THE DEVELOPMENT OF A STRATEGY FOR THE SUCCESSFUL IMPLEMENTATION AND MANAGEMENT OF TECHNOLOGY FOR VALOR FRUIT PROCESSORS (PTY) LTD.

by

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This paper is presented in partial fulfilment of the requirements for the degree of Master in Business Administration in the Faculty of Business and Economic Science at the Nelson Mandela Metropolitan University.

PROMOTER: DR. S KRAUSE
DATE : 17 JANUARY 2005
DECLARATION

I Riaan Olivier, hereby declare that:

- The work in this paper is my own original work;
- All sources used or referred to have been documented and recognised; and
- This dissertation has not been previously submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised educational institution."

RIAAN OLIVIER

JANUARY 2005
The successful completion of this study would have been impossible without the support, advice and assistance and encouragement of the following parties. I wish to record my sincere thanks and appreciation to the following:

- To **Jesus Christ**, my **Saviour**, for giving me the ability and talent to commence such a study.
- To my wife, **Odette** for her support and for assisting me with the typing; my daughter, **Michaela**, and my son, **Ruan**, for their understanding and for the purpose and strength they gave me to complete such a study. I love them all.
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In an ever-changing environment, it has become difficult for organisations to create and maintain a competitive advantage. Nowhere is it more evident than in the manufacturing industry. For organisations to be successful, it is imperative for them to have a clear and well-defined strategy. This strategy should be viewed as the steering mechanism of the organisation. With the ever-increasing demands of customers, organisations have been forced to be agile in order to adapt to sudden changes. Now more than ever, technology can be used as a powerful tool.

For organisations to be profitable and grow, they need to have a management team that is competent to manage the organisation in turbulent times. To ensure a competitive advantage, management must be able to predict the future needs of the organisation. The use of technology forecasting and technology audits can assist management in addressing this process. Most organisations are technology intensive and deliver products or services.

The research attempts to determine a strategy for the successful implementation and management of technology in a manufacturing organisation. It also tries to establish the impact of technology auditing on the competitive advantage of the organisation. A comprehensive technological audit questionnaire was used in conducting an audit at Valor Fruit Processors (Pty) Ltd. It must be emphasised that this model is a generic model and should be customised to suit each particular organisation.
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CHAPTER ONE

THE PROBLEM AND ITS SETTINGS

1.1 INTRODUCTION AND BACKGROUND

Industrial operations have undergone several phases of revolutionary transformation through the ages. If one carefully examines the genesis of these revolutions, it becomes apparent that all those revolutions were basically either change oriented or change - induced and the driving force behind all those change processes were the outcome of technological development.

Why do some enterprises prosper, while others do not? These questions have interested and confounded business people since the dawn of commercial history. Khalil (2000:1) explains that throughout the history, technology has had a profound effect on human development and on the progress of civilisation. It took humans about 200 million years to develop from nomads foraging for food in East Central Africa to agricultural settlers capable of augmenting their power with tools and domestic animals. He continues by stating that, despite of the fact that technology is the most pervasive force of influencing human lives today, it remains mysterious to many people, and its exact definition eludes most of the public and many professionals.

The task facing managers these days is daunting. They need to identify what matters in the business environment with the constraint that it is consistently changing. To generalise about what is likely to matter in the emerging business environment is fraught with risk. However, if any bet on the future is safe, it is that getting the technological side of the business environment right is going to be increasingly important for success.

According to Narayanan (2001:8), the management of technology links engineers, science and management disciplines in planning, developing and implementing technological capabilities to shape and accomplish the strategic and operational goals of an organisation.
He continues by stressing the importance of three important ideas:

1.1.1 The emphasis in the management of technology is on accomplishing the goals of an organisation. Value creation for investors as the primary goal of technology management in corporations, will be considered.

1.1.2 Technology management focuses on the development of technological capability and its implementation or deployment in products and processes.

1.1.3 Technology management within corporations is linked to other management activities such as marketing or manufacturing.

Val-Orange (“Val” stands for Valencia) was founded in 1946 by a group of Port Elizabeth businessmen. Their primary objective was to market high-class orange crushes and juices and sell these to the Ministry of Food in England. Valor manufactures mainly citrus concentrates and guava purée. The citrus is grown at Sundays River and Patensie and the substandard fruit for the fresh fruit market is supplied by the pack houses to Valor by road or by rail for juice extraction by Valor.

On arrival, the citrus is stored in storage bins or processed immediately. The processing involves oil extraction over a Browns Oil Extractor where the fruit is rolled over a series of rollers covered with fine spikes, which pierce the oil sacs in the peel. The juice is then extracted and the pips and rag removed by finishers. Then finer pulp material is removed by centrifugation, allowing some remaining pulp, which varies according to customer specification.

The company has received a number of quality accreditations from the South African Bureau of Standards. These include the following: ISO 1901:2000, HACCP and ISO 17205. The company is audited at least three times per annum by the South African Bureau of Standards to ensure compliance.
1.2 MAIN PROBLEM

Technology has long been recognized as playing a prominent role in man’s efforts to survive. Since the beginning of human time, hands, teeth and feet were used to obtain food. Millenia must have gone by before man realized that the tasks could be made more efficient with the aid of sticks or stones, according to Lustig-Arecco (1975:1).

Komacek, Lawson and Horton (1990:2) state that manufacturing is based on technology. However, without people, technology would not exist since technology depends on human knowledge. People apply their knowledge through tools, materials and processes. Technology always results in change and these changes in technology can affect people. Technology also changes the natural environment, which can affect human life. Because humans make the decision about the use of technology, they control the changes caused by technology.

Allen and Economy (2000:307) explain that sometimes, one has to look to the past to find the right road to the future. We have to go back nearly 200 years to find a time when manufacturing was more like it is today. That is because 200 years ago, manufacturing was essentially a craft industry that produced products to customers’ specifications. Quality was important, and people received exactly what they wanted when they wanted it.

This leads to the main problem:

What impact does the implementation of technology have on the improvement of production processes used in a citrus processing company?

1.3. SUB-PROBLEMS

In order to develop a research strategy to deal with and solve the main problem, the following sub-problems were identified:

(a) What does the literature reveal about implementing technology in a manufacturing company?
(b) What lessons are there to be learned from the introduction and implementation of new technology?

(c) Is there a correlation between the findings in the literature and the views of manufacturing companies?

1.4. DEMARCATION OF THE RESEARCH

Demarcating the research serves the purpose of making the research topic manageable from a research point of view. The omission of certain topics does not imply that there is no need to research them. This study was demarcated as follows:

1.4.1 MANAGEMENT LEVEL

The study will be limited to supervisory and middle management. All other levels, such as hourly paid employees and senior management, are excluded. This includes supervisors on grades 9 to 10 and middle managers on grades 7 to 8 on the peromnes grading system.

1.4.2 SIZE OF THE ORGANISATION

The scope of the study will be limited to Valor Fruit Processors (Pty) Ltd, a citrus juice processing company in Port Elizabeth. The organisation employs 16 hourly paid employees and 30 salaried paid employees.

1.4.3 GEOGRAPHIC DEMARCATION

The empirical component of this study will be limited to citrus processing companies in the Eastern Cape.

1.4.4 IMPLEMENTING TECHNOLOGY

The research will be limited to the implementation of technology in manufacturing organisations. The study therefore excludes the implementation of technology in other organisations.
1.4.5 MANAGING TECHNOLOGY

The research will be limited to the management of technology in manufacturing organisations. The study will therefore exclude the implementation of technology in other organisations.

1.4.6 SUBJECT EVALUATION

The main aim of this study will be to determine what impact technology will have on production techniques used in a citrus processing company and how effectively this process will be managed.

1.5 DEFINITION OF SELECTED CONCEPTS

1.5.1 TECHNOLOGY

The word technology derives from the Greek word technologia, meaning the systematic treatment of an art. It is composed of the words techno or tekhne, which means “skill” and logia, which means “study of,” according to Khol (1992:170). Kahlil (2000:1) explains that Technology can be defined as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services. In simple terms, technology is the way we do things. It is the means by which we accomplish objectives. Technology is the practical implementation of knowledge, a means of aiding human endeavour.

Slocum (1996:60) explains that technology is the method used to transform organisational inputs into outputs. Technology is more than machinery; it is also the knowledge, tools, techniques and actions applied to change raw materials into finished goods and services. The technologies that employees use range from simple to highly complex. Simple technology involves decision-making rules to help employees do routine jobs. Complex technology requires employees to make numerous decisions, sometimes with limited information to guide them.

Grun (1975: 525) explains that a comparatively more recent example to confirm our incomplete understanding and partial comprehension of technology, are the cases of
uranium and plutonium. The former was discovered in 1786 by a German scientist, M.H. Klaproth, but only became prominent when it was used in the first atomic bomb dropped on Hiroshima, Japan on August 6th, 1945. On the other hand, Plutonium 94 was only discovered in 1941, but used within four years in the second atomic bomb dropped on Nagasaki, Japan, only three days after the Hiroshima bomb. The reason why the Americans, at the time, used Uranium in the first bomb and Plutonium in the second was to evaluate the respective merits of the use of uranium and plutonium as enabling technologies in one of their final destructive technological innovations of the World War II era.

It is evident from these examples that technological innovation does not necessarily immediately follow on the heels of scientific discovery, but that is also closely allied to levels of human development, culture and values, which in turn collectively govern the rate of the diffusion of knowledge within nations. It is also clear that our understanding of technology has lagged behind that of science and only recently became the focus of serious academic endeavour. Individuals and corporations alike are judged to be rather slow at converting scientific breakthroughs into marketable value-added products by way of technological innovation. Yet, economic success has become more associated with technology, than with scientific achievement, according to Layton (1993: 24).

1.5.2 MIDDLE MANAGEMENT

Department managers, deputy project managers, brand managers, assistant plant managers and many other kinds of managers who report to top management make up the middle management level. While top management’s job is to develop an organisation’s vision and key goals, middle management must create the plans, systems and organisations to achieve them, according to Allen and Economy (2000:78).

1.5.3 SUPERVISOR

Allen and Economy (2000:79) explain that, going by an amazing array of titles, supervisors are the employees in an organization closest to the frontline workers and therefore, often closest to the organisations’ customers and clients. Supervisors execute the plans developed by middle managers and monitor worker performance on a day-to-day basis.
1.5.4 INNOVATION

Narayanan (2001: 67) explains that the word innovation appears to have its origins in the Latin innovare, meaning “to renew, to make new, or to alter.”

1.5.5 TECHNOLOGY AUDIT

Khalil (2000:264) defines a technology audit as a tool used to evaluate the conditions or the existing status of a certain sector in an organization. Accountants often use it to evaluate the financial status of companies. The American Accounting Association defines it as “a systematic process of objectively obtaining and evaluating evidence regarding assertions about economic actions and events to ascertain the degree of correspondences between those assertions and established criteria and communicating results to interested users.

1.5.6 EVAPORATOR

Tetra Pak Processing Systems AB (1998: 8) defines an evaporator as a machine that concentrates single strength juice by evaporating the water from juice in a vacuumed environment.

1.5.7 PASTEURISATION

Tetra Pak Processing Systems AB (1998: 8) describes pasteurisation as a process of heat treatment sufficient to kill some, but not all, of the micro organisms in a particular material.

1.5.8 COMPETITIVE ADVANTAGE

Johnson and Scholes (1997:140) explain that competitive advantage consists of core competencies, which underpin the organisation’s ability to outperform competitors. They may also provide the basis on which new opportunities can be created.
1.5.9 MANAGING TECHNOLOGY

Narayanan (2001:8) describes that management of technology links engineers, science, and management disciplines to plan, to develop and to implement technological capabilities to shape and accomplish the *strategic and operational* goals of an organization.

1.5.10 ISO 17205

General requirements for the competence of testing and calibrating laboratories or it can provide a framework for a quality management system for testing or calibrating laboratories.

1.6 ABREVIATIONS

1.6.1 ISO

International organisation for standardisation

1.6.2 ISO 9001: 2000

Quality management systems requirements

1.6.3 HACCP

Hazard Analysis and Critical Control Points.

1.6.4 TAM

Technology Audit Model

1.6.5 VAF’S
Value Added Functions

1.6.6 TAEP

Technology Acquisition Exploitation Protection

1.6.7 MOT

Management of technology

1.7 ASSUMPTIONS

1.7.1 ASSUMPTION 1

It is assumed that technology is independent of the type of manufacturing organisation and operates in the same way irrespective of type of manufacturing organisation.

1.7.2 ASSUMPTION 2

Assuming Valor needs to compete internationally, it will have to adapt to new technology in order to stay competitive.

1.7.3 ASSUMPTION 3

It is assumed that Valor’s management wishes to optimise the potential and the successful implementation of technology improving production processes.

1.8 THE SIGNIFICANCE OF THE RESEARCH

There is a great need for managers to be aware that both the environment in which organisations operate as well as the organisations themselves are continually changing. Slocum (1996:106) states that the growing global economy creates new imperatives for an increasing number of firms; for example, technological forces are influencing dramatic change. On the other hand, dealing with technological change sometimes

Change in South African organisations is likely to occur very rapidly as global forces influence the manner in which organisations are managed. Tyson (1991:4) acknowledges that major changes will take place in South Africa and that the survival of business amidst changing values and aspirations will depend on managers’ ability to understand and communicate across cultural lines.

For organisations to be successful in a rapidly changing business environment, it is imperative that all managers understand the effects of technology. Managers should be equipped with the best strategies for managing technology change and should know how to manage the resistance to technological change.

1.9. AIMS AND OBJECTIVES OF THE RESEARCH PROJECT

It is well known that structural change, in many fields, is perpetually on the increase in both frequency of occurrence and in extent (Toffler, 1970, 1980, 1990). But, whereas structural change is extensively driven by technological innovation, the strategic management of technology, is largely a neglected issue at corporate level (Burgelman, Maidique and Wheelwright, 1988; Aït-El-Hadj, 1993) and even more so at corporate board level. In this regard, Toffler (1980:18) argues that, in future, corporate boards will increasingly become involved in the management of technology. From an academic point of view, therefore, it is a relatively unresearched field with tremendous potential for academic endeavour, practical pursuit and personal development.

The aim and objective of this study is to generate a generic approach to the strategic management of technology based on theoretical and practical expositions, through exploratory and descriptive research, of relevant phenomena of a contextual nature. The need for such an approach is evident from a superficial perusal of the recent literature on the management of technology.

1.9 RESEARCH METHODOLOGY

In this section the broad methodology that will be followed in the study is described.
1.10.1 RESEARCH METHODOLOGY

The following procedure will be adopted to solve the main and sub-problems:

1.10.2 LITERATURE SURVEY

A literature survey will be conducted to identify what the impact of technology change will be on manufacturing processes.

1.10.3 EMPIRICAL STUDY

The empirical study involved conducting interviews, using a technology audit model questionnaire developed by Garcia-Arreola and recommendations.

1.10.3.1 Mail survey

A technological audit questionnaire will be completed by middle managers and production supervisors to establish what impact technological change will have on production processes. The aforementioned was chosen as they are at the centre when making decisions regarding technological changes to enable the organisation to function effectively. They are therefore in a good position to identify the impact of technological change on production processes.

1.10.3.2 Measuring instrument

As mentioned above, the researcher will make use of the technology audit model questionnaire for this research project to determine the appropriate strategy for the successful implementation of technology.

1.10.3.3 Sample
The focus will be on the citrus processing company. Global and local conditions place a high level of stress on the manufacturing organisations and thus on citrus processing companies. The researcher is currently employed at a citrus processing company.

1.10.3.4 Statistical analysis of data

The statistical procedure to be used in interpreting and analysing the data will be determined in consultation with a statistician at the time the question is drawn up.

1.10.3.5 Recommendations

After the results are complied and analysed, recommendations will be made.

1.11 THE SCOPE AND STRUCTURE OF THE DISSERTATION

The remainder of this dissertation is structured as follows:

1.11.1 Chapter One: A study for the successful implementation of technology.

An explanation of the concepts used in the study is provided. A statement of the problem and sub-problems and the unfolding of the objectives, demarcation of the research, definition and abbreviations of selected concepts and assumptions follow.

1.11.2 Chapter Two: Discussions on the implementation and the effects of implementing technology.

The chapter examines the dynamics of the technology change in manufacturing organisations. It explains the processes in the implementation of technology and elaborates on the effect new technology has on the organisation. This illustrates that a well and clear defined technology strategy is imperative for organisation to have a competitive advantage.
1.11.3 Chapter Three: The methodological approach (case study) to conduct research.

The researcher had to choose among various approaches to conduct the empirical study. A brief theoretical explanation is given to justify the methodology (case study) used to conduct the research.

1.11.4 Chapter Four: The analysis and interpretation of the empirical study

In this chapter the results of the empirical study are presented and interpreted in order to draw conclusions in terms of the theoretical paradigm set out in chapters two, four and five.

