

**The viability of high technology Research and Development
in South Africa: A case study of Nortech**

By

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Confidentiality Clause

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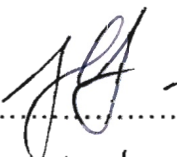
Due to the strategic importance of this research, it would be appreciated if the contents remain confidential and not be circulated for a period of ten years.

Sincerely,

K.J.R. Thompson.

Declaration

This research has not been previously accepted for any degree and is not being currently submitted in candidature for any degree.

Signed 

Date..... 12/9/03

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This study would not have been possible without the continued support and active encouragement of my wife. She has enabled me to concentrate on the work at hand, and prodded me to keep going when I was looking for excuses.

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ABSTRACT

This study focuses on the viability of locating a company that manufactures high-technology products in South Africa. A small electronics manufacturing company called Nortech is used as a case study, and the results of the case study analysis provide an insight into the state of the high-tech electronics industry in South Africa.

The economic models of Heckscher and others regarding factors of production, and the value-chain model of Porter as it related to the strategy of location of business activities, was used as a theoretical basis for the study. A theoretical model was constructed using these classical theories, modified to suit modern Knowledge-based economies, and this was used as a framework with which to analyse the case study.

The case study of Nortech is presented by means of a discussion of the company history, mission, and vision, and an analysis of the product offering, competitive environment, and Research and Development skills. The focus throughout the analysis is on the relative advantages obtained through location, and the contribution of innovation and technical skills to the overall product. The context of the company within South Africa is discussed, with reference to the effect of national policy and infrastructure.

The case study is evaluated within the framework of the theoretical model developed, and the relevance to the different product lines within the company. It was found that there were significant locational advantages related to high technical skills levels, flexible production methods and efficient value-chain structures. The sustainability thereof, in the light of decreased levels of national spending on Research and Development, and the continued loss of skills to foreign countries, remains a concern.

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1 Introduction

1.1 Background of the research

The Research and Development (R&D) environment in South Africa is critical to the degree of advancement in technology in South Africa. The amount of high technology products (HTPs) manufactured and exported in South Africa is an important indicator of the degree of economic development in the country (Hodge 1998, p. 1). HTPs are “value-add” products in that they provide a better return on investment (capital and resource) than other resource-based products. Thus, a country with a high percentage HTPs of total exports can be viewed as a technologically advanced country. The impact of this on basic economic factors such as Gross Domestic Product (GDP)/Capita and levels of education is significant, and serves as a major differentiator between developed and developing countries.

The R&D environment in industry is influenced by factors such as the level of skills available, the state and availability of advanced capital equipment, the willingness of companies to invest in such resources, and the relative competitiveness of the resultant HTPs.

The structural limitations of the country in terms of communications infrastructure, research facilities, and market access are environmental factors to consider when evaluating opportunities in South Africa. The potential decision maker could fall in a number of categories:

- Green field Foreign Direct Investment in a high-tech industry
- Product expansion to add value to low-tech products
- New ventures in existing companies seeking to diversify and develop new products

The decision is whether to base operations in South Africa as opposed to another country (if this is viable for the company, depending on degree of internationalisation), or whether to embark on high technology type product development at all instead of another “low-tech” type product.

Nortech is an established electronics manufacturing company based in Pietermaritzburg, Kwa-Zulu Natal (KZN). The products manufactured include a range of Inductive Loop Detectors for use in the parking and traffic industry. These are used to detect the presence of a vehicle, and give an electronic output when a vehicle is detected. Nortech also has a range of Access Control products that are used in industrial and commercial applications to control human and vehicular access. A more recent addition to the product range is People Counting equipment, which is used in shopping malls to monitor human traffic in and around the mall.

Nortech exports over 90% of all goods manufactured, and have markets in all corners of the globe. All the Research and Development is done in-house by a team of engineers, and new products are constantly being developed.

1.1.1 Company background

Nortech was established in the early 1970s as a member of the Control Instruments Group, as part of another company called Electromatic, which focussed on Automotive Electronics and Access Control.

The company produced electronic goods in a niche market that focussed on vehicle detection. The products were all variants of Inductive Loop Vehicle Detectors. Inductive Loop Vehicle Detectors (hereafter referred to as “detectors”) are an important part of any vehicle access or monitoring system (see section on “Detector principle of operation”). The range of products expanded over the years, and the market expanded from a local base to a global presence.

The export market became an increasingly large part of total sales, and currently accounts for over 90% of all sales. During the 1980s, the trade restrictions imposed as a result of apartheid were largely circumvented by using a front company in The Netherlands to distribute the goods, thus maintaining and expanding a presence in Europe. The Nortech brand of detector has become a market leader, and has a dominant position in most European countries and other countries around the world.

A management buyout in the late 1990s resulted in a split from Electromatic, and Nortech thus became a separate entity, with a private equity company called Brait holding a majority shareholding (they provide the bulk of the capital). This was later increased to a 100% holding. The company continued to grow and diversify, and in 1999 acquired an interest in people counting technology called "Headcount." This was a break from the traditional focus of vehicle based products, although still based on the concept of control and counting of "traffic."

The company is based in Pietermaritzburg, and has distributors and agents all over the world. The R&D department, administration, and production are in the same building, with all products designed and manufactured in-house. The current staff complement is approximately ninety people, split evenly between salaried and wage staff. The business has consistently provided a healthy return on net assets (RONA), although exchange rate fluctuations do have a direct influence on profits.

1.1.2 Literature survey

The literature related to the study can be grouped in terms of general literature pertaining to the theoretical background of the study, national literature, and company specific literature. The data is predominantly secondary, except for interviews with key Nortech personnel.

The relevant theoretical models appropriate to the study are based upon the work done by Heckscher-Ohlin regarding the economic principles (Heckscher, 1949) and Stolper and Samuelson (1941). The contrasting views of Leontief (1956) are also discussed in the context of the different factors of production. The evolution of these neo-classical theories in the context of the "information age" points to knowledge as the most important factor of production. Drucker (1993) goes as far as to say that knowledge is *the* resource, rather than *a* resource. Toffler (1980) states that "knowledge is the ultimate substitute for other resources". He further says, "For the Third Wave civilization, the most basic material of all, and one that can never be exhausted, is information".

Porter's value-chain model is used as a basis for discussing the strategic elements of the study, with R&D as one of the elements in the value-chain. The strategies for competing globally by utilising locational advantages are covered by Dawar and Frost (1999), and are of particular relevance to Nortech.

Various studies done in the South African context have been undertaken by Hodge (1998), Kaplan (1997, 1998), Scerri (1990) and others investigating the state of the high-tech industry in South Africa. The government has also contributed to the analysis with the "White Paper on Science & Technology" (1996), and more recently the "Government R&D Strategy" (2002). Various articles and papers have also been written on the net emigration ("Brain Drain") of skilled professionals, and the effect of this on skills levels in South Africa (Kaplan 2001).

Literature available at Nortech in the form of Strategy documents (Hallowes, 2002) and financial results (Campbell, 2003), as well as the author's own knowledge of the products and company form the basis of the data available. Unstructured interviews of personnel at Nortech have also provided primary data material (Loubser, Hallowes, 2003).

No research has been done on the merits of R&D in Nortech as compared with other global companies.

1.2 Motivation for the research

The research is motivated by the experiences of the author in the high-tech electronics industry, and the perception that South Africa is not suitable for this type of industry due to the view that we are lacking in skills and technological expertise.

The enforced isolation during the apartheid years has contributed to the development of significant skills in sectors that might not have developed independently to the same extent. A number of world firsts in the technology arena, and a continued high quality of HTPs in select areas point to an industry that has produced in excess of expectations over the years. The

more recent general decline in research output and the “brain drain” since 1994 have had a negative effect on the industry (See Chapter 3.5.1.1).

In the light of the above, the rejuvenation of the industry and the justification for investing in high-tech R&D are the questions that need to be answered. Nortech in particular serves as an example of a company that has gained a significant global market share in certain niche high-tech products, and is recognised as a market leader in two distinct technologies, namely Inductive Loop Vehicle detectors and People Counting technology.

1.3 Value of the project

The contribution this project can make to a number of bodies, including the government, is the focus on the factors affecting industry investment in the specific sector. The general efforts of groups such as “South African Technology Vanguard (SAVANT)” and the Department of Trade and Industry (DTI) will be complemented by analysis of this facet of industry.

The relevant economic theories of supply and demand, as well as company strategy in terms of choosing which markets to enter and how best to utilise available resources, will be augmented with a more in-depth view of a specific South African situation. The role of new technologies such as the Internet and their effect on the mobility of knowledge is also discussed.

1.4 Problem statement

“Is it viable for a “high-tech” company to be based in South Africa as opposed to another, more developed country, with reference to Nortech?”

1.5 Objectives of the study

The following are the proposed objectives of the study:

- To briefly review the current state of high-tech R&D in South Africa, with specific reference to the Electronics Industry.

- To determine the feasibility of establishing a high-tech industry in South Africa such as Nortech from an economic and resource point of view.
- To determine whether a company such as Nortech is and can remain at the forefront of technological innovation globally in its niche markets.

1.6 Research Methodology

The methodology is qualitative, due to the nature of the topic, which does not lend itself to quantitative analysis. Qualitative techniques will be used to establish the views of relevant people in the company, which will either support or contradict documentary evidence.

An analysis of Nortech as an example of a small company in the high-tech electronics industry in South Africa will be performed. This will serve as a pointer to the state of the industry in South Africa, and although by no means a general analysis, the findings can provide an indicative measure. Analysis of the operations and state of technology at Nortech will provide the basis of the research, with interviews with key people in the company providing additional insight.

The context of Nortech within the industry in South Africa will be discussed, with some previous industry research findings forming a basis for comparison. Nortech will be analysed in terms of product mix, reliance on R&D and high technology, and the effect that these factors have on the value of the product offering. The focus will be on the relative merits of the location of the various activities of Nortech in South Africa as opposed to elsewhere.

1.7 Limitations of the project

The project will be limited specifically to Nortech as an example of a high technology type industry in South Africa. Furthermore, the focus will be on the R&D aspect as opposed to the entire commercial activity. Certain financial figures are confidential and will be excluded from the study. The conclusions drawn from the case study do not represent the state of the industry in South Africa as a whole.

1.8 Structure of the study

- Chapter Two: This chapter covers the theoretical aspects of the study. Specifically, the relevant economic and strategic theories that provide a framework for the case analysis will be examined. The theories of Heckscher-Ohlin and Samuelson regarding the factors of production and the optimal use thereof are explored, and how R&D can be regarded in a similar manner as a factor of production. The evolution of these theories into “New Growth Theory”, where knowledge is the most important factor of production, is explored.

The strategic theories of Porter with regard to the value-chain, and how this can be applied to a company such as Nortech, are discussed, as well as how best to gain a competitive advantage through location of various activities, as proposed by Dawar and Frost (1999). A model that is relevant to Nortech is drawn from the various theories, which will be used as a basis for the analysis of the company in the following chapter.

- Chapter Three: The case review of Nortech is presented in this chapter. The chapter commences with a brief history of the company, and proceeds to discuss the various products, with the emphasis on the high-tech and R&D aspects required for the different types of products. The competitive environment in which Nortech operates will be discussed, using Porter’s five forces model as an analysis tool. A brief discussion of the financial position of the company will be provided, and an overview of the state of R&D in South Africa and in Nortech in particular. The chapter will conclude with a discussion of future R&D in Nortech.
- Chapter Four: The case study presented in the previous chapter will be evaluated against the theoretical model developed in Chapter 2. The factors of production related to the various Product lines will be discussed in the context of the South African environment. The validity of the findings will be assessed using general studies within the South

African context as a comparison where possible. The value-chain as defined for Nortech will be evaluated, with the focus on the R&D activities in the context of the production environment.

- Chapter Five: The final chapter will take the findings presented in Chapter Four to the logical conclusion. The positive aspects of the case as they relate to the locational advantages of R&D in South Africa will be presented, using Nortech as a basis for comparison. Areas that need improvement to ensure sustained competitive advantage will be identified, and additional measures that need to be taken at company and national level will be recommended.

1.9 Summary

This chapter serves as an introduction and outline for the study that is to follow. A brief overview of the case study is given, as well as a limited literature review. It is felt that the study will be of benefit, as the topic is relevant to the industry in the current economic climate, and it can add to the existing body of knowledge. The topic is clearly identified, namely “Is it viable for a “high-tech” company to be based in South Africa as opposed to another, more developed country, with reference to Nortech?”

The objectives of the study are outlined as they relate to the topic, and the research methodology is defined. The research is qualitative in nature, and relies primarily on secondary data sources, with some unstructured interviews within Nortech providing additional material. The study is limited to Nortech as a case, and does not represent the entire industry in South Africa, although some conclusions may be drawn from the study regarding the industry in general.

The study will be structured as follows: A review of the relevant theories that are applicable to the case, ending with a theoretical model within which the case can be analysed. The case study, namely a detailed analysis of Nortech, with reference to the R&D aspects of the company and products, will

be provided. The case will be evaluated within the framework developed, and recommendations made regarding the original problem statement.

The context of Nortech within the South African high-tech electronics industry will be referred to throughout the study, as the case provides a valuable insight into the typical issues such a company experiences in South Africa. It is hoped that the results will provide some guidance and inspiration to similar companies in South Africa. A case analysis benefits from a good theoretical grounding, as this establishes some of the principles that have already been tested. The following chapter provides a background to the case that follows.

2 Theoretical models applicable for strategic choice

One needs to examine the economic factors influencing investment in R&D as well as the overall strategic fit with a company's stated mission. In South Africa, the non-economic factors are more important than they might be in other western countries where the political climate and history has less of an effect. In a purely market driven world economy, without factoring in variables such as government assistance and political uncertainty, economics would dictate the country of choice for a global high-tech company.

2.1 Economic factors

2.1.1 Heckscher-Ohlin Theory

The Heckscher-Ohlin theories are relevant to the study as they examine the use of different factors of production in determining the correct product and resource mix, as well as the location of these factors, and this is central to the question.

