate against anyone based on their gender, sexual orientation, religious beliefs, political affiliation, physical disadvantages, opinions, cultural background.

## **C.2.2 RPDD objectives**

### **C.2.2.1 Long-term objectives (2 years and longer)**

- Become a recognised entity in ensuring that South African industries become globally competitive, starting with our industrial partners, through education, training and consulting.
- Strengthen the RPDD's functioning by continually identifying (searching for), acquiring, mastering, teaching and transferring relevant and feasible leading edge technology to industry in South Africa in collaboration with our Industrial Partners.
- Make full use of the equipment, facilities and expertise available within the boundaries of the GCC and its immediate environment.
- To provide an industry-comparable support structure to its employees to ensure that a core of skilled and motivated staff remain with the RPDD.
- Obtain new industrial partners who will support the technology and encourage innovation.
- Aid in the promotion of SA industry internationally and the exposure of local industry to the international market.

### **C.2.2.2 Medium-term objectives (1 to 2 years)**

- Reach financial independence within a given time frame by providing a bureau function to industry without competing directly with existing businesses. Financial independence is understood to imply establishing the ability to renew equipment and acquire new technology. Independence is required in order to establish and maintain a core group of competent personnel. New infrastructure acquired with respect to market development.
- Develop a third income stream that is acceptable to support as much as possible (own income / subsidiary).
- Establish a complete RPDD process chain with emphasis on the manufacturing industry.
- Acceleration of applied research based on industry related projects.
- Compression of time to market and development cost of new products.

### **C.2.2.3 Short-term objectives (shorter than 1 year)**

- Create a forum through which our Industrial Partners can continually compare knowledge and expertise in a mutually beneficial manner.
- Implement a costing system for all RPDD activities that is compatible with the GCC's costing system.
- Actively obtain more buy in from the Department of Industrial Engineering by providing more information on activities, and more particularly, the benefits and opportunities that these present to the department.
- Make employees and associated contributors to the RPDD aware of its mission, vision and values as described in this plan.
- Release a quarterly report of the RDPP completed and ongoing projects, as well as plans for the next quarter of the year.
- Develop one or two "focus courses" that can be actively marketed and presented to industry. It is vital that these courses are relevant to industry and that they are presented in a highly professional manner.
- Maintain an up to date web portal that provides information and can be used as a forum for networking through discussion groups etc.
- Identify roles and responsibilities within the RPDD and surrounding activities. This will eliminate many cases of confusion concerning who is responsible for what activity in the RPDD and the surrounding activities.
- Strengthen our position in industry and with our Industrial Partners by delivering credible work of the highest quality.
- Set up a business plan for the RPDD that will provide guidance as well as a common understanding of the direction in which both the GCC and RPDD are moving.
- Development of marketing material for the RPDD; brochures, posters and a web portal.
- Identify limiting factors in local industry in terms of international competitiveness.
- Identify all possible players who can contribute to the elimination of the limiting factors to competitiveness.

- Initiate a marketing program for the RPDD. This marketing program must clearly indicate what services are offered to industry.
- Maintain an effective configuration management system that makes traceability and management of projects and task responsibilities possible.
- Be available to conduct research in support of ideas and projects for the GCC, Department of Industrial Engineering and industry.

## **C.2.3 RPDD goals**

### **C.2.3.1 Long-term goals (2 years and longer)**

- Be financially independent by December 2001.
- Develop a consistent third income stream that is acceptable to support as much as possible (own income / subsidiary).
- Earn enough income to support expansion of the RPDD.

#### **C.2.3.1.1 Medium Term (1 to 2 years)**

- Compression of time from concept to first prototype to 15 working days
- Compression of time from model or drawing to first prototype of 5 working days.

#### **C.2.3.1.2 Short Term (within 1 year)**

- Implement a costing system for all RPDD activities that is compatible with the GCC's costing system.
- Reach 80% utilisation of all RPDD facilities.
- Cover costs of operation by 31 August 2000.
- Be in position to determine Business Entity's return on capital invested.
- Be in position to measure Business Performance Indicators such as productivity, quality, flexibility, cycle times and assets.
- Be able to measure productivity increase as a percentage of total economic return and in terms of percent productivity increase.
- Be able to measure quality increases as a percentage of total economic return and in terms of percent productivity increase.

- Be able to measure personnel cost savings as a percentage of total economic return and in terms of percent productivity increase.
- Be able to measure improved maintenance methods as a percentage of total economic return and in terms of percent productivity increase.

## **C.2.4 Strategies**

The RPDD will use the following strategies to achieve its goals and objectives:

- To form relationships with South African companies, academic institutions and the government.
- To form relationships with companies involved with RPDD in order to benchmark best practices, integrate technologies and forge strategic alliances.
- To form relationships with a network of international partners, which will ensure global credibility and awareness of current best practices.
- To adapt information architecture manufacturing equipment and human organisation to meet business needs.
- To maintain a close relationship with customers and partners both locally and internationally in order to detect changing market trends.
- To use the most recent communication technologies in order to optimise our communication with external entities.
- To attract enough business in order to cover costs and make a profit.
- To adopt a philosophy of total customer focus, thereby portraying a good public image.

## **C.2.5 Business Plan**

Refer to Mr James Reid

## **C.2.6 Critical success factors**

These are the objectives that must be achieved for the RPDD to be a self-sustaining enterprise.

### **C.2.6.1 Achieve critical mass**

Enough projects must be taken on by the company to create revenue to cover the costs. In the process to become self-sustaining, this is the first crucial step. Once this is achieved, further

changes can be made to the organisation to become profitable. Accurate calculation of profitability measures is vital in order to determine whether this factor has indeed been achieved.

#### **C.2.6.1.1 Actively participate in education and training**

The RPDD must ensure that its employees participate in education and training both within the Department of Industrial Engineering and their Industrial Partners. This involvement will create an environment of goodwill that will open doors to new business opportunities. A policy of 'practice what you preach' will have to be adopted so that the content of the training and education courses reflect what is done in reality within the business functions of the RPDD. The number of training courses, seminars and conferences must be set so as to reflect a definite impact on the business community.