1.11.5 Chapter Five: Summary, conclusion and recommendations

The aim of the research was to develop a strategy for the successful implementation of technology in a manufacturing company. The final chapter includes a brief summary of the investigation and makes recommendations for areas of further research.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

A company that wishes to survive and prosper has very little room in which to make mistakes. In this environment, the effective management of a company’s manufacturing effort is of crucial importance. Technology has always been a major concern for most operations managers and plant engineers. During the late 1990’s, most manufacturing companies faced stiffer competition than ever before. National boundaries are becoming less and less of a constraint on competition and in many industries; a single global market is becoming a reality. What makes things different now (as apposed to 20 years ago) is the sheer pace of technological change.

Technological change is accelerating at such a pace that it holds significant implications for most companies. Three significant aspects play an important part in overcoming the difficulty of forecasting technological change. The first aspect is to monitor the market for emerging technologies. The second is the fact that manufacturing companies must be able to move quickly in order to adapt to technological change. The third aspect and often the most difficult is that manufacturing companies must have a clear understanding between the potential (often unpredictable) of new technologies and the way in which they manage their operations.

The impact of technology on organisations and the impact of organisations on technology were recently identified as one of five critical areas that should receive attention in the area of the strategic management of technology, according to Likins (1991: 175). This argument is further developed by Steele (1991: 177) who explains that today, every manager must be aware of technology as part of the job. Although managers of technology do not necessarily require detailed technical knowledge, they must understand the main role of their companies and have an overall understanding of how their companies function.
2.2 IMPLEMENTING TECHNOLOGY IN A MANUFACTURING COMPANY

2.2.1 THE NATURE OF STRATEGIC MANAGEMENT

Schendel and Hofer (1979: 11) define strategic management as a process that deals with the entrepreneurial work of the organisation, with organisational renewal and growth, and more particularly, with developing and utilising the strategy which is to guide the organisation’s operations. Certo and Peter (1991:5) confirm this by stating that it is a continuous process, aimed at keeping an organisation as a whole appropriately matched to its environment.

In Certo and Peter’s model of the strategic management process, there are five major steps as shown in figure 2.1:

Figure 2.1: Major steps in the strategic management process

- Environmental Analysis
- Establishing Organisational Direction
- Strategy Formulation
- Strategy Implementation
- Strategies Control

Source: Certo and Peter (1991:14)

Sheasley (1999: 7&49) explains that the effective management of technology development rests on the extent to which clear expectations, including the time frame within which those expectations are to be met, can be communicated and understood by the project team and its leaders. "Expectations" in this context does not mean the discoveries; their timeline usually cannot be predicted and it serves little purpose for
teams to forecast future discoveries, or for managers to establish deadlines for them. Rather, the expectations must focus on learnings. These can be forecast and measured, and thus offer a basis for tracking the progress of technology development programmes.

He continues by stating that these expectations also must derive predominantly from the project team, not from the managers overseeing the programmes. Discovery and technical invention rely heavily on people's creativity, energy and sense of ownership. It is especially important, therefore, that technology development teams are and feel empowered. Success in such challenging undertakings requires a full measure of resourcefulness, and this can be obtained only when the team believes the future is in their hands.

The cornerstone to this essential communication and understanding between project teams and leaders is a common mindset around cycle time management. Time matters. Reducing the time to develop new technology could have an even stronger impact on a business's commercial rewards than shortening product development time. Those who bring new technology to the market first and who know how to sustain that competitive advantage, will be the leaders, explains Sheasley (1999: 7&49).

Burgelman, Maidique and Wheelwright (2001:742) explain that the magnitude of the change required on management’s part is captured clearly by figure 2.2. As illustrated, most senior managers play little, if any, role in the early stages (knowledge acquisition, concept investigation and basic design) of development effort. Once a project progresses to the point of building prototypes and trying to demonstrate the performance characteristics (or lack thereof) of those prototypes, management comes to life and remains attentive until prototyping problems have been resolved. When the product is introduced, all too often customers discover a number of remaining issues and problems, and management again focuses its attention on the effort.

They continue by stating that the problem with such a pattern is that management is only reactive. As suggested by the shaded curves in figure 2.2, the greatest amount of management’s energy on the project is expended when the ability to influence its outcome is at a minimum. It would be far more effective to focus management’s attention and efforts on development activity at the front end. To do so, however, management must have the appropriate skills, tools and methods to provide the foundation for a different type of involvement in development. Once accomplished,
management can then spend a far greater portion of its energies assessing the lessons learned from individual projects, using them to improve development capability on an ongoing basis and laying the groundwork for subsequent projects.

**Figure 2.2: Timing and Impact of Management Attention and Influence**


### 2.2.2 MANAGEMENT OF TECHNOLOGY AT BOARD LEVEL

For an organisation to develop a strategy with respect to technology requires the full cooperation from all stakeholders which include the board of directors, chief executive officer, managing directors and management team. This commitment is emphasised by Ansoff (1986: 5), who states that a key feature of a strategic orientation is the ability to dispassionately view the firm’s historical successes and a preparedness to abandon
sticking to the knitting in favour of being where the action is. Each firm, therefore, has to diagnose the complexity and turbulence of its future environment and to develop a response that has the requisite variety.

Handscombe and Norman (1993: 245) identify ten board supposed capabilities:

- Board deliberations focus on culture development and strategic corporate issues.
- The board plays a major role in defining strategic vision.
- Strong board involvement in development of a sense of mission.
- Active involvement by the board in developing customer strategic focus.
- Board involvement in defining strategy for effective use of technology.
- Directors and chief executive lead key action plans.
- Board involvement as agents for change.
- Communication to and participation by all stakeholders.
- Board oversees business-led management development.
- Decision support on key business issues used by the board.

2.2.3 TOP MANAGEMENT DEALING WITH TECHNOLOGY AS A STRATEGIC ISSUE

It is generally expected and accepted that top managers must play an active role in the entire strategic management process of the company. As the management of technology is beginning to attract attention at board level, this is a strategic field that chief executives and their immediate cohorts can no longer afford to ignore. Sommers, Nemee and Harris (1986: 25) argue that this, however, is not always the case because many top-management executives, particularly those in mature industries, continue to be uncomfortable with – even intimidated by – the prospect of managing technology-intensive business. As a result, they tend to adopt a relegate-and-delegate approach; they relegate technology to a secondary status and delegate technology decisions to senior technologists or trusted senior executives in their core businesses. This mind-set has to change. Top management cannot plan a strategic repositioning through technology and at the same time, delegate its management to others. Management must take the lead in setting the strategic direction for corporate technology decisions and investments. The need to develop top management’s enabling skills in order to function
effectively over the next few decades should be a priority of the highest order in all companies wishing to stay afloat in the future global business environment.

Khalil (2000:59) states that rapid technological change accompanied by intense global competition creates considerable problems in structuring and managing organisations in every sector of the economy. He continues by explaining that in technologically dynamic companies, the installation of technological gatekeepers, the encouragement of internal entrepreneurship and the increase of joint ventures in both R & D and production have major consequences of organisational structure, all of which need to be addressed rationally. Organisational structure interacts intimately with the technological posture of an organisation and provides an array of topics for reflection by modern managers.

Allen and Economy (2000:77) explain that until recently, management has been a simple proposition. According to most any management textbook, all one had to do was master the four classic roles of management – planning, organising, leading and controlling – and one was destined for success. Today, however, the profession of management is undergoing tremendous change. Managers must know not only how to manage but also how to lead.

Narayanan (2001: 70) stated that there are three significant managerial implications of the technological environment:

- A technological environment is dynamic and needs to be tracked on an ongoing basis. From an open-systems perspective, management of organisations, including technology, should be predicated on the environment facing organisations.
- Tracking technological changes in the environment requires managers to penetrate the organisations and networks that conduct and facilitate technology development.
- The three trends - globalisation, time compression, and technology integration - require managers to adopt a global perspective, enhance organisational speed of response and work with other organisations to adapt to technological changes as well as to fully exploit the potential of new technology.
Burgelman, et al (2001: 37) state that a competencies and capabilities-based view of technological leadership draws attention to the importance of accumulation of capabilities. Technological leadership cannot be bought easily in the market or quickly plugged into an organisation. A firm must understand the strategic importance of different competencies and capabilities and be willing to patiently and persistently build them, even though it may sometimes seem cheaper or more efficient in the short term to rely on outsiders for their procurement.

Thompson and Strickland (1987: 4) emphasised that the success-causing power of clear direction, good strategy, and effective implementation of organisational action plans is now generally recognised. The managers of successful organisations are action-oriented strategic thinkers who make a habit of training their eyes externally on customer needs, new opportunities and competitive positioning, as well as internally on operations. They have a talent for entrepreneurship combined with a flair for day-to-day management and internal leadership. In unsuccessful organisations, managers fail to appreciate the importance of charting a clear organisational course and being good entrepreneurs.

### 2.2.4 FORECASTING AND DECISION-MAKING

Twiss (1992: 260) explains that forecasting can assist business decision-making in the following ways:

- **Wide ranging surveillance of the total environment to identify developments, both within and outside the business’s normal sphere of activity, which could influence the industry’s future and in particular, the company’s own products and markets.**
- **Estimating the timescale for important events in relation to the company’s decision-making and planning horizons. This gives an indication of the urgency for action.**
- **The provision of more refined information following a detailed forecast in cases where an initial analysis finds evidence of the possibility of a major threat or opportunity in the near future, but where this evidence is insufficient to justify action,**
Continued monitoring of trends which, while not expected to lead to the necessity for immediate action, are, nevertheless, likely to become important at some time in the future and must consequently be kept under review.

- Major reorientation of company policy to avoid situations which appear to pose a threat or to seek new opportunities by:
  - Redefinition of the industry or the company’s business objectives in the light on new technological competition
  - Modification of the corporate strategy
  - Modification of the R & D strategy

- Improving operation decision-making, particularly in relation to:
  - The R & D portfolio
  - R & D project selection
  - Resource allocation between technologies
  - Investment in plant and equipment, including laboratory equipment
  - Recruitment policy.

According to Twiss (1992: 262), it can be concluded that:

- All companies should undertake some form of technology forecasting.
- The amount of effort devoted to technology forecasting should take into account:
  - The rate of change in the environment
  - The planning horizon determined by the technological and marketing lead times for new products or processes
  - The complexity of the underlying problems
  - The R & D strategy
  - The size of the company only in so far as the availability of resources limits the choice of techniques which can be afforded.
Technology is used to either drive a business through technology push or market pull. Technology push is a situation in which inventors discover something that gives people the ability to do new things, but people are not always sure they need these new inventions.

In order to promote this new technology, the potential customer must be convinced that this new invention solves a problem that is important to them. An example of technology push is DVD’s. Consumers are told that DVD’s provide a superior entertainment experience over conventional Hi-Fi systems. Before the announcement of this new technology, few, if any, people were demanding higher definition of sound. The industry has had to spend a number of years trying to convince consumers that it would be a good thing to have and that it would be worth the expense (Narayanan 2001:71).

Market pull is the opposite of technology push. Because of a need in the market, people demand a solution to a problem, and a technology is then developed to solve that problem. Market pull is a preferable situation, because if it solves an existing problem that people recognise as important, it is generally not as difficult to convince them to adopt the new technology. An example of market pull would include technology to cut process time by incorporating multiple actions in one process that will save time and effort. Some of these devices may have been a modification of existing devices. Any improvements to or invention of devices were in direct response to consumer demand and therefore are examples of market push, according to Narayanan (2001:71).

Twiss (1992: 70) explains that before deciding upon a strategy, it is essential to make a realistic appraisal of one’s own strengths and weaknesses. Wishful thinking must play no part in this exercise. The relative strengths of the functions within a business have an important bearing on the formulation, not only of the corporate strategy, but also of the R & D strategy. For example, a company whose main strengths relative to the competition lie in marketing and production rather than in technology is unlikely to be successful in new product innovation. Conversely, R & D strength would suggest an offensive strategy where a stream of innovative products makes up for possible shortcomings in marketing and high manufacturing costs which are less important in this situation.
2.2.5 TECHNOLOGY AUDIT

Technology audit is a topic of current interest and importance to most South African companies. In anticipation of developing technological audits, companies find it difficult to get started. The difficulty is as a result of key questions that are posed such as:

- “What is a technology audit?”
- “Are there any accepted standard procedures or best practice for such audit?”
- “What do we require from an audit?” and
- “How can we best act on the findings of an audit for the benefit of the institution, departments and individuals?”

Any R & D department possesses its own unique mixture of strengths and weaknesses, which should be analysed. Twiss (1992: 70) explains that the identification of a technological opportunity or a creative idea does not necessarily mean that the ability exists to carry them through the successful commercial exploitation. The analysis can take the form shown in Table 2.1. The column gives examples of the types of factors to be considered; the factors themselves will differ to some extent from one company to another, according to the characteristics of the industry. The column ‘Audit of present position’ contains an assessment of the current position represented in the form of a profile to aid in the identification of areas of particular strength or weakness. The third column ‘Technological capital for the future’ is more difficult to complete. Its purpose is to evaluate the company’s technological capabilities in relation to the demands upon it to meet its future objectives.
<table>
<thead>
<tr>
<th>Item</th>
<th>Audit of Present position</th>
<th>Technological capital For the future</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strong 1</td>
<td>2</td>
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<tr>
<td><strong>Resources</strong></td>
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<td></td>
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<tr>
<td>Size of budget</td>
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<tr>
<td>Budget growth</td>
<td></td>
<td></td>
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<tr>
<td>Personnel number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab equipment by category:</td>
<td>(a) ......</td>
<td></td>
</tr>
<tr>
<td><strong>Technological expertise</strong></td>
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<tr>
<td>Technology A</td>
<td></td>
<td></td>
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<tr>
<td>Technology D</td>
<td></td>
<td></td>
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<tr>
<td><strong>Personnel</strong></td>
<td></td>
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<tr>
<td>Creativity ability</td>
<td></td>
<td></td>
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<tr>
<td>Etc.</td>
<td></td>
<td></td>
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<tr>
<td><strong>Past Performance</strong></td>
<td></td>
<td></td>
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<tr>
<td>Experience of innovation</td>
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</tr>
</tbody>
</table>

Source: Twiss (1992: 71)
According to Khalil (2000:264), a technology audit is a tool used to evaluate the conditions or the existing status of a certain sector in an organisation. Garcia-Arreola (1996) developed a technology audit model (TAM) that included important areas to be considered in a technology audit. The objectives of TAM are:

- To determine current technological status
- To stress areas of opportunity, and
- To take advantage of the firm’s strong capabilities.

TAM is a three-level model, with each level going deeper into more specific functions. The upper level is composed of six categories. At the second level, 20 assessment areas exist. Finally, 43 assessment elements constitute the third level (see Table 2.2).