The Heckscher-Ohlin (H-O) idea was formulated as early as 1919 (Pugel 2000, p. 55). A clear overall explanation was developed and published in the 1930s by Heckscher's student Bertil Ohlin. The H-O theory predicts that countries export the products that use their abundant factors intensively (and import the products using their scarce factors intensively). A country is relatively **labour-abundant** if it has a higher ratio of labour to other factors than does the rest of the world. A product is relatively **labour-intensive** if labour costs are a greater share of its value than they are of the value of other products.

This difference in factor endowments leads to the patterns of trade. A country with a relative abundance of certain factors will be more likely to export products that utilise these factors. Thus, if a country has a relative abundance of the factors that are conducive to high tech R&D, namely skills, technological infrastructure and a potential market, then the amount of R&D in that country should be higher than that in a country with less of these

factors. It should be noted that the use of the terms “products” and “factors” has a broader definition in the modern era of increased services and technology. Thus, a product can be virtual, and factors of production can be purely intellectual. A discussion on the effect of the Internet on the traditional economic theories is given in Chapter 2.2.3.

The implications of the H-O theory are as follows:

2.1.1.1 The Stolper-Samuelson Theorem

“Given certain conditions and assumptions, an event that changes product prices in a country unambiguously raises the real returns to the factor used intensively in the rising-price industry and lowers the real returns to the factor used intensively in the falling-price industry in the long run, regardless of which goods the sellers of the two factors prefer to consume” (Pugel 2000, p. 66).

In effect, this theorem states that a change from no trade to free trade of products will result in the products that utilise the more factor abundant resources providing a rise in the real income of the providers of the product, whereas the providers of a product utilising less abundant factors of production will experience a decrease in real income.

Thus, a country that is able to trade freely in products that utilise **high tech R&D** as an abundant and major source of value will gain from increased free trade. This seems intuitive, but is worth noting in the context of the broader H-O theory. This implies that if high tech R&D is an abundant resource in South Africa, the use or increased use thereof will result in a rise in real income of the providers of that product, such as Nortech.

2.1.1.2 Specialised-Factor Pattern

“The more a factor is specialised, or concentrated, into the production of exports, the more it stands to gain from trade. Conversely, the more

a factor is concentrated into the production of the importable good, the more it stands to lose from trade” (Pugel 2000, p. 67).

This is really just a broader statement of the Stolper-Samuelson theorem, which holds for any number of factors and commodities. An importable good in this case implies that it is importable due to the relative abundance of factors elsewhere, making it more competitive than local goods. The same can hold for goods that utilise R&D as a significant factor of production. The specialisation, in the case of Nortech, is high tech R&D, and the implication is that products that utilise this factor extensively will gain most in the export market. The long-term sustainability of this factor is instrumental to the strategic success of the company.

This will be explored in the following section where the different products are discussed and their relative merits analysed with reference to the degree of innovation, and by extension R&D, in each product. The sustainability of the competitive advantage obtained will also be discussed.

2.1.1.3 The Factor-Price Equalisation Theorem

“Given certain conditions and assumptions, free trade will equalise not only commodity prices but also the prices of individual factors between the two countries, so that all labourers will earn the same wage rate and all units of land will earn the same rental in both countries even if factors cannot migrate between countries” (Pugel 2000, p. 68).

This implies that the factors that cannot migrate between countries end up being implicitly shipped between countries in commodity form. The commodity is in effect causing the levelling of prices to occur. In the case of high tech, R&D dependant goods, this theory predicts that the free movement of the goods between countries will result in the factors of production, such as the unit cost of R&D, moving towards the same cost in the different countries. Thus, the costs of R&D in Nortech will tend towards the same costs elsewhere in the world, provided there is free trade in this factor, and people are able to immigrate and emigrate freely with minimal additional costs.

Of particular importance in the discussions that follow is the factor of “Intellect” as a component of production. The relative mobility of intellectual capital as compared to other factors of production is significant, especially in Information Technology (IT) dominated industries. This aspect will be discussed in more detail in Chapter 2.2.3. For the purposes of the “Factor-Price Equalisation Theorem,” the factors of production are assumed to be relatively immobile.

The Stolper-Samuelson theorem is based on a number of assumptions, specifically regarding the freedom of trade in the various factors of production. This is not usually true, but certain factors, such as the skills required for R&D in the form of Human Resource, are relatively free, and becoming increasingly more so with the “globalisation” of technology. Thus, the assumption is that the skilled resources utilised at Nortech are able to move wherever there is a market demand for them.

There are thus a number of limitations to the theory, but it does provide a broad general principle, namely that abundant factors of production favour exporting. If South Africa, and in particular Nortech, has an advantage in high tech R&D skills and expertise relative to other countries and companies, then Nortech is well placed to export products utilising these resources.

International trade patterns broadly confirm the H-O prediction, although the “Leontief Paradox” (1956, pp. 386-407) provides an insight into the pitfalls of viewing a theory in isolation. Wassily Leontief put the H-O theory to the test when he examined the economy of the U.S. in 1950s. His test was as follows: If the H-O prediction was correct, and the United States was more capital-abundant, then the U.S. export bundle should embody a higher capital-labour ratio (K_x/L_x), when all the contributions of the input industries were also included, than the capital-labour ratio embodied in the U.S. production that competed with imports (K_m/L_m). However, Leontief found that the opposite was true, namely that the key ratio $(K_x/L_x) / (K_m/L_m)$ was only 0.77 imports, when H-O said that it should be well above unity.

It was realised that other factors of production besides just capital and labour play an important role in explaining the patterns of trade. Despite the Leontief Paradox, trade patterns fit the H-O theory reasonably well, but certainly not perfectly. The importance of labour as a factor of production in the high-tech R&D industry cannot be overstated, as it constitutes up to 90% of R&D costs in a company such as Nortech (Hallowes, 2002). This should be differentiated from “Intellect,” which plays a lesser, albeit important role in certain products.

The emergence of technology as a determinant of international trade patterns is a result of further research to explain the Leontief Paradox. An important assumption in the above theory is that access to technology is assumed to be costless. In practice, this is not the case, and imperfect competition, where differing national attitudes to innovate, is a prime determinant of trade patterns.

2.1.2 New Growth Theory

The above neo-classical theories of production, as well as others such as the theories of entrepreneurship by Schumpeter (1939), have evolved and been superseded in certain instances by the “New Growth Theory”. This theory relates to the emergence of endogenous growth as opposed to growth associated with exogenous factors, and in particular the importance of knowledge as a factor of production. This line of thought flows from the theories mentioned earlier regarding technology as a factor of production in the H-O model.

Drucker (1993) postulates that knowledge is the only meaningful resource today. The traditional factors of production – land, labour, and capital – have not disappeared, but they have become secondary. Value is now created by “productivity” and “innovation”, both applications of knowledge to work. The economic challenge of the post-capitalist society will therefore be the productivity of knowledge work and the knowledge worker.

Alvin Toffler, well known for book “The Third Wave” (1980), has stated that knowledge is the central resource of the Third Wave economy. The right

knowledge inputs can reduce labour requirements, cut inventory, save energy, raw materials, and reduce time, space, and money needed for production. Information is the most basic raw material of all, and one that can never be exhausted. The manipulation of information is becoming the new growth area of the economy, rather than the mass processing of raw materials.

Nicho Stehr (1996) argues that the change in the structure of the economy and its dynamics are increasingly a reflection of the fact that knowledge becomes the leading dimension in the productive process.

The above theories have all gained prominence with the emergence of the “information age” in the last decade, especially with the advent of the Internet as a massive new source of information. Products that utilise knowledge as a primary factor of production are well poised to overtake traditional sources of competitive advantage in knowledge-based economies. A product such as Headcount (see Chapter 3.2.3) fits this mould perfectly.

2.1.3 Trade policy for Developing countries

South Africa is generally classified as a developing country, and has made concerted efforts to avoid the trap of relying on primary goods for foreign income. The “White Paper on Science & Technology” (1996) provides guidelines as to what strategic steps need to be taken to ensure the promotion of Science and Technology as a building block of the economy in the future. The effect of government policy on companies like Nortech is very significant, from general factors such as the exchange rate policy and immigration laws, to more specific factors, such as export incentives like the “Motor Industry Development Programme (MIDP)” in the automotive industry. The effect of the “Immigration and Industrial Innovation” policies will be examined in Chapter 3.5.

Developing countries have historically exported primary-products, as these products have provided the greatest comparative advantage due to low labour costs and abundant raw materials. South Africa has followed this

trend, although recent data suggests that there is an increased focus on the production and export of HTPs, and this has also been the subject of the “White Paper on Science & Technology” (1996). The following table illustrates the small but growing percentage of HTPs relative to total exports, as well as the significantly higher but decreasing percentage of HTP imports:

	1991	1992	1993	1994	1995
Exports (\$m)	489.9	420.6	579.2	602.2	784.5
Imports (\$m)	3 160.3	3 019.1	3 193.8	3 764.0	4 531.9
Trade Balance (\$m)	-2 670.4	-2 598.4	-2 614.6	-3 161.8	-3 747.4
Export Growth (annual)	na	-14.1	37.7	4.0	30.3
Import Growth (annual)	na	-4.5	5.8	17.9	20.4
Deficit Growth	na	-2.7	0.6	20.9	18.5
Exports as a % of Imports	15.5	13.9	18.1	16.0	17.3
HTPs as a % of total Exports	2.1	1.8	2.4	2.4	2.8
HTPs as a % of total Imports	18.1	16.4	17.7	16.9	

Table 1 Dollar value of HTPs and their share of total trade (1991 - 1995)

Source: South African Customs & Excise Trade Statistics & Armscor Annual Report 1996.

The main challenges faced by a developing country are:

- *Factor endowments are different in developing countries.* They have less nonhuman capital and fewer human skills per person in the labour force.
- *Capital markets work less efficiently in developing countries.* There are more barriers to the lending of money to the most productive uses. There is thus a higher cost of capital for “good projects” than that for less promising sectors.

- *Labour markets work less efficiently in developing countries.* The wage gaps between expanding and declining sectors are greater than in high-income countries.

These challenges imply a special role for governments in developing countries to play a more active role in promoting the production of manufactured goods for export purposes. This will add value and earn foreign exchange at less cost to the country as a whole. Strategies such as Import-Substituting Industrialisation, Trade Barriers, and Export Promotion incentives are popular methods to encourage an export orientated manufacturing sector. One could therefore ask the question: “Are the long-run price trends against primary producers?”

There are at least two major forces depressing, and at least two forces raising, the trend in the prices of primaries relative to manufactures. The relative price of primary products is depressed by Engel’s law (Pugel, 2002) and synthetic substitutes.

- *Engel’s law:* In the long run, per capita incomes rise. As they rise, demand shifts towards luxuries, and away from staples. The income elasticity of demand for food is less than one (food is a staple), thus the relative price of food will continue to drop in the long run.
- *Synthetic substitutes:* Human-made substitutes for natural materials also depress the relative prices of primary products. The more technology advances, the more we are likely to discover substitutes for a variety of primary products.

There are also two basic forces that tend to raise the relative price of primary products:

- *Nature’s limits:* Primary products are non-renewable resources, thus increased scarcity will eventually raise the relative price of these products.

- *Relatively slow productivity growth in the primary sector:* Experience has shown that productivity has advanced more slowly in agriculture, mining, and other primary sectors than in manufacturing. This translates into a slower relative advance in the supply curves of primary-product markets than in manufacturing markets, and therefore a rising relative price of the primaries.

An analysis of the prices of primary products between 1900 and 1980 has been done (Grilli, Yang, 1988). This has shown that there has been a general downward trend in prices, in the order of 0.8% per year over the past century. This tends to confirm the view that the producers of primary based products face long-term price erosion, as stated by Engels and the Synthetic Substitutes arguments above. It is thus evident that for a developing country such as South Africa, the manufacturing industry needs to be encouraged and incentivised, as this is the only way to promote long-term growth in the country. A company such as Nortech would provide an offset to over-reliance on primary products, and as such needs to be encouraged via incentives and other policy mechanisms (see later section on Industry Analysis).

	1970	1975	1980	1985	1990	1994
Non-fuel primary products	49.9%	25.8%	18.7%	22.4%	18.7%	17.2%
Fuels	32.4	58.6	61.3	42.2	27.5	17.7
Manufactures	17.4	15.2	18.5	32.4	52.9	64.3

Table 2 The Changing Mix of Exports from Developing Countries (1970-1994).

Source: United Nations Conference on Trade and Development, *Handbook of International Trade and Development Statistics*, 1987 and 1995 (New York: United Nations, 1988 and 1997).

The changing mix of exports for developing countries (as defined by the World Bank) has accelerated rapidly over the past thirty years. Manufactured goods have risen from a 17.4% share of total exports in 1970 to 64.3% in 1994 (See Table 2). This is despite the considerable barriers erected by developed countries. Non-tariff import barriers apply to a greater percentage

of goods from developing countries than to goods from other industrial countries.

One of the reasons that developing countries have still managed to increase their share of manufactures so substantially is that they have been able to become exporters in standardised manufacturing lines where there has been less technological progress, such as textiles, tires, and simple electrical appliances. A second reason is that developing countries have become locations for low-cost assembly of more technologically advanced products like computers, with multinational firms from the industrialised countries providing the advanced technology, the components, and the marketing and distribution of the finished products. This has been highlighted in a study done by Hodge (1988) for Trade and Industrial Policy Strategies (TIPS), in which it is shown that much of the trade in HTPs is in this form, where the country is simply a low-cost manufacturing facility, and all the expertise is imported.

A third reason is that barriers against imports of manufactures from developing countries are not very solid. The barriers are often country specific, but newcomers can gain market access for new manufactured-product exports because they are not hindered by such barriers.

The importance of the policies of the government to the success of a company such as Nortech should not be underestimated, especially labour and skills policies and how these affect the trade in knowledge and skills between industries and countries. The discussion in Chapter 3.5.1 provides a more detailed overview of the state of R&D nationally. Programmes such as the Support Programme for Industrial Innovation (SPII) (see discussion in Chapter 3.5) can go a long way towards encouraging new high tech developments in the industry.

