

**MANAGERIAL ASPECTS FOR THE ENGINEERING ENTREPRENEUR**

by

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DISSERTATION

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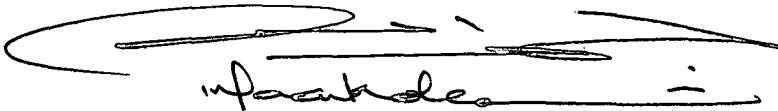
**RAND AFRIKAANS UNIVERSITY**

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## DECLARATION

I hereby declare that the mini-dissertation submitted for the degree of Magister Ingenieriae at the Rand Afrikaans University, apart from the help recognised, is my own work and has not been formerly submitted to another university for a degree.



(Irfaan Khota)

Signed on this 29th day of June 1998



## **ABSTRACT**

This dissertation encompasses a literature study into the management principles that affect engineers who are involved in entrepreneurial activity.

The research begins with a quantification of the engineering resource in South Africa, the government's approach to science, engineering and technology and the potential macro-economic effects of encouraging entrepreneurial engineering activity. The research also incorporates some basic management principles, for the engineering manager. The study then progresses to discuss in significant detail, the domain of the entrepreneur. In particular the research outlines the definition, motivation, personal characteristics, career dilemmas, environment, background, academic training, strategies, business planning and conceptualisation issues that affect the entrepreneurial engineer. Moreover, the engineer's activities of design and manufacture are discussed from the entrepreneurial perspective, together with a brief outline on consulting engineering as a possible entrepreneurial engineering alternative.

In addition to the literature study, field research has been conducted in order to answer the research question: "In general, can engineers become successful entrepreneurs?" Studies were conducted amongst engineers who have successfully entered into an entrepreneurial career, as well as amongst engineers who are employed (corporate environment), to assess the entrepreneurial potential and compare the results of the literature study with the results of the field research.

The research concludes by showing that more than 50% of engineers working within the corporate environment possess the necessary skills and attributes in order to start-up their own businesses and become successful entrepreneurs.

## SINOPSIS

Hierdie skripsie bevat 'n literatuurstudie oor die bestuursbeginsels wat ingenieurs affekteer wat betrokke is in entrepreneursaktiwiteite.

Die navorsing begin met 'n kwantifisering van die ingenieurshulpbron in Suid Afrika, die regering se benadering tot wetenskap, ingenieurswese en tegnologie en die potensiele makro-ekonomiese effek van die aanmoediging van die entrepreneurs ingenieursaktiwiteite. Die navorsing bevat sekere basiese bestuursbeginsels vir die ingenieursbestuurder. Die studie bespreek dan verder die domein van die entrepreneur in redelike detail. Die ondersoek bespreek die definisie, motivering, persoonlike karakteristieke, beroep, beroepsprobleme, omgewing, agtergrond, akademiese opleiding, strategie, besigheidsbeplanning en konseptualisering kwesies wat die entrepreneur ingenieur as affekteer. Verder, bespreek die studie die ingenieurs aktiwiteite van ontwerp en vervaardiging uit die entrepreneur se oogpunt. Daar word ook 'n kort opsomming oor die rol van die raadgevende ingenieur as 'n moontlike entrepreneurs ingenieursalternatief.

As uitbreiding op die literatuur studie is 'n praktiese veld studie gedoen om die volgende vraag te beantwoord: "Kan ingenieurs in die algemeen suksesvolle entrepreneurs word?" Studies is gedoen on ingenieurs wat suksesvol 'n entrepreneursloopbaan betree het, asook ander ingenieurs wat werkzaam is in die korporatiewe omgewing, om die entrepreneurspotensiaal vas te stel en die resultate te vergelyk van die literatuurstudie met die praktiese opname.

Die ondersoek bewys dat meer as 50% van ingenieurs wat werkzaam is in die korporatiewe omgewing, ook beskik oor die nodige vaardigheid en karakteristieke wat hulle in staat sal stel om hulle eie besigheid te begin en suksesvolle entrepreneurs te word.

**Dedicated to my parents AbuBakr and Hawa,  
And to my sisters Mashooda, Faiza and Zulaikha,  
Thanks for waiting!**



## **ACKNOWLEDGEMENTS**

I hereby give thanks to God for the ability, strength, health and determination to work towards enlightenment; to my family for the sacrifice, encouragement and motivation; to my study leader Prof. L Pretorius for making the study so interesting and enjoyable; to my manager at Transtel, Mr Rob McClarty, thanks for the time off so that I could pursue my studies, and to my colleagues and friends, thank you for your assistance.

## **RESEARCH METHODOLOGY**

The research conducted for this mini-dissertation aims to follow the methodology and guidelines specified in Business Research Methods [1].



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# CHAPTER 1

## RESEARCH OVERVIEW

### 1.1 Project Statement

This dissertation aims to identify the skills, characteristics and management principles necessary for engineers who are involved in entrepreneurial activity.

The dissertation covers the fundamental concepts influencing engineering managers; the marketing skills and processes which serve as a basis for successful entrepreneurship; training and development of entrepreneurial engineers; the engineer's function within the entrepreneurial environment; consulting engineering as a facet of entrepreneurship; business planning and financial controls, and finally a case study to correlate theory and practice and to provide a reference for future study.

The primary objectives of the research are: to assess the realm of entrepreneurship; to determine what the engineering management principles required are in order to become a successful entrepreneur; to discuss the engineering process from an entrepreneurial perspective; to assess the engineering population in order to determine the potential for entrepreneurship and to formulate a proposal for successful entrepreneurial engineering. This study aims to serve as a reference for engineers who may decide to enter into an entrepreneurial at some point in their career.

### 1.2 Introduction

Within the South African environment, there is a huge demand for engineers within industry [5], particularly as we emerge and integrate within the global village in the post-apartheid era.

Since the formulation of a government of national unity, and the establishment of the Government's *Reconstruction and Development Program*, there has been an acceleration in economic growth and development, expansion of business, and reconstruction of the national infrastructure. This program has resulted in a surge in industry's demand for engineers to spearhead the "renaissance of industrialisation" of Southern Africa [2].

The implications of encouraging development and greater self-reliance locally, has the tremendous implications of economic growth, the creation of employment, the globalisation of South Africa as a developing nation, wealth creation and increased exports (and less imports) of goods and services [3].

This research embodies a literature study that focuses on the particular aspects required to encourage engineers to utilise their technical skills as

entrepreneurs, toward product and service development in order to achieve some of the goals identified above.

### **1.3 The Supply and Demand for Engineers in South Africa**

The intention of this segment is to attempt to answer the following questions, in order to establish a measure of the quantity of the engineering resource (number of engineers in South Africa) which has a bearing on the number of potential entrepreneurial engineers possible:

- What is the situation regarding the engineering resource in South Africa?
- How does this impact on entrepreneurial engineering?

Whilst this dissertation aims to identify the aspects related to entrepreneurship and management with the intent of assisting engineers to go into their own business enterprises, there exists the paradoxical situation where the supply of engineering professionals is far less than the demand [5], with the result that industry *absorbs* engineers as soon as they graduate.

The *engineering resource* is defined as the number of graduate engineers in South Africa.

In a study conducted by the *Federation of Societies of Professional Engineers (1986)* [5] it was found that the:

- The demand for engineers was directly proportional to the economic growth of the country (demand seems to vary with the index of physical volume of production) [5];
- The supply of engineers was isolated to the growth in population and the number of graduate engineers entering industry. On average there was one engineer available for every two jobs available (in 1986 - during a economic recession) [5].
- A relevant cautionary which was raised in the survey, particularly applicable to the recent economic recovery [36], was that with an improvement in the economy the demand could easily rise to a point where there are more than four jobs for every engineer in several disciplines [5].

From the above, one may easily state that the engineering resource is a relatively scarce commodity.

#### **1.3.1 Factors Influencing the Demand for Engineers**

The study [5] showed that the demand for civil, electrical and mining engineers was negatively affected during a recessionary climate and that economic activity and the demand for engineers is correlated.

Other factors that were indicated in the study were that:

- The business cycle has a direct influence on the demand for engineers. Typically demand grows with the population at about 2.7% per annum [5].
- Once economic recovery sets in, the index of physical volume will increase and the demand for engineers will accelerate [5].

In this situation the "only way to increase the supply will be by immigration, which is unlikely unless the Rand recovers against the currencies of those countries (Britain, West Germany) which have traditionally sent us much of our skilled engineering forces." [5]

### 1.3.2 Factors Influencing the Supply of Engineers

The supply of engineers is dependent on the output of graduates and the number of immigrants [5].