The following results should be obtained from a technology audit, according to Khalil, (2000:274):

- Analyse the firm’s internal technologies (products and processes) to identify core competencies.
- Identify external and basic technologies.
- Identify “technology gaps,” that is, situations in which new technologies must be acquired.
- Review the technology/science push and the market pull.
- Establish whether or not the innovation process takes into account science push and market pull.
- Check time to market. Identify constraints in the process.
- Review the R&D strategy. Is it consistent with science push and market pull?
- Check for consistency between core technologies, R&D, and marketing.
- Look for evidence of continuous improvement in manufacturing.
- Analyze partnerships and joint ventures. Are they in line with the overall strategy?
- Review the technology transfer procedures. How is the company ensuring that knowledge is preserved and transferred?
- Analyze the corporate structure. Is it flexible? How is the communication between levels?
Table 2.2: **Technology Audit Model**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1.1 Executive Leadership</td>
<td>2.1 Product Technology</td>
<td>3.1 Market Needs</td>
<td>4.1 Ideas Generation</td>
<td>5.1 R&amp;D</td>
<td>6.1 Acquisition</td>
</tr>
<tr>
<td>Technology as a Priority</td>
<td>- Internal Technologies</td>
<td>- Market Assessment</td>
<td>- Intrapreneurship</td>
<td>- Teams</td>
<td>- Methods of Acquisition</td>
</tr>
<tr>
<td>Involvement</td>
<td>- External Technologies</td>
<td>- Marketing of Technology</td>
<td>- Entrepreneurship</td>
<td>- Portfolio Justification</td>
<td>- Capital Investment</td>
</tr>
<tr>
<td></td>
<td>- Basic Technologies</td>
<td></td>
<td>- Success/Failure</td>
<td>- Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Technology Trends</td>
<td></td>
<td>- Investment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Technology Strategy</td>
<td>2.2 Process Technology</td>
<td>3.2 Competitors’ Standing</td>
<td>4.2 Technology</td>
<td>5.2 Operations</td>
<td>6.2 Transfer of Technology</td>
</tr>
<tr>
<td>Corporate Strategy</td>
<td>- Internal Technologies</td>
<td>- Competitors’ Assessment</td>
<td>Generations</td>
<td>- Process Improvement</td>
<td>- Transfer Procedures</td>
</tr>
<tr>
<td>Goals</td>
<td>- External Technologies</td>
<td>- Benchmarking</td>
<td>- Science-Push</td>
<td></td>
<td>- People Transfer</td>
</tr>
<tr>
<td>Deployment</td>
<td>- Basic Technologies</td>
<td></td>
<td>- Market-Pull</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technologies Trends</td>
<td></td>
<td></td>
<td>- People Transfer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Organization Structure</td>
<td>2.3 Technology Strategy</td>
<td>3.3 Market Needs</td>
<td>4.3 Form Concept</td>
<td>5.3 Environment-conscious Technology</td>
<td>6.3 Exploitation for Profit</td>
</tr>
<tr>
<td>Organization Chart</td>
<td>- Innovation in Marketing</td>
<td>- Market Needs</td>
<td>Concept to Marketing</td>
<td>- Technology</td>
<td></td>
</tr>
<tr>
<td>Teamwork</td>
<td>- Product-Service Concept</td>
<td></td>
<td></td>
<td>- Environment-conscious</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>- Technology</td>
<td></td>
</tr>
<tr>
<td>1.4 Technology Culture</td>
<td>2.4 Technology Strategy</td>
<td>3.4 Market Needs</td>
<td>4.4 Form Concept</td>
<td>5.4 Environment-conscious Technology</td>
<td>6.4 Technology Protection</td>
</tr>
<tr>
<td>Learning</td>
<td>- Innovation in Marketing</td>
<td>- Market Needs</td>
<td>Concept to Marketing</td>
<td>- Technology</td>
<td></td>
</tr>
<tr>
<td>Organization</td>
<td>- Product-Service Concept</td>
<td></td>
<td></td>
<td>- Protection</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>- Management of Change</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Management of Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 People</td>
<td>2.5 Technology Strategy</td>
<td>3.5 Market Needs</td>
<td>4.5 Form Concept</td>
<td>5.5 Environment-conscious Technology</td>
<td>6.5 Technology</td>
</tr>
<tr>
<td>Recruiting</td>
<td>- Innovation in Marketing</td>
<td>- Market Needs</td>
<td>Concept to Marketing</td>
<td>- Technology</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>- Product-Service Concept</td>
<td></td>
<td></td>
<td>- Protection</td>
<td></td>
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<tr>
<td>Empowerment</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Reward System</td>
<td></td>
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</table>

Source: (Khalil, 2000:267)
2.2.6 TECHNOLOGY INTELLIGENCE AS CRITICAL INPUT INTO STRATEGIC DECISION-MAKING.

Organisations are legally and ethically collecting, analysing and applying information about the capabilities, vulnerabilities and intentions of their competitors, and monitoring developments within the overall competitive environment, such as previously unseen rivals over the horizon, or new technologies that could change everything, according to Narayanan (2001:202).

The goal is actionable intelligence that will provide a competitive edge. By analysing the competition’s moves, competitive intelligence allows the organisation to anticipate market developments rather than to react to them. The advantage of competitive intelligence is that it will point out weaknesses that the organisation has internally because of the strengths of their competitors. Technology intelligence is a critical input into strategic decisions. The technology-related data is interpreted to yield information and intelligence results from inferences of implications from the information.

Technology intelligence falls into three levels: macro, industry and programme/project-related (see Table 2.3).

Table 2.3: Levels of technology intelligence

<table>
<thead>
<tr>
<th>Level</th>
<th>Characteristics</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro</td>
<td>General technology trends</td>
<td>Long-range focus</td>
</tr>
<tr>
<td></td>
<td>Directional, imprecise,</td>
<td>National and corporate levels</td>
</tr>
<tr>
<td></td>
<td>ambiguous</td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td>Specific technologies</td>
<td>Medium-range focus</td>
</tr>
<tr>
<td></td>
<td>General trends</td>
<td>Business strategy</td>
</tr>
<tr>
<td>Program/Project</td>
<td>Specific technologies</td>
<td>Short-range focus</td>
</tr>
<tr>
<td></td>
<td>Specific trends</td>
<td>Product, process, and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>materials</td>
</tr>
</tbody>
</table>

Source: Narayanan 2001:205
Technology audit refers to the process of gathering intelligence internal to an organisation, whereas mapping refers to gathering intelligence about the external environment, according to Narayanan (2001:205) (see Table 2.4).

**Table 2.4: Mapping technology environment**

<table>
<thead>
<tr>
<th>Industry stages and intelligence gathering</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intelligence Gathering Characteristics</strong></td>
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<tr>
<td></td>
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<tr>
<td>Focus</td>
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<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td>Types of Information</td>
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<tr>
<td></td>
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<tr>
<td>Benefits strategy</td>
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<td></td>
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</tbody>
</table>

Source: Narayanan 2001:213

Four steps are involved in gathering intelligence: scanning, monitoring, forecasting and assessment. By scanning and monitoring the environment, the focus is on data gathering. In technology-related matters, data need to be collected from both personal and secondary sources. The sources may be developers or facilitators, either private or public. Secondary sources are made easier with the advent of the Internet.

The process of technology intelligence generation should be carefully managed. The Herring Model’s five steps namely needs assessment, planning, collection, analysis, and presentation provide a useful way of organising the activity, according to Narayanan (2001:232). He continues by stating that in the current environment intelligence gathering should be global and frequent; in addition, have to act quickly on the information thus obtained.
2.2.7 STAGES OF TECHNOLOGY DEVELOPMENT

Organised technological development follows a hierarchical progression: (1) basic research, (2) applied research, (3) development, and (4) technology enhancement.

- **Basic Research** - This is research undertaken to gain new scientific knowledge or understanding. It is not directed toward a specific practical aim or application. The objective of basic research is to gain a fuller knowledge or understanding of the subject under study, rather than to develop practical applications. Basic research is conducted to advance science, which can be thought of as a process of generating and accumulating knowledge over a long period over time. Basic research is perceived to be a drain on organisations’ resources, and may not lead to an immediate commercial return on investment but it is essential for new discoveries and for the growth of knowledge explains (Khalil 2000:306).

- **Applied Research** - This is research directed toward a specific practical aim or objective and conducted to develop ideas into operational form. Applied research is directed toward gaining the knowledge or understanding necessary to meet a recognised and specific need. Applied research is a mix of science and engineering (Khalil 2000:307).

- **Development** - Development involves the systematic use of the knowledge or understanding gained from research to produce useful materials, devices, systems, or methods, including the design and development of new or improved services. Development work is overseen by engineering. Development effort is a connecting link between research and the commercial use of ideas Khalil (2000:307).

- **Technology Enhancement** – Khalil (2000:307) explains that this can be defined as the continuous effort by scientists and engineers to support and improve existing or developed technologies. It aims to improve the performance parameter of the technology, lengthens the technology life cycle and fosters incremental innovations. Key technologies require eight to 15 years to develop. The time horizon of technology planning is significantly longer than that of business planning. The challenge to managers is to forecast technological change and make the necessary provisions for it in their business plans.
2.3 THE EFFECTS OF IMPLEMENTING NEW TECHNOLOGY

2.3.1 DEVELOPMENT STRATEGY AND PRE-PROJECT MANAGEMENT

While individual development projects are where much of the action is, senior management can have its greatest leverage in the preproject stages, according to Burgelman et al (2001:743)

They continue by emphasising that the overall conceptual view of development activity for both approaches is that of the development funnel, shown in Figure 2.3.

**Figure 2.3: The development funnel**

![Development Funnel Diagram](source: Burgelman et al (2001:743))

As suggested in this figure, organisations encounter a range of products ideas and concepts that can be investigated as potential new products and processes. From that range of possibilities, the organisation must pick a handful of specific projects to which resources will be applied, with the goal of creating on-target, on-time, on-budget products and processes that can be introduced to the marketplace in an effective and efficient manner.
They further states that the *traditional role* of senior management in the development funnel is to select, consider (screen) and evaluate a handful of projects ideas from all of those available and then make “go/no-go” decisions with regard to those projects. Senior management thus reacts to the possibilities raised from throughout the organisation (and perhaps adds a few ideas of its own) and commits resources to get selected projects developed and into the market place.

The above-mentioned traditional views have several shortcoming and weaknesses:

- Firstly, it assumes that the set of concepts proposed by the organization adequately covers the firm’s opportunities and needs for new products and processes.
- Secondly, it assumes that senior management will have the required information to properly decide which product ideas to develop, in the context of ongoing business and product line strategies.
- Thirdly, this view presumes that advanced development and technology work will have occurred before each development project receives its initial funding and approval.
- Finally, it assumes that senior management will adequately consider the capacity and resources requirements for prospective individual projects and for the mix of projects already approved. Unfortunately, few of these assumptions hold in practice and the traditional approach ends up, again, being reactive, piecemeal and tactical rather than proactive, comprehensive and strategic.

Sheasley (1999: 7&49) states that developing new technology is fundamentally different from developing new products. In the former case, technology is the end result; in the latter, it is the raw material. In the former, technology is the output; in the latter, the input. Technology development, under the constraints of short-term business expectations and existing customer needs, will explore neither the scope nor depth of learning needed for significant discoveries. In order to succeed, programmes for technology development must be established as such.

Shealey continues by emphasising that technology development programmes take aim at major advances or market-changing discoveries. Successful programmes provide sustainable competitive advantage and can tip the balance of control or influence in the
They are expected, in other words, to have a substantial impact on a company's business. However, in order to allow these programmes the time and latitude necessary in exploratory investigations, they cannot be tied to immediate market opportunities or customer needs. These programmes need to be guided by the organisation's knowledge of the longer-range trends, key issues and dynamics of their business. Market intelligence and vision are critical ingredients in effective technology development.

Twiss (1992: 72) argued that the raw material for all technological innovation is knowledge. This may be knowledge required to solve current problems or that needed for incorporation in new projects to further the corporate strategy. In addition, new technologies or developments in existing technologies may in the longer term provide opportunities for entirely new products or suggest areas for business diversification. This ‘strategic push’ can come only from the knowledge base residing in R & D.

Narayanan (2001: 76) stated that technology evolution refers to the changes in the performance characteristics of a specific technology over time. Figure 2.4 displays evolution of a typical performance characteristic. Once a new technology has come into existence, the performance characteristics of interest show very little improvement in the early stages of the technology. This initial stage is followed by a second phase of very rapid improvement in the performance characteristic. During the third stage, the performance characteristic continues to improve, but the rate of improvement begins to decline. In the final stage, very little improvement is visible in the performance characteristic.
2.3.2 PREPARING FOR CHANGE

Both the basic obstacles for a change namely, the desire for a change and acceptance of a change, are mostly of human origin owing to reluctance and hesitation of people as a result of high degree of build-in rigidity. Operation rigidity does not allow organisations to change as fast as they should. Thus, in order to eliminate this obstacle good flexibility should be built into the process. Operation flexibility builds dynamism into organisations. This is possible only through involving people and making them responsible for the entire change process Mruthyunjaya (2001: 8 &39).

He also emphasised the fact that people's involvement could be enhanced by enhancing their will power and their skill power. He identifies the following as methods of improving will power:

- Giving everybody full knowledge of why they should change, when to change and how to change and providing ready access and/or exposure to new technology, knowledge and expertise. Giving every body opportunity to tap his/her intrinsic potential.
• Imbedding in them the sense of realization of need to change:
  
  ▪ Generating an understanding that all activities of the organisation serve only as a means to serve the end purpose resting with the customer.
  ▪ Building a feeling of ownership and a feeling of partners-in-progress.
  ▪ Eliminating all types of corporate malpractices like not giving the right of say in matters, non-delegation of decision powers, absence of freedom of action, prevalence of fault-finding missions, nurturing unhealthy competition, non-recognition of accomplishments, non-sharing of credits, non-equitable distribution of returns, practice of converting a right of share on returns to a bait, intolerance for mistakes, operation rigidity, non-acceptance of new concepts or persons, etc.
  
• Creating and maintaining an environment ever ready to give a serious try to proposed changes:
  
  ▪ Evolving an integrated interface representing the highest level of cohesive participation with a common understanding, with a common objective, joint responsibility but individual commitment to results.
  ▪ Practising the score-board system of open communication, namely providing a ready access to relevant unfiltered data and unbiased information to all those who need to use them for their operations.
  ▪ Free-flow of thoughts in all directions, uninhibited sharing of knowledge, expertise and infra-structure.
  ▪ Distribution of decision power through out the organisation.
  ▪ Continuous and speedy updating of skills and imparting multiple skills to empower executives to accomplish continuous improvements, coupled with infra-structure and facility updation.

Skill power enhancement could be achieved through the following:

• Giving appropriate training to all people at all levels.
• Building multiple skills in people, enabling them to handle multiple activity centers.
Through the modification of certain techniques or approaches, successful change can be brought about. Ivancevich and Matteson (1996:623) and Slocum (1996:692) state that technology is an approach to change. They state that the technological approaches emphasize changes in the flow of work. This could include, for example, new physical plant layouts, changes in office design and improved work methods and techniques. Many technological changes are related to advances in equipment design and capability. For example, computer-aided-design technology has transformed the job (and productivity) of draftspersons; laser-guided production equipment has dramatically increased the accuracy of many manufacturing processes; the desktop computer has altered literally millions of jobs; and on a growing number of factory floors, robots are outnumbering people. Organisational researchers are just now beginning to examine some of the longer-term effects of technological change on individuals.

Communication is a powerful change tool. If organisations have to change their operations to match changing external requirements, the first requirement is that they should know what changes are taking place elsewhere in the world. This information nucleates the process of change within the organisation. When this data undergoes some refinement and some fine tuning to market frequency, namely the knowledge of when the new products are likely to enter the market and what changes they would bring in the consumption and demand pattern, the change process within the organisation gets catalyzed. If the organisations can generate the data and relevant information well in advance and ahead of others, it would have enough time to suitably prepare itself for the change, including pushing its own product to market ahead of others (Mruthyunjaya 2001: 8 &39).

- The power of change - McCallum (1996:87) explains that technology is where pure science meets practical problems; it is best thought of as how we do what we need and want to do. Applying science to improve the way we live by making products better, faster and cheaper has always mattered in business. Theodore Maimen in 1960 built the first laser. Surgery, manufacturing, defence, communications, retailing, printing and education have changed enormously as a consequence. Will laser-surgery corrected vision make us the last generation to wear spectacles?
• Catalysts for the change - Mruthyunjaya (2001:39) states that quality depends on the innovation level of technology and the price depends on how innovatively the technology is being managed. The search for newer products at lower prices with better performance is an eternal process. Continuous change, arising from continuous technological innovations and the innovative techniques of managing the same, is a by-product of this eternal search. Organisations have to accept that the market environment keeps changing continuously owing to the following five basic facts:

- Organisations do not have any control over the intensive technology inventions or process improvement taking place in other organisations.
- Organisations cannot prevent others from improving and updating their technology.
- Organisations cannot stop others from introducing newer and better products in the market.
- Organisations cannot prevent others from acquiring better technologies for the same products for enhancing their competitiveness.
- Organisations cannot prevent new units from entering the market already established by them.

• How Technology has changed the Production Process - Allen and Economy (2000:308) explain that it is important to recognize the impact of technology on manufacturing processes. This understanding can help one recognize what is possible for one’s business, whether one chooses to manufacture products oneself or find someone to do it.

Allen and Economy (2000:309) continue by asking what customers want today. They want superior quality, fanatical service, on-time delivery (or sooner, if possible) and the specific features and benefits they are interested in. The question is how traditional manufacturers with standard mechanical, assembly-line processes are supposed to meet those demands. They cannot and that is the point. Yes, technology has indeed made it possible for manufactures to meet all those demands, but to do so, a company has to be relatively small, flexible and fast.
In a word, one’s company must be agile- The rapidly changing global business environment has made agile manufacturing an absolute necessity, not just an attempt to adopt the latest business fad. *Agile manufacturing* is about responding quickly and effectively to changes in demand, preferences, expectations and opportunities. The customer decides what is produced, when it is produced and how much is produced, and the company responds. It is as simple as that, according to Allen and Economy (2000:309).

Allen and Economy (2000:309) describe in detail how, the perceived value of a product nowadays is directly related to the knowledge, information and services bundled with it. These new products are known as *knowledge-based products*. The positive feature about producing products that have more value that just their tangible value (their features) is that they give one an opportunity to create long-term customer relationships, which are essential to long-term business survival.

To become an agile manufacturer, one needs to comply with the following, according to Allen and Economy (2000:309).

- Create a team that consists of employees, suppliers, and customers, so that everyone is in this together.
- Try to stick with a core technology that allows one to produce a variety of products. This approach is much less expensive and more efficient than creating something completely new each time.
- Strive to use common parts on several different products. Doing so saves design time on the parts that are built and permit one to buy in volume on the parts one obtains from ones suppliers.
- Wherever possible, use off-the-shelf components instead of designing from scratch. Why reinvent something that someone else has already done very well?
- Suppliers should be approached to design or modify their products to meet one’s own requirements. Suppliers will view this as a viable market for their parts, and so both parties’ needs are met.
• Strategic change in a nutshell - These are exhilarating times. Rapidly changing technologies demand that even larger investments in plant and equipment are made in order to improve aggregate productivity. Falling national barriers make it possible for aggressive global firms to invade traditionally sheltered industries (Fombrum 1992:9).