2.2 Strategic factors

2.2.1 Pursuing competitive advantage: Porter's value-chain

A firm can gain competitive advantage by expanding outside its domestic market in three ways (Porter, p. 54). One way exploits a multinational or global competitor's ability to deploy R&D, parts manufacture, assembly, distribution centres, sales and marketing, customer service centres and other activities among various countries in a manner that lowers costs or achieves greater product differentiation.

A second way involves efficient and effective transfer of competitively valuable competencies and capabilities from its domestic markets to foreign markets.

A third way draws on a multinational or global competitor's ability to deepen or broaden its resource strengths and capabilities and to coordinate its dispersed activities in ways that a domestic-only competitor cannot (Thompson & Strickland, p. 209).

Nortech seeks to use the above methods in the most optimal way to maximise competitive strengths and minimise weaknesses. This is the background to the key question as to the viability of locating R&D in South Africa.

2.2.1.1 Achieving Locational Advantages

To use location to build competitive advantage, a company must consider two issues: (1) whether to concentrate each activity it performs in a few select countries, or to disperse performance of the activity to many nations, and (2) in which countries to locate particular activities. Companies tend to concentrate their activities in a limited number of locations:

- *When the costs of manufacturing or other activities are significantly lower in particular geographic locations than in others. India is an example of a situation where the costs of skilled software developers*

is significantly lower than elsewhere, resulting in a significant proportion of global software development and support being moved to India in recent years. Nortech out-sources the manufacturing of all Printed Circuit Boards (PCB's) to Singapore. The details of the Supply-chain logistics are discussed in Chapter 3.

- *When there are significant scale economies in performing the activity.* In situations where some competitors are intent on global dominance, being the worldwide low-cost provider is a powerful competitive advantage. Having the largest worldwide manufacturing share is often a pre-requisite for these companies. For example, although only 40% of worldwide videocassette recorders carry a Japanese brand name, Japanese companies do 100% of the manufacturing (Prahalad, Doz 1987, p. 60). All Nortech's products are manufactured in a single factory, with commonality of components between the various products a key focus of design. This is discussed in detail in Chapter 3.
- *When there is a steep learning or experience curve associated with performing an activity in a single location.* Some industries, especially high-tech type industries, rely heavily on experience in parts manufacture or assembly, resulting in a company establishing one or two large plants from which it serves the global market. The semiconductor market is an example of such an industry.
- *When certain locations have superior resources, allow better coordination of related activities, or offer other valuable advantages.* **An R&D facility or sophisticated production facility may be situated in a particular nation because of its pool of technically trained personnel.** Samsung became a leader in memory chip technology by establishing a major R&D facility in Silicon Valley and transferring the expertise gained back to headquarters and its plants in South Korea. The relative locational advantages of various countries for a specific product or type of industry, and whether South Africa

provides this to a company like Nortech is the fundamental question that is asked in the study.

In several instances, dispersing activities is more advantageous than concentrating them. The typical structure of a multinational firm will thus centre buyer-related activities close to the buyers (Hollensen 2001, p. 293). The hierarchical mode in a value-chain perspective can be split across the border between the home country and the host country across the whole range of value chain activities. This spans a mode of centring R&D, Production, Marketing and Sales and services in the home country, to a mode where all these activities are based in the host country. The classic reason for locating an activity in a particular country is low cost (Porter, p. 57). This assumes all other factors are equal, which is clearly not the case when examining skills levels in various countries.

Depending on the type of industry and the relative importance of the various factors in the value chain, activities such as materials procurement, parts manufacture, finished goods assembly, technology research, and **new product development** can frequently be decoupled from buyer locations and performed wherever advantage lies. Porter's value-chain is the central model used in this analysis, as it provides the necessary emphasis on the strategic importance of each function in the chain.

Nortech currently splits its value-chain to a lesser or greater extent between two regions, depending on the products involved, and it is the degree to which this should occur, particularly with respect to the R&D function, which is the main focus of the study. This question will be analysed in depth in later sections.

2.2.1.2 Transferring Competencies and Capabilities across Borders

Expanding outside the domestic market is a way for companies to leverage their core competencies and resource strengths, using them as a basis for competing successfully in additional country markets and growing sales and profits in the process. Transferring of competencies, capabilities, and

resource strengths from country to country helps a company achieve dominating depth in some competitively valuable area. Domestic companies are usually not able to achieve dominating depth because a one-country customer base is too small to support such a resource build-up, or because their market is just emerging, and sophisticated resources have not been required.

2.2.1.3 Coordinating Cross-Border Activities

Aligning and coordinating activities located in different countries contributes to sustainable competitive advantage in several different ways. Companies that compete in multiple locations across the world can choose where and how to challenge rivals. A tool such as the Internet can be used to involve the company's best design and engineering personnel (wherever they are located) in coming up with the next-generation products. If workloads are heavy in one location, they can be shifted to locations where personnel are under utilised. A company can shift production from one country to another to take advantage of exchange rate fluctuations, to enhance its leverage with host country governments, and to respond to changing wage rates, components shortages, energy costs, or changes in tariffs and quotas. Production schedules can be coordinated worldwide, and shipments can be diverted from one distribution centre to another if sales rise unexpectedly in one place and fall in another.

Nortech keeps in daily contact with the global distributors and agents via e-mail and telephone, thus ensuring that accurate forecasts can be made for future sales orders, as well as keeping up to date with industry trends.

2.2.2 Strategies for Local Companies in Emerging Markets

Figure 1 illustrates the strategic options available for a local company such as Nortech competing against global challengers. Nortech can be regarded as operating in the upper right quadrant of the model, where there is industry pressure to globalise, as well as a fair degree of mobility of resource and

competitive capabilities. This will be analysed in more detail in the next section.

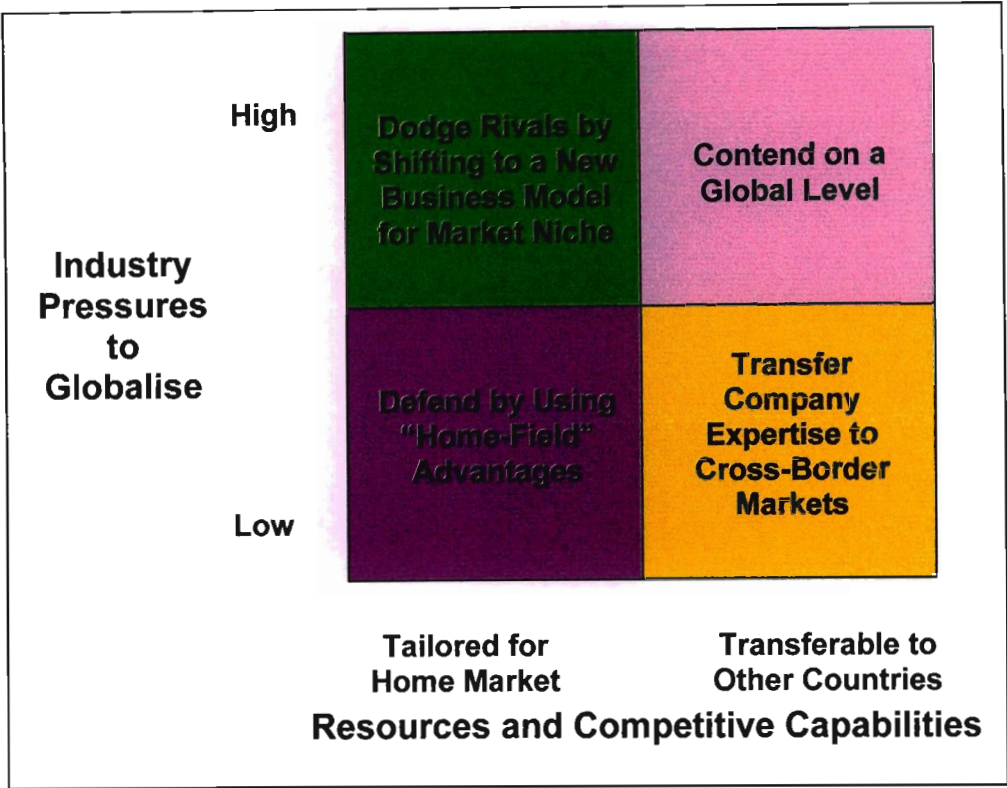


Figure 1 Strategies for Local Companies in Competing against Global Challengers.

(Dawar & Frost 1999, p. 122)

A local company’s optimal strategic approach in the face of competition from global giants hinges on (1) whether the firm’s competitive assets are suitable only for the home market or can be transferred abroad, and (2) whether industry pressures to move toward global competition are strong or weak. The four generic options (Thompson & Strickland, 2001, p. 209) are shown in Figure 1.

2.2.2.1 Defending against Global Competitors by Using Home-Field Advantages.

When the pressures for global competition are weak and a local firm has competitive strengths well suited to the local market, a good strategy option is to concentrate on the advantages enjoyed in the home market, cater to

customers who prefer a local touch, and accept the loss of customers attracted to global brands (Dawar & Frost 1999, pp. 122-3). A local company, in many cases, enjoys a significant cost advantage over global rivals (perhaps due to exchange rate advantages or transportation costs), allowing it to compete based on lower prices.

2.2.2.2 Transferring the Company's Expertise to Cross-Border Markets

When a company has resource strengths and capabilities suitable for competing in other country markets, launching initiatives to transfer its expertise to cross-border markets becomes a viable strategic option (Dawar & Frost, p. 124). Televisa, Mexico's largest media company, used its expertise in Spanish culture and language to become the world's most prolific producer of Spanish-language soap operas.

2.2.2.3 Dodging Global Entrants by Shifting to a New Business Model or Market Niche

When industry pressures to globalise are strong, any of three options make the most sense: (1) shift the business to a piece of the industry value chain where the firm's expertise and resources provide competitive advantage, (2) enter into a joint venture with a globally competitive partner, or (3) sell out to a global entrant into the home market who concludes the company would be a good entry vehicle. When Microsoft entered China, local software developers shifted from cloning Windows products to developing Windows application software customised to the Chinese market.

2.2.2.4 Contending on a Global Level

If a local company in an emerging market has transferable resources and capabilities, it can sometimes launch successful initiatives to meet the pressures for globalisation head-on and start to compete on a global level itself. When General Motors decided to outsource the production of radiator caps for all its North American vehicles, Sundaram Fasteners of India

pursued the opportunity; it purchased one of GM's radiator cap production lines, moved it to India, and became GM's sole supplier of radiator caps in North America – at 5 million units a year. The technical expertise that Sundaram acquired in the process enabled them to pursue opportunities to supply automotive parts in Japan and Europe.

This is the quadrant where Nortech is situated for the majority of its products, as the resources and competitive capabilities are transferable globally, and the industry is becoming increasingly global. Because this is the indicated strategic option, the question as to how best to contend on a global level is highly relevant, especially with respect to the nature and location of the R&D activities necessary to achieve a competitive advantage.

2.2.3 The effect of the Internet on location limitations

The advent of the Internet in the last decade has had a dramatic effect on the way in which many businesses operate. It has spawned many new businesses, and has facilitated a constantly increasing knowledge base in all types of business activities. Improved global sourcing abilities, better knowledge sharing and enhanced communication have been some of the more obvious advantages associated with the Internet.

Companies in the Information Technology (IT) industry in particular have been able to capitalise on the mobility that the Internet provides. The ability to work from home and to outsource work to anyone in the world without any geographical boundaries has been demonstrated by many companies in the IT industry. India has been a good example of the ability to utilise the cheapest available resource globally in the software industry. Many large companies have based their software development and call centre facilities there, as the skills are available at a fraction of the costs elsewhere. Software can be written, e-mailed, and produced using developers in the US and India working around the clock by taking advantage of Time-zone differences, and transferring information across the Internet almost instantaneously.

In other industries where more tangible products are manufactured, the effect of the Internet has been less pronounced from a skills point of view. Geographic limitations mean that a factory has to be located somewhere that is best suited to the job at hand, and any associated development or research needs to be located in the same area. "Tele-commuting" and the Internet can still be used as effective tools in certain spheres of operation within these industries, especially to co-ordinate logistics, but cannot be the primary means of work.

A company like Nortech, which is primarily a producer of electronic goods, utilises the Internet for certain aspects of the job function. The ability to source electronic components anywhere in the world is a valuable advantage, as well as the ability to e-mail the files required for the manufacture of Printed Circuit Boards (PCBs) to any desired suppliers worldwide. The electronic transfer of User-Manuals, and the dissemination of data (in the case of Headcount), are also examples of effective use of the Internet. It is certainly also possible to develop some of the PC based software required remotely. However, this aspect of the business is small, and would not require more than one or possibly two resources dedicated to this task. It can thus be argued that this function can be located wherever in the world the skills are situated and affordable, but the same people are also often required to develop products that require interaction with hardware based products that are located at a single location.

The Internet certainly aids R&D due to the large volume of information and improved communication channels, but non-IT related development is still largely bound by locational constraints to a facility that has the necessary equipment and high-tech facilities required to carry out the work.

2.3 Theoretical model for the Nortech case

The theories discussed above are centred on two predominant issues: The relative advantages that can be gained by utilisation of certain key factors of production, and the optimum use of core competencies to maximise competitive advantage. The model to be used as a basis for analysis of the

case is thus a combination of the Heckscher-Ohlin type model, modified for the knowledge bases economy, and the theories based on Porter's value-chain strategic fit model.

The H-O model is modified to focus on technology as a critical factor of success in the global market for a company like Nortech, as opposed to land and labour. Technology utilises knowledge and information as critical factors of production. The model for achievement of competitive advantage in the global marketplace, based on optimum location of the components in the value chain, is used to determine the best location of the various activities. The R&D function is assessed based on availability of skills and resources.

3 Case study analysis

This chapter will review the various aspects of the Nortech business model, with the focus on the R&D aspects of the business, and using the framework developed in the previous chapter as a basis.

The background to the business has been provided in the Introduction, so what follows is a review of the Vision and Mission, a product analysis, a market overview, competitor analysis, financial analysis, and long term strategic objectives.

3.1 Vision, Mission and Essential Business

As stated in a strategy document presented by Hallowes (2002), the following is the company vision:

Nortech: A global benchmark for the profitable industrialisation and supply of electronic components and systems for the control and counting of all forms of traffic.