From the data of the study [5] for the period 1975-1985, an aggregate of the total supply and demand of engineers year on year may be derived which includes the study's predictions for 1987-1989. The following statistical relationship between supply and demand is obtained (table 1):

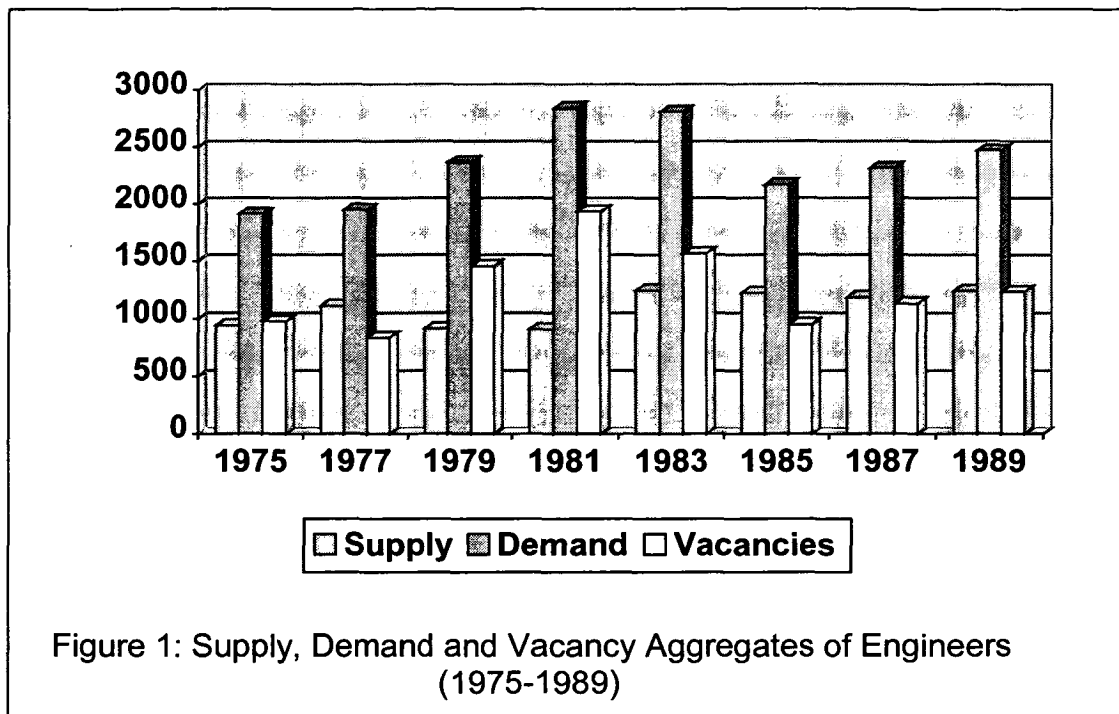
**Table 1: Supply, Demand and Vacancy Level for Engineers 1975-1989**

	1975	1977	1979	1981	1983	1985	1987	1989
Supply	940	1112	913	906	1246	1221	1186	1238
Demand	1914	1949	2368	2841	2810	2171	2316	2473
Vacancies	974	837	1455	1935	1564	950	1130	1235

From the table it is clear that there has been a consistent shortage in supply of engineers, with the number of vacancies usually being more than half the total demand. This relationship is graphically illustrated in figure 1 below. It is evident that the demand of engineers far exceeds the supply, whilst the vacancy levels have been higher than the supply.

The current situation is that growth in the supply of engineering and science graduates needs to increase by 7,6 % per annum [2] and that it is necessary for South Africa to increase its output of science graduates by twofold over the next two decades [2]. This increase is especially needed in areas such as engineering and agriculture, in order to achieve economic success and development [2].





### 1.3.3 The Supply and Demand Effect on Entrepreneurial Engineering

From the above it is evident that the engineering resource is a particularly scarce commodity in South Africa. Unless the output of engineering graduates (supply) is increased, the author suggests the following possible impacts of this condition on entrepreneurial engineering:

- Engineering graduates will continue to be absorbed by industry;
- Job security and higher salaries (demand exceeds supply) will be a hindrance toward engineers taking the risk of start-up businesses;
- Engineering skills will be isolated to specific industries, who can afford the engineering resource; this hinders diversification of goods and services that are produced;
- Entrepreneurial skills and efforts will be isolated to organisational structures.

The increase in supply of the engineering resource is thus viewed as a necessary step in advancing development and diversification.

## 1.4 A Macro-Economic Approach to Entrepreneurial Engineering

This sections attempts to establish the following questions within the macro-economic structure:

- Where does the entrepreneurial engineer function?
- And what aspects of the macro-economy are affected by the entrepreneurial engineer's outputs?

The objective behind this is to derive a feel for the importance of entrepreneurial engineers as a contributory to the macro-economy.

### 1.4.1 The macro-economic structure

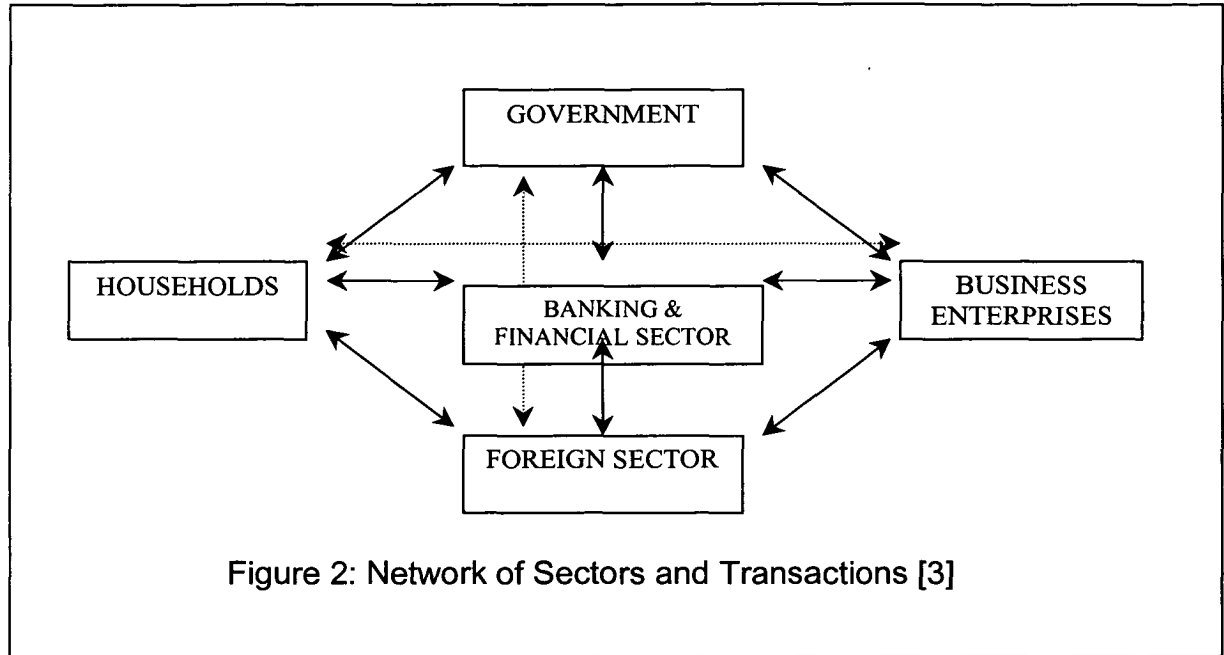
The modern macro-economic network comprises of essentially the Government, Banking, Business, Household and Foreign sectors, where each interacts with the other in the economic sphere according to supply and demand constraints in order to provide or utilise specific goods or services [3].

Within this interaction (see figure 2 below), the main thrust of economic activity stems from the *demand* by households for goods and services, and the *supply* of these by the business sector [3]. At the same time, the Government provides for certain collective needs of households and/or business enterprises (e.g. justice, education), and levies taxes on those sectors to cover its expenditure [3], whilst the financial sector provides services to facilitate easy monetary exchange for payments of goods and services both domestically as well as being the primary interface between the domestic sectors and the foreign sector [3].

From the entrepreneurial engineering perspective, every sector is directly dependent on the engineer's products or services to some degree, however the primary sector wherein entrepreneurship may be exercised efficiently is within the business sector, which supply goods and services to the other sectors [3].