Fombrum (1992:13) continues by explaining that globalization and technological change tend to increase rivalry and so magnify demands for efficiency and entrepreneurship. Simultaneously, demands for institutional responsiveness focus the attention to questions of fairness and ethics. To keep up, managers contemplate changes in business, corporate and collective strategies.

Strategic change requires a new mindset, a new way of organising. It forces one to recognise that tall pyramids no longer pass muster in an environment that demands more rapid informational exchange and more timely and effective decisions. A new kind of leader must therefore arise like a Phoenix from the ashes of our crumbling corporate hierarchies - one who recognizes that, at heart, if change involves managing emotions, and then revolutionary change requires mobilizing collective passions (Fombrun 1992:13).

2.3.3 KEY FACTORS FOR SUCCESS IN THE MANAGEMENT OF TECHNOLOGY

According to Levy (1998:13), at the beginning of the new century highly competitive business posed a particular challenge for the management of technology. To manage a high-technology, innovative organisation successfully, one needs not only to master the basic managerial knowledge and skills necessary to run any type of organisation, but also to acquire and thoroughly understand a body of specific knowledge about factors that play a key role in this industry.

There are five factors which Levy describes as crucial to the success of any manufacturing organisation. Levy (1998:13) starts by explaining that in order to be
successful one has to begin with the concept of innovation. Clearly, innovation is in the soul of high technology.

The second factor of particular significance in the high-technology industry is the human factor. Extremely important in the management of any organisation, this factor becomes critical in high technology for two reasons. Firstly, high-technology companies, unlike the more traditional industries, are based on innovation. Innovation depends entirely on individuals. Secondly, in high-technology organisations, the proportion of engineers, scientists, mathematicians and other professionals is much larger than in low-technology industries. This concentration of highly qualified employees requires a different management approach from the one appropriate in the more traditional industries.

The third critical factor that must be adapted specifically to high-technology needs and requirements is the organisation factor. Most companies need to change and adapt their organisations over time, but the pace in the high-technology sector requires a much faster and more dynamic matching of the organisational structure to the changing needs of a company as it grows from a start-up to a mature, diversified firm.

The fourth critical factor in the high-technology industry is the management competency factor. In the high-technology area, however, managers at all levels have to be better educated and more competent to perform their task than other managers because of the extreme complexity of balancing the factors just discussed.

The fifth factor noted is the know-how factor, which is a prerequisite for business success in the high-technology sector. It needs to be complemented by and distinguished from the know-how factor. Much as one differentiates between efficiency and effectiveness, one should distinguish between know-how and know-why. Know-how is important to develop an innovative product. Know-why, however, implies insight and understanding of future trends and is essential for exploiting the market success of the product.

Mruthyunjaya (2001:8&39) explains that the secret of success in a dynamic environment is a fourfold truth. The first one is realistic vision for the future, followed by the desire to continue to remain in business with a passion for growth. The third
element is a dedicated team to accomplish success and the last one is commitment to quality which had thus far opted to remain as an invisible force. When the first three elements are properly harnessed, the invisible (quality) force could be transformed to an invincible force and organisations are bound to meet with total success. This is the case even in a dynamic environment because the end purpose of dynamism and associated changes is to supply the most appropriate product, which would fully meet the application requirements and far exceed customers' expectations in the context of readily available high technology alternate products.

He continues to explain that in order to successfully manage the technology in the current global context; organisations should examine the technology basically from three points of view.

- The first one is acquiring the state-of-the-art-technology from wherever it is available, including technology developed in-house
- Second one is to guard the same from becoming obsolete, and
- The third one is to maintain a balance between new technology and technology updating.

Management of technology (MOT) is an interdisciplinary field that integrates science, engineering and management knowledge and practice (Khalil 2000:7). He states that the focus is on technology as the primary factor in wealth creation. Wealth creation involves more than just money; it may encompass factors such as the enhancement of knowledge, intellectual capital, effective exploitation of resources, preservation of the natural environment and other factors that may contribute to raising the standard of living and quality of life. Managing technology implies managing the systems that enable the creation, acquisition and exploitation of technology. It involves assuming responsibility for creating, acquiring, and spinning out technology to aid human endeavours and satisfy customers' needs. Research, inventions and development are essential components in technology creation and the enhancement of technological progress. However, more important for the creation of wealth is the exploitation or commercialisation of technology. Technology generates wealth when it is commercialised or used to achieve a desired strategic or operation objective for and organisation. MOT treats technology as the seed of the wealth-creation system. What can be viewed as part of the building blocks towards a model of the strategic management of technology is a list of some seventeen key success factors identified by
Cleland and Bursie (1992: 184). This list is presented below in a slightly augmented form:

- A corporate culture rewarding creativity and innovation
- Top management support for technology
- The interdependence of product and process technology
- Simultaneous engineering via product design teams
- The technology life cycle system
- A corporate culture that is excited about technology
- Recognition of R & D’s changing profile towards centralised basic research and towards business units in the case of applied research
- Strategic alliances as a competitive strategy
- Competitive analysis
- Central information systems and technology monitoring
- Technological leadership
- Technology audits and portfolios
- People links for the transfer of technology
- Customer and supplier interfaces
- Integrated technology and business planning
- An emphasis on teamwork
- The management of technology.

2.3.4 SPECIAL PERSONNEL CHARACTERISTICS OF A TECHNOLOGY COMPANY

Levy (1998: 25) states that the human factor is of fundamental importance in all management activities. Clearly, whatever the nature of the business, all basic managerial tasks have to do with managing people. In high - technology and innovation companies, however, managers have additional concerns. In addition to the general, well-known and accepted principles of leading, guiding and motivating people, managers must adapt their leadership approach to the characteristics of the personnel responsible for the vital activities of the organisations.

The creativity common to all innovators often allows them to look at a situation from an entirely different perspective from that of most people, and to see novel ways of solving
a problem. No wonder, therefore, that innovators are often individualists with varying
degrees of ability – or disability – in communicating effectively with the rest of the
organisation. Innovative people typically share other characteristics, but individualism,
unrealistic optimism, and neglect of details are the major and most frequent causes of
problems associated with managing organisations involving inventors and innovators.

One of the most important policies that managers of a high-technology company must
establish concerns recruitment of new personnel. In view of the critical role the human
factor plays in high technology, management should strive to get the best people for
every job in the company. Because the most critical capability in high-technology
industries is knowledge, and because knowledge resides in people, managers cannot
expect to achieve a long-term competitive advantage if they compromise the quality of
people recruited.

Twiss (1992: 22) states that strategy is concerned with providing a sense of direction
and coherence to corporate policies and actions. It is evident that technology is one of
the most important forces shaping the future – for many companies it is the most
important. Often this is not sufficiently recognized. In such cases the corporate
strategy is developed by top management with inadequate technical representation.
This can arise because of a failure of top management to appreciate the importance of
technology or because the senior technologists involved accept a specialist and
subservient role isolated from the wider interests of the business. Technology must be
regarded as an integral part of the business, not as a tool to be used to meet
predetermined corporate objectives.

The linkage between the corporate and R & D strategies must, therefore, be a
continuous and iterative process, for the latter may well reveal opportunities which
might warrant a modification of the former. Whilst strategic thinking is important it can
become an arid intellectual exercise if it is used solely to justify the status quo or is not
translated into effective implementation. It can only provide a framework within which
R & D must exercise its creativity and development skills.

According to Khalil (2000:54), an overriding concern is the highly dynamic conditions
that exist for manufacturing and service organisations, conditions dictated by changes in
technology and by the global business environment. Table 2.5 lists several of the changing trends in industry during recent years:

Table 2.5: Changing trends in industry

<table>
<thead>
<tr>
<th>Factor</th>
<th>Traditional</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life cycle</td>
<td>Long life cycles</td>
<td>Short life cycles</td>
</tr>
<tr>
<td>Innovation</td>
<td>Few innovations</td>
<td>Continuous innovations</td>
</tr>
<tr>
<td>Competition</td>
<td>Expected competition</td>
<td>Stronger competition</td>
</tr>
<tr>
<td></td>
<td>Competitors are the enemy</td>
<td>Alliance with competitors</td>
</tr>
<tr>
<td></td>
<td>Cooperation not allowed</td>
<td>accepted</td>
</tr>
<tr>
<td>Market</td>
<td>Expected market</td>
<td>Uncertain market</td>
</tr>
<tr>
<td></td>
<td>Local market</td>
<td>Global market</td>
</tr>
<tr>
<td>Quality</td>
<td>Quality is desirable</td>
<td>Quality is imperative (a hygiene factor, a survival Factor)</td>
</tr>
<tr>
<td>Production</td>
<td>Mass production</td>
<td>Customized production</td>
</tr>
<tr>
<td></td>
<td>Produce in large lots</td>
<td>Produce in small lots</td>
</tr>
<tr>
<td></td>
<td>No commitment to suppliers</td>
<td>Suppliers are partners</td>
</tr>
<tr>
<td></td>
<td>Large inventories</td>
<td>Reduce inventories (JIT)</td>
</tr>
<tr>
<td></td>
<td>Fixed manufacturing</td>
<td>Flexible manufacturing</td>
</tr>
<tr>
<td>Organisation</td>
<td>Large corporations vertically</td>
<td>Smaller plants; companies</td>
</tr>
<tr>
<td></td>
<td>Integrated companies</td>
<td>rely on outsourcing</td>
</tr>
<tr>
<td></td>
<td>Bureaucratic organisations</td>
<td>Nimble organisations</td>
</tr>
<tr>
<td></td>
<td>Financial methods control the</td>
<td>Financial methods to serve</td>
</tr>
<tr>
<td></td>
<td>organisation</td>
<td>organisation’s objective</td>
</tr>
</tbody>
</table>

Source: Khalil (2000:55)

2.3.5 TECHNOLOGY AND CULTURE

Glackon (1980: 1 & 14) describes the interface between technology and culture as the relationship between nature and technology whether simple or complex, it can only be understood in terms of culture – those patterns of behaviour and thought common to a
people. Culture is the crucial link between nature and technology. Culture determines both how we use and modify nature and how we think about it.

Throughout history and up to the present, different cultures have valued and sought in nature different things. For example, the Native Americans did not search for plutonium as we do now; we no longer seek whale oil for lamps as our ancestors did.

Every culture, prehistoric, primitive and civilised so far has developed a conception of nature. If we look back at prehistoric times, two technologies that modified nature stand out: plant and animal domestication and the use of fire. People living in a culture like our own, depending on advanced technologies based on applications of theoretical science, either overlook these fundamental facts or are unaware of them. Thus there has been a tendency to think that technology is a modern phenomenon coming from the basic innovations like the steam engine of the industrial revolution in the latter part of the 18th century, and that before then humanity relied primarily on its own and animal power. This belief ignores the role of water and wind in the history of technology. Water management by aqueducts, canals, stream division and draining is ancient. Drainage has been one of the fundamental activities of the human race in many parts of the world and its cumulative effects have been to make the earth drier.

The conclusions regarding nature and technology depend partly on how we look at history. If we study the history of technology, we are apt to be impressed by inventions, successes and failures, anticipations, improvements and applications. Our perspective would be different were we to study the history of the modification of the earth by human beings and their technologies.

Pacey (1993: 4-5) stated that we would understand much of this more clearly, if the concepts of practice were to be used in all branches of technology as it has traditionally been used in medicine. By remembering the way in which medical practice has a technical and ethical as well as an organisational element, we can obtain a more orderly view of what technology practice entails. We might then be better able to see what aspects of technology are tied up with cultural values, and which aspects are, in some respects, value-free. We would be better able to appreciate technology as a human activity and as part of life. We might then see it is not only as comprising machines,
techniques and crispy precise knowledge, but also as involving characteristic patterns of organisation and imprecise values.

2.4 CONCLUSION

Mruthyunjaya (2001: 8 &39) stated that industrial operations have undergone several phases of revolutionary transformation through the ages. If we carefully examine the genesis of these revolutions, it becomes clear that all those revolutions were basically either change-oriented or change induced and the driving force behind all those change processes were the outcome of development activities.

Sheasley (1999: 7&49) explains that long-term or exploratory research aimed at the development of new technology has remained largely outside the scope of management strategies for enhancing productivity in R&D. Increasing the effectiveness of these efforts, however, can have a major impact on the corporate well-being. Leaders must cultivate clear and disciplined thinking without curtailing the creativity that is so essential to success in exploratory research. Breakthroughs in technology require time; discoveries cannot be scheduled. However, resources and programmes can and must be managed. Applying the "right" level of managerial oversight to technology development programs is like walking a balance beam: penalties await error on either side. Two much oversight may detract from people's creativity and spirit, constrain the inventive process and risk premature termination of genuinely worthwhile programmes. Too little oversight may risk loss of the sense of urgency or importance, digression from business intent and continuation of unsound programmes.
CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Much has been written about social science research. Some authors follow a more philosophical approach to research design, while others follow a pragmatic approach. The importance of including both schools of thought in a study of social science research is increasingly emphasised by contemporary social scientists (Leedy and Omrod 2001:143). The objective focus of this chapter is to establish an appropriate research strategy for a given research problem.

3.2 WHAT IS RESEARCH DESIGN?

3.2.1 THE CONCEPT OF RESEARCH

Allison, Owen, Rice, Rothwell and Saunders (1996:18) define research as a collaborative human activity in which social reality is studied objectively with the aim of gaining a valid understanding of it. The Oxford Dictionary (1961:325) defines research as the systematic investigation into sources in order to establish facts and reach new conclusions or collate old facts by the scientific study of the subject or by a course of critical investigation. Finally, Leedy and Ormrod (2001:4) define research as studious inquiry or examination, having for its aim the discovery of new facts and their correct interpretation.

3.2.2 THE CONCEPT OF DESIGN

Yin (1994:20) defines design as the preparation of a working plan aimed at systematically assembling, organising and integrating data, in order to solve the research problem. Leedy and Ormrod (2001:91) state that research design includes the planning, visualisation of the data and the problems associated with the employment of the data in the entire research project. The Oxford Dictionary (1995:1169) states that design is a preliminary plan, concept or purpose.
There seems to be a broad consensus amongst theorists on a framework for research design. Some researchers focus on the philosophical aspects of design (Mouton & Marais 1992) while others have developed useful pragmatic frameworks (Yin 1994).

The views of these authors have been consolidated into a conceptual model of decision steps. This model, as illustrated in Diagram 3.1, forms the foundation on which the research design for this research project has been based:

**Diagram 3.1: A conceptual model for research design**

![Diagram of research design](image)

Source: (Mouton & Marais 1992) and (Yin 1994)

There are two very important considerations when dealing with any type of measurement. One of these is validity and the other reliability. Validity is concerned with the soundness and the effectiveness of the measuring instrument. Leedy and
Ormrod (2001:31) explain that the validity of a measurement instrument is the extent to which the instrument measures what it is supposed to measure. The following questions can be asked: Does the measuring instrument measure what it is supposed to measure? What is the accuracy of the measurement?

There are several types of validity: the more common types, according to Leedy and Ormrod (2001:103) are:

- **Face validity** – is concerned with the subjective judgement of the researcher.
- **Content validity** – is the accuracy with which an instrument measures the representative sample, factors or situations under study.
- **Criterion-related validity** – employs two measures of validity, the second assessment instrument as a criterion check against the accurate correlation of first related measure.
- **Construct validity** – is any concept such as honesty that cannot be directly observed or isolated.
- **Internal validity** – is the freedom from bias in forming accurate conclusions about cause-and-effect and other relationships within the data.
- **External validity** – is concerned with the generalisability of the conclusions reached from a sample to other cases.

Reliability deals with accuracy. According to Leedy and Ormrod (2001:31), it is the extent to which, on repeated measures, the indicators yield similar results. Reliability in quantitative research projects can be evaluated by repeating a question in a questionnaire. Reliability asks only one question: with what accuracy does the measurement, test, instrument, inventory or questionnaire measure what it is intended to measure?

### 3.3 COMPARING QUANTITATIVE VERSUS QUALITATIVE RESEARCH

The argument usually becomes muddled because one party argues from the underlying philosophical nature of each paradigm, and the other focuses on the apparent compatibility of the research methods, enjoying the rewards of both numbers and words. Because the positivist and the interpretivist paradigms rest on different assumptions about the nature of the world, they require different instruments and procedures to find the type of data desired. This does not mean, however, that the
positivist never uses interviews nor that the interpretivist never uses a survey (Mouton & Marais 1992). They may, but such methods are supplementary, not dominant.