The mission statement is as follows:

Nortech:

- Determines electronic solutions to vehicle, human, and other traffic opportunities
- Engineers solutions:
 - Innovatively
 - Cost-effectively
 - Specifically for application
- Is the global benchmark producer for:
 - Low cost components & systems
 - Flexibility

- Shortest lead times
- High and consistent quality to certified standards
- Response faster than any competitor
- Works with:
 - Lean structures
 - Stimulated, purposeful, well rewarded & incentivised employees
 - Up-to-date machinery and methodologies
 - Clear principles, policies, procedures and strategies
 - Well supported representation & distribution in all significant countries
- Aspires to:
 - Government Employment Equity guidelines and requirements
 - Good corporate governance
 - Participative management practices
- Provides:
 - Shareholders with excellent returns
 - Employees with opportunities for equity and further education
 - Suppliers with fair & reliable custom
 - Customers with value & product back up better than competitors

The following diagram provides a graphical representation of Nortech's essential business:

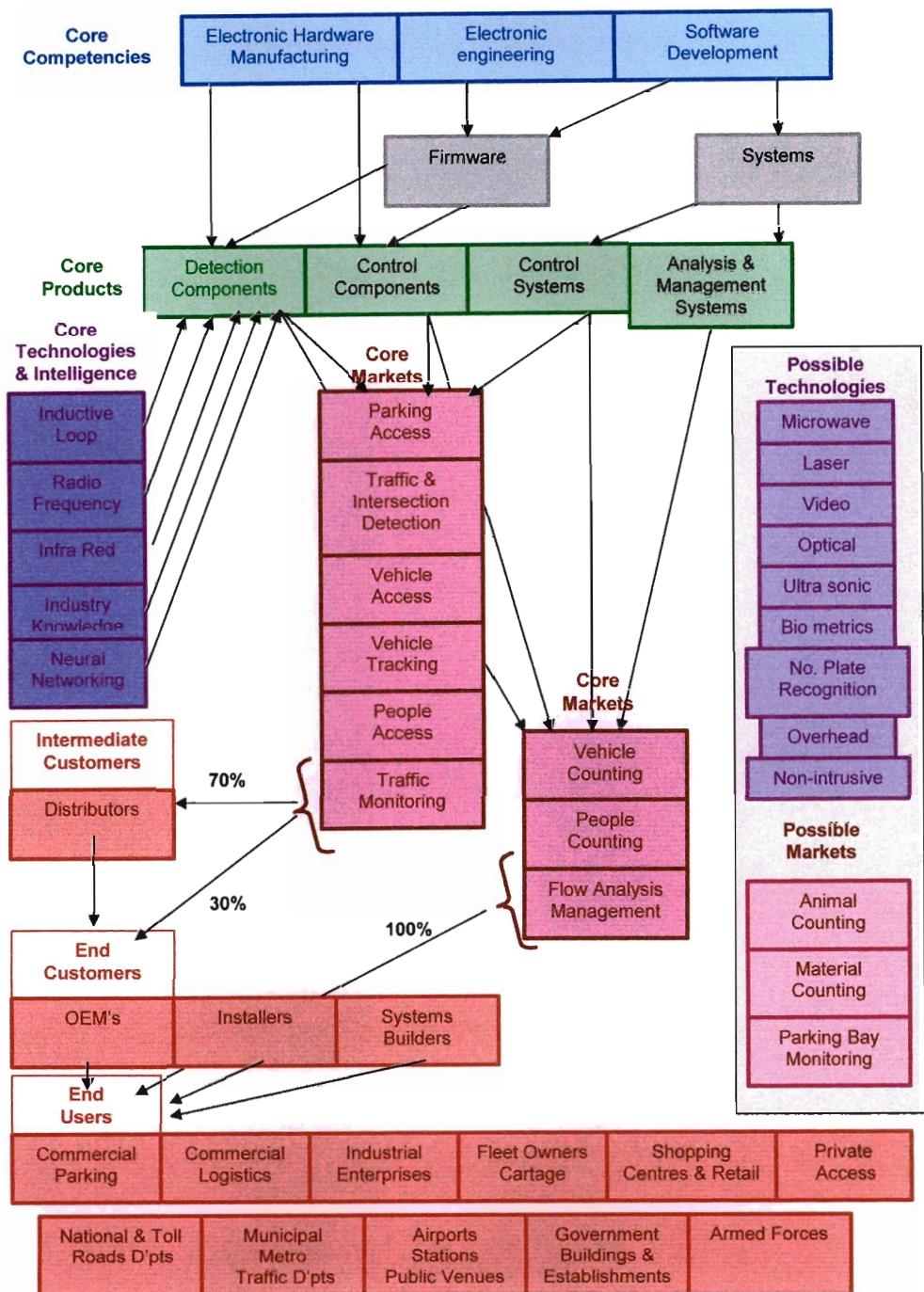


Figure 2 Nortech's Essential Business

Source: Hallowes, 2002. Nortech Strategy document.

Figure 2 provides a valuable insight into the core competencies, products, technologies and markets of Nortech, and serves to show the inter-relationships that exist between the various components of the business. The Core Technologies and Intelligence, namely Inductive Loop, Radio

Frequency, Infrared, Industry Knowledge, and Neural Networking are integral to the success of the business. The various products manufactured (over a hundred different products) utilise the above-mentioned “intellectual factors” to a greater or lesser degree, depending on the product. The product portfolio has been built on innovation and quality, enabling the Nortech brand to command a premium for the perceived added value.

3.2 Product analysis

The company commenced trading approximately twenty-five years ago in the local market with a single range of products, namely Inductive Loop Vehicle Detectors (“detectors”). This has remained the core business, with constant technology updates and variants ensuring a dominant position in the global market place. The product portfolio has gradually expanded to include Access Control products and more recently People Counting products.

3.2.1 Parking and Traffic Detectors

Inductive loop detectors form the basis of any parking or traffic management system. This technology is mature and is in the decline phase of the Product Life cycle. Newer technologies such as microwave, infrared, radar and others are gaining prominence in the marketplace as they become cheaper and more reliable. This will be discussed in more detail in the “Competitor Analysis” section.

The product portfolio has expanded over the years to include a broader range of Traffic and Parking detectors. Traffic detectors are used for intersection control and highway traffic management, and parking detectors are used mainly in parking garages and vehicle access points. The products in this sector are viewed largely as commodities these days, especially in the parking industry, where large Original Equipment Manufacturers (OEMs) constitute the bulk of sales. The OEMs develop complete parking and traffic management systems, and the detector is a very small part of the operation. Their main requirement is that the detector must work reliably, with minimum maintenance, and suit the specific needs of the installation.

Nortech's product offering is able to provide reliability and quality (an ISO 9001 accreditation helps in this respect), and the brand name has become synonymous with these features over the years. Nortech is thus able to command a premium for the brand name, and is still one of the dominant brands globally in this industry, especially in the European market.

The technology utilised in the development and production of detectors is not very advanced compared to more modern detection methods. It is, however, proven and reliable, and has been refined over the years to optimise any competitive advantages available. The software algorithm used in the microprocessor that controls the detector is the main area of innovation and source of competitive advantage, as well as a patented diagnostics system that uses infra-red communications with a handheld device to analyse the parameters of operation of the detector.

The ability to rapidly customise the software and aspects of the hardware according to customers' requirements is another major source of competitive advantage. A variation on a product can be delivered to a customer anywhere in the world within two weeks of the initial request, and a new product can be developed within a couple of months, depending on the complexity and degree of innovation involved.

The limitations of this type of technology are as follows:

- Inductive Loop detectors require a loop to be cut in the road, which is expensive and inconvenient.
- The detectors cannot identify the type of vehicle over the loop.
- Loops become damaged over time, and are difficult to replace or move.
- Vehicles with a low metal content or very high clearance (such as large trucks) might not be detected.
- Vehicles following close together ("tailgating") can be interpreted as one vehicle.

It is clear from the above that there are a number of limitations to the technology, and these are becoming more obvious as newer technologies enter the market. The relatively low cost of a detector (typically €40 for a simple single channel detector) is still a determining factor in the purchasing decisions of the majority of buyers. More modern detector technologies like a microwave detector range from €250 upwards.

The challenge remains to maximise profits from these products (the “Cash cows” in the BCG matrix,) and use this source of cash to fund new development as this technology nears the end of its life cycle. The new development challenges faced are global in nature, and will be discussed in the “Future developments” chapter.

3.2.1.1 Detector principle of operation

Detectors function on a relatively simple principle of monitoring the change in inductance of a loop in the road as the metal in a vehicle passes over the loop (a type of metal detector). The small change in inductance caused by the metal in a vehicle affecting the oscillating frequency of a loop placed under the road results in a measurable difference in oscillating frequency of the loop. This change is analysed via a microprocessor or analogue circuit, and if the change is sufficient to indicate the presence of a vehicle, an output is generated in the form of a relay switching or some other communication means that can be interpreted by some other equipment connected to the detector. This equipment, such as a boom at the entrance to a parking garage, will make a decision based on the information received from the detector. Thus, a boom at a parking garage might open automatically as a vehicle approaches, because of the signal received from the detector.

3.2.2 Access Control Products

Access Control products can be categorised into two main sub-categories, namely Human Access and Vehicular Access. Nortech is active in both of

these areas, with the Vehicular Access products being a natural extension of the detector range of products, and the Human Access products stemming from industry requirements where both types of access control are offered by systems providers. Many of Nortech's end customers are Access Control solutions providers, both Vehicular and Human, and would prefer to have a single supplier for both forms of components.

3.2.2.1 Human Access Control

As the world becomes increasingly security conscious, and the need to control access to private, business and commercial areas becomes more urgent, a large number of Access Control products have been developed in the industry over the years. Nortech ventured into this industry in the early 1990s, and has continued to expand its product offering ever since. This is one of the most competitive markets in the electronics industry due to relatively low barriers to entry and a huge and growing demand.

The development of products in this sector has been driven by the needs of existing parking industry clients, thus development was initially unstructured and performed on an ad-hoc basis. Proximity Readers were the first product to be developed. These relatively simple devices use a Radio Frequency (RF) field to transmit a code from a small chip embedded in a credit card or key ring type transponder ("tag") to a reader. They are widely used as a means of electronically controlling access to buildings and other controlled access areas. They are very much a commodity product, thus margins are low, and there are a number of variants.

Nortech has developed over thirty variants of proximity readers to date, and has been able to compete on price, reliability and quick customisation benefits in this market. The price advantage has been due to economies of scale (all the variants are housed in only two types of custom plastic moulds, and there is a high degree of commonality of electronic components across the entire Nortech product range) as well as low costs of production relative to other global companies. This aspect will be discussed further in the "Competitive Advantages" chapter.

Proximity readers are always used in conjunction with Access Controllers (controllers), and it was thus a natural progression to develop controllers to complement the range. Controllers communicate with the proximity readers, or other types of readers, to determine whether the code of the tag presented to the reader is valid. The valid codes are stored in the controller, and on presentation of a valid tag, the controller operates a relay to open a door strike (used to secure a door), or sends a message via some form of communications protocol to some other product that operates a door or other Access Control device.

Nortech has developed a number of controllers in response to market needs, and it is in this area where significant “value-add” has been created through unique features and a high degree of customisation. The degree of innovation is higher in these products than in the proximity readers, thus a greater profit margin is possible. This product range has been the focus of recent R&D activity, especially the development of an access system as opposed to just the individual components. This is a significant departure from the previous strategy of supplying only the components needed for a particular system, and was a conscious strategic decision based on the market need to provide a complete system from one supplier.

This project has entailed the development of a suite of PC based software products that are able to communicate with the controllers and provide the user with complete control of access to a building via a Graphical User Interface (GUI). All the controllers are connected via a network to a computer, and the whole system is “Online”, thus live event data is recorded and controlled. This type of access system is becoming the preferred method of access control, as opposed the traditional “stand-alone” type of system where there is only one controller and no PC interface.

Although the competition in this industry is very high, particularly from low-cost manufacturers in the Eastern countries, Nortech has been able to provide customisable products with a high degree of innovation in some cases, thus enabling the company to carve out a small niche in the industry

and provide a strategically important complement to the traditional detector market.

3.2.2.2 Vehicle Access control

With a history in detectors, vehicular access control is a logical step in any product extension plans of the company. A number of products have been developed over the years, with the Barrier Logic Controller being the first in this segment. A Barrier Logic Controller is used to raise and lower barriers at parking garages, either remotely, manually, or as the result of a cash or card transaction at a ticket vending machine. There is limited innovation in this product, and it is based largely on the existing detector technology. The product continues to sell in small volumes, but is very dated and at the end of the product life cycle.

A Vehicle Prioritisation system, referred to as “Track 2000” is an important product in this segment, and continues to generate a lot of market interest due to the relatively unique offering and attractive pricing. It was initially developed to allow emergency vehicles priority thoroughfare at traffic intersections, but has also been used in a number of other applications. The principle of operations is simple: a transponder is mounted underneath a vehicle, which continuously transmits a code via RF, and this code is received via a loop in the road, which serves as an antenna. This is connected to a receiving unit at the roadside, which interprets the code and sends a signal to a traffic-controlling device at an intersection, thus enabling the traffic lights to be switched to green as an emergency vehicle approaches. This concept has also been used to provide priority access to trams, buses that use reserved parking, and restricted customs areas.

The degree of innovation in this product is relatively high, as the RF interface required to produce reliable operation (at up to 200 km/h) is complex and not easily copied. Nortech continues to market this product range to a niche market, and is able to command a significant premium due to the lack of global competitors in this sector.

One of the most interesting products in Nortech is Autotag. This hands-free access system performs the same basic function as a push-button remote control device for opening gates, but without the need to “push a button”. It was developed in the late 1990s to provide a unique offering to the industry, and is still a market leader in its field.

A small tag is mounted on the inside of a vehicle’s windscreen, and communicates via RF to a base station mounted near the access point. The base station transmits the tag number to a controller, and if the controller recognises the number as valid, it allows access to the vehicle. The range of operation is up to eight meters, and the cost of a tag is relatively low (approximately €10), thus providing a convenient, secure and hassle free means of access. The cost of the base station is substantially more, but as the number of tags used per base station increases, the overall cost of the system per head becomes less.