#### **C.2.6.1.2 The client must perceive a clear benefit from the RPDD's services**

To establish a reputation in the business community, the value added to the client's products by the RPDD must be evident. Therefore, manufacturing companies should view the RPDD as an integral part of their product development process. The quality of the business functions should therefore be superior. The amount of repeat business from clients is a measurement of this type of success.

#### **C.2.6.1.3 Focus on core competencies**

The RPDD should not get involved with functions outside its core competencies (e.g. mass manufacturing), even though those markets may exist. By monitoring the amount of time spent on the division's activities, a measure of how focused it is on its critical business functions can be achieved.

#### **C.2.6.1.4 Remain up to date with world-class manufacturing principles**

The RPDD division should keep up to date with current developments in the product development field. This should include research on new technologies, business trends, materials, etc. This is vital to keep the RPDD competitive as well as help South African companies to become globally competitive. The number of research papers published by RPDD employees is a measure of this, and will also ensure academic credibility with outside institutions. There should be a predetermined amount of time that employees should spend on research and benchmarking current best practices.



## **C.3 TO-BE Business Process and Manufacturing Policies**

The business process and manufacturing policies to be affirmed are those of the defined Enterprise Business Entity. The PERA Master Plan must consistent with these policies.

### **C.3.1 RPDD policies related to manufacturing facilities**

#### **C.3.1.1 Business policies**

- To ensure that the focus of the company is evaluated according to the mission, vision, objectives and goals in this plan, and made known to employees of the company. This activity must be done at regular intervals (at least twice per year) to ensure that the company is focusing on its core business.
- To be financially independent from the University of Stellenbosch and the GCC, and be a profitable organisation.
- To gain insights into the industry, especially with respect to suppliers and partners.
- To continually evaluate and assess the RPPD's activities and impacts on the various organisations and the environment.
- To adhere to and exceed international standards.
- To provide safe and secure working environments to all employees.
- To provide sufficient training to all parties, personnel and clients of the RPDD.
- To periodically review the master plan of the RPDD to ascertain whether it is still on track with its developments and projects.
- To maintain acceptable levels of transparency both within the RPDD and externally, for equal benefit of all parties involved.
- To communicate the RPPD's goals to all business levels at all times.
- Information regarding projects will be made readily available to the appropriate clients, stakeholders and partners. The RPDD will sign a confidentiality agreement if requested by the client. All project information will be handled in a professional and confidential manner.
- The financial position of the RPDD will be readily available to all employees and clients.

- The RPDD must convey a professional appearance so as to promote its image to the external businesses and clients.
- If the customer requirements change during the course of a running project, the project will be re-evaluated and re-planned. The customer will be charged for work already done.
- Personnel will be appointed on a part-time or a full-time basis and will be compensated according to the time they work for the RPDD.
- The technology that the enterprise invests in should be related to their core business.
- Employee training and education is considered a priority to ensure company development.

### **C.3.1.2 Manufacturing/service policies**

- To stay abreast of the latest trends in technology and other fields of interest.
- To appraise its performance by means of self-assessments and evaluations.
- To adhere to and exceed international manufacturing policies.
- To always provide quality services and products.
- Product designs should be done in collaboration with customers to ensure that the resultant product meets customer requirements.
- Developed prototypes should be of a high enough standard so as to demonstrate the critical aspects of the final product and, if required, the RPDD must be able to support the manufacture of a fully functional prototype.
- The maintenance of the equipment of the enterprise will be carried out at regular intervals as specified by the manufacturers of the equipment.
- Appropriately educated and trained support personnel will perform maintenance on the equipment. Proof of competency is required for these maintenance activities.
- A performance evaluation will be held after each project to assess the quality of the work done and to make recommendations. This evaluation must include feedback from customers.
- The RPDD will always work with the most technologically advanced equipment that can be afforded and is in use or needed by the South African industry.
- A highly effective information system that ensures effective communication flow within the RPDD and with its clients should be maintained.

### **C.3.1.3 Corporate policies**

- To adhere to all government regulations and laws.
- To adhere to all international standards and procedures regarding manufacturing and the safety of facilities and employees.
- To consider environmental impact of business processes and products.

### **C.3.1.4 Regulatory policies**

- To accept responsibility, accountability and credibility where necessary and applicable.
- To use Knowledge Management techniques to maintain the RPDD's past and present data concerning projects, activities, published materials, research ventures, expansions, etc.
- Standard industrial regulations will apply for the facilities used by the RPDD.
- All access to the enterprise facilities will be controlled. Only authorised persons will be allowed on the premises of the enterprise.
- Data security will be managed in-house.
- All employees must sign an intellectual property agreement stating that all research or knowledge gained whilst employed by the RPDD cannot be used for personal gain, for a predetermined time period.

### **C.3.1.5 Policies of interfacing with external entities**

- To answer the needs of its external and internal customers, thereby upholding its customer relations.
- To collaborate with the Department of Industrial Engineering, the GCC and the industrial partners in order to foster consensus among all involved in the RPDD's projects.

## **C.3.2 Analysis of the manufacturing policies of the RPDD**

The following comments can be made regarding existing and future policies:

- Policies defining the focus of the company need to be developed.
- A marketing strategy and policy is lacking at the moment. These should be developed, bearing in mind that the success of the RPDD is dependant on the industry's level of awareness of their business activities.