Normally quantitative research is associated with positivism and qualitative research with interpretativism. All research methods could be placed somewhere between the extremes of pure quantitative and pure qualitative research (Yin 1994:115). It is, however, imperative to indicate whether research projects have a qualitative or quantitative nature. This will assist in determining what process to follow and measuring instruments to select. A summary of the main differences between qualitative and quantitative research is given in Table 3.1:

<table>
<thead>
<tr>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Test hypothesis that researcher begins with. Hypotheses are stated explicitly and are formulated beforehand.</td>
<td>• Capture and discover meaning once the researcher becomes immersed in data. Hypotheses are frequently undeclared or stated in the form of a research goal.</td>
</tr>
<tr>
<td>• Concepts are in the form of distinct variables. Concepts have an ambiguous meaning.</td>
<td>• Concepts are in the form of themes, motifs, generalisations, taxonomies. Concepts can be interpreted in a number of ways.</td>
</tr>
<tr>
<td>• Measures are systematically created before data collection is standardised. The researcher remains largely aloof.</td>
<td>• Measures are created in an ad hoc manner and are often specific to the individual or researcher. The researcher is involved with the events/phenomena.</td>
</tr>
<tr>
<td>• Data are in the form of numbers from precise measurement.</td>
<td>• Data are in the form of words from documents, observations and transcripts.</td>
</tr>
<tr>
<td>• Theory is largely causal and is deductive.</td>
<td>• Theory can be causal or non-causal and is often inductive.</td>
</tr>
<tr>
<td>• Procedures are standard, and replication is assumed.</td>
<td>• Research procedures are particular, and replication is very rare.</td>
</tr>
<tr>
<td>• Analysis proceeds by using statistics, tables or charts and discussing how what they show relates to hypotheses.</td>
<td>• Analysis proceeds by extracting themes or generalisations from evidence and organising data to present a coherent, consistent picture.</td>
</tr>
</tbody>
</table>

3.3.1 QUANTITATIVE RESEARCH

Leedy and Ormrod (2001:101) explain that quantitative research is used to answer questions about relationships among measured variables with the purpose of explaining, predicting and controlling phenomena. Mouton and Marais (1992:159) reinforce this opinion and define quantitative research as more highly formalised as well as more explicitly controlled, with a range that is more exactly defined, and which, in terms of the methods used, is relatively close to the physical sciences.

Quantitative research seeks to quantify, through numbers, observations about human behaviour. The emphasis is on precise measurement, the testing of hypotheses based on a sample of observations and a statistical analysis of the data.

A quantitative research project would usually test the most important causal links to be found in the research domain. This relationship between variables is usually expressed as a hypothesis. Quantitative research usually ends in with confirming or disconfirming of the hypotheses that were tested.

3.3.2 QUALITATIVE RESEARCH

According to Yin (1994:68) human behaviour is significantly influenced by the setting in which it occurs; thus one must study that behaviour in situations. The physical setting e.g., schedules, space, pay and rewards and the internalised notions of norms, traditions, roles and values are crucial contextual variables. One cannot understand human behaviour without understanding the framework within which subjects interpret their thoughts, feelings and actions. Qualitative research relies on interpretative and critical approaches to social sciences. The aim of qualitative research is to study individuals and phenomena in their natural settings in order to gain a better understanding of them. It is also evident that qualitative research does not follow a fixed set of procedures.

3.3.2.1 Characteristics of qualitative research

- Qualitative researchers are concerned primarily with process, rather than outcomes or products.
• Qualitative researchers are interested in meaning that is how people make sense of their lives, experiences and their structures of the world.

• The qualitative researcher is the primary instrument for data collection and analysis. Data are mediated through this human instrument, rather than through inventories, questionnaires or machines.

• Qualitative research involves fieldwork. The researcher physically goes to the people, setting, site or institution to observe or record behaviour in its natural setting.

• Qualitative research is descriptive in that the researcher is interested in process, meaning and understanding gained through words or pictures.

• The process of qualitative research is inductive in that the researcher builds abstractions, concepts, hypotheses and theories from details.

3.4 CHOOSING THE MOST APPROPRIATE RESEARCH METHOD

3.4.1 BRIEF HISTORICAL OVERVIEW

Case study research is a long established methodology. Researchers began to recognise the importance of the case study approach and single case investigations for the development of a knowledge base that is unobtainable through traditional group designs in research. A case study approach allows for an in-depth study of an individual which can yield relevant insight and results while looking at the individual in its entirety.

Case studies are not a new form of research; naturalistic inquiry was the primary research tool until the development of the scientific method. The fields of sociology and anthropology are credited with the primary shaping of the concept, as we know it today. However, over the years, case studies have drawn their share of criticism. In fact, the method had its detractors from the start. The debate between pro-qualitative and pro-quantitative is an ongoing concern. Case studies, when compared to statistics, are considered by many to be unscientific.
3.4.2 INTRODUCTION AND DEFINITION OF A CASE STUDY

Case study refers to the collection and presentation of detailed information about a particular participant or small group, frequently including the accounts of subjects themselves. A form of qualitative descriptive research, the case study looks intensely at an individual or small participant pool, drawing conclusions only about that participant or group and only in that specific context (Mouton and Marais 1992). Researchers do not focus on the discovery of a universal, generalisable truth, nor do they typically look for cause-effect relationships; instead, emphasis is placed on exploration and description. It is generally used when a researcher wants to answer “how” or “why” questions concerning an individual or single case.

3.4.3 CASE STUDY RESEARCH

There are various dimensions to consider when explaining case study research, the most relevant being the number of cases investigated, followed by the amount of detailed information that an individual collects about each case studied. Other aspects being equal, the fewer cases studied, the more information can be collected on each case. Case study research also carries implications for the kind of data that is collected, which is, more often than not, unstructured and qualitative in nature. This is also related to the purpose of the case study, which arguably, is to capture the uniqueness of a case, rather than use it as a basis for wider generalisation or theoretical inference (Allison, O’Sillivan, Owen & Rice, Rothwell, & Saunders, 1996)

3.4.3.1 COMPOSING THE CASE STUDY REPORT

In the many forms it can take, a case study is generically a story; it presents the concrete narrative detail of actual or at least realistic events; it has a plot, exposition, characters and sometimes even dialogue (Boehrre 1990).

This contextualisation usually includes a detailed explanation of the researchers' theoretical positions, of how those theories drove the inquiry or led to the guiding research questions, of the participants' backgrounds, of the processes of data collection, of the training and limitations of the coders, along with a strong attempt to make connections between the data and the conclusions evident.
After considering the different sub-categories of case study and identifying a theoretical perspective, researchers can begin to design their study. Research design is the string of logic that ultimately links the data to be collected and the conclusions to be drawn to the initial questions of the study. Typically, research designs deal with at least four problems:

- What questions to study
- What data are relevant
- What data to collect
- How to analyse that data

3.4.3.2 TYPES OF CASE STUDIES

Under the more generalised category of case study, there are several subdivisions, each of which is custom-selected for use, depending upon the goals and/or objectives of the investigator (Armisted1984). These types of case study include the following:

- Illustrative Case Study - These are primarily descriptive studies. They typically utilize one or two instances of an event to show what a situation is like. Illustrative case studies serve primarily to make the unfamiliar familiar and to give readers a common language about the topic in question.

- Exploratory Case Study - These are condensed case studies performed before implementing a large-scale investigation. Their basic function is to help identify questions and select types of measurement prior to the main investigation. The primary pitfall of this type of study is that initial findings may seem convincing enough to be released prematurely as conclusions.

- Cumulative Case Study - These serve to aggregate information from several sites collected at different times. The idea behind these studies is the collection of past studies that will allow for greater generalisation without additional cost or time being expended on new, possibly repetitive studies.

- Critical Instance Case Study - These examine one or more sites for either the purpose of examining a situation of unique interest with little to no interest in generalisability, or to call into question or challenge a highly generalised or
universal assertion. This method is useful for answering cause and effect questions.

3.4.3.3 STRENGTHS OF CASE STUDIES

Minnis (1985:2) explain the advantages of conducting a case study research project as the following:

**Flexibility** - The case study approach is a comparatively flexible method of scientific research. Because its project designs seem to emphasize exploration rather than prescription or prediction, researchers are comparatively free to discover and address issues as they arise in their experiments. In addition, the looser format of case studies allows researchers to begin with broad questions and narrow their focus as their experiment progresses, rather than attempt to predict every possible outcome before the experiment is conducted.

- **Emphasis on Context** - By seeking to understand as much as possible about a single subject or small group of subjects, case studies specialise in deep data, or thick description information based on particular contexts that can give research results a more human face. This emphasis can help bridge the gap between abstract research and concrete practice by allowing researchers to compare their first hand observations with the quantitative results obtained through other methods of research.

3.4.3.4 WEAKNESSES OF CASE STUDIES

Minnis (1985:2) continue to explain, that choosing to conduct a case study research project also have its weaknesses:

**Inherent Subjectivity** - The case study has long been stereotyped as the weak sibling among social science methods, and is often criticized as being too subjective and even pseudo-scientific. Likewise, investigators who do case studies are often regarded as having deviated from their academic disciplines, and their investigations as having insufficient precision (that is, quantification), objectivity and rigor (Yin, 1989:24). Opponents cite opportunities for subjectivity in the implementation, presentation and evaluation of case study research. The approach relies on personal interpretation of data
and inferences. Results may not be generalisable, be difficult to test for validity, and rarely offer a problem-solving prescription. Simply put, relying on one or a few subjects as a basis for cognitive extrapolations runs the risk of inferring too much, from what might be circumstance.

- **Ethical Considerations** - Researchers conducting case studies should consider certain ethical issues. For example, many educational case studies are often financed by people who have, either directly or indirectly, power over both those being studied and those conducting the investigation. This conflict of interests can hinder the credibility of the study.

The personal integrity, sensitivity and possible prejudices and/or biases of the investigators need to be taken into consideration as well. Personal biases can creep into how the research is conducted, alternative research methods used and the preparation of surveys and questionnaires.

A common complaint in case study research is that investigators change direction during the course of the study, unaware that their original research design was inadequate for the revised investigation. Thus, the researchers leave unknown gaps and biases in the study. To avoid this, researchers should report preliminary findings so that the likelihood of bias will be reduced.

### 3.4.4 DATA COLLECTION METHODS

#### 3.4.4.1 SINGLE OR MULTI-MODAL

When one envisages using a single or multi-modal it is important to obtain as complete a picture of the participant as possible. To this end case study researchers can employ a variety of methods. Some common methods include interviews, protocol analyses, field studies and participant-observations.

The single-case experiment makes use of pre-defined measures, which are used to assess pre-defined variables. The conditions under which the experiment takes place are normally closely controlled in order to conduct a study of one or more aspects of behaviour of a single subject. These studies aim to record and measure specific changes that occur as a result of the application of the specific variables. Owing to the conditions
being controlled, an advantage is created for the researcher as they can draw definite, accurate and valid conclusions about causal relationships (Yin 1989). The primary disadvantage is that the controlled circumstances remove any external influences, which would influence the subject under normal circumstances.

Armisted (1984:76) places an emphasis on the development of theory and defines case study as a detailed examination of an event (or series of related events), which the researcher believes exhibits the operation of some, identified theoretical principle. Both these definitions encompass different aspects of case studies and the combination of the technical along with the theoretical components is the basis of this particular study.

3.4.4.2 REASONS FOR UTILISING A SINGLE CASE STUDY APPROACH

There are underlying bases for utilising a single case design in research. The first is when the case is critical in testing a well-formulated theory. The theory has a clear set of propositions as well as circumstances under which the propositions are believed to be true. The single case can thus be used to determine whether a theory’s propositions are correct or whether an alternative explanation may be more relevant. A second rationale is one in which the case represents an extreme or unique case. The third, and final rationale, is the revelatory case (Yin 1994). This occurs when the researcher is presented with an opportunity to observe and analyse phenomena that may have previously been inaccessible.

3.4.4.3 PARTICIPATING SELECTION

Case studies can use one participant, or a small group of participants. However, it is important that the participant pool remain relatively small. The participants can represent a diverse cross section of society, but this is not necessary. Often, a brief "case history" is done on the participants of the study in order to provide researchers with a clearer understanding of their participants, as well as some insight as to how their own personal histories might affect the outcome of the study.
3.4.5  DATA ANALYSIS

As the information is collected, researchers strive to make sense of their data. Generally, researchers interpret their data in one of two ways: holistically or through coding. Holistic analysis does not attempt to break the evidence into parts, but rather to draw conclusions based on the text as a whole.

However, composition researchers commonly interpret their data by coding; that is by systematically searching data to identify and/or categorise specific observable actions or characteristics. These observable actions then become the key variables in the study. Merriam (1988:13) suggests seven analytic frameworks for the organization and presentation of data:

- The role of participants
- The network analysis of formal and informal exchanges among groups
- Historical
- Thematically
- Resources
- Ritual and symbolism
- Critical incidents that challenge or reinforce fundamental beliefs, practices and values

3.4.6  THEORY TESTING AND DEVELOPMENT

According to Yin (1994:45), theory plays an important role in both the collection of data and in generalisation. During data collection, the researcher can use the theory as a guide to decide on objectives and design of the case. It also serves as the basis on which the researcher can compare and analyse the collected data. This serves to assist in conceptualising the case within the chosen theoretical domains or constructs.

An additional role that theory plays is in generalising from case study to a specific theory (analytical generalisation), thus allowing a previously developed theory to act as a basis against which to compare the results of the study.
There are six types of data collected in case studies:

- Documents
- Archival records
- Interviews
- Direct observation
- Participant observation
- Artefacts

Depending on whether researchers have chosen to use a single or multi-modal approach for the case study, they may choose to collect data from one or any combination of these sources.

### 3.4.7 ISSUES OF VALIDITY AND RELIABILITY

Once key variables have been identified, they can be analysed. Reliability becomes a key concern at this stage, and many case study researchers go to great lengths to ensure that their interpretations of the data will be both reliable and valid. Because issues of validity and reliability are an important part of any study in the social sciences, it is important to identify some ways of dealing with results.

#### 3.4.7.1 A GUIDE TO IMPROVING RELIABILITY AND VALIDITY

According to Williams (1987:31), the following are some guidelines for improving the reliability and validity of data presented during a case study research.

- **Prolong the Processes of Data Gathering on Site** - This will help to insure the accuracy of the findings by providing the researcher with more concrete information upon which to formulate interpretations.
- **Employ the Process of "Triangulation"** - Use a variety of data sources as opposed to relying solely upon one avenue of observation.
- **Conduct Member Checks** - Initiate and maintain an active corroboration on the interpretation of data between the researcher and those who provided the data. In other words, talk to the subjects.
• **Collect Referential Materials** - Complement the file of materials from the actual site with additional document support.

• **Engage in Peer Consultation** - Prior to composing the final draft of the report, researchers should consult with colleagues in order to establish validity through pooled judgment.

### 3.4.8 GENERAL PROCEDURES

The case study methodology adopted in this research project was discussed earlier in this chapter. The primary data used in this research project was acquired from observations by way of interviews, questionnaires and observations.

The method adopted in this project was to identify and assess areas of expertise, implementing technology or equipment from department reports, by questionnaires and by interviewing staff members. The project was also conducted to identify opportunities and then to identify the most likely mechanisms or routes for exploitation of each opportunity. Opportunities where a possible mechanism or route for exploitation could not be identified were discounted or treated with skepticism. The audit concentrated on areas of strength which could be built on, and did not seek to identify weaknesses of individuals.

This project was a detailed audit of a section of a department. Based on experience and wider discussions, the following method is proposed for a detailed audit of the department. The crucial element is interviews with leaders and operators. Altogether five people were interviewed. The interviewer’s background is a mixture of academic and industrial knowledge, current industrial awareness and experience of technology transfer.

The initial phase was important to ensure that the audit proceeded smoothly and effectively. It included discussions with the Managing Director and Board of Directors to explain and to agree on the purpose of the audit, to modify the questionnaire and the framework of the report. Departmental reports were analysed and information was gathered. Analysis and drafting of the questionnaires was done prior to the interviews.
The purpose of the audit was explained to all relevant staff members. The approximate one-hour interviews conducted among operators and supervisors yielded a favourable outcome with some interesting observations and facts that would not have surfaced from any survey questionnaires. These interviews were unstructured to gain a better understanding and the focus was on concepts, themes, generalisations and actual versus make-believe.

The interview proceeded with a review of initial information and questionnaire responses to draw out more detail in important areas. Additional questions not appropriate for a written questionnaire was then asked to establish attitudes to exploitation of opportunities. For certain categories of opportunity, the role taken by the interviewer was crucial to the successful exploitation. The details of the interviews were formalized in order be more meaningful. These results are presented in Chapter 4.