Within such a *static* representation of the economy are the *dynamic* macro-economic variables that shapes the economy and which are directly affected by (and effect) the entrepreneurial engineer's outputs (amongst other contributories). In essence, most of the macro-economic variables may be categorised into one of the following groups [3]:

- Financial variables;
- Real variables;



- The *real* variables comprise primarily of income, production, consumption, employment and expenditure aggregates. These variables generally tend to fluctuate as a group [3], and have a direct impact on the cost factors of the outputs of the entrepreneurial engineer [3].
- The Financial variables comprise average prices or price changes of goods, services, funds, assets and foreign currencies, as well as a range of financial flows or aggregates. Generally, these variables also fluctuate as a group [3]. The specific impact of these variables on the engineering entrepreneur is on the prices of products and their competitiveness with similar domestic and foreign products.

### 1.4.2 The effect of the entrepreneurial engineer's outputs on the macro-economy

The effect of South Africa's interaction with the international economy is that both the domestic and foreign macro-variables are interwoven. Since the South African economy represents less than 1 per cent of the world economy, "the impact of international trends on domestic variables are, comparatively speaking, much greater than the effect of domestic movements on the rest of the world economy"[3].

The impact of the international economy on domestic macro-economic variables occurs via the balance of payments (BOP), which measures South Africa's foreign transactions.

The balance of payments has a notably important influence on the domestic financial variables such as the exchange rate, inflation and interest rates. It furthermore impinges upon domestic real trends since exports, which is the largest component of the balance of payments, constitutes about one-quarter of domestic production [3]. It is within this facet of the economy that entrepreneurial engineering is viewed as having the most impact, since by increasing domestic output of goods and services (within a suitable macro-economic environment), South Africa's level of imports should decrease, positively influencing the BOP, and coupled with an increase in exports, should increase employment significantly as well as to contribute toward further economic growth.

The balance of payments influences domestic real variables directly and immediately via the export component, which may also be positively influenced by entrepreneurial engineering.

Since imported inputs such as machinery, spare parts, computers, fuel and equipment play an important role in most components of domestic production and expenditure, any fluctuations in domestic real variables always have a direct impact on South Africa's total imports.

A more detailed interaction between the financial and real variables, and the balance of payments and the international variables is summarised in figure 3 below. In general, the factors that are directly affected by the entrepreneurial engineer's outputs of production and manufacturing may be categorised as *output factors* - these are also influenced by outputs of other participants in the economy. Similarly, factors that influence the level of production and manufacturing may be called *input factors*. These are included in figure 3.

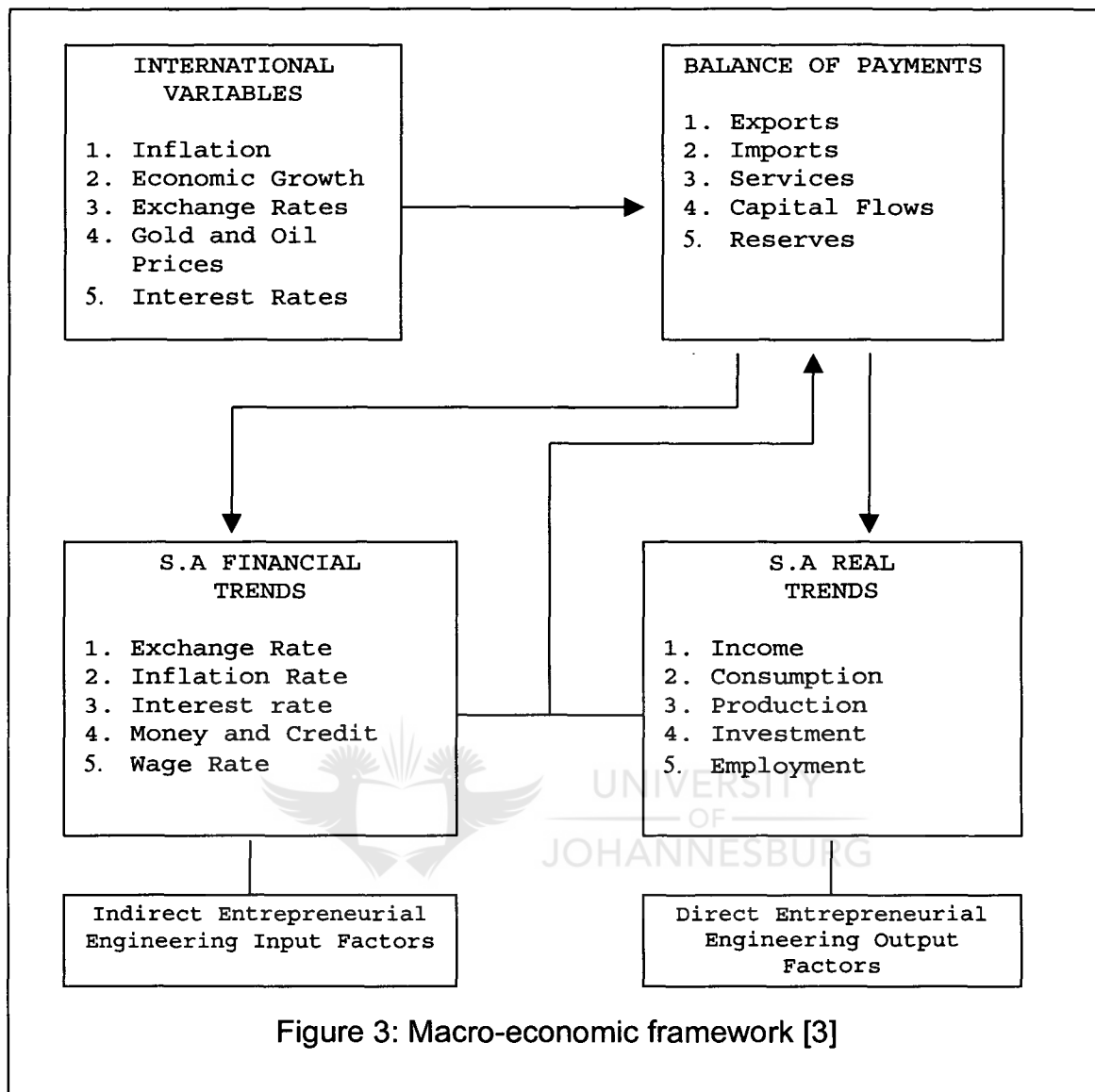


Figure 3: Macro-economic framework [3]

Whilst the discussion above focuses mainly on the domestic variables of the economy that are affected by market participants (including the entrepreneurial engineer), there are also external factors such as politics, sanctions, rainfall, labour unrest and economic policy that affect projections of future economic trends.

It is noted that the economic components discussed above are not isolated to entrepreneurial engineers, but rather to all contributors within the economy. However, since approximately 90% of all exports and 65% of all imports are related to engineering activity [3], the scope of influence of the entrepreneurial engineer, is considered greater than that of other contributors.

## 1.5 The Government's Approach Toward Science and Technology in South Africa

The country is currently undergoing a major *renaissance*, with enormous challenges both locally and internationally as it opens its society and the economy to the combined impact of global investment, free trade and environmental regulations. In the government's recent *Green Paper on Science and Technology* [4], it has recognised knowledge, science, innovation and *entrepreneurship* as the building blocks of change, operating within an effective national system of innovation (NSI) [4]. In this document [4] the Government has taken as its premise that science, technology and innovation can make a positive contribution to job creation, housing, water and electricity supply, youth development and community efforts, with the objectives of realising:

- an improved quality of life for all;
- improved international competitiveness for South African economic activity;
- and a well-educated population capable of participating fully in the new South Africa.

The governments current attitude is one in which it is endeavouring to strengthen industrial innovation and entrepreneurship within South African firms and research organisations, by assisting small, medium and micro-enterprises to access knowledge, apply and adapt technology, and adopt best practice [4]. The governments role in supporting the human resources and entrepreneurship required to promote a knowledge thirsty society is changing, and the current trend is to enhance the pool of trained personnel who understand the processes of scientific research, technology development and innovation [4].

The current reality of science, engineering and technology (SET) places the country in the top rank of the continent [4]. The country possesses a relatively solid science base that produces excellent research. The country also has distinct global advantage in the financial services sector, leaders in corrective medicine and synthetic fuel technology, and much of the work produced by the science councils is valued and admired [4]. "Co-existing with this first world practising of science and technology however, there is a third world reality of disempowerment, environmental degradation, low crop yields, and a high incidence of preventable diseases such as tuberculosis." [4]

Whilst the country's research and development (R&D) investment constitutes 60% of the African total, this is not reflected by the level of human development, where numerous reports indicates deep systematic weaknesses, particularly in *management and technical skills*.