There are very few competitors in this market, and the demand is continuously outstripping supply. There are a number of limitations to the technology, especially due to the nature of RF, which means that interference from other sources such as cell phones can cause inconsistent operation. Despite these shortcomings, the price of the product relative to similar products in the market, as well as the flexibility of communications and customisation, has resulted in substantial interest in the product worldwide. Instances of installations outside the recommended scope of operation have resulted in some negative responses, but sales of Autotag have contributed significantly to Nortech for a number of years.

The R&D that went into the development of this product was significant, as it required specific RF skills to work within very tight cost parameters. The design is a good example of a compromise between optimum operation and cost of components, and it has been this ability to provide a low cost product, that works adequately within specified operating conditions, that has provided a competitive advantage.

3.2.3 People Counting

The most exciting product that Nortech has developed, and the one with the biggest potential globally, is Headcount. Headcount is a people-counting range of products developed over a period of nearly ten years, initially by a separate company based in Pretoria, and later by Nortech after buying the technology. It was originally developed with the counting of rail commuters in mind, but soon expanded to focus on shopping malls. There is a growing need to quantify the people-traffic in malls, particularly large malls, as this data serves as an important indicator of the success of marketing campaigns, as well as the basis for property owners to calculate shop rentals. The need for occupancy data for building safety requirements has become increasingly important as well.

People counting has previously been done via simple “clickers” (a single infrared beam at an entrance), which provide very inaccurate results (often as low as 50% accuracy), especially in high traffic situations. The industry has identified people-counting as an increasingly important aspect of mall management, and large property owners are prepared to invest significant capital to provide them with accurate, relevant data for their malls. Nortech has been able to provide a complete solution for this in the form of Headcount, and is still expanding the product range.

3.2.3.1 Headcount principle of operation

Headcount uses a patented method of counting people passing through an entrance. Four infrared beams are transmitted and reflected back across an entrance at ankle level, and it is the pattern in which these beams are broken that determines the direction and number of people. The pattern of broken beams is processed via a neural network that has been trained over an extended period to recognise the patterns in terms of number and direction of people. This information is then processed and passed on to a software analysis program on a PC via a network.

The Headcount system provides 96% accuracy (under prescribed conditions), as well as a sophisticated data-reporting interface that is available via the Internet or custom software package. It has been accepted as the de-facto industry standard for accurate people counting, and has achieved 60% market penetration in South African malls, as well as a significant and growing presence in the USA. The estimated growth rate for the next five years is a conservative 50% per annum. The product range has also expanded to include vehicle counts in the reporting structure, thus enabling key figures such as the average occupancy per vehicle to be calculated, and accurate measurement of car-park occupancy. The latest product development is a processing unit that replaces the PC in a retail type environment and transfers the data directly via a modem to a central server where it is processed. This reduces overall system cost as well as removes the problems associated with human interference with a PC based in a mall's management offices. Due to the lower cost of the system (the custom processing unit is a third of the cost of a PC), the counting system is more attractive to individual retailers who would also like a people counting system, but could not previously afford it.

The level of technology present in the Headcount system is high and innovative, with a worldwide patent on the concept. The neural network approach is unique, and the sophisticated internet-based reporting provides real value to the customer. A business model has been developed whereby the mall owner pays a monthly fee for maintenance and reporting, as well as paying for the initial equipment installation. The recurring income generated is an excellent source of revenue for little additional effort, thus providing cash for further expansion and product development. This model also ensures that the customer is more tightly bound to Nortech, resulting in higher switching costs.

3.3 Competitive environment

The competitive environment in which Nortech operates can be examined using Porter’s Five Forces model (1980), which analyses the state of competition in the industry in terms of five competitive forces.

3.3.1 Rivalry among Competing Sellers

Competition varies significantly in the various sectors, with some overlap between the Access and Parking sectors. Following is a Boston Consulting Group (BCG) type analysis of existing competitors in terms of Market Attractiveness vs. Market Share, as done by Hallowes (2002). Note that “CD” refers to Nortech (“Components Division”), and categories are included in areas that Nortech does not yet have a presence, but would like to.

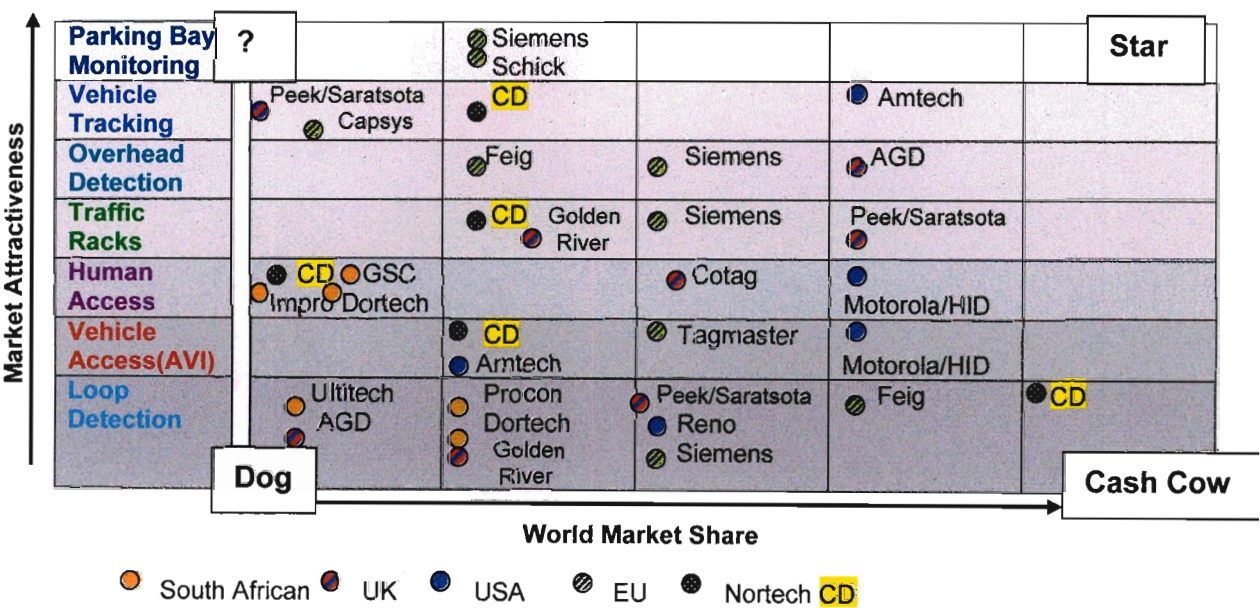


Table 3 BCG model Competitor analysis (Components industry)

What is immediately apparent from the above table is that the Loop Detection sector is the backbone of the business, and although it is the market leader, it rates low on the Market Attractiveness scale due to the age of the technology. It is also interesting to note that there are a number of South African companies in this sector, many populated by ex Nortech or Electromatic employees.

Nortech has a moderate industry presence in the Traffic and Access related markets, and the Vehicle Tracking (earlier referred to as "Vehicle Access") sector is rated as attractive. The current Nortech products in this sector, namely "Autotag" and "Track 2000" have garnered some market share, but there is potential for additional market share in this sector.

The Human Access sector is highly competitive, and there are many more small operations not listed in the above table that also compete in this sector, mainly on price. Nortech has a small presence here, and it has been a strategic decision not to over-capitalise in this sector in terms of R&D due to the price sensitive nature of this market, but rather to investigate strategic alliances with other companies that can provide complementary products.

Headcount competitors are much fewer in number, and in fact there are only two other significant players in the market, namely "Footfall" and "Shopper-track."

Footfall is the market leader in the European markets, where Headcount has not yet developed a market presence (due to lack of Marketing resources). The technology used is based on image processing, using overhead cameras at entrances to analyse the traffic flow. This method of people counting is fairly accurate in the right conditions, but architectural limitations at some entrances and the effects of shadows can compromise the effectiveness of the technology. It is also substantially more expensive than Headcount, due to the need for expensive high-resolution cameras to be mounted at each entrance. The method of data reporting is also less flexible than that offered by Nortech, but the Marketing and Consultancy function is very strong.

Shopper-track uses a similar counting method to Footfall, and is the market leader in the USA. Similar problems to those described above affect the product, but there is much more focus on integrating the data products with Point-of-Sale information to provide more meaningful data, such as "Spend per head." Their presence is concentrated mainly in the USA, although this large market provides ample scope for growth without needing to venture into other countries.

Headcount also provides the advantage of integrating Vehicle Counting in the data provided, which is a significant competitive advantage when promoting the product to large mall owners.

Nortech has significantly more R&D capability than the local competitors do, and a comparison with some of the major European competitors has shown that there is no major technological advantage in the majority of the foreign competitor products. In fact, the technology in products such as Headcount is more advanced than most international competitors use.

3.3.2 Potential Entry of New Competitors

New entrants into markets and market segments featuring Nortech products would come from companies peripherally connected to Nortech's markets, but possibly in other technologies and segments. For instance, "human access" could be adapted to "vehicle access" or as in the case where "AGD" (see Table 3) have moved from overhead detection into loop detection. There is a possibility that large companies manufacturing and marketing electronic devices could look to expand in these areas in the search for growth and diversification.

Most segments, with the exception of the new parking bay monitoring opportunity (See Chapter 3.6), are populated with a spread of competent competitors but with sufficient room for fair margins. Inductive loop detection has become crowded with concomitant competition on price, especially as the more dominant players such as Nortech did not adjust prices when circumstances warranted (deteriorating exchange rates) and left gaps at fair margins for new entrants. As was noted in the previous section, many of these new entrants are ex Nortech employees who are able to utilise existing knowledge and a similar production environment to develop competing products, often prices very competitively to gain an initial market share.

The People Counting industry is relatively new, although the barriers to entry are fairly high due to the technological sophistication of the products required in the high accuracy applications. As the need for people-counting grows,

there will be more scope for new entrants, although the “first mover” advantage, as enjoyed by Nortech in South Africa and Shopper-track in the USA, is significant.

The competitive advantage that new competitors can achieve is the key question that needs to be asked when analysing the threat they pose, specifically with reference to any technological or skills advantage they might have. The major trend in this respect has ironically been the spread of skills and knowledge from Nortech into other small companies located in KZN. This can be seen as affirmation that the level of technical skills that Nortech historically possessed was of a high level. These skills have been largely maintained and augmented with additional skills in the form of the Headcount technology.

3.3.3 Substitute products

Substitutes for Nortech products will mainly be from new technologies doing the same job. There is a real opportunity or threat that some form of permanent vehicle identification transponder will be legislated for all vehicles during manufacture, (retrofitted to older vehicles), on a country or international basis which may make current vehicle detector systems obsolete.

The Traffic sector is especially vulnerable to substitute products, and the market share has been declining for a number of years in this sector. This is due to the project based nature of this industry, and the very small percentage of the project costs allocated to vehicle detection. Non-intrusive detection methods such as overhead microwave or radar detectors are preferable, as no disruption to traffic is needed during the installation of such devices, unlike loop detectors. Although the cost of these types of detectors is substantially higher, the ease of installation offsets this in many instances. The switching costs are relatively low, as the detectors will provide a similar output whether they are inductive loop detectors or more modern types.

The parking industry is still more suited to the traditional type of detectors, although this is also gradually changing as new technology based products become more affordable and economies of scale reduce costs. The trend amongst OEMs is to continue using inductive loop detectors, but to demand more from the detector in terms of features and quality, at the same or lower price.

The people counting industry is still in its infancy, thus there are no substitutes except products like Headcount which are a substitute for no people traffic data or very inaccurate data.

The technologies used in the development and manufacture of new substitute products pose a potential threat to Nortech, as the same level of technology and associated skills needs to be acquired in order to keep up and remain a market leader in the various market segments. This is the challenge posed by the competitive environment, and is central to the question of sustainable competitive advantage that can be achieved through locating R&D in South Africa.

3.3.4 Supplier bargaining power

The electronics components industry is volatile in certain sectors like micro-processors and memory products, due to the huge buyer bargaining power of certain users such as cell phone and PC manufacturers. This results in the prices of these types of products see-sawing, depending on the worldwide demand for the product. Nortech is a very small user of electronic components, and is thus subject to supplier bargaining power in most cases. This is especially true for single manufacturer products, as a second source is sometimes impossible due to the specialised function of the part.

The relatively small volume of other non-electronic parts like plastic moulds that are required also means that the supplier charges a premium. It is only the commodity type components like standard resistors and capacitors that are cheap due to their widespread use.

Other supplier issues include:

- Suppliers of Capital: Banks are generally reluctant to supply loans to Nortech due to the full ownership by Brait and the existing loan with Brait Merchant Bank.
- Temporary Labour: Factory, tea and cleaning services – supplied satisfactorily by labour contractors located nearby.
- Elements of Design, Engineering, and Software where Nortech capacity is limited due to numbers or expertise have been outsourced.
- Supply of Staff: Recruitment is done mainly through employment agencies.

In general, due to the small and relatively isolated nature of the electronics industry in South Africa, the supply of components is costly, as well as the available staff for this type of industry. This topic will be discussed in more detail later.

3.3.5 Buyer bargaining power

The structure of Nortech's distribution channels is as follows:

- Distributors: There are five major distributors based in Australia, UK, France, Spain, and the Netherlands. They account for 70% of total sales.
- Agents: There are a number of agents around the world; the most prominent of these being those based in the US and China.
- OEMs: A number of OEMs, mainly in Europe in the parking industry, are amongst the oldest and most loyal customers of Nortech.
- End Users: A small percentage of the customers are the actual end users, predominantly in the Access market. These are serviced through direct sales and retail intermediaries.

The above structure would seem to indicate a strong reliance on a small group of distributors and agents. The pricing structure to the various groups is fairly similar, thus there is not a big difference between the margins in any of the groups. The pressure exerted by the distributors is usually focussed on the need for new products and enhancements as opposed to price. It is this

pressure for a new product that has often been a driving force behind a haphazard development strategy, with the distributor who “shouts the loudest” often getting what he wants.

As the number of agents has increased and the geographic location of the sales areas has broadened, the reliance on a single distributor or area has lessened, especially with the rapid growth of business in China. The buyer bargaining power has lessened as a result, and a more inclusive manner of new product development in recent years has left potentially unhappy distributors, who rely heavily on Nortech products forming the majority of their sales, with little room for complaints.