- The GCC states that it doesn't want to be in competition with other companies, but a conflict arises where the RPDD is concerned, as it effectively does compete with other companies with the same capabilities and business activities. This policy should therefore be clarified for the RPDD.
- An effective project scheduling policy should be developed so as to ensure fairness to both academic and commercial clients.
- At the moment, the ultimate goal of the RPDD conflicts with the University's policy that states that personnel on contract work are not entitled to full benefits, and people employed by spin-off centres (like the RPDD) may not be employed on a permanent basis. With this in mind, the RPDD should develop a policy that ensures their employees receive benefits such as pension and medical aid, regardless of permanent contract employment. These benefits should be optional to the employee.
- A detailed policy regarding financial matters, including auditing, should be developed.
- A policy should be set up regarding suppliers, e.g. payment details, delivery times, etc.
- A policy regarding costing for academic and commercial projects must be set up. This must include clear definitions of what is considered academic and commercial work.

## C.4 Initiatives and Opportunities

**This step offers a major opportunity to take a fresh look at several potential sources of further economic and technological benefits for the RPDD.**

### C.4.1 Benchmarking

No benchmarking study has been done concerning the current AS-IS condition of the RPDD. When defining the TO-BE condition of the RPDD, the possibility of a benchmarking study should be considered.

The business sectors that should be investigated for benchmarking include virtual entrepreneurial companies; small enterprises in the manufacturing sector that outsource some of their projects to larger manufacturing companies; and large manufacturing companies that provide services to businesses that need to do small manufacturing projects.

### C.4.2 Identifying new opportunities

The following opportunities exist for different areas in the Rapid Product Development field:

#### C.4.2.1 Business opportunities

- Perfecting prototypes for customers with a view to mass-manufacture, for example jewellery, industrial parts and decorative objects.
- Growing prototypes with the Z Corp machine to assess ease of manufacturing or assembly. This will also aid in product visualisation. Investment casting can also be considered as a way in which to use the models grown on the Z Corp machine.
- To build partnerships with product development companies to capture the once-off component market.
- To provide a service where handmade prototypes can be converted to CAD files and surface profiles for later reproduction.
- To offer CAD/CAM training and refresher courses to highlight new developments of computer-aided design tools. This can also serve as an effective marketing tool.
- To expand into international arenas in order to build up contacts with international leaders in the RPD field, and also to remain up to date with international trends.

- To use the Internet as a business portal where clients have real-time access to all information regarding their projects.
- To provide quality control services to clients, for example the measurement of part dimensions.
- To become a certified metrology laboratory.
- To provide tooling and dies for the injection moulding and casting industries.
- The RPDD can provide a consulting service on product viability with respect to the support of the manufacturing activities for example tooling.
- Using CAT scan technology, graphic models can be developed of brains, bones etc. These 'pictures' can then be used in the future as a reference.
- CAD/CAM can be used both to develop product designs and cutting-paths for CNC machining.
- Develop the RPDD's links with facilities at UCT, Pentech and the Cape Technikon, where Rapid Prototyping capabilities exist.

#### **C.4.2.2 Research opportunities**

- Because of extensive research facilities available, the RPDD has the opportunity to investigate and implement new ideas in existing business fields.
- Because of some employees' specific interest in the field of e-commerce, the RPDD can do extensive research in business opportunities on the Internet.
- Explore the integration of manufacturing and the medical industry, specifically in the field of biomechanics.
- The field of Laminated Object Manufacturing (LOM) is undeveloped and gaining a leading edge in this field can be beneficial to business.

#### **C.4.2.3 Identifying opportunities from present problem solutions**

Some problems are currently experienced in the RPDD. Solving these problems creates some additional opportunities:

#### **C.4.2.3.1 Critical mass**

A lack of available staff sometimes causes manpower problems. The fact that work usually does not arrive at regular intervals places a strain on the manpower capabilities of the company. The solution to this problem is to develop a critical mass of staff that will be able to balance machine and human utilisation, which will enable the RPDD to accept more projects, generating more revenue. This critical mass of staff will ensure that employees going on leave no longer cause major disruptions in production schedules.

#### **C.4.2.3.2 Staff retention**

The present situation is that most of the RPDD's employees are employed on a contractual basis. This can result in a high turnover of staff and does not facilitate the building of close relationships with customers. There is also a considerable amount of time and money invested in the training of this staff. The benefit of which is lost when the staff member leaves the RPDD. Thus the employment of permanent staff or offering long-term contracts will prevent these problems. The company will benefit from the training of their employees and allow relationships to develop between the clients and employees. This will also open new areas of opportunity for the RPDD due to the trust and confidence of their clients.

#### **C.4.2.3.3 Ownership of equipment**

There is a 50-50 ownership of some of the equipment by the GCC and the Department of Mechanical Engineering. These machines are controlled mainly by the Mechanical Department. This causes problems in the prioritisation of academic and commercial work. By developing an agreement between the two parties, promises made to clients can be met. This will enhance customer satisfaction.

### C.4.2.4 Prioritising opportunities

The matrix below was created in order to determine the priorities of suggested opportunities. Management should pursue the opportunities with the highest priority first.

Opportunities	ACHIEVE CRITICAL MASS	ACTIVELY PARTICIPATE IN EDUCATION AND TRAINING	THE CLIENT MUST PERCEIVE A CLEAR BENEFIT FROM THE RPD DIVISION'S SERVICES	FOCUS ON CORE COMPETENCIES	REMAIN UP TO DATE WITH WORLD-CLASS MANUFACTURING PRINCIPLES	TOTAL
<b>Weights</b>	<i>25</i>	<i>15</i>	<i>20</i>	<i>10</i>	<i>30</i>	<i>100</i>
Perfecting prototypes for customers with a view to mass-manufacture, for example jewellery, industrial parts and decorative objects.	6	2	11	2	9	30
Growing prototypes with the Z Corp machine to assess ease of manufacturing or assembly	20	7	16	8	23	74



To build partnerships with product development companies to capture the once-off component market.	19	9	17	8	24	77
To provide a service where handmade prototypes can be converted to CAD files and surface profiles for later reproduction.	22	7	16	10	18	73
To offer CAD/CAM training and refresher courses to highlight new developments of computer-aided design tools. This can also serve as an effective marketing tool.	21	15	16	6	23	81