In addition, South Africa today is characterised by enormous bias in the distribution of skills, whilst having a well-developed infrastructure and financial management ability [4]. If South Africa hopes to achieve its national goals in terms of economic growth, employment creation and output, it needs to focus

on addressing the human resource development (HRD) problems, and specifically the distorted distribution of skills [4] - 76% of the workforce is currently located in semi- or unskilled categories, compared with the international norm of 40%[4].

South Africa faces massive unemployment and a critical skill shortage simultaneously. This is clear from the generally low ratio of managers to subordinates and low numbers of skilled personnel in the workforce [4]. For example, in 1993 the workforce participation rates (proportional ratio in workforce) for scientists and engineers was only 17 per 1000 (or 1.7%) of the economically active population [4]. This compares very unfavourably with the workforce participation rates of countries with comparable economic levels and with countries characterised by advanced economies, as shown in figure 4 below.

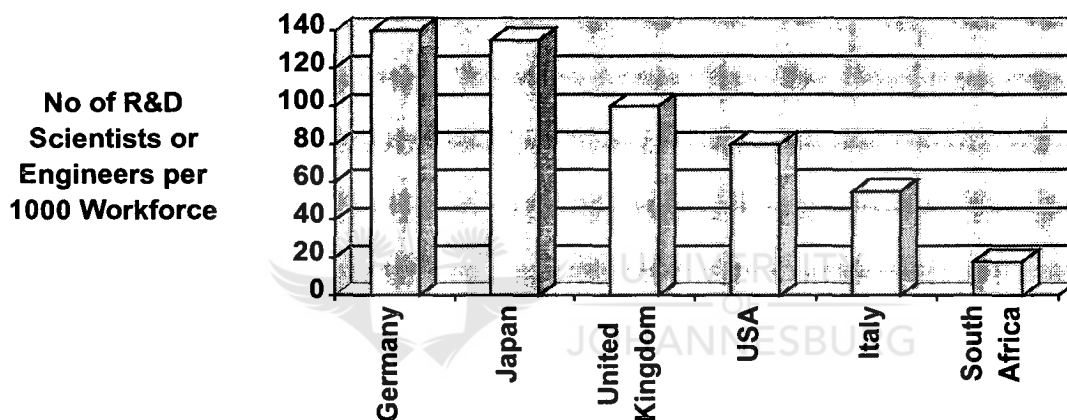


Figure 4: The number of R&D scientists and engineers in the labour force [4]

There is thus a distinct need to develop good technically skilled people and good *management*, particularly in the technical field [4]. If such skills are then implemented in entrepreneurial activity, it will contribute effectively in achieving the SET objectives outlined above - hence the research topic *Managerial Aspects for the Engineering Entrepreneur*.

## 1.6 Delimitations of the Research

This study will review current literature and methodologies on entrepreneurship and management practises and based thereon, in conjunction with the author's contribution, formulate relevant methodologies and recommendations for entrepreneurial engineers.

## 1.7 Definitions

### 1.7.1 Definition of creativity

Creativity is the creative, intellectual process of man to generate a new idea that solves a particular problem. It is usually a unique, need-fulfilling, original idea for implementing or improving something [8].

In the context of this dissertation creativity thus refers to the application of the engineers intellectual process to provide unique solutions to particular needs.

### 1.7.2 Definition of innovation

Innovation is the use or application of a new idea for developing a far better product, service, process or technique for solving a problem.

In the engineering discipline, innovation refers to the "application of the intellect, to implement a conceptual idea in order to realise a product" [21].

### 1.7.3 Definition of the "New South Africa"

This term refers to the transformed social and political climate in South Africa, since the 1994 national elections.

### 1.7.4 Definition of an entrepreneur

The classic definition of the entrepreneur is "a person who organises and manages a business or industrial undertaking, taking the *risk* of not making a profit and gets the profit when there is one" [7].

According to Smith [8], the concept of the *entrepreneur* usually describes people who have leadership qualities, are enterprising and willing to take risks, although these individuals are not necessarily involved in the economy.

### 1.7.5 Definition of an engineer

The engineer is defined as someone who practices engineering, where:

- "Engineering is the art of organising and directing men and controlling the forces and materials of nature for the benefit of the human race." [37]
- "Engineering is the professional and systematic application of science to the efficient utilisation of natural resources *to produce wealth*." [37]
- "The science by which the properties of matter and the sources of energy in nature are made useful to mankind in structures, machines and products" [39].
- The engineer is described as one who "guides or manages"[8].



- "The engineer is the key figure in the material progress of the world. It is his engineering that makes a reality of the potential value of science by translating scientific knowledge into tools, resources, energy and labour to bring them into the service of man. To make contributions of this kind the engineer requires the imagination to visualise the needs of society and to appreciate what is possible as well as the technological and broad social age understanding to bring his vision to reality" [37].

In the context of this dissertation the concept *engineer* refers to those individuals that possess a technical academic qualification and working within a technical environment, with the objective of making the resources of nature *available in a form beneficial to man*.

### **1.7.6 Definition of a manager**

The term *manager* refers to someone who practices management, where:

- "Management is the process of planning, organising, directing and controlling the resources of an organisation in order to achieve stated goals" [27].
- "Management is the process of working with and through others to achieve organisational objectives in a changing environment. Central to this process is the effective and efficient use of limited resources" [14].

### **1.7.7 Definition of an engineering-manager**

The *Engineering Manager* is regarded as that individual who functions as both an engineer and a manager. This is a person managing any process or organisation, with the technical academic background to assist in management decisions that influence that process or organisation [20].

### **1.7.8 Definition of opportunity**

Swart [8] defines an opportunity as an idea that has been developed into something of greater value through innovation. In order for an idea to be classified as an opportunity, it needs to satisfy two requirements: it must represent a need that can be satisfied in the future, and it must be realised

## 1.8 Chapter Summary

In summary, this chapter has outlined the principle objectives of this dissertation, which is to identify those principles that will contribute toward successful *entrepreneurial* engineering and which will result in improved development within the economy. This is contrasted to the relative shortage of engineering resources within South Africa, which is now being recognised and addressed by Government, as a necessary ingredient for innovation.

The following chapter discusses the broad concept of *engineering management*. Focus is made on particular management styles and principles required for optimising the use, direction and instruction of others in the utilisation of the principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of things [37].



## Chapter 2

# The Engineering Management Concept

### 2.1 Introduction

The aim of this chapter is twofold:

- To provide an overview of the concept of engineering management;
- To discuss the suitability of the engineering management concept for the engineer who is involved in entrepreneurial activity.

In general, *engineering management* focuses on the application of management principles within the technical domain, with the concept of engineering management as a basis of reference for engineers who wish to proceed beyond purely technical activities, toward the management of those activities [9].

Whilst historical engineering programs provided a broad technical knowledge base for the industrialised society while sometimes failing to address skills required to produce the engineering manager - with the capacity to integrate technology efficiently with the needs of society [10], the current trend in engineering studies at numerous Universities is to include management within the engineering curriculum [11][39].

The basic objective outlining the study of engineering management is to equip engineers with a resource of management skills that may be applied to both technology and personnel, in order to optimise the achievement of the primary goals of the business or organisation [12][39].

Literature suggests the necessity for engineers to be skilled in their engineering discipline as well as in the management of all contributories toward the end objective of the engineer [12][39]. These contributories include personnel and financial management - thus, every engineer necessarily functions jointly as a manager of technical resources and processes, as well as a manager of people involved with those processes [12]. It is thus imperative that management and engineering be viewed as mutually dependent processes; the absence of such a holistic view will lead to inefficient engineering and management [13] and inevitably a failure to achieve the optimum of the bottom-line objective.