The above overview of the various factors in the competitive environment points to a number of interesting findings related to the topic of discussion:

- The location of Nortech in South Africa is not ideal from a purely manufacturing point of view, due to the economies of scale in electronic components.
- The limited availability of skills in the high-tech electronics industry has resulted in a shortage of staff in this area, forcing reduced R&D output and non-ideal project outsourcing where possible. The outsourcing route has not always been successful, due to the lack of control possible and the limited resources available, especially in KZN.
- The increasing competition from new technology products needs to be addressed with urgency to avoid further market erosion, and innovation as opposed to “catch-up” is required to obtain a sustainable competitive advantage.

These findings will be discussed in more detail in Chapter 4.

3.4 Trading History

The following graphic gives an indication of the trading trends at Nortech over the past four years:

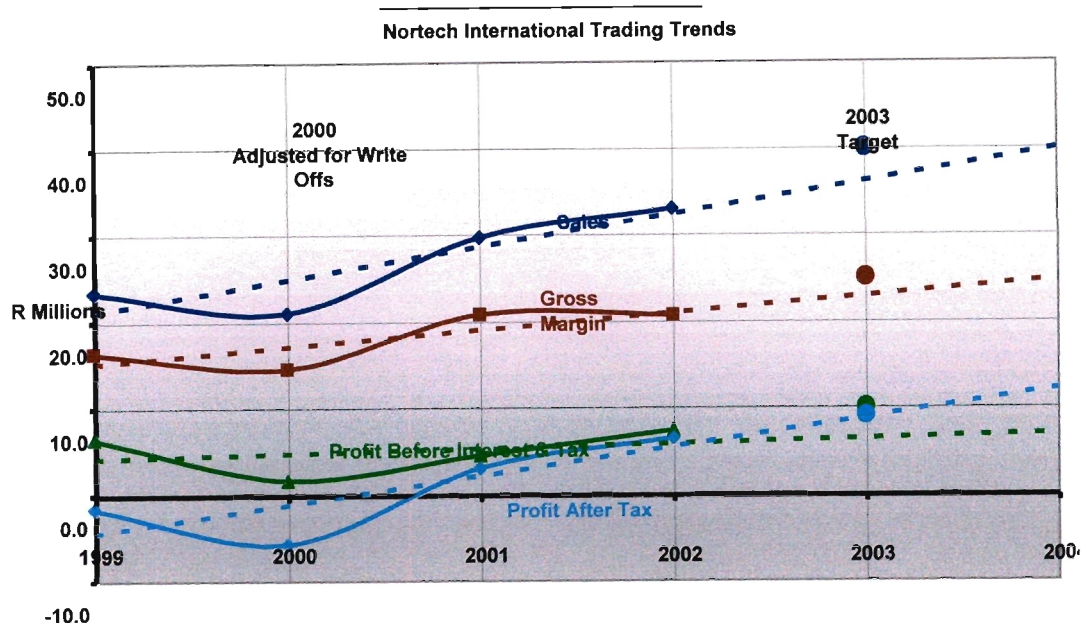


Figure 3 Nortech Trading Trends

The following patterns are evident:

- Gross Margin as a percentage of sales is declining.
- Profit before Interest and Tax is climbing as a percentage of sales indicating a proportional decline in expenditure.
- Profit after Interest and before Tax is climbing sharply indicating positive cash flow.

The effect of a volatile rand also has a significant effect on the above picture, especially in the last year, where the rand has seesawed between a low of R13 to the dollar and a high of R7 to the dollar. A weak global economy, particularly in Europe and the USA, has resulted in static sales and increased price pressure. New entrants have also forced prices down, especially in the Parking industry where detectors are becoming more of a price driven commodity. This explains the relative drop in Gross Margin, and serves as a warning that new developments and innovation need to be the driving forces behind continued good returns.

It is only through the ability to produce goods that provide a real competitive advantage that high profit margins can be maintained. The increasing global nature of trade and the inability to rely on a weak rand to sustain exports means that the product is the only sustainable long-term advantage for continued strong growth.

3.5 State of R&D skills and government incentives

3.5.1 National R&D

An indication of the levels of R&D in a specific industry can be measured in the following ways (SAJE v64 (4), p.351):

- i. Numbers of scientists and engineers employed by companies
- ii. Outlays for R&D
- iii. Number of patents registered
- iv. Output indices such as the number of significant technological innovations and sales associated with such innovations.

A commonly used indicator in a company such as Nortech is the R&D/Sales ratio. A ratio of 10% is often cited by financial analysts (Loubser, 2003) as a good ratio to aim towards in this type of industry. A national indicator is the ratio of R&D spending to GDP, which has dropped from 1.1% in 1990 to 0.7% in 2002. This equates to R4.1 billion, or US\$23.4 per capita, compared with US\$842.5 in the USA. Thirty-nine percent of R&D spending comes from state coffers (Sunday Times, 23/9/2001). Average R&D spending in Organisation of Economic Cooperation and Development (OECD) countries stands at 2.15% of GDP (Sunday Times, 18/8/2002). Some key indicators of the level of investment in R&D are shown below, illustrating the decrease in spending over the past decade, and the proposed increases as outlined in "South Africa's National Research and Development Strategy, 2002."

Indicator/Target	1990	Current	2012
Economic growth attributable to technical progress	n/a	10%	25-30%
High and medium-tech exports	n/a	30%	40%
Number of SA originated US patents	100	100	>200
Government civilian R&D as a proportion of GDP	0.36% estimate	0.29%	0.6%
Government R&D expenditure/GDP	0.48%	0.36%	0.66%
Intellectual property net cost to SA (copyright and royalties)	R200 m	R800 m	Improve ratio
Internet hosts per 1000 people	0	8.4	64
Telephone density per 1000 people	87	270	700

Table 4 Investment and Outcomes

Source: South African National Research and Development Strategy, p. 33, DTI, 2002.

A survey done by Kaplan (1997) revealed some interesting statistics. The focus of the survey was on innovation, and the correlation between innovation and R&D is of particular interest. A sample of 244 firms across all levels of manufacturing was undertaken, and some of the findings were as follows:

- Total innovation expenditure for all firms represented 4.9% of turnover.
- Metal, products, machinery, and equipment were highest (14.3%), and food, beverage and tobacco lowest (1.46%).
- Overall R&D represented only 32% of total expenditure on innovation. There was considerable sectoral variation with R&D constituting over half of innovation expenditure in electrical machinery and apparatus, but less than 2% in furniture.
- Product innovation accounted for 77% of all R&D activities, whereas 21% was for process innovation.

A comparison with other countries that have a similar level of technological development was done by the United Nations Development Program (2001), using relative indicators and South Korea, Malaysia and Australia as comparisons. This further reinforces the fact that there is not enough attention given to R&D in South Africa when compared to a country like Australia.

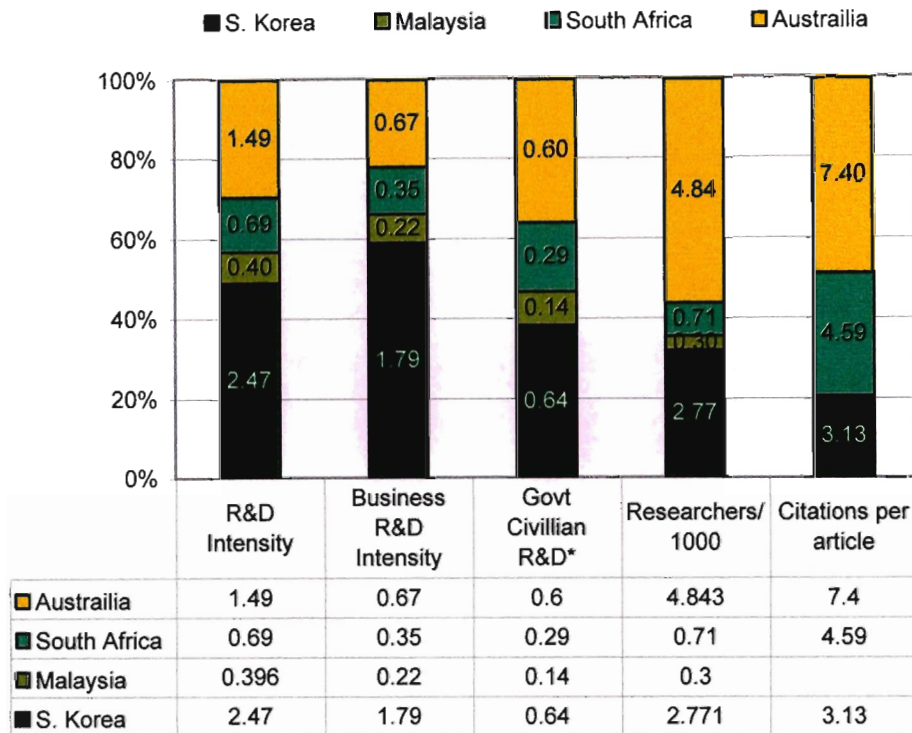


Figure 4 Key indicators of National R&D levels

Source: United Nations Development Program, Report on Human Development, 2001.

The "White Paper on Science & Technology" (1996), prepared by the Department of Arts, Culture, Science and Technology (DACST), is a serious attempt by the government to address some of the historical deficits in the South African manufacturing sector. This paper was created in consultation with political parties, business, the higher education sector, the science councils, labour, NGOs, and civil society. It is presented as a "blueprint" to use Science and Technology (S&T) to enable South Africa to become

economically competitive on a global scale. Following is an excerpt from the introduction:

“Science and Technology are considered to be central to creating wealth and improving the quality of life in contemporary society. To facilitate this function it is accepted that government has a prime responsibility in creating an enabling policy environment in terms of regulatory and funding mechanisms. This White Paper presents government's vision for S&T within the overall framework of the Reconstruction and Development Programme (RDP) , its later and more detailed specification through the Growth and Development Strategy (GDS) and the Macroeconomic Strategy presented by the Ministry of Finance.

The core vision of the White Paper is the conceptualisation of a national system of innovation which seeks to harness the diverse aspects of S&T through the various institutions where they are developed, practised or utilised. No government can order innovation to take place, but government can ensure that a competent pool of expertise from which innovation can spring is grown and maintained. This is where the White Paper strongly addresses one of the pillars of the National Strategic Vision in recognising the need to invest in people at all skill levels. The policy thrusts of this White Paper are in harmony with the White Paper on Education and Training in its identification of investment in mathematics, science and technology as a fundamental goal.”

The paper presents an extensive overview of South Africa's S&T requirements, recommends certain policy formulations as well as regulations, financing to be made available, performance measures, Human Resource development and Capacity Building, infrastructure required, and the importance of private sector involvement in these initiatives. The degree to which the various proposals and recommendations have been implemented is questionable. In particular, proposals regarding tax incentives have not

come to pass (SAJE v69 (1), p. 78), but what is encouraging is the large increase in grants, from less than R35 million in 1996 to over R290 million in 1999. These grants have been through four major funding programmes, namely “Technology for Human Resource Development” (THRIP), the “Innovation Fund” (IF), the “Support Programme for Industrial Innovation” (SPII) and the “Partnership in Industrial Innovation” (PII). The SPII is of particular interest to Nortech, and will be discussed shortly.

Another study performed by Nkosi and Bhembé (2002) for the DTI to assess the effectiveness of the above funding programmes also reveals some interesting results. A Durban based electronics design and manufacturing company (UEC) who manufacture, amongst other items, DSTV decoders, was identified as the company with the biggest increase in R&D spending over the past five years out of a sample of twenty companies with an active R&D function. UEC planned to spend R30 million on R&D in the next financial year, compared with R32.8 million in the previous five years. This represents 7% of total turnover. They state that 33% of their turnover is generated by sales of innovative products, and 40% of the products are exported, with this figure set to rise to 85% in the next three years. The major sources of competitive advantage are stated as (1) Product Specialisation, (2) Flexibility of Production, (3) Quality of Service, and (4) Prices.

Other feedback from this survey is that the majority of the companies surveyed do not make use of the government grants available due to difficulty in obtaining the grants, limited size of the funds available, and general scepticism as to the motives of the DTI. A comment which is particularly relevant to Nortech is that the stringent requirements for innovation under the SPII excluded most projects. This aspect will be discussed with reference to Nortech shortly.

3.5.1.1 The effect of the “Brain Drain” on R&D

The “Brain Drain” has been a popular topic of conversation in professional circles for a number of years. It refers to the net outflow of skilled professionals from the country, resulting in a skills shortage in many critical

sectors. The following graph illustrates the net gain/loss of professional, semi-professional and technical people over the period 1985 to 1995.

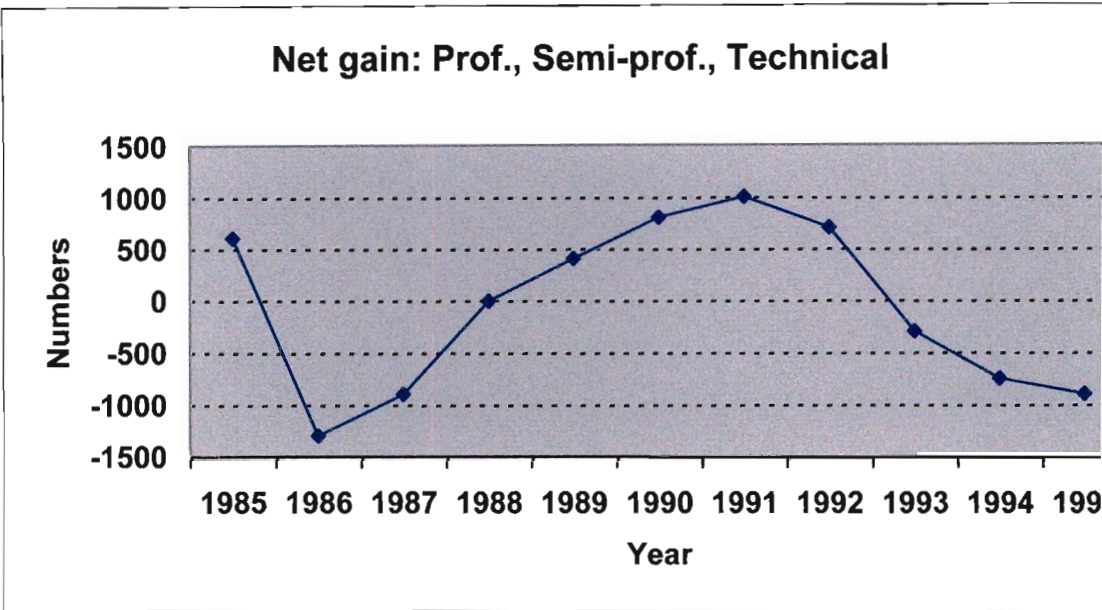


Figure 5 Graph showing net gain/loss of migrants.