To expand into international arenas in order to build up contacts with international leaders in the RPD business field, and also to remain relevant internationally.	20	4	16	7	26	73
To provide quality control services to clients, for example the measurement of part dimensions.	15	2	13	4	6	40
To become a certified metrology laboratory.	24	2	17	1	4	48
To provide tooling and dies for the injection moulding and casting industries.	20	0	17	6	23	66

Because of extensive research facilities available, the RPDD has the opportunity to investigate and implement new ideas in existing business fields.	3	7	7	4	20	41
Because of some employees' specific interest in the field of e-commerce, the RPDD can do extensive research in business opportunities on the Internet.	20	7	15	6	13	61
Explore the integration of manufacturing and the medical industry, specifically in the field of biomechanics.	17	2	15	4	9	47
Staff retention.	24	10	18	8	21	81
Ownership of equipment.	15	0	0	6	2	23

To use the Internet as a business portal where clients have real-time access to all information regarding their projects.	20	7	15	6	13	61
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Table 4.1 – Opportunities Matrix

From the above matrix the following opportunities or projects have been identified as the priorities for the RPDD because they contribute the most value to achieving the Critical Success Factors previously defined:

- To offer CAD/CAM training and refresher courses to highlight new developments of computer-aided design tools. This can also serve as an effective marketing tool.
- Staff retention
- To build partnerships with product development companies to capture the once-off component market.
- Growing prototypes with the Z Corp machine to assess ease of manufacturing or assembly

Once these projects have been completed, the other opportunities can be considered in their order of importance, which is measured by their total score relative to the Critical Success Factors.

## **C.5 TO-BE Human and Organisational Architecture**

**The following is the structure of the company with respect to the staff involved. The interaction of staff, equipment and the information system will be discussed in Chapters C.6 and C.7.**

For the purposes of this report, the TO-BE time period is roughly two years from the date of creation of this Master Plan.

### **C.5.1 External Influences**

The TO-BE RPDD will be affected by various external factors that are out of the RPDD staff's control. Economic factors affecting the RPDD will include:

- Exchange rates, taxes, and import duties affecting the acquisition of new equipment.
- Extent of government funding of the University and small businesses.
- Success of manufacturing companies in South Africa affects whether they are willing to spend money on development.
- Partnerships with businesses.

The political situation in South Africa will affect business confidence and capital invested in the country. The RPDD may be affected by University policies and regulations, and by regulations put in place by the Department of Trade and Industry.

### **C.5.2 TO-BE Human and Organisation Policies**

In line with the RPDD's focus on world-class rapid prototyping, its policies will provide a platform to create a world-class working environment.

- The business processes will be transparent.
- The RPDD will train its employees in areas that interest them and will benefit the RPDD.

- The RPDD will provide support to its employees to stay abreast of world-class manufacturing techniques.
- The RPDD will promote the participation of its customers in the business to stimulate quality improvements and customer satisfaction.
- Employees will be recognised for good performance.
- If required, all employees will be expected to work in teams to complete projects.
- Employees should be honest and considerate of other employees' needs.
- The RPDD will not discriminate against any employee according to race, gender, physical abilities, sexual orientation or religious and political beliefs. It will be expected of employees to follow the same policy.
- The RPDD will consider environmental impact issues before accepting projects that may be harmful to the environment.
- Employees must endeavour to provide world-class quality products and service to customers.

### **C.5.3 Organisation Capabilities**

The RPDD will offer services in three main fields: Rapid Prototyping, Quality Control and Reverse Engineering. These capabilities can be used in parallel if necessary, and should not be seen as separate. The RPDD will also be able to outsource work. Links with businesses and other tertiary institutions will broaden the field of work that the RPDD can accomplish, and will strengthen its position in the marketplace. Financial control and advertising will be contracted to an outside company to reduce pressure on the staff and in order to lower support expenses. The organigram below displays the TO-BE organisation.