## 2.2 Engineers and Managers in Context

If one chooses to selectively review the basic definitions of the engineer and manager as described in chapter 1:

The engineer practices

- "the science by which the properties of matter and the sources of energy in nature are made useful to mankind in structures, machines and products"[39]; and
- "the professional and systematic application of science to the efficient utilisation of natural resources *to produce wealth*." [37]

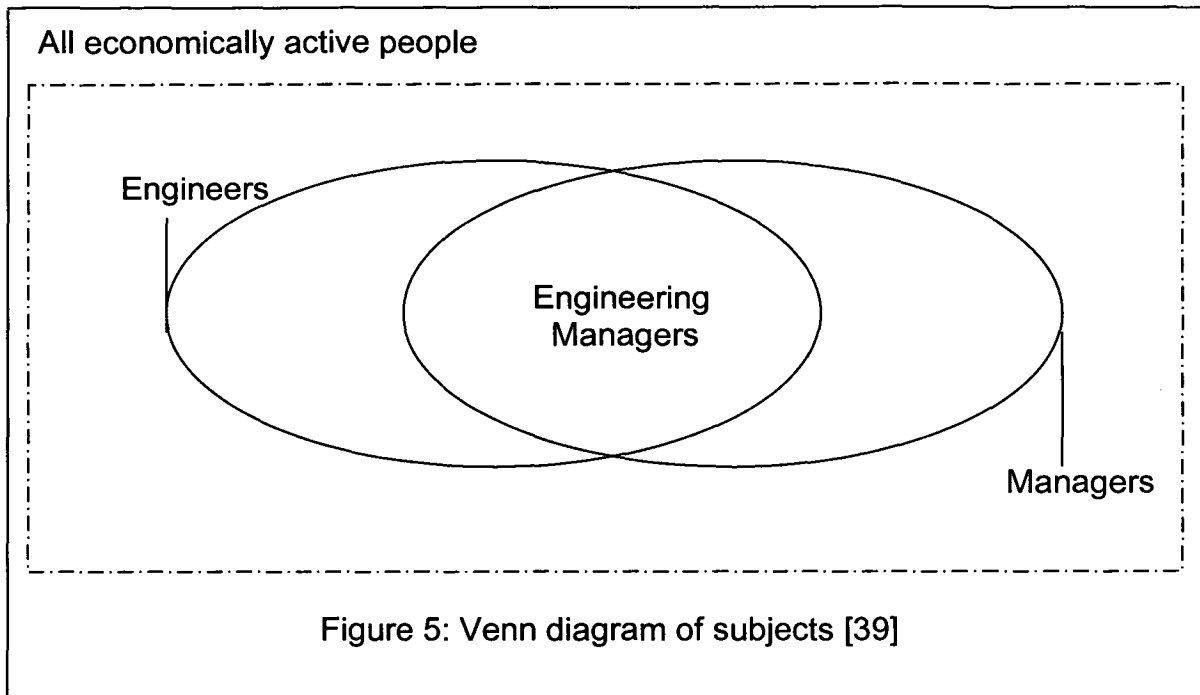
The manager practices:

- "the process of planning, organising, directing and controlling the resources of an organisation in order to achieve stated goals"[27]; and
- "the process of working with and through others to achieve organisational objectives in a changing environment. Central to this process is the effective and efficient use of limited resources" [14].

### 2.2.1 The focus of engineering and management within organisations

Consider the Venn diagram in figure 5, which aims to clarify the focus of managers and engineers. It simply shows that, of all the people working in economic organisations, focus is made on the two subsets shown, which are not mutually exclusive, thereby throwing up a third subset. In the first case there are people who function simply as engineers within organisations, then there are those who function simply as managers, and finally there are those who function as both engineers and managers, that is they are involved in both the practice of engineering and in the practice of management, as set out above. It is this third subset who are the considered as engineering managers [39].

In contrasting the functions of management and engineering, the former is primarily about making decisions regarding purpose and the allocation of resources, or the processes by which purposes will be pursued. The latter on the other hand, deals primarily with the "creation of the processes by which purposes are pursued"[39]. Engineers are thus means to the ends over which managers preside [39].

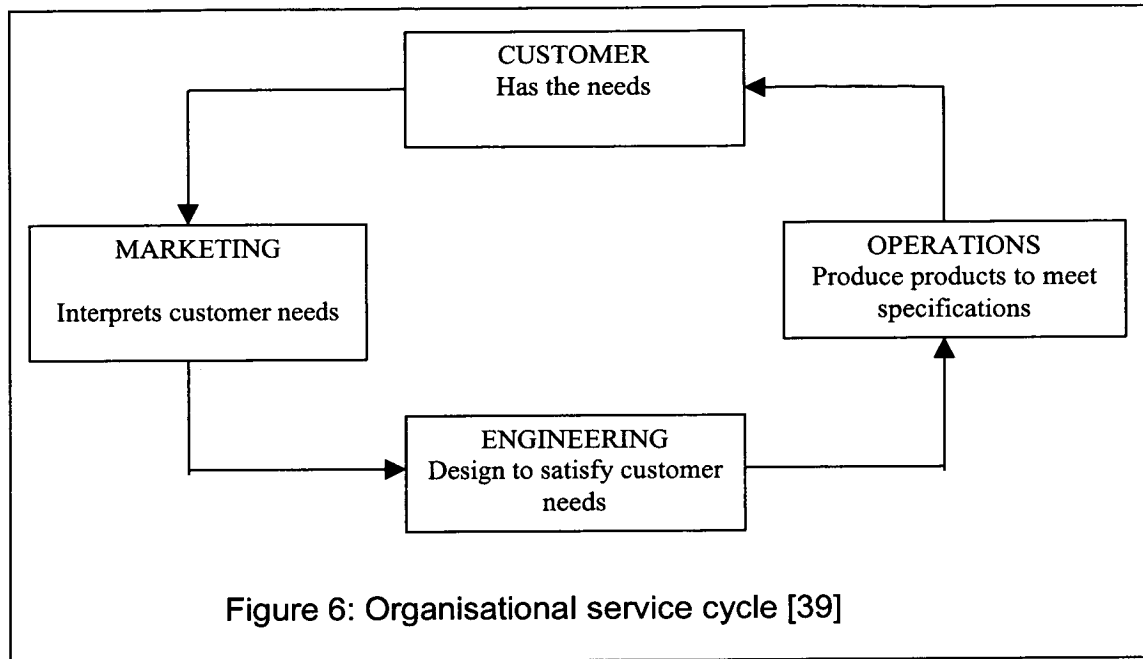


### 2.2.2 The organisational service cycle

An American observer has noted that "80% of all engineers will end up in some sort of managerial position during their working careers. In most of these positions engineers will manage professional personnel who perform technical functions"[39].

The progress of the engineer from a technical professional to a professional managing other technical professionals may be attributed to the experience and academic insight that the engineer achieves during his or her career. Within the organisational level, such experience could be as a result of exposure to the various functions that need to be executed within the organisation.

Figure 6 illustrates the interaction of customer, marketing, engineering, and operations in the economic organisation.



### 2.2.3 The impact of management and the personnel resource

The manager impacts on the organisational service cycle by his or her decision as to what will be done to compete effectively. This may be the reduction of costs, the increase of quality, or the creation of novel products.

Co-operation between an individual and the organisation cannot be achieved in the absence of the following three elements [39]:

- Willingness to serve;
- Common purpose;
- Communication.

In a 1980 study of the competitive capabilities of 19 countries based on 200 criteria [39], the *European Management Forum* rated Japan first, the United States second, Switzerland third, and West Germany fourth. The dominance of Japan was attributed to the importance placed on the economic success of the country, whilst that of the United States for example, was the success of the individual company. So, in Japan, the managers and engineers serve organisations that serve the nation. The cause-effect vision (the picture or vision in the mind of the individual which links the individual's self-interest to the purpose of the organisation) of the individual Japanese worker is, it is suggested, that "If I work effectively and efficiently, my company prospers; if my company prospers, my country prospers; if my country prospers, I and my community prosper"[39].

From the economic perspective, it is believed [39] that the economic engine of this country, as represented by mining, agriculture, manufacturing, civil contracting, etc. serves the people of this country, by feeding, clothing,

sheltering and ultimately, by empowering them. Engineers, managers and engineering managers are crucial to the process of making the economic engine more effective, efficient, and more powerful [39].

This section has aimed to identify exactly what the concept of *engineering management* refers to and its scope of application. The following section aims to discuss some commonly accepted management concepts that are of interest in engineering management.

## 2.3 Management Concepts

As discussed, the objective of the engineering manager is to optimise the primary goals of the business or organisation. For the entrepreneurial engineer, whether functioning within an organisational environment (intrapreneur) or in private business (entrepreneur) this objective is *profit* (by the definition of an entrepreneurial engineer). This is achieved via the efficient management of the contributories discussed. The following management ideologies are quoted from literature as guidelines toward such efficiency.

### 2.3.1 Maslow's hierarchy of needs [12][15][16]

Maslow's theory of human needs, developed in the 1970's, suggested that human needs were hierarchical in nature. Maslow, a humanistic psychologist, believed that people are not merely controlled by mechanical forces (the stimuli and reinforcement forces of behaviourism) or unconscious instinctual impulses of psychoanalysis. Instead, Maslow focused on human potential, believing that humans strive toward the maximum levels possible. People pursue the frontiers of creativity, and strive to reach the highest levels of consciousness and wisdom. People at this level were labelled by other psychologists as *fully functioning* or possessing a *healthy personality*. Maslow called these people *self-actualising persons*.