3.5 CONCLUSION

A formal systematic approach to research design is crucial to ensure that a research project conforms to the principles of validity and reliability. The research design decisions guide the researcher in effectively addressing the research problem. A qualitative case study approach is the most appropriate research strategy for this research project. Questionnaires, interviews and observations are the main methods of data collection.
CHAPTER FOUR

THE ANALYSIS AND INTERPRETATION OF THE EMPIRICAL STUDY

4.1 INTRODUCTION

In chapter three the research methodology was discussed. In chapter one the main problem to research was the development of a strategy for the successful implementation and management of technology. To effectively solve the main problem, a technology audit was conducted at Valor Fruit Processors (Pty) Ltd. The audit was conducted with the involvement of the researcher and five other employees from the company, all of whom proved to be highly co-operative with the researcher. This appeared to be because the researcher’s emphasis on early consultation with the departmental head, which established it as a priority. Time was also allowed for consultation and feedback from all staff members concerned at each stage of the audit.

The aim of this chapter is to analyse and interpret the results of the empirical study. The outcome of each statement is presented, followed by an interpretation relating to the theoretical framework outlined in chapter two. Every organisation is unique and the steps for implementing the technology audit as discussed in this chapter can differ. A technology audit as presented by Tarek Khalil will be used as a model for the auditing programme. A systematic diagram will illustrate which steps are normally followed while carrying out a technology audit.

4.2 STEPS WHEN CONDUCTING A TECHNOLOGY AUDIT

The general aim of a technology audit is to evaluate the capacity of firms and organisations to integrate new technologies, work with technological partners and better define what they need in order to successfully integrate these technologies into the company. How does the organisation approach the task of being audited? How does the organisation look beyond the vulnerability of evaluating its technology, business practices and process infrastructure? How can the organisation successfully accomplish this? The answer is simple; a process flow and a clearly defined audit plan are necessary as seen in Diagram 4.1.
The first area to focus is evaluating a company's business process. This is evidence that they "plan their work and work their plan" (www.urenio.org). The following methodology will be used to indicate what tools to be used for the successful implementation of an audit. Table 4.1 depict 1o steps to be followed when an external consultant is approached to conduct the technology audit. For the purposes of this audit, steps 4-10 will be followed.
<table>
<thead>
<tr>
<th></th>
<th>Steps followed for technological audit. Slightly augmented</th>
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<tbody>
<tr>
<td>1</td>
<td>Desire/wish of firm to carry out technology audit. The firm may be enticed through promotional campaign from projects such as Innoregio or RIS type programs.</td>
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<tr>
<td>2</td>
<td>Selection of intermediary organisation/expert to carry out the technology audit</td>
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<td>3</td>
<td>First contact/visit of expert to firm is to have discussion on procedure/benefits of technology audit and presentation of steps</td>
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<tr>
<td>4</td>
<td>Preparatory work by expert on collecting basic information on the firm and the sector</td>
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<tr>
<td>5</td>
<td>General short diagnosis. Company interview with questionnaire normally with the Managing Director aiming at, collecting general company data, shaping company technology profile, performing a SWOT analysis and to identify technological areas for further analysis</td>
</tr>
<tr>
<td>6</td>
<td>Data analysis by expert – report on first diagnosis</td>
</tr>
<tr>
<td>7</td>
<td>Presentation of first diagnosis report to Managing Director and company management to have discussions, verification of findings and finalisation on the subjects for further analysis with/without additional experts (specialists). Further analysis may cover issues, such as: Production operations, R&amp;D, Quality, Product Development, Human Resources Management, etc.</td>
</tr>
<tr>
<td>8</td>
<td>Additional visits/interviews to department heads, as chosen in step 7. These visits may be done either by the generalist, the specialist or jointly. The advisors may have their own methodology, but typical areas that should be covered in the above mentioned departments are described in 3.2</td>
</tr>
<tr>
<td>9</td>
<td>Final report of the technology audit, compiled by the experts, which should cover:</td>
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<td></td>
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<tr>
<td>10</td>
<td>Presentation of report by expert(s) to company management should be aimed at:</td>
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<td></td>
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</table>

Source: www.urenio.org
4.2.1 STEP 1: DESIRE TO CARRY OUT TECHNOLOGY AUDIT

Taking a quantum leap by admitting that there is a need for a technology audit is the first step that needs to be taken by top management. Running the day-to-day operations of an organisation can be demanding. It is thus imperative that a specialist be consulted on the auditing process before commencement. The scope or initiative, brief description of technique and potential benefits to the small to medium-sized organisation must be indicated (www.urenio.org).

4.2.2 STEP 2: EXPERT TO CARRY OUT TECHNOLOGY AUDIT

Appointing an external consultant can be demanding. Only after a thorough investigation and interview can an appointment be made (www.urenio.org).

4.2.3 STEP 3: FIRST CONTACT/VISIT OF EXPERT OF FIRM/ PREPARATION OF AUDIT PLAN

The first contact is always important. At this stage, the consultant should be able to present a flow diagram indicating what the audit entails. By presenting examples of previous audits, management can associate themselves with the process that needs to be followed. The audit plan is devised together with top management. The consultant should not overlook emphasising to management the benefits that could be derived from such an audit (www.urenio.org).

4.2.4 STEP 4: PREPARATORY WORK BY EXPERT ON COLLECTING BASIC INFORMATION ON THE FIRM AND THE SECTOR

The expert consultant collects the data from two primary sources namely:

- The firm: collection of data from published information, brochures of company, annual reports, economic data, employees, products, exports, etc.
- The sector: published data on employment, turnover, economic trends and markets (www.urenio.org).
4.2.5  STEP 5: GENERAL SHORT DIAGNOSES

The expert consultant will consult with the Managing Director on issues relating to company strategy, SWOT analysis, technology innovation, change management, capital expenditure and developments in other departments i.e. Human Resources, Production, Quality, etc (www.urenio.org).

4.2.6  STEP 6: DATA ANALYSIS BY EXPERT – REPORT ON FIRST DIAGNOSIS

After the data have been analysed, the expert consultant will present a report to the company that will include the following:

- Background
- Overview of company/activities
- Overview of sectors/markets
- Synthesis of: strengths/weaknesses/opportunities/threats identified
- Possible improvement or suggestions to existing procedures
- Executive summary (www.urenio.org).

4.2.7  STEP 7: PRESENTATION OF FIRST DIAGNOSIS REPORT TO GENERAL MANAGER AND COMPANY MANAGEMENT

The presentation is done with the handing out some time earlier of a hard copy of the report. The presentation should be done with slides/transparencies and should cover the main findings of the report. The finalisation on whether to continue for further diagnosis and the agreement on the subject(s) to analyse also happen performed here (www.urenio.org).

4.2.8  STEP 8: ADDITIONAL VISITS/INTERVIEWS TO DEPARTMENT HEADS

Typical areas and themes that could be covered with either specific subject tools or in a less structured way (if done by a specialist) could be:
(a) Quality
- Policy – goals – personnel involvement – training
- Process quality – monitoring and control systems – handling – storage – packaging
- Keeping of records/use of results
- Product quality – raw materials quality control – product quality control

(b) Human resources
- Organogram – skills – availability
- Satisfaction – rewards
- Meetings – awareness of company activities/products
- Team working/project management
- Continuing education/training
- Promotion – evolution – enumeration.

(c) Research and development – Product development
- Research and development strategy/partners
- Product mix/product lifecycle analysis
- Analysis of procedures for new product development
- Analysis of research and development activities
- Participation in research and development projects
- Focus on specific research and development area – identification of potential technology suppliers.

(d) Production operation
- Walk through production facilities – bottlenecks – problem areas
- Material flow – flow diagram
- Overview of system automation/needs – opportunities
- Floor and product safety
- Maintenance – procedures – planning – problems
- Analysis of productivity.
(e) Marketing/sales
- Existence/analysis of marketing plan
- Strategy – market share/local – exports
- Competitors analysis/sector analysis/opportunities – threats
- Distribution networks – problems

4.2.9 STEP 9: FINAL REPORT OF THE TECHNOLOGY AUDIT
COMPiled BY THE EXPERTS

The final report should contain the following:
- Executive summary
- Summary of results from first diagnostic
- Subject(s) analysed in second part
- Methodology used for analysis
- Problems identified
- Solutions proposed
- Actions to be taken (action plan).

The action plan should be specific to the subject, with a timeframe, with determined milestones and with an estimated budget. The action plan must list the expected results, identify potential problem solvers (technology or service providers) and indicate provisional funding for implementing the solutions. An implementation, monitoring-schedule must be done by the technology auditor, in conjunction with a project manager (www.urenio.org).

4.2.10 STEP 10: PRESENTATION OF REPORT BY EXPERT (S) TO
COMPANY MANAGEMENT

A detailed report must be presented to management, emphasising key issues discussed with the Managing Director in step 5.
### 4.3 THE TECHNOLOGY AUDIT

#### 4.3.1 TECHNOLOGY AUDIT MODEL (TAM)

A comprehensive assessment for Valor Fruit Processors (Pty) Ltd was based on all levels.

<table>
<thead>
<tr>
<th>Checklist 4.1: Technology Audit Checklist</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment areas</strong></td>
</tr>
<tr>
<td><strong>Rating</strong></td>
</tr>
<tr>
<td>Corporate environment</td>
</tr>
<tr>
<td><strong>1.1 Senior Executive leadership and orientation</strong></td>
</tr>
<tr>
<td>- Technology as a top priority: Technology is appreciated and managed as a key factor in the overall business strategy. There is a chief technology officer, whose judgement has a considerable influence in the decision-making process. The management style is consistent with the maturity of the enterprise.</td>
</tr>
<tr>
<td>- Involvement and participation: Managers are active members of the technology culture within the corporation. They have close relationships with the chief technology officer and with technology gatekeepers.</td>
</tr>
<tr>
<td><strong>1.2 Technology strategy</strong></td>
</tr>
<tr>
<td>- Corporate strategy: There exists a corporate strategy aimed at achieving the corporation’s vision. One aspect of this strategy is aimed toward the technologies within the corporation. The technology strategy is a significant contributor to the corporate strategy.</td>
</tr>
<tr>
<td>- Goals: There are specific goals directed at establishing technology standards and positioning the company as the industry leader.</td>
</tr>
<tr>
<td>- Deployment: The technical strategy is effectively communicated and deployed throughout all levels in the organisation.</td>
</tr>
<tr>
<td><strong>1.3 Organisation structure</strong></td>
</tr>
<tr>
<td>- Organisational chart: The organisation has a structure that enables agility. It facilitates the decision-making process. Technology is explicitly represented by a chief officer, whose judgement influences the decision-making process. There exists evidence of organisational structure around technologies, not around products.</td>
</tr>
<tr>
<td>- Teamwork: The roles and jobs are designed to facilitate teamwork. The teams are self-managed, with only occasional reviews from the manager. The teams can establish their own objectives and measures to support the overall technology strategy.</td>
</tr>
<tr>
<td><strong>1.4 Technology culture advancement</strong></td>
</tr>
<tr>
<td>- Culture: There are values within the corporation that highlight the importance of technology as a strategic factor. The corporate culture supports and encourages technology.</td>
</tr>
</tbody>
</table>
TAM AUDIT CHECKLIST (continued)

<table>
<thead>
<tr>
<th>Assessment areas</th>
<th>Elements</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Poor</td>
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</tbody>
</table>

- **Learning organisation**: The organisation is skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights. The organisation has established methods for systematic problem solving, experimentation with new approaches, learning from its own experiences (both successes and failures) and most successful practices of others, and transferring knowledge quickly and efficiently throughout the organisation. Lessons are documented and distributed throughout the organisation.

- **Communication**: There are no organisational barriers threatening the communication top-down, bottom-up, and horizontally. Ideas and concerns can be freely expressed. Information is made available to whoever might need it. The organisational structure is not a barrier when trying to communicate with top management levels.

- **Management of change**: The organisation is effective in dealing with change. People perceive change as an opportunity, rather than a threat. Teams can be easily reorganised to adapt quickly to new corporate needs.

- **Recruiting policies**: Human resources are in continuous contact with the operative departments to be aware of their needs regarding new employees. Candidates are identified and selected by taking into account their initiative, leadership, and technical skills.

- **Training**: A process is in place to ensure that the employees are high-skilled, knowledge resources, customer-driven, trainers, and problem solvers.

- **Empowerment**: Employees are empowered to take direct action when a problem occurs or an opportunity exists. Managers are perceived as facilitators. Data are accessible to the person/team that requires information.

- **Reward system**: The reward system takes into account the different motivation factors for managers, engineers, scientists, and entrepreneurs, as well as the flexible nature of the organisation.
## TAM AUDIT CHECKLIST (continued)

<table>
<thead>
<tr>
<th>Assessment areas</th>
<th>Elements</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2 Technologies categorisation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.1 Service/product technologies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <em>Internal technologies:</em> The corporation has clearly identified its core competencies and core service/products. Managers make sure that efforts are focused on strengthening and exploiting them.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>External technologies:</em> Technology gatekeepers have identified the external technologies included in the products, and made sure that none of them are of strategic importance. The system must be able to identify any important technology and develop it in-house before it becomes a competitiveness factor. There are established systems to forecast future developments.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>Basic technologies:</em> The basic technologies of the industry are clearly identified and maintained in good competitive position. There are established systems to forecast future developments.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>Technology trends:</em> Technology gatekeepers must know the current standing and trends of the technologies behind the core competencies. There are established systems to forecast the future developments.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
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<tr>
<td></td>
<td>1</td>
<td>2</td>
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<tr>
<td><strong>2.2 Back office/process technologies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• <em>Internal technologies:</em> The organisation values the development of process technologies as much as the development of product technologies. Managers make sure that efforts are focused on strengthening and exploiting them.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>External technologies:</em> Technology gatekeepers have identified the external technologies included in the processes. They make sure that the latest developments are included in the processes. There are established systems to forecast future developments.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>Basic technologies assessment:</em> The basic technologies of the industry are clearly identified and maintained in good competitive position. There are established systems to forecast future developments.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• <em>Technology trends:</em> Technology gatekeepers know the current standing and trends of the key process technologies that support the manufacturing process of the core products. There are established systems to forecast future development.</td>
<td>Poor</td>
<td>Outstanding ( \sqrt{ } )</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Assessment areas</td>
<td>Elements</td>
<td>Rating</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>
| 2.3 Technology in marketing | • *Innovation in marketing:* The company develops sound and aggressive marketing plans to better capitalise on the characteristics of the products, making them more accessible to customers.  
• *The product-service concept:* The company is able to identify the service customers require from the products and to look for alternative ways to satisfy that need. Products are customised solutions. The boundary between product and service becomes less obvious. | Poor √ 1 2 3 4 5  |
| 3 Markets and competitors | 3.1 Market needs  
• *Market assessment system:* There are systems which effectively identify the market’s needs and its future possible trends. This information is available to research and development leaders, and people within the organisation are encouraged to understand it. Market trends are included in the overall corporate strategy. Technology gatekeepers are active participants in this process.  
• *Marketing of technology:* The marketing department has developed systems to exploit not only products but technologies. Plans must be consistent with exploitation policies and with the overall technology strategy. | Poor √ 1 2 3 4 5  |
| 3.2 Competitors’ status | • *Competitor assessment:* Cross-functional teams are in charge of periodically assessing the core competencies, technological status, and possible future capabilities of competitors.  
• *Benchmarking:* The company periodically looks for the best practices related with its business, wherever they can be found. Internal processes and policies are compared with the benchmarks, and plans are developed to reduce the gaps. | Poor √ 1 2 3 4 5  |
| 4 Innovation process | 4.1 Idea generation  
• *Intrapreneurship:* Policies exist to permit innovation at all organisational levels. Employees are encouraged to suggest new ideas for products, services, or processes. Reward systems are in place to motivate innovation within the company. Employees know the market needs and build on them in order to create new products or services. There exists a system that enables intrapreneurs to communicate and develop new ideas.  
• *Entrepreneurship:* Entrepreneurs are motivated to develop their ideas within the organisation if the ideas are consistent with the strategy. Otherwise, the system allows the entrepreneur to go elsewhere to develop the idea. | Poor √ 1 2 3 4 5  |
### TAM AUDIT CHECKLIST (continued)

<table>
<thead>
<tr>
<th>Assessment areas</th>
<th>Elements</th>
<th>Rating</th>
</tr>
</thead>
</table>
| 4.2 Technology generators | • *Science push:* Technology gatekeepers have the resources to be experts within their fields and are empowered to suggest new directions and trends. They are aware of the latest scientific discoveries within their specific fields.  

• *Market pull:* Marketing is able to relate current products to market needs, identifying gaps and opportunities. The information regarding market needs is available to all interested persons/teams. |
|                  | Poor √ Outstanding 1 2 3 4 5                                             |                         |
| 4.3 From concept to market | • *Break-even time and break-even cost:* There is evidence of continuous improvement on the time-to-market variable. The teams are able to provide follow-up on their expenses throughout the entire time-to-market period. |
|                  | Poor √ Outstanding 1 2 3 4 5                                             |                         |
| 5 Value-added functions | • *Cross-functional teams:* Cross-functional and autonomous teams are used to plan, develop, and implement new products, processes and/or services. Design for manufacturability is achieved through early involvement of all departments in the company. Every new venture has a champion leading the effort.  