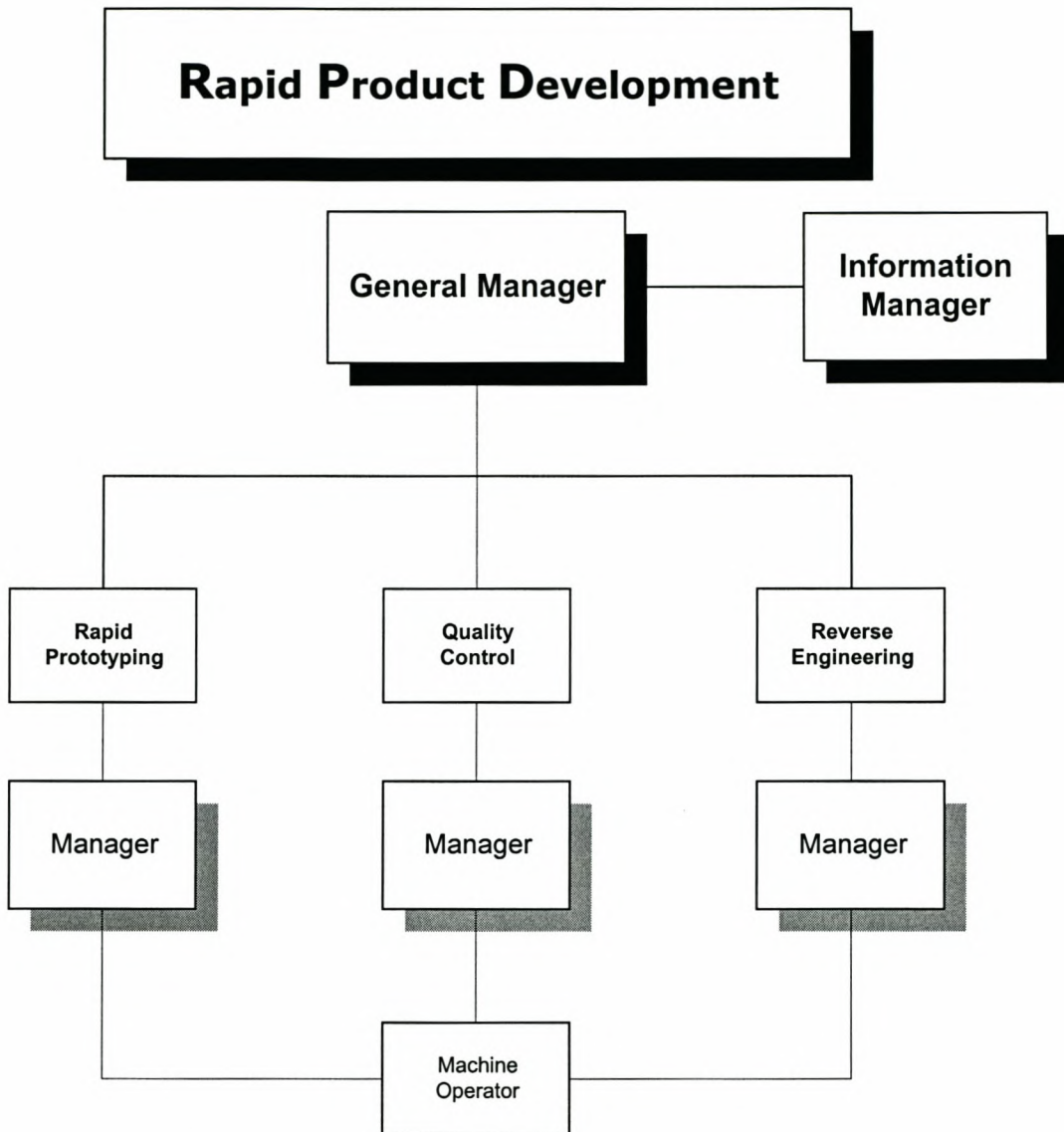


Figure 5.1 – Organigram of the RPDD

## C.5.4 TO-BE Staff Requirements

To limit staff numbers, staff are expected to be multi-skilled.

### C.5.4.1 General Manager

**Number of staff:**

One

**Qualifications:**

Industrial or Mechanical Engineering degree



**Characteristics:**

Highly motivated

Sound grasp of financial control procedures

Good public relations skills

Interest in the field of RPD

Project Management experience

**Responsible to:**

GCC and the Institute of Industrial Engineering

**Responsible for:**

Coordinating all staff in RPDD

Assigning responsibility for projects to RPD, QC or Reverse Engineering staff

Building team spirit

Ensuring job scheduling on machines is without conflict

Ensuring jobs are completed on time

Building good relationships with clients and initiating contract work

Ensuring RPDD remains focused on its mission, vision, objectives, goals and core business

Control capital and other spending of RPDD

**C.5.4.2 RPD, Quality Control, Reverse Engineering**

The RPD, QC and Reverse Engineering employees are expected to support each other in all projects, as the three activities are closely interlinked.

**Number of staff:**

One for each division (three in total)

**Qualifications:**

Industrial or Mechanical engineering diploma or degree

**Characteristics:**

Proficiency in his/her respective fields

Interested in research of the field

Ability to work on their own and in a team

**Responsible to:**

General manager

Customers

**Responsible for:**

Cooperating with other RPDD staff to complete projects on time.

Projects where the bulk of the activity is product development, quality control or reverse engineering respectively.

Ensuring that his/her projects are completed to the satisfaction of the customer.

Scheduling of his/her projects on available machines with consideration for other projects.

### **C.5.4.3. Information Manager**

**Number of staff:**

One

**Qualification:**

Degree or Diploma in the field of Information Technology or Technology Management

**Characteristics:**

Skilled with latest network technologies

Skilled in Internet technologies

Sound grasp of financial and advertising concepts

**Responsible to:**

General Manager

**Responsible for:**

Managing the Internet and extranet software and infrastructure

Managing local network software and hardware

Making themselves aware of the range of activities going on in the RPDD and what services are available to businesses

Managing advertising and financial portfolios

This involves liaising with companies that are contracted to perform advertising and accounting for the RPDD

They must ensure that potential customers are aware of all services that the RPDD offers

Maintaining a professional and effective web portal that can attract clients and other interested parties

**C.5.4.4 Machine Operator****Number of staff:**

One

**Qualifications:**

Experienced in mechanical workshop environment.

**Characteristics:**

Responsible

Trained to use machines (This can be provided by the RPDD).

**Responsible to:**

General Manager

**Responsible for:**

Running machines acquired by the RPDD.

Cooperating with University machine operators in running existing machines.

Keeping the production areas in a neat and orderly state.

Ensuring that all machines are well maintained.

### **C.5.5 Training of Employees**

Employees hired by the RPDD will be expected to have sufficient training in their respective fields to be able to start working immediately. In special cases, extra initial training will be needed (such as for machine operators using new machines, or new software acquisitions). Training programs set up in collaboration with the Department of Industrial Engineering will be used to ensure that machine operators are comprehensively trained. New acquisitions of software are usually accompanied by training, and the persons responsible for using the new acquisitions will be sent on the training courses required. Training material in the form of books will be readily available for all machines and software in the RPDD.

In addition, employees are expected to show initiative with respect to areas in which further training should be done.

## **C.6 TO-BE Manufacturing Equipment Architecture**

**This section outlines the equipment to be acquired and the relevant changes it will bring to the RPDD.**

The RPDD is mainly concerned with becoming specialised in the area of rapid product development, quality control and reengineering. This is achievable through multidisciplinary competencies.

### **C.6.1 New processing equipment**

The envisioned growth of the RPDD will primarily require expansion in the field of rapid product development equipment; computer aided engineering equipment and reverse engineering equipment. The required equipment for the expansion in these fields is discussed below.