Maslow set up a hierarchical theory of needs in which all the basic needs are at the bottom, and the needs concerned with man's highest potential are at the top. The hierarchic theory is often represented as a pyramid, with the larger, lower levels representing the lower needs, and the upper point representing the need for self-actualisation. Each level of the pyramid is dependent on the previous level. The need-fulfilling process is however not mutually exclusive between levels. Each level is simultaneously fulfilled with varying degrees, depending on which level has current priority.

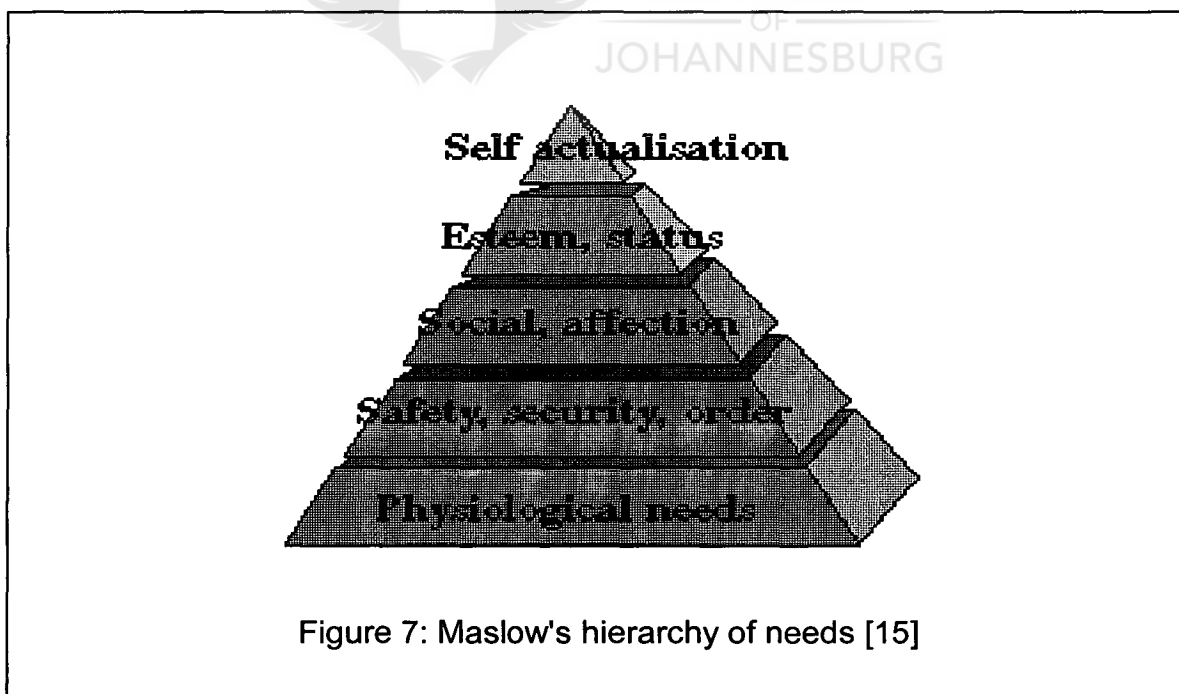
The hierarchy of needs is:

- Physiological needs which are biological and consist of the needs for oxygen, food, water, and a relatively constant body temperature. These needs are the strongest because if deprived, the person would die.
- Safety Needs: Except in times of emergency or periods of disorganisation in the social structure (such as widespread rioting)

adults do not experience their security needs. Children, however often display signs of insecurity and their need to be safe.

- Love, affection and belongingness needs: people have needs to escape feelings of loneliness and alienation and give (and receive) love, affection and the sense of belonging.
- Esteem Needs: People need a stable, firmly based, high level of self-respect, and respect from others in order to feel satisfied, self confident and valuable. If these needs are not met, the person feels inferior, weak, helpless and worthless.
- Self-actualisation Needs. Maslow describes self-actualisation as a person's need to be and do that which the person was born to do. It is his *calling* - a musician must make music, an artist must paint, a poet must write, and an engineer must design and innovate. If these needs are not met, the person feels restless, on edge, tense, and lacking something. Lower needs may also produce a restless feeling, but here it is much easier to find the cause. If a person is hungry, unsafe, not loved or accepted, or lacking self-esteem the cause is apparent. It is not always clear what a person wants when there is a need for self-actualisation.

This hierarchy is illustrated in figure 7 below.



According to Maslow, self-actualising persons are people with exceptionally healthy personalities, marked by continued personal growth. Think for a moment about what motivates one at the moment. Now imagine what ones motivation would be if you were in the desert dying of thirst. This led him to



believe that the higher needs are expressed only when the physiological needs are satisfied.

The physiological needs such as air, food, water, sleep, etc. as well as safety and security are regarded as basic needs. Once there is a sufficient amount of stability in meeting these basic needs then a person will try to satisfy the growth needs, including love and belonging, needs for self-esteem and self-actualisation needs.

Although Maslow believed that the desire for self-actualisation is universal he also believed that this desire was fragile and easily interrupted by lower needs. Hence its positioning at the top of the hierarchy.

What are the characteristics of self-actualisation? Maslow called these meta-needs. These are listed in figure 8 below. He believed that everyone tended to move up the hierarchy towards the meta-needs. A person whose survival needs have been met, but whose meta-needs remain unfulfilled soon experiences, despair, despondency, boredom, apathy and alienation. It was this inability to satisfy the meta-needs that led Henry David Thoreau to proclaim that "The mass of men lead lives of quiet desperation" [17].



Maslow believes that the only reason that people would not move through the needs to self-actualisation is because of the hindrances placed in their way by

society. For example, education can be a hindrance, or can promote personal growth. Maslow indicated that educational process could take some of the steps listed below to promote personal growth:

- One should teach people to be authentic; to be aware of their inner selves and to hear their inner-feeling voices;
- One should teach people to transcend their own cultural conditioning, and become world citizens;
- One should help people discover their vocation in life, their calling, fate or destiny. This is especially focused upon finding the right career and the right mate;
- One should teach people that life is precious, that there is joy to be experienced in life, and if people are open to seeing the good and joy in all kinds of situations, it makes life worth living.
- One must accept the person and help him or her to learn their inner nature. From real knowledge of aptitudes and limitations one can know what to build upon, what potentials are really there;
- One must see that the person's basic needs are satisfied. That includes safety, belongingness and esteem needs;
- One should refreshen consciousness, teaching the person to appreciate beauty and the other good things in nature and in living;
- One should teach people that controls are good, and complete abandonment is bad. It takes control to improve the quality of life in all areas;
- One should teach people to transcend the trifling problems and grapple with the serious problems in life. These include the problems of injustice, of pain, suffering and death;
- One must teach people to be good choosers. They must be given practice in making choices.

From the engineering perspective, the author suggests that in general, most engineers who are employed have their basic needs (lower needs of Maslow's pyramid) being fulfilled, as a result of their profession, which makes them highly sought after, and consequently their social status and financial position that directly impacts on these needs.

From the management perspective, the relevance of the Maslow paradigm is to contextualise the needs and objectives of the personnel under the engineering manager, and by satisfying these needs, achieve the needs of the organisation. The steps in the educational process outlined above, serves as guidelines for the engineering manager.

### **2.3.2 McGregor's theory [12][17][18]**

The above model serves as a broad framework for managers in understanding the career and life profile of individuals which may be used to motivate employees toward self-actualisation, whilst optimising the primary goals of the business or organisation. In conjunction with this, McGregor's theory is now introduced which defines in more detail the better management style that can be utilised to achieve this objective.

In 1960 McGregor theorised what he felt underpinned the practices and stances of managers in relation to employees. These were evident from their conversations and actions. Two sets of propositions were dubbed Theory X and Y respectively. His view was that what managers said or exhibited in their behaviour revealed their theories-in-use. Their tendency lead managers to pursue particular kinds of policies and relationships with employees. These theories are outlined below.

#### **2.3.2.1 McGregor's theory X**

A manager holding to this theory would be inclined to believe and state that:

- On average staff (employees) really do not want to work. If they had a choice they would not want to commit themselves to work for the employer in the employer's time. They avoid it wherever possible. Basically they are self-interested and prefer leisure rather than working for someone else;
- Because of this it is necessary to structure work and energise the staff. Tasks need to be well specified. Even then many need pushing and more direction and control so that they apply adequate effort towards what has to be achieved. Even though good rewards are provided, many of the staff are still hesitant to apply consistently the kinds of effort the organisation needs. Many accept the rewards, complain that they need more and yet behave in ways that are less than fully committed. It is necessary to resort to more checks, instructions, persuasion and sometimes even punishments. The impression is that if the manager relaxes control, then sloppiness sets in.
- Indeed most people prefer to be directed. They do not really wish to carry the burden of responsibility - they tend to avoid this. They have little ambition and prefer a secure, steady life.