• *Portfolio justification:* The research and development portfolio is fully consistent with the corporate and technology strategies, with the maturity of the industry, and with the core competencies of the corporation. There is a process to select new projects that will support the overall strategy and its congruency with technology priorities, acquisition, and exploitation.  

• *Success/failure analysis:* Projects are analysed to identify and understand causes of success or of failure; learning is documented and distributed within the company. |
|                  | Poor √ Outstanding 1 2 3 4 5                                             |                         |
| 5.2 Operations | • *Improvement:* There are measures related to all the important variables of the processes. There is evidence of continuous improvement in those measures. The organisation is able to reach economies of scale and economies of scope to satisfy market needs. |
|                  | Poor √ Outstanding 1 2 3 4 5                                             |                         |
| 5.3 Environment-conscious technology | • *Green products and processes:* The company is concerned about designing and producing environment-friendly products. The processes are equipped with filters or appropriate non-pollution devices.  

• *After-life analysis:* The design of the product takes into account the fact that the product will be discharged at the end of its lifetime; its recycling is already considered. |
|                  | Poor √ Outstanding 1 2 3 4 5                                             |                         |
TAM AUDIT CHECKLIST (continued)

<table>
<thead>
<tr>
<th>Assessment areas</th>
<th>Elements</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Acquisition of technologies</td>
<td>Method of acquisition: The technology acquisition options (internal research and development, joint ventures, licensed in, or purchase) support the technology strategy. The decisions are based on the lifecycle position of the specific technology. Decisions take into account factors such as the company’s standing, urgency of acquisition, investment, lifecycle position, and technology category.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td>Capital investment: Capital appropriations are analysed and approved based not only on financial statements but also on the competitive advantage they may create.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
<tr>
<td>6.2 Transfer of technology</td>
<td>Transfer procedures: The company has transfer procedures, which allow it to successfully transfer technologies from other institutions, i.e., companies, laboratories, universities.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
<tr>
<td></td>
<td>People transfer: When a new technology is acquired, people are also transferred to support the transfer process.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
<tr>
<td>6.3 Exploitation for profit</td>
<td>Exploitation for profit: Procedures exist to ensure the optimal exploitation of technologies, whether in product or processes, contracting out manufacturing, joint venture or licensing out. The decisions are consistent with the overall technology strategy and the technology classification.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
<tr>
<td>6.4 Protection</td>
<td>Protection: The innovation process is a closed loop requiring that the knowledge be protected either by patenting, secrecy, or other methods.</td>
<td>Poor Outstanding √ 1 2 3 4 5</td>
</tr>
</tbody>
</table>

Source: (Khalil, 2000:268)
### Table 4.2: Technology Audit Comparative Rating

#### 4.3.2 TECHNOLOGY AUDIT COMPARATIVE RATING

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FIRST WORLD: AUDIT</th>
<th>VALOR: AUDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POOR</td>
<td>1</td>
</tr>
<tr>
<td>1. Technical Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Executive Leadership</td>
<td></td>
<td></td>
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<tr>
<td>1.2 Technology Strategy</td>
<td></td>
<td></td>
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<tr>
<td>1.3 Organization Structure</td>
<td></td>
<td></td>
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<tr>
<td>1.4 Technology Culture</td>
<td></td>
<td></td>
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<tr>
<td>1.5 People</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Technologies Categorization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Product Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Process Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Technology in Marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Competitors and Markets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Market Needs</td>
<td></td>
<td></td>
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<tr>
<td>3.2 Competitors’ Standing</td>
<td></td>
<td></td>
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<tr>
<td>4. Innovation Process</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Ideas Generation</td>
<td></td>
<td></td>
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<tr>
<td>4.2 Technology Generators</td>
<td></td>
<td></td>
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<tr>
<td>4.3 From Concept to Market</td>
<td></td>
<td></td>
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<tr>
<td>5. VAFs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 R&amp;D</td>
<td></td>
<td></td>
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<tr>
<td>5.2 Operations</td>
<td></td>
<td></td>
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<tr>
<td>5.3 Environment-Conscious Technology</td>
<td></td>
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<tr>
<td>6. TAEP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1 Acquisition</td>
<td></td>
<td></td>
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<tr>
<td>6.2 Transfer of Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 Exploitation for Profit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.4 Technology Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple Average</td>
<td>4.7</td>
<td></td>
</tr>
</tbody>
</table>
4.4 FINDINGS – TECHNOLOGY AUDIT SURVEY

The final process was to audit a small to medium-sized organisation using technologies in the manufacturing process. The researcher decided to use Valor Fruit Processors (Pty) Ltd. to conduct the audit. After discussing the purpose of the audit and its content with the Managing Director, Wallace Barnes, it was agreed that the audit could be performed.

The researcher used the steps as described in the beginning of this chapter as a guideline to conduct the technological audit. The researcher conducted several interviews with the Managing Director as to the specific information to be publicised. The following information is background to the company and its operations.

The aim of the audit was to compare Valor Fruit Processors (Pty) Ltd. with that of first world countries i.e. United States of America and Europe. The researcher had to study various literatures in order to compile enough information to be able to conduct an audit. The results of the audit on first world countries are thus the views and interpretation of the researcher. Literatures from the following authors were used to compile enough information to be able to conduct the audit:

- Aït-El-Hadj, S. 1992
- Ansoff, H. 1986
- Ivancevich, J.M & Matteson, M.T. 1996
- Kelessidis, V. 2003
- Khalil, T. 2000
- Levy, N. 1998
- Mruthyunjaya, H.C
- Narayanan, V.K. 2001
- Sommer, W.P. & Nemee, J. & Harris, J.M. 1986
- Sheasley, W.D. 1999
- Steele, L. 1989
4.4.1 GENERAL INFORMATION

Valor Fruit Processors is located at 255 Grahamstown Road, Deal Party, Port Elizabeth. The organisational structure is very flat, with the Managing Director at the top of the organisation and four departmental managers (Finances, Operations, Factory and Quality) reporting to him.

Valor’s shareholding consists of three shareholders, namely Sundays River Citrus Company with 68% shareholding, Patensie Beheerend Beperk with 22% shareholding and a Valor employee trust of 10% shareholding. The company’s annual turnover varies between 25 million to 45 million Rand per annum, depending on the fruit volumes received from the two-shareholding pack houses.

4.4.2 HUMAN RESOURCES

Valor employs 46 permanent employees and during the seasonal production period, approximately 50 contract workers. The company has a quarterly performance review where training needs are identify and addressed.

4.4.3 PRODUCTIVITY

The factory consists of two production facilities. The first is the primary production facility where fruit is received, juices extracted and then concentrated via an evaporator. Other products produced in this production facility are essential oils and cells. The second is the secondary production facility where the finished products from the primary production are used as raw material in producing nectars and comminute products. Some of Valor’s well – known clients are Bromor Foods (Oros drink) and Woolworths (Nectars).

It is in the primary production facility that Valor recently purchased a high-tech evaporator to concentrate its citrus juice. The fully automated evaporator requires intense training to operate. The machine has the capacity to evaporate single strength juice of up to 24000 litres per hour. The company purchased the machine in 2002 at a cost of five million Rand. The company anticipates that the outcome of the audit will assist them in future decision-making with regards to technological equipment purchases.
4.4.4 QUALITY CONTROL

Valor Fruit Processors (Pty) Ltd. hold numerous quality awards. They were the first citrus processing company in South Africa to be accredited with ISO 1900/2001 and HACCP. They have also recently been accredited with ISO 17205. Quality is a high priority and the company strives to maintain its immaculate record. With clients such as Woolworths and Bromor they cannot afford to produce sub-standard products. They pride themselves on the slogan that they produce “Quality Products for Quality Customers”. This motto has ensured that they have maintained a healthy relationship with all their clients over the years.

4.4.5 RESEARCH AND TECHNOLOGICAL DEVELOPMENT

Valor does not have a technological research and development department. Most of its engineering and maintenance of high-tech machines is outsourced.

4.4.6 PROBLEMS

The problem relating to the citrus processing industry is that they work with a perishable product. The fruit needs to be processed immediately after off-loading to ensure the best yield and quality products. The longer the fruit is stored, the less yield and quality is produced. Enzyme activity in un pasteurised juice is one of the biggest quality problems experienced at Valor. It is therefore essential to evaporate the juice immediately after extraction. The production facility can produce up to 23850 litres of juice per hour. It is therefore crucial to have a machine available that can be able to process such volumes.

4.4.7 STRATEGY AND TECHNOLOGY STRATEGY

Valor has clearly defined its corporate strategy. Although technology is not specifically addressed in the strategy, it definitely forms part of a resource to successfully fulfil their strategy. Management and staff are up to date with new technological development in the citrus processing industry. The company has done extensive research on new developments in the industry, but because of financial constraints, they were unable to implement these. They maintain a positive approach throughout this period.
Training forms an integral part the company’s strategy. It is essential that their permanent staff is multi-skilled because of the unskilled contract workers they employ annually. Valor can be considered as a technological leader in the citrus processing industry. Its technology position compares favourably to that of its competitors. Valor’s customers have played, and will continue to play a big role in the decision to buy new technology.

4.5 FINDINGS OF THE TECHNOLOGY AUDIT

4.5.1 TECHNOLOGICAL ENVIRONMENT

4.5.1.1 EXECUTIVE LEADERSHIP

In many first world countries, organisations employ a chief technology officer who ensures that technology is promoted amongst all employees, especially the managers. Valor has not employed a technology officer. Part of the factory manager’s portfolio is special projects. In this portfolio, technology and product development is strongly promoted. Valor’s rating in comparison to first world countries is very low.

4.5.1.2 TECHNOLOGY STRATEGY

Valor has a clear defined corporate strategy. Technology does not feature as a separate unit within the strategy, but is most definitely a means of accomplishing the strategy. The company has set goals that establish Valor as a technology leader in the industry. The involvement of other departments in communicating technical strategies is limited to only to a few departments. Valor rates average in comparison to first world countries.

4.5.1.3 ORGANISATION STRUCTURE

Although the company maintains a flat hierarchy that improves decision-making, it lacks the services of a chief technological officer. Teams are not self-managed. As a result employees neglect to set own objectives for the implementation of technology. The company scores a low rating of one.
4.5.1.4 TECHNOLOGY CULTURE

Many of Valor’s customers dictate the processes to be followed in order achieve a specific result. As a result, the employees view change as an opportunity and not as a threat. They are well aware of the importance of change and of adapting to new procedures and technology. This continuous endeavour to improve and adapt has brought about a vast pool of knowledge. Employees are keen to learn and most are multi-skilled. The flat structure has assisted Valor in the communication process from top-to-bottom and bottom-to-top. Despite the flat structure, communication remains a thorny issue when communicating upwards. The company’s rating is above average and compares favourably to first world countries.

4.5.1.5 PEOPLE

The company has a quarterly performances appraisal review. During this review session, each employee’s performance is scrutinised and at this stage, training needs are determined in conjunction with the individual employee. Valor does not outsource its recruitment. With every new appointment, Human Resources, together with the departmental manager, will determine what skills, knowledge, experience and competencies the potential candidate should possess. The potential candidate’s competencies are evaluated through a series of tests that could also include psychometric testing. This function is outsourced to Competent Choices. Valor’s rating is above average and compares favourably with first world countries.

4.5.2 TECHNOLOGIES CATEGORISATION

4.5.2.1 PRODUCT TECHNOLOGY

Valor has succeeded in addressing their core competencies and core products/services through internal values. Goals are clearly identified and vision and mission statements are displayed throughout the organisation. The company lacks a chief technology officer and therefore lacks a proper system that enables it to accurately forecasts future technology developments. The company is rated at two and compares poorly to first world countries.
4.5.2.2 PROCESS TECHNOLOGY

The staff and management of Valor value both the process technology and product technology. They constantly reminded the researcher that they consider themselves as being the technology leaders in the industry. Basic technologies are clearly identified and included in the manufacturing processes. First world countries are experts in this matter. Valor is determined to emulate this trend, and they are confident of accomplishing this by 2007.

4.5.2.3 TECHNOLOGY IN MARKETING

Citrus juice concentrate and essential oils are commodities and the price is entirely driven by demand. Through innovative marketing, Valor has managed to sell the entire content of the fruit, except for the pips. The company extracts the following from the fruit:

- Oil from the peel and they sell this as an essential oil to be used in cosmetics, cleaning material and food flavours;
- The peel is sold to a local transporter. He then sells this as cattle feed to dairy farmers;
- The juice is extracted and concentrated. This is sold as a citrus juice concentrate;
- Cells are extracted from the juice, before evaporation. These are sold as citrus cells to give nectars a more natural appearance.

Trading in a very competitive market, and selling a commodity product, Valor has successfully managed to customise its products to suit the clientele. They are able to offer not only one product but also a variety of products. By achieving this, they have decreased the boundaries between product and service to be less obvious. The outcome of the rating was four.

4.5.3 COMPETITORS AND MARKETS

4.5.3.1 MARKET NEEDS

The company lacks a formal system that enables them to effectively identify possible future trends. The marketing department is closely linked to their customers and can
offer them a variety of products based on technological developments in production. Only once customers require a different product would the company evaluate how compatible their technology is in terms of producing the required product. The company scores a low two.

4.5.3.2 COMPETITORS’ STANDING

Valor has build up a strong relationship with one of world’s most knowledgeable companies in the citrus processing industry, FMC Technologies. Their core business is R&D. Every year they arrange visits to the USA, and allow Valor to nominate a candidate to accompany them. FMC Technologies subsidise this visit with a 50% payment. The purpose of the visits is to benchmark the company against the giants of the industries. This also allows them the opportunity to evaluate new technology in action and to looks at best practices. The company rated at above average.

4.5.4 INNOVATION PROCESS

4.5.4.1 IDEAS GENERATION

Once a month the company has a management meeting. During these meetings, the company’s performance is measured. Each department manager has an opportunity to discuss his/her department’s performance. It is at this forum that departmental managers will nominate, discuss and evaluate new ideas and innovations. If the innovation is approved and successfully implemented, the employee receives a financial reward. The concept of entrepreneurship, however, is unfamiliar with the employees. The consequence is that not everybody works to achieve a common goal. The company is rated at a disappointing two.

4.5.4.2 TECHNOLOGY GENERATION

In the production facility it was clear that the employees lack the resources to empower themselves to be experts within their fields. Although regular meetings are held with a supervisor, where technology updates are given, it was clear that this information does not filter through to the lower level employees. In first world countries, where general workers are more educated, they are rated as outstanding. Valor is rated at average.
4.5.4.3 FROM CONCEPT TO MARKET

As previously discussed, during management meeting new ideas and innovations are presented, discussed and evaluated. When an innovation is approved, the relevant employee and all other departmental managers with dissect the new idea in terms of the financial feasibility, possible process alterations, the time period from approval to implementation to the market, etc. The result of the comprehensive study will determine whether the project will be approved. If approved, a project leader will be appointed to coordinate the activities. Aspect such as break-even time and break-even cost will be able to be monitored on a daily basis. Weekly feedback is given to all relevant managers, including the Managing Director. The company is rated at above average.

4.5.5 VAF’s

4.5.5.1 R&D

As discussed under the previous heading “From Concept to Market”, the company appoints a project leader to coordinate all aspects of the project. After the completion of the project, a post-mortem is done to determine any successes and failures. This information is crucial for the company in its endeavour to ensure those projects are completed timeously and within budget. The company, however, lacks the services of a chief technology officer that plays a pivotal role in all projects. The company is rated at average.

4.5.5.2 OPERATIONS

The company’s financial system, Omnix allows anybody with access to compare historical data with present data. If changes have been made on a production line, anybody will be able to compare historical data with the present to evaluate the successes/failures. All information from the receiving of fruit, the yields in production, stock in the warehouse and sales are updated daily on a one-page document for scrutiny by any of the managers. The company is rated at above average.
4.5.5.3 ENVIRONMENT-CONSCIOUS TECHNOLOGY

Amongst all the company’s prestigious accreditations, it misses one, the ISO 14000 environmental-friendly accreditation. From interviews with the Managing Director, they will endeavour to be accredited in the near future. Valor makes use of two boilers. The one is a coal boiler (8 tons of steam per hour) and the other an oil-fired boiler (10 tons of steam per hour). None of the boilers have any filters to purify the air discharged.

All the concentrates are either frozen or preserved and are not therefore re-cycled. If the products are contaminated beyond a stage where it is safe for human consumption, the company disposes of it through waste management services such as Waste Tech. The company is rated at average.

4.5.6 TEAP

4.5.6.1 ACQUISITION

As previously discussed under the heading “From Concept to Market”, the company involves all departmental managers in the acquisition of new technology. The decision to approve capital investment is mainly based on the financial advantage, but exceptions are made. From discussions with the Managing Director it appears that projects in past were approved not only on grounds of the financial benefits, but also if they would give the company a competitive advantage over competitors. The company is rated at average.