#### **C.6.1.1 Rapid Product Development machine requirements**

With respect to solid freeform manufacturing, envisioned capabilities are in the 3D printing and solid gluing sheets field.

The machines to be acquired are a Helysis LOM 1015 or equally comparable LOM (Laminated Object Manufacturing) machine.

#### **C.6.1.2 Reverse engineering machine requirements**

The capabilities of reverse engineering need to expand in the following three areas of operation:

- Computer hardware (refer to section C.7.1)
- Software (refer to section C.7.1)
- Machining capabilities.

Requirements for machining capabilities have indicated that a high-speed milling machine needs to be acquired.

## **C.6.2 New process effectiveness**

The new computer hardware, software and high speed milling machine will increase productivity because of faster processing speeds. The different products that can be concurrently developed also significantly increase the number of projects that can be accepted.

### **C.6.2.1 New rapid product development equipment effectiveness**

The newly acquired LOM machine will enable the RPDD to produce more cost effective models and faster prototypes for companies that do not require great dimensional accuracy. The product quality is sufficient for visual requirements and use in the building of assembled models to check spatial constraints.

### **C.6.2.2 New computer aided engineering equipment effectiveness**

The upgrade in computer hardware and software (refer to section C.7.1) will enable work throughput to be increased significantly. This is because of faster processing, better techniques and improved interfacing between workstations and machines. Better products will be developed because better modelling techniques are used.

### **C.6.2.3 New machining capabilities effectiveness**

Plant throughput will be significantly increased by faster production capabilities. The surface quality of products made by high-speed milling machines will be better. The types of materials used in these machines are flexible and thus will provide additional flexibility to the type of products to be manufactured. Rework will be negligible because, apart from human error in the process of production, the machine produces according to requirements almost every time.

## **C.6.3 Changes in operational procedures**

The spatial requirements of new machines will affect the physical operational area. The effect will necessitate either a new location for the RPDD, or machines will have

to be located at different places for operation. The decentralisation of machines is not critical because the machines are computer controlled and operators are not required to be present while work is in progress on the machine.

Multi-skilled personnel are very important because of the diversity of work done by the RPDD. The personnel should be flexible in handling any work in the areas of the core competencies of RPDD, because the absence of any of the personnel should not hinder the progress of overdue work.

The provision of a network link will significantly affect the operation of machines by providing direct interfaces for transferring work and monitoring progress of machine operation. This infrastructure should be complemented by the technical expertise of personnel.

### **C.6.3.1 Manufacturing requirements**

The functional flows of manufacturing are the same as that of a job shop environment. The acquired machines will not bring any changes to conformity of functional flows, but rather a closer move towards the job shop environment.

The yield of products is very high and product quality defects are very seldom caused by machine failure, but most of the time caused by human error. Multi-skilled personnel are necessary to ensure that high quality work can be done even when some machine operators are absent. It is also important to ensure high machine utilisation.

The physical products and processes are shown in the diagram below. As an example, the process *plan for development* has been exploded in Figure 6.1.