Source: CSS Statistical Release P0351. May, 1996.

It is clear from the above graph that the “brain drain” fears have not been exaggerated. The economic climate has improved markedly since 1994, yet skilled professionals continue to emigrate at a much higher rate than immigrants arrive. The figures for the years from 1995 to 2003 show a similar negative trend, indicating a persistent underlying factor for emigrating. The main factors cited as reasons for leaving are high crime rates and affirmative action policies (Kaplan, 1998), with the major countries of choice being the United Kingdom, USA, Australia, Canada, and New Zealand (Kaplan, 1999). There is also some evidence that these numbers might be far higher due to the many unreported emigrations occurring.

The government immigration policies also do little to aid the situation. Work permits for foreign skilled workers are extremely difficult to obtain, and no effort on the part of the government is being made to attract skilled workers from outside the country’s borders. Some efforts have been made in recent months by the Department of Home Affairs to encourage foreign skilled

workers, but this issue has become a political football between the ANC and the IFP, thus to date, no progress has been made on this front.

The repercussions of the continuing exodus of skilled workers are very serious, particularly in companies such as Nortech who rely on highly skilled engineers to perform “cutting edge” R&D and develop innovative products that can compete globally. The majority of the engineers that have left Nortech over the past five years have emigrated, and it is becoming increasingly difficult to recruit suitable qualified staff to fill these positions or to expand the existing knowledge base.

The average salaries for skilled professionals worldwide vary dramatically between countries. To compare the salaries directly in dollar terms would be a mistake, as the costs of living in the various countries vary widely. As the global workforce becomes more mobile, however, and decisions regarding the location of manufacturing and development facilities become less country dependant, direct costs of production are affected by the actual dollar values of the salaries, especially where R&D labour costs play a significant role. The large discrepancies definitely contribute to the “brain-drain”, as well as the location of high-tech production facilities in less developed countries.

Country	Average Salary (US\$) (Annual, 2002)
USA	89,100
Japan	62,900
England	58,150
South Korea	21,492
South Africa (estimate)	21,000
Taiwan	18,539
South East Asia	15,188
China	8,135

Table 5 Average Electronic Engineer's salary

Source: EE Times annual Salary Survey, 2002

The above table provides a valuable insight into possible reasons for skills migrations worldwide, as well as production decisions. Salaries are only part of the picture, as the relative skills levels might vary widely between countries as well, but, as has been demonstrated with a number of examples, South African skills are highly regarded worldwide (Independent Online, 2001).

3.5.2 Skills levels and technology in Nortech

The technical staff at Nortech can be roughly divided between Hardware and Software development and support. There are approximately four software developers, and six hardware design and development engineers. The line between hardware and software can be grey in certain instances. Software is traditionally defined as something that runs on a computer, but software in the Electronics industry encompasses two types, namely applications that run on a computer, and applications that run on embedded micro-processors used in the majority of products manufactured. This is referred to as “firmware” in the industry, and requires very different skills from the traditional IT type skills much sought after worldwide.

An Electronics Design engineer needs to have a detailed knowledge of the physical electronic circuits (the “analogue” design), as well as a good software basis to enable development of the code required to run the many types of micro-processors used in electronic design (the “digital” design). These skills can be focussed in a particular area of expertise, or someone could have good general knowledge of most of the skills required for successful electronics design (a typical South African characteristic).

Nortech has retained and nurtured a strong core of key technical staff, despite high turnover rates, particularly in the software department (emigration being one of the most common reasons cited for leaving, as discussed above). The need to attract new staff as the business grows, as well as retain existing staff, remains a priority for the management team, as it is the quality and experience of the technical team that shapes the level of product development to a large extent.

Some specialist skills such as RF development need to be outsourced, due to the current lack of such skills internally. The good knowledge base developed over the years in the people counting technology areas has provided a significant competitive advantage, and rapid growth in this facet of the business has vindicated the extensive investment over the past five years in people and marketing for Headcount.

The SPII fund has been identified as a possible source of government grants for Nortech, due to the relatively innovative products that have been developed. The fund was created by the DTI to stimulate industrial innovation, and provides up to 50% of the total costs of a project, up to R1 million, provided the product is deemed to be sufficiently innovative and has a good business model. An extensive application process was undertaken in 2002 to apply for funding for a Headcount related product, but this was ultimately turned down due to lack of innovation (see previous discussion on this issue). A new product under development has also been earmarked for SPII funding, and the hope is that this application will prove successful.

3.6 Future Developments and Strategies

In the past year, the decision on which new developments to undertake was done in consultation with the major distributors and agents. A list of a number of possible new developments was sent to them, and they were required to rank them in order of preference. The results were weighted according to total potential value added to the company, and a number of new developments were agreed upon, based on this inclusive approach. A timetable was drawn up for the expected launch of the new products, and development was commenced on the new projects. One such product is a "Bay Monitoring System," which is used to monitor the presence of a vehicle in a parking bay.

Due to the resource constraints prevailing in the company, and a number of unexpected support related problems, the developments did not progress at the anticipated pace, leading to frustration and missed deadlines for all concerned. In the light of this, the structure of the engineering department

was altered to focus certain resources solely on new projects, without any distractions from product support related issues. Some of the engineering staff have been assigned to a purely support role, thus enabling the R&D staff to maintain better control of the new projects and keep to the original deadlines.

This policy appears to be working, and a more focussed R&D team has resulted in more realistic project plans and deadlines. Continued development in close consultation with the global representatives is a cornerstone of the company's long-term strategy of growth through technical innovation and globally competitive products.

A RONA of 30% per annum is the goal, and although the exchange rate can play a big role in the achievement of this goal, the continued rapid expansion of the Headcount products (budgeted 50% growth for the next five years) is the main driver.

Partnerships with other companies and increased outsourcing of development work are a necessity to achieve these goals with the limited human resource available. Maintaining a clear focus on the core strengths of the company and utilising the existing resources in an optimal manner are also necessary to ensure maximum value is obtained.

It is hoped that within five years, the Headcount products will constitute 50% of the business (from 10% currently), through expansion in Europe, North America and China. A full-time employee is already based in the UK, with the aim of looking for new markets in the existing components industry and the new people-counting business in Europe. New distributor agreements with companies in Canada and China, as well as training programmes where necessary, will pave the way for increased expansion of the Headcount products in these countries.

4 Discussion and Evaluation

The case study has been conducted using available data pertaining to the company and country specific secondary data sources, personal observations of the author, and unstructured interviews with key personnel. These findings will be evaluated against the model developed in Chapter 2. The findings can thus be discussed in terms of (1) the relative locational advantages gained, (2) the level and utilisation of core competencies, and (3) the optimal structure of the value chain.

The reliability of the data obtained and the validity thereof is important if the results are to be meaningful. Due to the qualitative nature of the research, analytical methods are not relevant in determining the validity of the data. Rather, a method of triangulation, whereby data is obtained from at least two independent sources is used to determine the validity of the data. The different sources of data will be mentioned and the validity of the result evaluated in each case. The reliability of the data obtained is based on the factual nature of the data, the majority of which is officially published information. The personal observations and interview results are the only non-factual data, and can be assumed reliable due to the nature of the sources.

The preceding case study has revealed the following findings, which are discussed in the context of the model developed earlier.

4.1 Factors related to Product

The various products manufactured by Nortech were discussed in Section 3.2, and can be categorised into Parking and Traffic Detectors, Access Control and People Counting products. These product categories have certain distinct characteristics, and require different levels of technical expertise, thus need to be discussed independently. The markets and technological maturity also vary between the product categories, thus these aspects will be examined in each category.

The ability to offer rapid product customisation, as well as produce quality products at competitive prices are the main source of competitive advantage. These factors have also been identified as key factors of success in similar industries in South Africa by Hallows (2003), and Kaplan (1997). In the face of increased global trade and lower trade barriers, competition from the East, where factors of production are cheaper, and economies of scale that allow further savings, these factors provide a crucial differentiator.

The advantages of a weak Rand (on average) compared to the Euro and the Dollar, and a flexible technical ability provide the locational advantages necessary to sustain a competitive advantage. The predominance of labour as a percentage of R&D costs (greater than 80%, Loubser, 2003) means that countries situated in Western Europe or North America have far higher costs to recover due to the higher skilled labour rates in these countries, as shown in Table 5 in the case of Electronic Engineer's salaries. When relatively small quantities of a specific product are manufactured, the fixed cost component, specifically the R&D labour costs, becomes a large portion of the total cost. This makes it uneconomical for producers of high-tech products to manufacture small volumes if their R&D costs are high. This provides an important competitive edge to Nortech, and explains the continued demand for specialised products in this sector.

The question of the skills levels of the labour required when compared to other countries has been answered by the high demand for South African professionals worldwide (See Figure 5.) It has also been demonstrated by the achievements of South African high tech products in the international arena, especially in defence related industries. Examples such as the G5 and G6 canons, the Rooivalk helicopter, and the "Heads-up Display" units used in fighter-jets are some of the better-known products. Other examples in the private sector are the "Fuel from Gas" technologies used by Sasol, the advanced deep mining methods used on the gold mines, and the digital encryption methods used by Thawte (Mark Shuttleworth's company). The above examples are illustrative rather than exhaustive, but serve to emphasise some of the technical achievements. It is also very clear that the

level of investment in R&D has decreased in the past decade (See Table 4 Investment and Outcomes).

4.1.1 Parking and Traffic Detectors

These products constitute the majority of the current sales at Nortech, and are the core products of the company. The markets are well established and in the mature/declining phase of the lifecycle in most cases. Newer technologies have eroded market share, particularly in the Traffic related products, and customer demands for better products at lower prices have resulted in many of the product lines becoming commodity type items. The increased number of competitors in the market has also contributed to the general decline in margins, although exchange rate vagaries have had a significant effect in recent years.

The level of innovation and technological expertise was relatively high in this sector fifteen to twenty years ago. The knowledge is now commonplace and the skills have been diluted through imitation and personnel migration. The strategies in this market are thus limited, and centre on two things: developing new products to counter market erosion, and providing value added services to differentiate the products from competitors. The new product development strategy is based on developing other related detection products, as Inductive Loop Detection as an industry is in slow decline. Locational and structural factors can provide an advantage in this sector through value added services.

The manufacturing and logistical advantages are not apparent in this sector when compared to manufacturers in the East, but it is only when economies of scale become a factor as volumes increase that this is apparent. It could be argued that the manufacture of standard products, which constitute the bulk of total volume, could be “outsourced” to a contract manufacturer in Singapore, where the PCBs and many of the components are sourced. This would certainly decrease the direct costs of production. This has been a “threat” used in the past by management when labour has not been sufficiently compliant. A detailed study would need to be undertaken to

evaluate the total costs of such an exercise, and is not within the scope of this paper.

4.1.2 Access Products

The Access line of products is a more recent addition to Nortech's product offering. The market is linked to the Parking industry in many instances, especially in the Vehicular access sector. The Human Access Control sector is one of the most competitive in the industrial electronics industry, as the barriers to entry are low and the applications are widespread. Nortech's entry into this sector was a logical follow-on from the Parking sector, as many of the foreign distributors and agents are in the Parking and Access markets.

Certain products within Nortech's Access product portfolio contain significant levels of innovation, and this is still the main differentiator for these products. This industry also attaches greater value to the integration of the products within a system, as a number of components, including parking products, constitute a complete Access Control system. A single supplier of all the components in the system is preferable, even at a slight premium. This aspect has been the driving force behind the continued expansion of the product range, thus products with little benefits in isolation become acceptable to the customer when bundled with more innovative products. The Autotag as well as the Track products provide differentiation based on innovative features, and are thus able to leverage other products as part of an integrated package.

The level of technical expertise required in the development of the above products was high, and coupled with consistent quality and competitive pricing, these products occupy a lucrative niche market position. Continued technical support of these products requires a relatively high skills level, especially as they are RF type products. These skills are available in Nortech and South Africa, although the continued exodus of skilled labour from South Africa makes these people increasingly hard to come by. The defence industry played a big role in developing skills in this area prior to 1994 (SA National R&D Strategy, 2002), and the large-scale reduction in spending in

this area in the past decade has affected the available and future skills in critical high-tech areas. This fact has been mentioned in the “South African National R&D Strategy” paper delivered by the Minister of Science and Technology (2002), as well as measures designed to try to counteract this trend.

The equipment and testing infrastructure required for development in the RF field is available in South Africa, mainly because of investments by the government and private sector during the isolation years. The equipment and national testing facilities are ageing, however, and significant capital expenditure is required to keep the technology current. The government’s ability to fund this is lacking, as there are more pressing social issues to address. This is of concern when looking at future development in this field, and is a convincing argument to base this type of high-tech RF R&D offshore, or receive sufficient backing to warrant the capital expenditure required to maintain and upgrade the existing infrastructure.

The relative labour costs remain a locational advantage in this sector, and similar arguments apply here as in the Traffic and Parking sector. The more expensive equipment required in the RF and Optical fields of the Access sector can prove prohibitive, and are high barriers to entry in these areas. Economies of scale or government assistance in the form of tax concessions or grants are needed to undertake substantial innovative development in this field. Skills levels and efficient, quality production processes still provide locational advantages in this area, although these might not be sustainable in the long term.

4.1.3 People Counting Products

This is the newest addition to Nortech’s product line, and the one with the most potential. The Headcount product range is a world leader in its field, and has found widespread acceptance in the South African market, with nine out of the top ten large shopping malls on the client list. The technology is patented and innovative, and provides Nortech with a compelling sustainable

competitive advantage in this industry. There are a limited number of competitors globally, but none utilising the same technology as Headcount.