4.5.6.2 TRANSFER OF TECHNOLOGY

Valor is the only company of its kind in Port Elizabeth. It does not have any other branches in South Africa. If technology is transferred from one department to another, then that particular expert would also be transferred. This, however, does not often happen in the organisation. The company is rated at average.
4.5.6.3 EXPLOITATION FOR PROFIT

It was not evident that the company has a set of procedure, that ensure the optimal exploitation of technology, whether in product or processes, contracting out manufacturing, joint ventures, or licensing out. The company is rated at one.

4.5.6.4 TECHNOLOGY PROTECTION

In the citrus processing industry, the machinery and technology used are very similar. Valor has not yet developed any systems or processes that need protection or patenting from competitors. The company is rated at one.

4.6 CONCLUSION

In this chapter a technology audit was done on Valor Fruit Processors (Pty) Ltd. The results were compared to that of a first world country. The report of the Technology Audit was aimed specifically at the opportunities that exist and how these can be used in the most effective way to enable effective decision-making. In most cases routes or mechanisms for exploitation and possible courses of action were identified. The great strength of this research meant that more opportunities were identified than could be exploited with the available resources. The next chapter contains a summary of the findings of the study, followed by concluding remarks and recommendations.
5.1 INTRODUCTION

It was the purpose of this dissertation to develop a strategy for the successful implementation and management of technology for Valor Fruit Processors (Pty) Ltd, through exploratory and descriptive research. In chapter four the empirical study was analysed. This chapter unfolds with a summary of the significant, positive responses to the empirical study, and will formulate recommendations for improvements. The chapter concludes with recommendations for further study.

5.2 SUMMARY AND CONCLUSION OF THE UNFOLDING DISSERTATION

In chapter one, the main problem and sub-problems relating to the research were identified. In chapter two, the general views of technology were expounded and discussed. The chapter covered two main aspects of technology. The first aspect was the implementation of technology in a manufacturing company. The second aspect was the effects of implementing new technology.

5.2.1 IMPLEMENTING TECHNOLOGY IN A MANUFACTURING COMPANY

The importance of strategic management was discussed, with the emphasis on the involvement of management in the early stages of technological developments. From the review of the theory, it was clear that the implementation of technology as a strategy begins with the full and unequivocal commitment from both the board of directors and management. Global changes accompanied by technology changes have created considerable problems in structuring and managing an organisation. To overcome this, many technologically dynamic companies have made use of technological gatekeepers and encouraged entrepreneurship. As a result, organisations have endeavoured to employ technology gatekeepers, encourage entrepreneurship and increase joint ventures.
It is imperative that technology teams feel and are empowered. This will facilitate people’s creativity and energy and give them a sense of ownership in order to discover new technology. Cycle time is a cornerstone in the delivering of technology. Reducing the time to develop new technology could have an even stronger impact on a business's commercial rewards than shortening product development time. Those who bring new technology to the market first, and who know how to sustain that competitive advantage, will be the leaders. Management’s involvement in the creation of technology has been emphasised on numerous occasions. Their involvement in the initial stages of development is crucial to ensure constant growth up to the maturity stage.

Technology forecasting is important to ensure the company’s competitiveness, growth and profitability. A wide range surveillance of the environment will ensure that initiatives both from within and outside the normal business sphere of the organisation are identified. This could influence the industry’s future and, in particular, the company’s own product and markets. It is crucial for the organisation to ensure that the estimation of timescales in relation to important events are accurate. Where the environment has forecasted possible threats or opportunities, provisions should be made for a more refined analysis of the data. This will enable the company to justify its decision-making.

Two important aspects of technology forecasting must be studied methodically to ensure technology growth. Technology is used to either drive business through *technology push* or *market pull*. For technology push, the customer must be convinced that the new technology will solve a problem. The opposite is true for market pull. Because of a need in the market, people demand a solution to that problem. Technology is then developed to solve that problem. Before deciding what strategy to implement, it is important to conduct a realistic appraisal of the company’s strengths and weaknesses. Here wishful thinking must not be an option.

One method of appraising strengths and weaknesses is through conducting a technology audit. A technology audit consist of an internal scrutinisation of the company’s industry specific technologies, and a panoramic external scan of the relevant technological
environment in search of weak and strong signals that may impact on the firm by way of technological opportunities or threats. A technology audit model (TAM) can assist an auditor in conducting a technology SWOT analysis.

Technology intelligence is capable of collecting, analysing and applying information about the capabilities, vulnerability and intentions of competitors. The goal is actionable intelligence that will provide a competitive edge. By allowing it to analyse the competition’s moves, competitive intelligence allows the organisation to anticipate market developments rather than to react to them. Technology intelligence is a critical input into strategic decision-making.

Technology development follows a hierarchical progression. There are four stages of development. The first is basis research that is undertaken to gather scientific knowledge or understanding about the subject being studied. The second is applied research that is directed towards a specific aim or objective. The third stage is the development stage. It is during this stage that the data collected from the research is used to devise systems or methods, including the design and development of new or improved services. The final stage is the technology enhancement stage, at which continuous improvement, are being done on existing or new technology.

5.2.2 THE EFFECTS OF IMPLEMENTING NEW TECHNOLOGY

Organisations encounter a range of product ideas and concepts as potentially for new products. The art is in picking the correct product idea for which resources could be applied, with the goal of creating on-target, on time and on-budget products. Management is obligated to choose a handful of project ideas and then decide to “go/no-go. A development funnel was discussed to in order to illustrate this concept.

After new technology has been implemented, little or no performance characteristics can be detected. It is only after the initial stage that rapid improvements in performance characteristics are evident. In the third stage performance characteristics continues to show improvements, but the rate of improvement declines. In the final stage, very little performance characteristics are visible.
The desire for change and the acceptance of change originate from the human reluctance and hesitation of people owing to a high degree of innate rigidity. This could change by enhancing people’s willpower and their skill power. Methods of improving these powers include the following:

- When new technology is implemented make sure that everybody is involved in the process by giving them knowledge of why they need change, when to change and how to change;
- Embed in them the sense of realisation of the need to change;
- Create and maintain an environment conducive to giving the proposed change a serious try.

The power of change is where pure science meets the practical problem. Applying science to improve the way we live by making products better, faster and cheaper has always mattered in business. The continuous search for newer, better and lower cost products has always been the catalyst for change. New technology has changed production processes in so many ways that customers are continuously demanding superior quality, outstanding service and on-time deliveries. Can traditional companies meet these new demands? It appears that they cannot. The solution is that the company has to be agile. Agile manufacturing is about responding quickly and effectively to change in demand, preferences, expectations and opportunities. The thrust of change is the fact that the customer decides what is produced, when it is produced and how much is produced, and the company responds.

In order to manage technology successfully, organisations have to nurture the following five factors:

- The first factor is innovation. Innovation is the heart and soul of technology.
- The second factor is the human factor. Innovation depends entirely on individuals. In high-technology organisation, the proportion of engineers, scientists, mathematicians and other professionals is much larger than in low-technology organisation. This concentration of highly qualified employees requires a different management approach.
- The third factor is the requirements of the organisation. Most companies embrace change. However, the pace with which it changes will determine its success or failure. The fourth factor is the management competency factor. In high-technology organisations these managers must be better educated and
more competent to perform their tasks. Much as one differentiates between efficiency and effectiveness, one should distinguish between know-how and know-why. *Know-how* is important to develop an innovative product. *Know-why*, however, implies insight and understanding of future trends and is essential for exploiting the market success of the product.

It is often found that innovators are individualists with varying degrees of ability - or disability - in communicating effectively with the rest of the organisation. To manage innovation requires managers to adapt their leadership approach to the characteristics of the personnel. In high-technology organisations, recruitment of competent staff is of paramount importance. Because high-technology organisations require knowledge and knowledge resides in people, managers cannot expect to achieve long-term competitive advantage if they compromise the quality of people recruited.

In chapter three the emphasis was more on the methodology. It is important that the working plan aimed at systematically assembling, organising and integrating data, in order to solve the research problem should be prepared adequately. A qualitative case study approach was used as the most appropriate research strategy. Case study research is a long established methodology. It allows for an in-depth study of an individual in his or her entirety. A form of qualitative research, the case study investigates the individual or small group, drawing conclusions only about that participant or group and only in that context.

It its most simplistic form, a case study is generally a story. There are four types of case studies that can be used:

- The first is the illustrative case study. These are descriptive and serve primarily to make the unfamiliar familiar.
- The second study case that could be used is the exploratory case study. This approach serves to identify questions and select types of measurement prior to the main investigation.
- The third type of case study is the cumulative case study. This study utilises past studies in order to form a greater generalisation without additional cost or the possibility of repetitive studies.
- The final type of case study is the critical instance case study. This method is typically used for answering cause and effect questions.
There are two strengths and weaknesses in conducting a case study. The first strength is flexibility. The researcher is free to explore without too much prescription. The second strength is the emphasis on context. The researcher can compare the first hand observation with the other quantitative results. The first weakness is inherent subjectivity. It is believed that the researcher lacks precision quantitative data. The second weakness is ethical consideration. Conflict of interest could hinder the credibility of the study.

Because issues of validity and reliability are an important part of any study in the social sciences, it is important to identify some ways of dealing with results. The following are some guidelines that should be used in improving reliability and validity:

- Prolong the processes of data gathering on site
- Employ the process of "triangulation"
- Conduct member checks
- Collect referential materials
- Engage in peer consultation

In general, the method adopted in this chapter was to identify and assess areas of expertise, implementing technology or equipment from department reports, by means of a questionnaire and by interviewing staff members. The project was also conducted to identify opportunities and then to identify the most likely mechanisms or routes for exploitation of each opportunity. The TAM concentrated on areas of strength which could be built on and did not seek to identify weaknesses of individuals.

The initial phase was important to ensure that the audit proceeded smoothly and effectively. It included discussions with the Managing Director and Board of Directors to explain and to agree on the purpose of the audit, to modify the questionnaire and the framework of the report. The purpose of the audit was explained to all relevant staff members. The approximate one-hour interviews conducted among operators and supervisors yielded a favourable outcome, with some interesting observations and facts that would not have surfaced from any survey questionnaires. The details of the interviews were formulized in a TAM audit document in order be more meaningful.
In chapter four, three prominent questions are answered. How does the organisation approach the task of being audited? How does the organisation look beyond the vulnerability of evaluating its technology, business practices and process infrastructure? How can the organisation successfully accomplish this? A process flow and a clearly defined audit plan are required. The process flow consists of ten steps to be followed.

- **Step 1:** Desire /wish to carry out technology audit.
  This involves commitment from all relevant parties, from the Board of Directors to the lowest level employee in the organisation.

- **Step 2:** Expert to carry out technology audit
  Appointing an external consultant might be demanding. Only after a thorough investigation and interview can an appointment be made.

- **Step 3:** First contact/visit in expert of firm/preparation of audit plan
  It is important for the expert to present a plan to management in order for them to comprehend what activities are about to take place.

- **Step 4:** Preparatory work by expert on collecting basic information on the firm and the sector.
  The information collected by the expert must be accurate and tangible information. In order to gather this information, discussions were held with the Managing Director.

- **Step 5:** General short diagnoses
  The expert consultant consulted with the Managing Director on issues relating to company strategy, SWOT analysis, technology innovation, change management, capital expenditure and developments in other departments i.e. Human Resources, Production, Quality, etc.

- **Step 6:** Data analysis by expert – Report on first diagnosis
  After the data have been analysed, the expert consultant presented a report to the company.
• Step 7: Presentation of first diagnosis report to Managing Director and company management.
The presentation was conducted by handing out some hard copies of the report. The presentation took the form of a slide show.

• STEP 8: Additional visits/interviews to department heads.
The following area were covered with departmental heads:

  - **Quality**
    - Policy – goals – personnel involvement – training
    - Process quality – monitoring and control systems – handling – storage – packaging
    - Keeping of records/use of results
    - Product quality – raw materials quality control – product quality control

  - **Research and development – Product development**
    - Research and development strategy/partners
    - Product mix/product lifecycle analysis
    - Analysis of procedures for new product development
    - Analysis of research and development activities
    - Participation in research and development projects
    - Focus on specific research and development area – identification of potential technology suppliers.

  - **Human resources**
    - Organogram – skills – availability
    - Satisfaction – rewards
    - Meetings – awareness of company activities/products
    - Team working/project management
    - Continuing education/training
    - Promotion – evolution – enumeration.
• **Production operation**
  - Walk through production facilities – bottlenecks – problem areas
  - Material flow – flow diagram
  - Overview of system automation/needs – opportunities
  - Floor and product safety
  - Maintenance – procedures – planning – problems
  - Analysis of productivity.

• **Marketing/sales**
  - Existence/analysis of marketing plan
  - Strategy – market share/local – exports
  - Competitors analysis/sector analysis/opportunities – threats
  - Distribution networks – problems
  - Use of information technologies for sales/e-commerce –

• **Step 9: Final report of the technology audit compiled by the expert.**
  A final report was given to the Managing Director that includes the following:
  - Executive summary
  - Summary of results from first diagnostic
  - Subject(s) analysed in second part
  - Methodology used for analysis
  - Problems identified
  - Solutions proposed
  - Actions to be taken (action plan).

• **Step 10: Presentation of report by expert (s) to company management**
  A detailed report similar to the one discussed with the Managing Director in step 9 was presented to the management and staff of Valor.
A technology audit model checklist was conducted at Valor Fruit Processors (Pty) Ltd. The following are the results of the audit:

- **Technological Environment.**
  The company has not employed the services of a chief technology officer. The company therefore lacks the ability to continuously scan the internal and external environment for threats or opportunities. Valor has adopted a culture of change. This is a result if its customers dictating certain technological manufacturing processes. In order to be profitable in a very competitive market, the company conducts quarterly performance appraisals with the staff. The average of a first world country is rated at 4.6. The result of the company’s audit was 2.2.

- **Technologies Categorisation**
  The company proudly displays its mission and vision statements throughout the organisation. Valor consider themselves as being technology leaders in the industry. There is no illusion that Valor is conducting business in a very competitive industry, where price determines the demand. They have managed to create a market for the entire content of the fruit, except for the pips. Valor was rated at an average of 3 compared to an average of 5 in first world countries.

- **Competitors and Markets**
  As mentioned before, the company lacks a chief technology officer. To make up for this, the company has formed a close alliance with FMC Food Technologies to assist with technology forecasting. The company is closely linked with their customers and has a long-standing relationship with its top customers, Woolworths and Bromor Foods. Valor was rated at an average of 2.5 compared to a 4.5 in first world countries.

- **Innovation Process**
  The company has created a platform to discuss innovations and entrepreneurial concepts. This process will reap benefits in the future. The company, however, needs to empower its employees to allow them to flourish in their fields.
each approved capital investment a project leader is appointed. This is a positive step to ensure effective coordination, budget control and timeous completion of the project. Valor was rated at an average of 2.6 compared to an average of 4.6 in first world countries.

- **VAF’s**
  Valor has a very efficient financial system in place that enables anybody with authority to access the database and retrieve information. At any stage of a project information can be retrieved to determine cost estimations, budgets, etc. The company is not accredited with ISO 14000 environmental analysis. The Managing Director has indicated during an interview with the researcher that they will endeavour to be accredited in the near future. Valor was rated at an average of 2.3 compared to an average of 4.6 in first world countries.

- **TAEP**
  Although many capital investment decisions are made based on the outcome of the financial feasibility studies, there were instances in the past that capital investments were approved because they gave the company a competitive advantage over competitors. Valor was rated at an average of 1.5 compared to an average of 5 in first world countries.

### 5.3 RECOMMENDATIONS

As far as research in the field of technology audits, management of technology and the implementation of technology strategies is concerned, it is suggested that a structured curriculum be introduced for masters and doctoral studies. The use of a technological audit can be implemented as a strategy for the successful implementation and management of the manufacturing processes. Managing risk in any organisation is a top priority. With an adopted technological audit model, a company would be able to forecast technological changes in advance, thus maintaining the competitive edge.

It is the experience of the researcher that the word “audit” can be seen in a very negative light. It is thus suggested that the phrase “survey of opportunities based on technology, expertise and equipment” be used instead of “technology audit”. The tangible benefits of an audit are primarily that it uncovers the raw material for exploitation and that it
provides valuable new management information. Another intangible benefit is that it can be a motivating experience for staff.

It is suggested that a technology audit should be done at least twice a year. This should be conducted in tandem with the steps outlined in Chapter 4. Together they will ensure an effective audit, resulting in valuable information. It is important to implement the recommendations of the technology audit and to ensure that the process is repeated. The result of the audit should at least indicate the following:

- Identify opportunities to generate more income for the company from the available technology, equipment and expertise
- Be a source of strategic management information and
- Motivate staff and increase awareness of the department/company.

The following themes are recommended for further research in management of technology:

- Technological change through the eyes of a general worker
- The evaluation and implementation of a technology forecasting model and
- The possibility of a need to investigate whether shorter product life cycles have an influence on new product development.
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