Such a manager thus gives close supervision and defines jobs and systems that structure how a worker allocates and applies their time. They place stress on workers being calculative.

The above statements are spin-offs from McGregor's originals but the sense remains the same. McGregor felt that such managerial views led to behaviours and organisational systems which relied on rewards, promises,

incentives, close supervision, rules and regulations, even threats and sanctions all designed to control workers.

### **Soft X and hard X:**

There are soft and hard methods in the Theory X list. Hard approaches are represented by *the stick* - coercive language, harsh authoritarian management. Soft applications- *the carrot* - dangle rewards and promises in front of the employees nose i.e. more pay (cash and non-cash), more work, a fair day's work for a fair day's pay. The relationship is a wage-work bargain, an exchange.

### **2.3.2.2 McGregor's theory Y**

A Theory Y manager tends to believe that:

- Given the right conditions for employees, their application of physical and mental effort in work is as natural as rest or play. Work is play, offers satisfactions and meaning;
- There are alternatives to reliance on external controls, pushing and threats - implied or real. These are not the only means for linking individual effort with organisational objectives. If people feel committed, they will exercise self-direction and self-control in the service of the firm's objectives.
- Their objectives will complement the firm's and commitment is a function of the *intrinsic* rewards associated with their achievement i.e. not just extrinsic rewards/punishments.
- The Theory Y manager recognises the influence of learning. He/she believes that if the right conditions are created the average person learns not to accept and seek responsibility.
- The capacity to exercise imagination, ingenuity and creativity in the solution of organisational problems is widely not narrowly distributed in the workforce.
- In modern organisations, the intellectual potential of the average person is only partially utilised. People are capable of handling more complex problems.

### **2.3.2.3 Summary of McGregor's theory**

McGregor suggests that one should use theory Y principles to shape ones organisational culture and management style [17].

As an extension to this, reference is made to the model for *empowering leadership* [19], which promotes the following group processes necessary for fostering micro empowering skills (which motivates individuals to perform):

- ownership;
- getting the group involved;
- consensus decision-making processes;
- mediation and reconciliation;
- ritual processes;
- mutual help processes.

This model reinforces McGregor's Theory Y - "A leader empowers people by joining with them. In this process an empowering leader uncovers new sources of creative leadership" [19] - in the engineer's environment, he or she is more capable of taking the lead as a result of being highly trained, experienced or empowered by position.

Based on McGregor's theories, it is suggested that engineering managers adopt a consultative stance toward subordinates (theory Y), where a team culture is encouraged. This is regarded as more beneficial than an authoritarian style of management (top-down approach) [17].

### **2.3.3 Drucker's new-management concept**

The preceding management concepts have placed emphasis on how to develop and motivate personnel in order to optimise the productivity. The *Drucker Concept* instead places emphasis on the environmental processes that are necessary in order to optimise productivity.

Drucker's management concept [20] outlined the following principles:

- People at work desire and need to feel that they have the capacity to contribute to the enterprise, at whatever their level of operation;
- Having the training and experience makes them competent to do so, and such contribution should be demanded;
- All personnel within the enterprise, from the Chief Executive Officer to the lowest level, are both managers and workers, and are on the same team.
- Responsibilities should be delegated to the people who perform the tasks, and that management's role is to determine the major objectives of the business and to setup the necessary structure and resources, and then to motivate and train their people to perform in the right direction;
- If responsibilities are to be delegated then project managers should be given responsibility and authority and the freedom to make decisions within broad directives.
- Quality management is the only factor that really differentiates competing businesses. Management determines how well the

resources are applied, and it is the application of the resources of business that determines success or failure.

- Managers must be teachers, so that they can develop their subordinates.

### **2.3.4 Deming's fourteen points for management**

This management style is particularly practical in nature and is thus especially relevant to the engineering manager who manages personnel as well as physical resources (e.g. production plants).

Deming's fourteen points for management are quoted as follows [12][18]:

- Create consistency of purpose for the continual improvement of products and service, allocating resources to provide for long-range needs rather than only short-term profitability;
- Advocate a philosophy of continuous improvement and elimination of all waste, delays and defects;
- Eliminate dependence on inspection to assure quality, by creating quality products at inception;
- Terminate the practice of awarding business on the basis of initial cost only, and insist upon quality - Develop partnership arrangements with single suppliers rather than adversarial dealings with multiple suppliers;
- Promote continuous improvement of every process of production, planning and service;
- Institute continuous on-the-job training for all, including managers to develop new skills and to keep up to date with new methods, materials etc;
- Provide leadership at every level of management, to help people do a better job;
- Remove fear from the workplace by encouraging effective communication between all people within the organisation;
- Eliminate departmental and functional barriers, by implementing teamwork;
- Eliminate slogans and targets that demand higher productivity without providing methods;
- Abolish work standards and quotas. Replace them with help and leadership towards continual improvement;

- Remove all barriers preventing people from having pride in their work;
- Institute a comprehensive programme of education, and encourage self-improvement;
- Ensure that top management is totally and permanently committed to continuous improvement in quality and productivity, and that the commitment is shared at all levels, by active leadership and participation.

Deming particularly stressed the employment of statistical methods as one of the essential tools for improvement.

In summary, the unifying principle between Maslow, McGregor, Drucker and Deming is that *people want to excel as individuals and want to feel that the value of their work is appreciated*. In effect, when the output is that of a team, the individual wants the team to excel, so the team aims must be harmonised with the aims of the individual - this is the challenge for the efficient engineering manager.

## 2.4 The Development of Engineering Managers

The role of the engineer is considered as comprising of 1) the professional engineer and 2) the manager. The necessity for engineering managers to be competent engineers in the disciplines that they manage is absolute [20].

The overriding reasons why engineers manage engineering processes are:

- Engineer understand the work easily;
- Engineers can acquire adequate knowledge in accountancy, law etc necessary for business;
- Non-engineering professionals (e.g. Accountants & Lawyers) are employed to support the business, but the engineers make engineering (risk judged) decisions and manage the engineering effort [12].
- When engineering enterprises are administered by non-engineers, or when engineers in management lose management influence, then there is a strong tendency for short-term advantages to take precedence over long-term planning, particularly in areas that do not appear to affect direct costs [12]. In reality training, staff improvement and research are necessary investments, to be balanced against the expenditure necessary for immediate operation in order to ensure future growth and development [20].

## 2.5 Chapter Summary

Whilst the above management styles serve to outline various motivating factors that may be employed by the manager in order to stimulate performance from personnel, the main principles that may be derived from the above are:

- People inherently desire achievement and recognition and appreciation of those achievements - people will thus respond to stimuli that will facilitate them to achieve. It is necessary though that people have confidence that such stimuli do not compromise job security;
- A preferred management style is the consideration and empowering of people by giving them broad but challenging objectives and permitting them to plan and execute the work, in line with the organisations objectives. This empowering can only be achieved by creating teams and by demanding that they excel [19][21].
- Managing the personnel of the business is the most important role of management, and has a direct impact on the overall productivity of the organisation via its personnel.

This chapter has broadly discussed relevant engineering management concepts that may assist in optimising the unique objectives of a particular business or organisation. The following chapter aims to discuss the concept of entrepreneurship, and specifically the necessary planning and conceptualisation processes that should be adopted in order to develop a successful business.



# Chapter 3

## The Entrepreneur

### 3.1 Introduction

The chapter aims to review the environment of the entrepreneur and the various aspects that contribute toward (or are required for) entrepreneurial success. The specific aspects for of discussion include:

- The concept of entrepreneurship;
- The personality and psychological characteristics of an entrepreneur;
- The scope of entrepreneurship;
- The *ingredients* necessary for entrepreneurial success;
- The planning and conceptualisation steps necessary in starting up a new business venture;
- The legal aspects governing the new venture;

The aspects discussed are made from the perspective of the engineer who intends on going into his or her own business. These aspects serve as a means by which the engineer may be made aware of the requirements of an entrepreneurial career, as well as a means of self-analysis.

### 3.2 Defining Entrepreneurship

The concept *entrepreneur* usually refers to any individual who possesses leadership qualities, is particularly enterprising and is willing to take risks in starting a new business with the prime objective of realising a profit [8].

#### 3.2.1 The classical definition of entrepreneurship

There are varied historical opinions regarding the concept of entrepreneurship and the characteristics of entrepreneurs.