The technical expertise required to develop Headcount is predominantly software skills. The maintenance and expansion of the product range is also reliant on a high level of software expertise, although the core concept remains unchanged. The marketing and total product offering has provided the leverage to transform a good technical idea into a marketable product that has gained industry acceptance. A high level of technical backup is required to ensure that the product continues to provide added value to the customer, especially those on a fixed maintenance contract.

The margins on the Headcount products are high due to the significant added value, thus physical location and component costs play a smaller role in the total costs of the product. The embedded software that enables the technology is the real source of competitive advantage, as well as the sophisticated internet reporting and the software that enables this. This software could have been written anywhere in the world, but South Africa provided a fertile entrepreneurial breeding ground for the initial development of the concept, and the expertise was available to make the concept work.

The relatively high level of technical skills available in South Africa, and cheap labour costs compared to more developed countries, combined with a generally favourable exchange rate, have ensured that a locational advantage has been achieved in South Africa. The location of the R&D team and a production facility on the same premises has also enabled the product to evolve through experience. Rapid prototype development of new concepts, with the help of flexible and professional local suppliers, has meant that Nortech has been able to respond very rapidly to customer needs. An example of this was the development of a new variant of the Headcount system within the space of three weeks, including a demonstration of the new product to potential customers in Toronto.

This ability to respond rapidly to changing conditions, using in-house expertise, has been a critical differentiator in the Headcount and other

product lines. Detailed documentation of all steps in the design and production process, as per defined procedures under ISO9001, ensure that knowledge transfer was achieved with the minimum of disruption. The loss of technical staff thus has a minimal impact on the development of a product, provided a person with similar skills is recruited as a replacement.

4.2 Optimal Value Chain

The value chain for the various Nortech products is similar. The model has evolved over the years, and is still evolving as the environment changes. The major activities in the company value chain, namely R&D, Production, Logistics, Sales and Marketing, and Distribution need to provide the best means of delivering the product in the most effective manner.

Nortech has minimised the locational disadvantage of component sourcing inherent in South Africa by developing a relationship with a large component supplier. The supplier keeps stock of the majority of electronic components required, and provides them as needed at a fixed low mark-up, ensuring availability at competitive prices.

The Headcount products require a lot of precision metalwork, and a local laser-cutting company with state-of-the-art equipment is able to provide the necessary level of precision manufacturing required, often with very short turnaround times. Foreign manufacturers of this type of product have been investigated, especially in locations close to the final product location in instances where Headcount has been installed abroad. It was found that the cost of manufacturing was prohibitive and that it is cheaper to manufacture the parts locally and ship them overseas than use foreign manufacturers.

The inbound logistics activities are thus competitive, and do not form a weak link in the value chain.

The location of the R&D facilities, Production, Sales and Marketing and Administration in one building also provides good synergistic advantages. The distribution chain, whereby Distributors and Agents in the various countries provide the goods to the end customer, has been necessary in

most instances, especially where a different language is spoken. More recently, a Nortech ex-employee has established himself in Australia, and acts independently as a distributor for Nortech. This has the advantage of a detailed knowledge of the Nortech products, and a good working relationship with Nortech. Nortech has also recently appointed a full-time representative in the UK to provide closer links with customers and the end user in Europe.

The value-chain is thus expanding beyond the borders as markets expand, but the current model of a single location for R&D and Production has provided the flexibility to respond rapidly to customer needs, as well as smaller gaps between engineering prototypes and manufacturability of products. This is consistent with Nortech's strategy of customisation and rapid prototype development for smaller volumes (Hallowes, 2002), and this view has been echoed by studies nationally (Sunday Times, 10/8/2003). The only possible area of development where locational constraints are not as apparent is in the PC software development sector. This forms a small part of the total Nortech business, but is expanding as the Headcount range of products becomes more reliant on PC based software. Development in this area could in theory be done anywhere in the world, and this was indeed the case recently when an ex-employee was contracted to do some software development in the US. Product specific knowledge is still a prerequisite in this type of niche market, so extensive training would be required before this type of "remote" development could occur. Due to the limited number of staff involved with software development, they are often required to be "multi-skilled" and work on embedded software projects or even hardware related projects if required.

The value-chain at Nortech is configured in an efficient manner, although as has previously been mentioned, the possibility of locating the standard production functions elsewhere should be investigated.

4.3 Competitive environment

The competitive environment provides a very good indication of the success or otherwise of the company's strategy. A company that is not competitive will

be forced out of the market by economics. The fact that Nortech has been trading for twenty-five years provides evidence that the company has been able to compete globally over this period. This is not, however, a reason for the company to rest on its laurels, as the global competition demands faster and more proactive strategies.

The factors contributing to competitiveness are of relevance in this study. It has been shown that competing purely on manufacturing costs is not viable in the South African context (See Chapter 3), thus other factors have enabled a sustained competitive advantage. It has been shown that the contribution of R&D to the value of a product can provide significant competitive advantage, both nationally in the form of increased exports of HTPs (See Table 1), and within Nortech with products such as Headcount. Classical theorists such as Schumpeter (1939), as well as more modern theorists (Drucker, 1993), have also argued this viewpoint.

Rivalry amongst competing sellers in this type of market is often not based on price, especially in the more advanced technologies. These types of HTPs are the primary focus of the company, as the levels of innovation and technological advancement become the main differentiators. The Headcount product range in particular is able to compete successfully in the world market based on the benefits offered to the customer. This has also been argued by Porter (See Chapter 2.2.1) as a means of attaining a sustainable competitive advantage.

New competitors in the market choose either a pricing strategy, which is usually unsustainable in the long term, or a product strategy. The product must offer superior features and reliable operation at a similar price to existing products. The threat of new competitors is often the driving force behind new product development, as the company's products need to stay ahead of the pack, or risk becoming uncompetitive in the face of newer, cheaper products.

Nortech has identified the threat of new competitors in the Parking and Traffic industries as a major threat to future business, hence the need to develop

new products and improve existing ones. Competitors have largely been kept at bay up to now through quality products that offer additional technical differentiation in many cases. This is in line with the theories of Porter and a cornerstone of long-term company strategy (Hallowes, 2003). The Headcount products will also face increased competition as the industry matures and customers become more educated regarding the uses of the available information regarding the flow of people. This will also lead to new competitors, especially in the field of information analysis, as this is ultimately what the product offers. The need to provide new and better means of utilising the information through customised reports will become the main driver in maintaining competitive advantage in this sector.

Substitute products have eroded market share in the Traffic industry in particular, and development of products with new technology that remain at the leading edge of technological development is the single biggest challenge facing Nortech. A long-term sustainable competitive advantage can only be attained through continuous product development to counter substitutes and to gain additional market share (See Chapter 2.2.1.1). The ability of Nortech to develop products that are able to compete globally based on technical innovation has been demonstrated with products such as Headcount (See Chapter 3.2.3), and this core competence has provided the ability for the company to grow and expand into new markets. The advantages of location pertaining to the skills and knowledge available have been utilised in this achievement, and there is every prospect that these factors will continue to provide a competitive advantage (See Chapter 2.1.1 on the use of abundant factors of production). The modern theories of production, stressing knowledge as the only important factor (See Chapter 2.1.2) support this finding.

The bargaining power of suppliers has been argued to be less significant when the products are produced in low volume and the value added is more intellectual in nature (See Chapter 3.3.4). The supply of knowledge in the form of skills can also be viewed as a form of supplier bargaining power, and this area is of more concern in terms of continued high-tech innovation. The

net loss of skills in South Africa has been discussed (See Chapter 3.5.1.1), and proactive measures need to be undertaken by the Government and companies such as Nortech to ensure that there are sufficient skills levels available to sustain technological growth (See Chapter 3.5).

Buyer bargaining power is based on the ability of the buyers to source alternative products without significant penalties. A high level of responsiveness to the needs of the customer, and a sustained level of quality has resulted in a relatively loyal customer base, but it is the spectre of better and cheaper technologies that pose the biggest threat to the company. Continued new product development and a close relationship with the customer are the best defences against this threat, which reinforces the points made earlier regarding the need for continued product innovation.

4.4 National and industry trends

At the national level, the state of R&D does not look good. This is based on the decrease in the ratio of government R&D spending to GDP from 0.48% in 1990 to 0.36% in 2002 (See Table 4). This compares with an average rate of 2.25% in OECD countries. Numerical values paint an even bleaker picture due to the relatively small GDP of South Africa. Other indicators such as the number of patents granted and the number of research papers published all point to a declining level of R&D. The government has attempted to address the situation through measures outlined in the South African National Research and Development Strategy, but without any meaningful financial commitment to the initiatives. The necessary skills required to effectively manage the apportionment of government funding is also important, as a budget for R&D does not necessarily imply that the funds will be wisely allocated. Studies such as that conducted by Kaplan (1997) indicate that R&D is an important source of innovation, and that innovation is the only true creator of added value in production.

An industry level analysis reveals that the companies with the largest proportion of their sales in the form of exports also spend a significantly higher percentage of turnover on R&D (Ricci, Nkosi, 2000). This is also what

the theories of Stolper-Samuelson predict (See Chapter 2.1.1.1). A company such as UEC is projecting an increase in exports from 40% to 85% of total turnover within the next five years.

Nortech is already predominantly export orientated, and spends well above the industry average on R&D. The company is thus in a strong position to take advantage of any locational benefits arising from good technical skills and efficient production methods. Additional government support in the form of more easily obtainable grants and tax incentives, as well as a more attractive political and economic environment to retain skilled staff will ensure a competitive high-tech environment.

5 Recommendations

“The future depends on what we do in the present.”

- Mahatma Gandhi.

Nortech has provided a valuable example of a small company that has successfully made the transition from a local supplier to a high technology exporter in a global market. South Africa has undergone a transformation in all spheres since 1994, and this has affected business, attitudes, perceptions, and global competitiveness.

The high-tech industry in South Africa was strongly biased towards the Defence industry prior to 1994. Academic institutions and Research Institutes such as the CSIR favoured a particular segment of the population, and the government strategy regarding R&D and technology was centred on self-sufficiency. Many projects were government funded, and due to the isolation of the apartheid era, a high level of technological proficiency was attained through necessity. South African engineers were regarded as “multi-skilled,” and this legacy persists to the present day. Post 1994, the focus of the government was very different, and industry had to adapt accordingly. The market environment was opened up to global competition, and many companies did not survive this transition. Those that did survive found that they could not rely on protectionist policies to shield them from international competition, but had to exploit their competitive advantages to succeed. It is in this climate of change that companies such as Nortech were able to exploit the new opportunities presented to them to their own advantage.

Nortech has been able to maintain consistent growth in earnings over the past decade through continued expansion of their market share globally. This has been through quality products at competitive prices, and continued product innovation and development. The ability to offer innovative products and respond rapidly to changing market conditions has enabled the company to counter the threat of increased global competition over a sustained period. The life cycles of the various products have been extended through

improvements and additions to the ranges, and new products have been introduced as others have declined. The effective use of foreign agents and distributors has enabled the various global markets to be penetrated using local knowledge. The continued success of this model is dependant on constant adaptation to the changing market, primarily through adding value to the products to differentiate them from mass-produced commodities where price is the only differentiator.

In order for Nortech to continue to prosper in an evolving market, and by extension, other South African companies in the industry, a number of things need to occur. From a company point of view, the strategy of continued development to provide products that are differentiated through innovation is a necessity. The ability to rapidly provide custom solutions to customers anywhere in the world is part of this strategy. The skills required to ensure that this is achieved are in place in the company, namely the strong knowledge base of existing staff, and the experience of the production facility to efficiently produce quality products. The infrastructure and value-chain are in place to ensure that a competitive advantage relative to more developed countries can be achieved. It is important to ensure that this structure is maintained and improved to remain competitive.

The lack of human resources necessary for continued growth is of concern, and this needs to be addressed through proactive measures. Steps must be taken to ensure that key technical staff are retained, and suitable new staff are recruited. This should occur through involvement at a tertiary level in the form of bursaries and practical training opportunities, as well as professional recruitment in major centres. Increased promotion of the company as a centre of technical excellence to raise the visibility would assist recruitment efforts. This needs to be complemented through active involvement of the government on a number of levels.

The role of the government in developing countries like South Africa is more important than in developed countries. The limited infrastructure and market size mean that government has to play an active role in assisting the sectors

of the economy that will add the most value. The high-tech manufacturing sector has been identified as such a sector, and some effort has been made to provide financial assistance in the form of grants. Increased assistance at an industry level through tax incentives for innovation related expenditure is required, as well as a more favourable macro environment. The labour policies in South Africa are not conducive to high levels of productivity, as evidenced by the low position of South Africa on the world productivity rankings. Strict immigration laws also limit the number of foreign skilled labourers able to work in South Africa, and these need to be relaxed if any meaningful skills transfer is to occur. A stronger emphasis on higher education, especially in the Maths and Science fields, needs to be encouraged and actively funded if the long-term high-tech skills levels are to be maintained. Increased investment in advanced research facilities and infrastructure is necessary to maintain a sufficient level of support for the industry.

Initiatives such as the “Innovation Hub” in Gauteng and “Blue IQ” are good examples of technological investment, and this type of development needs to be encouraged. The role of industry in this regard, where partnerships are formed with government agencies, is crucial to the long-term sustainability of these ventures.

Stable political and economic climates are ultimately the most effective means of fostering growth. The high-tech industry is particularly susceptible to the “brain-drain” effect, and this can only be countered through an attractive local environment that encourages skilled labour to invest in the country.

Crime is one of the most cited reasons for emigration, and the strong growth in sales of security related products (such as Nortech’s Access products) is evidence of this. Initiatives by the government in conjunction with the private sector in the security industry, such as the design and manufacture of innovative crime prevention products (the handgun with a fingerprint reader

developed by a local company is a good example), would serve the dual purpose of reducing crime and providing employment in this sector.

High-tech R&D is definitely viable in South Africa, and can continue to be so, provided steps are taken now to ensure that the necessary skills are retained and fostered, and continued investment in technical infrastructure is assured through strong market demand.

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