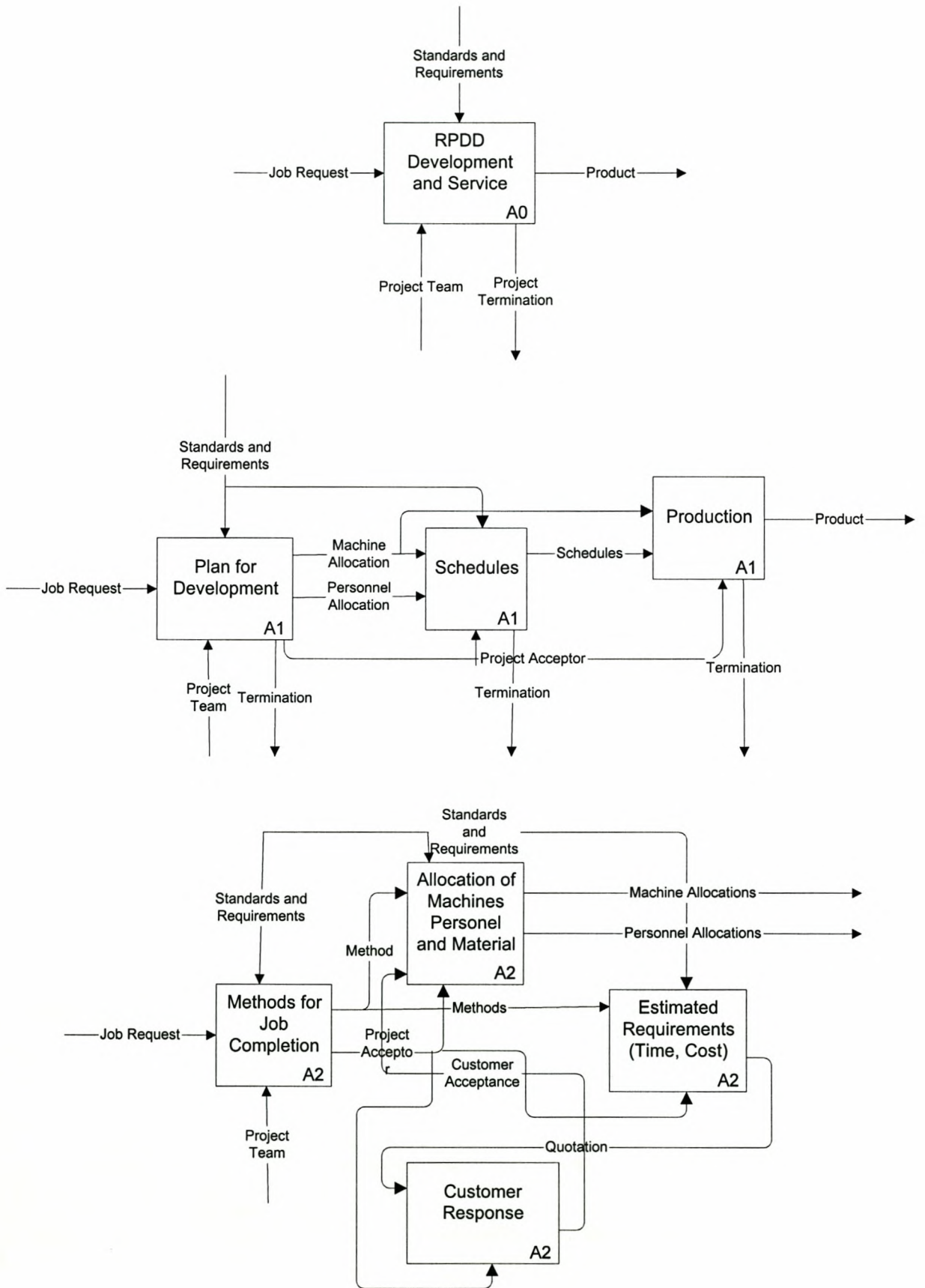


Figure 6.1 - IDEF0 Diagram of Business Processes



## **C.7 TO-BE Information Systems Architecture**

The TO-BE Information Systems Architecture is defined in this chapter with respect to the TO-BE Manufacturing and Human/Organisational Architectures.

### **C.7.1 TO-BE Information Technology structure**

#### **C.7.1.1 Basic IT architecture**

The RPDD will have to explore new ways to capitalise on the new opportunities of the Information Age. In accordance with the goals and objectives of the RPDD, it should make use of the most up to date Information Technologies available. The following IT architecture is proposed:

- **Workstations in use should be systems that can handle the computing power needed to run the software in use.** Because the work done is very graphic intensive, and because a high level of integration is needed, powerful workstations with Dual Pentium 600 MHz processors and at least 256 MB RAM are suggested. It is important not to compromise on computer hardware, because this is the backbone of all operations.
- **A vast client database should be set up,** consisting of extensive information on each client. This information can be used for data mining and effective marketing.
- **An intranet, preferably using Microsoft Windows 2000, should be in place.** This is essential because activities are performed on different locations, and communication between these locations is very important. This intranet should provide all possible information on projects and potential customers. It should also provide a point of contact with the RPDD's client database.
- **An extranet with the University of Cape Town, Cape Technikon, Pentech and the CSIR should be set up.** This will result in effective knowledge sharing on best practices. It will also provide a means for facilitating prototype

production at these institutions when facilities are not available in-house. They can also market each other's core competencies.

- **The Web Site of the RPDD should become more than just a display window of products and services delivered.** It should be a single point of contact for customers. The portal should have the following capabilities:
  - **Up to date information** on all the products and services provided by the RPDD.
  - **Infrastructures to submit CAD/CAM diagrams** to the RPDD over the Internet.
  - **Real-time reports for clients on the progress of their projects.** Live Web cams can be used so that customers can physically see how their parts are being made.
- **Effective security is essential.** Clients must be able to trust the RPDD, and therefore they should be assured of total information confidentiality. Only authorised personnel should be allowed on different levels of the intranet, extranet and web portal.
  - The **intranet** should be restricted to full-time employees of the RPDD.
  - The **extranet** should be restricted to 3 or 4 authorised personnel of each entity in the network.
  - The **basic web portal** should be accessible to the general public, but information on certain projects should be restricted to one or two authorised employees of the company for which the work is being done.
- The following software applications should be incorporated with the systems mentioned above:
  - ProEngineer
  - Materialise
  - AutoCAD
  - PowerShape

- Metris
- Dellcom
- Duke Nukem 3D Multiplayer

The hardware used should be able to facilitate a high level of integration. The following information transfer is necessary:

- Internally between the machines in use;
- Between the machines in use and the personnel operating it;
- Between different locations of the RPDD; and
- Between the different divisions of the GCC.

### C.7.1.2 Basic Hardware model

In order to satisfy the requirements set in this section, the following hardware model is proposed:

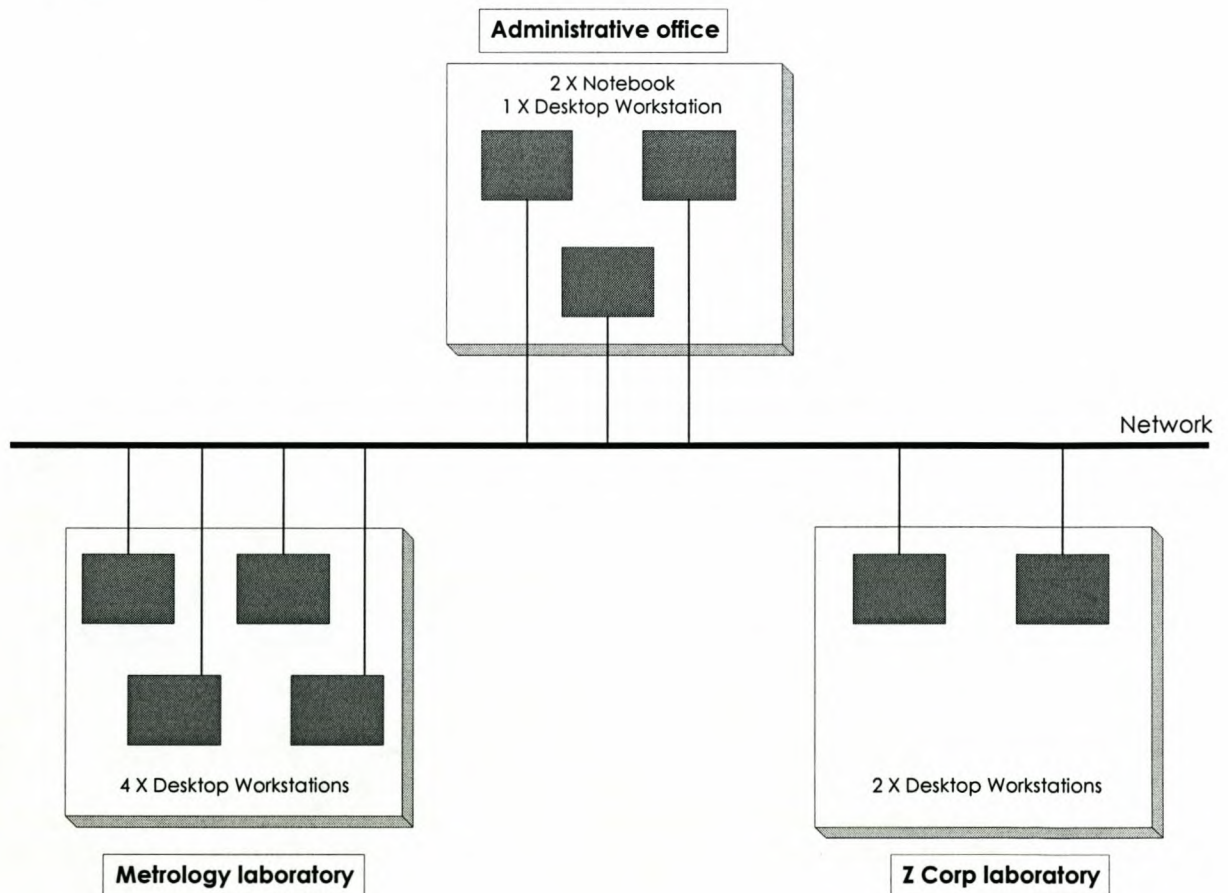


Figure 7.1 - Hardware model of IT architecture

**Notes:**

- The administrative office will be equipped with two notebook computers, for use by the General Manager and Information Manager. The desktop workstation will be used by the Information Manager to manage the network infrastructure.
- The metrology laboratory will be equipped with 4 desktop workstations: one for each of the three persons working with the machines, and one for simulations and CAD/CAM that may need to be done. All workstations must be capable of running CAD/CAM or ProEngineer depending on the RPDD's requirements.
- The Z Corp laboratory will be equipped with 2 desktop workstations: one for the Z Corp machine and one for the Laminated Object MFG machine (refer to sections C.6.1 and C.6.2).

The overall hardware model, including extranet details, is shown below:

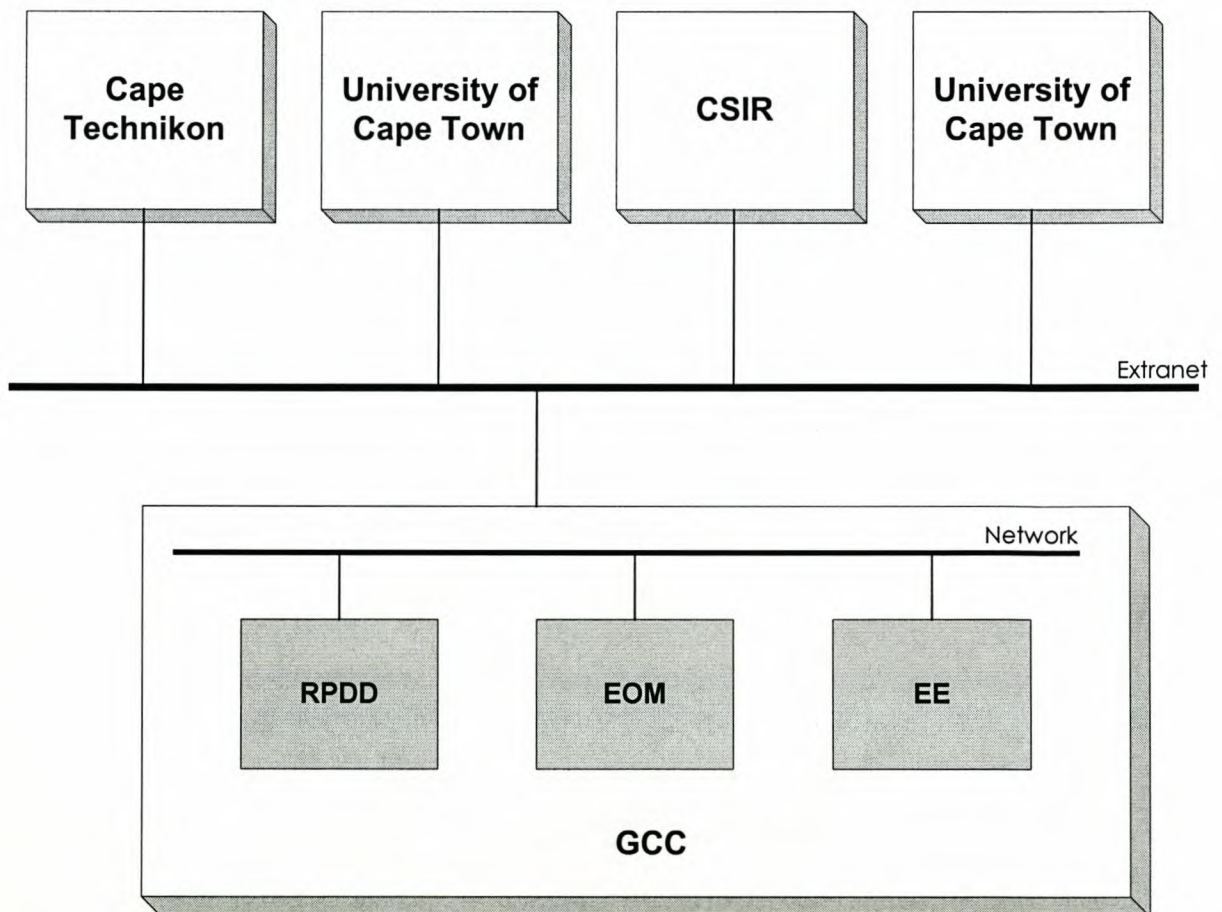


Figure 7.2 - Extranet Hardware Model