The author Cantillon [8] classifies the entrepreneur as:

"an individual endeavouring to purchase products at a known price with the intention of its sale at some later period at an uncertain price"[8].

In his definition, Cantillon emphasises the component of *uncertainty* concerning the market demand for the product and the *risk of bankruptcy* attached to the business endeavour.

Mill [8] distinguishes the processes of leadership, supervision, control and risk-taking as capacities of the entrepreneur, with the characteristic of risk-taking being the differentiating factor between entrepreneurs and managers.

In meeting the requirement of risk-taking, the author suggests that engineers in general are *calculated* risk-takers, aiming to quantify the problem and then find a solution (take the risk) based on the knowledge derived from the quantification process.

A variation from the risk-taking distinction between entrepreneurs and managers is suggested by Schumpeter [8] who considers *innovation* to be the distinguishing factor; he regarded both the entrepreneur and the managers as risk-takers.

His concept of entrepreneurship includes the following functions:

- The implementation of new goods and services;
- The development of new production techniques;
- The identification of new markets;
- The mastery of new suppliers;
- The development of new organisational structures;

In essence, Schumpeter considers the entrepreneur as "the individual who innovates, reconstructs and acts creatively"[8]. This is the entrepreneurial approach that this dissertation will use as a framework for classifying the *entrepreneurial engineer*.

### **3.2.2 The modern definition of entrepreneurship**

The modern approach to entrepreneurship, whilst stemming from the classical definition, is considered in the broader context of today's sophisticated business environment, global markets and high technology.

Broadly defined, the following are regarded as the basic constituents of entrepreneurship [8]:

- Uncertainty and risk;
- Complementary managerial competency;
- Creative opportunism.

The author Drucker [21] states that in order to be entrepreneurial, it is necessary for an enterprise to possess a unique attribute other than being new and small. They should create something new and different, which includes transform values.

The author Vesper [8][25] characterises the entrepreneur as the individual "who combines resources, raw material and other factors, aiming to improve the environment, introducing changes, making discoveries, and introducing a new economic dispensation".

At an operational level within a business, entrepreneurship encompasses the generation, selection, development, implementation and harvesting of ideas in response to a perceived opportunity in the business environment.

Entrepreneurship emphasises the role of innovative ideas within a business environment and can thus be defined as "the management of bold ideas" [22].

The above definitions serve to indicate the broad base from which entrepreneurial activity is derived. This is considered comparable to the diverse environment and functions that apply to the engineer. With these definitions as a foundation, the following section outlines the motivating factors for entrepreneurial (or economic) activity [8].

### **3.3 The Characteristics of Entrepreneurs**

As a first step in classifying and establishing the personal traits are of a typical entrepreneur (as a means of quantifying the entrepreneurial potential of any individual), consideration is made of the Kierluff Model [8]. This section also discusses the primary psychological and personality attributes that are prevalent in entrepreneurs.

#### **3.3.1 The distinction between the entrepreneur, general-manager and personnel-manager**

McClelland's [8] *achievement motivation theory* is considered significant in identifying the differences between the entrepreneurial manager and other manager-types (e.g. personnel manager). McClelland distinguishes between three social motives in humans, claiming that the human's strife for economic goals is influenced by these motives. The three-need theory encompasses the following:

- the need for achievement; this need motivates and influences the individual toward achievement;
- the need for affiliation; this need motivates an individual to maintain good relations with others; it is the desire to be popular and accepted by others;
- the need for power; this need allows an individual to exercise power over others, by guiding and controlling them.

The following distinctions are made between the entrepreneur, the personnel manager and the manager [8]:

- the entrepreneur reveals a relatively high need for achievement, aiming to achieve more than others, always having the will to win, settling and demanding high personal standards , revealing unique and innovative views with a long-term desire to attain something or plan for it;
- the typical personnel manager displays a high need for affiliation, placing priority on not being rejected, refused or hated by others. This individual makes friends relatively easily and is sensitive to the problems of others;

- the general manager displays a strong inclination to influence and control others. This need for power is based on own gain, whilst social power drives the individual toward community gain. The manager constantly aims at influencing others; he or she gives unasked for support and advice, trying to impress others, provoking strong positive and negative feelings in others, and is acutely aware of his or her reputation and position.

The above comparison is graphically represented in figure 9. The profiles of the entrepreneur (A), manager (B) and personnel manager (C) are shown. The three-need comparison for these individuals is made on a scale of 1 to 10. Referring to figure 9, it can be seen that entrepreneurs possess a significantly higher *need for achievement*, which is their driving force.

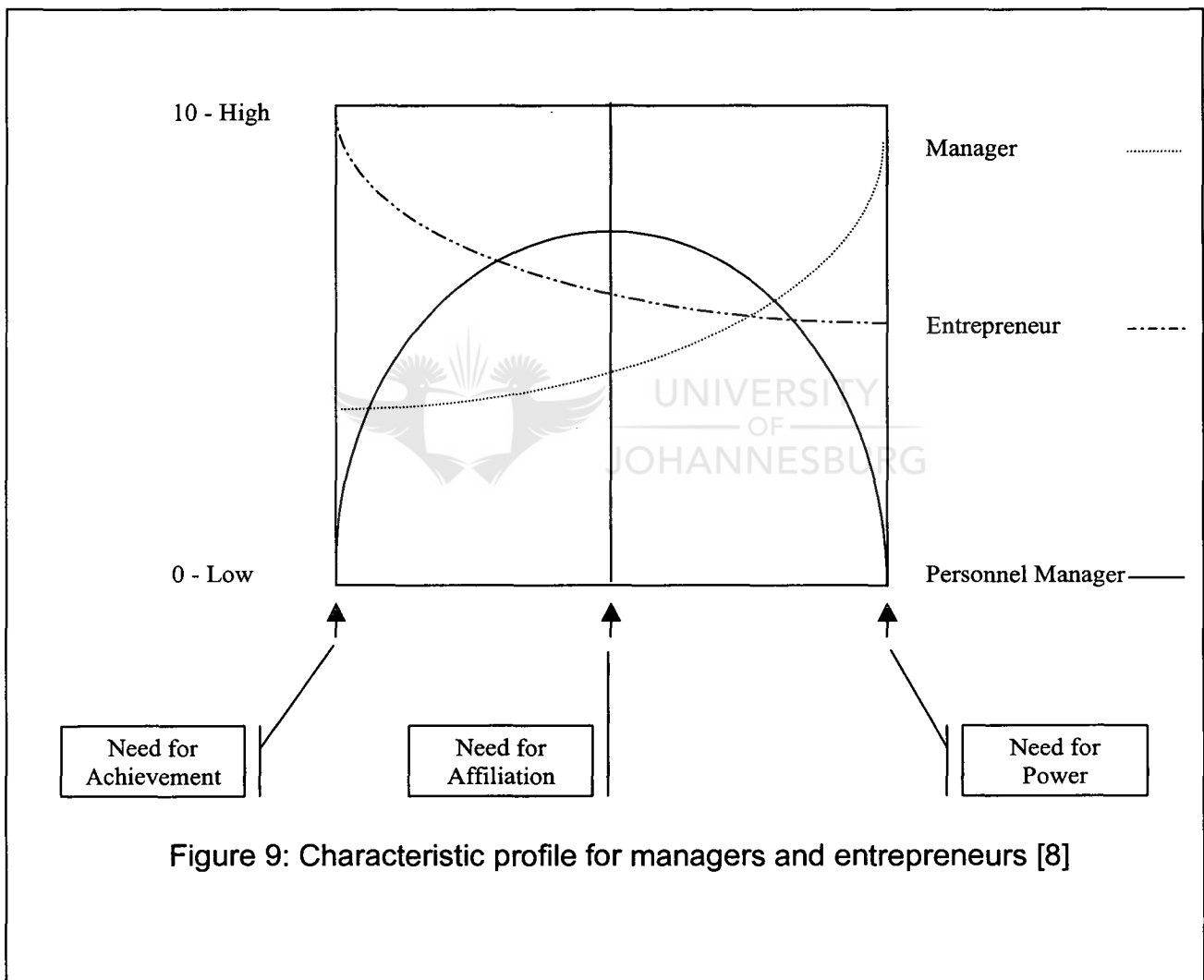


Figure 9: Characteristic profile for managers and entrepreneurs [8]

### 3.3.2 The Kierluff Model

As mentioned, the Kierluff Model [8] is a tool whereby the characteristics of any individual may be assessed and compared with that of entrepreneurs, to determine the entrepreneurial potential of that individual. The model, shown in figure 10 below, serves as a reference point in identifying the necessary characteristics that should be developed in the entrepreneurial engineer.

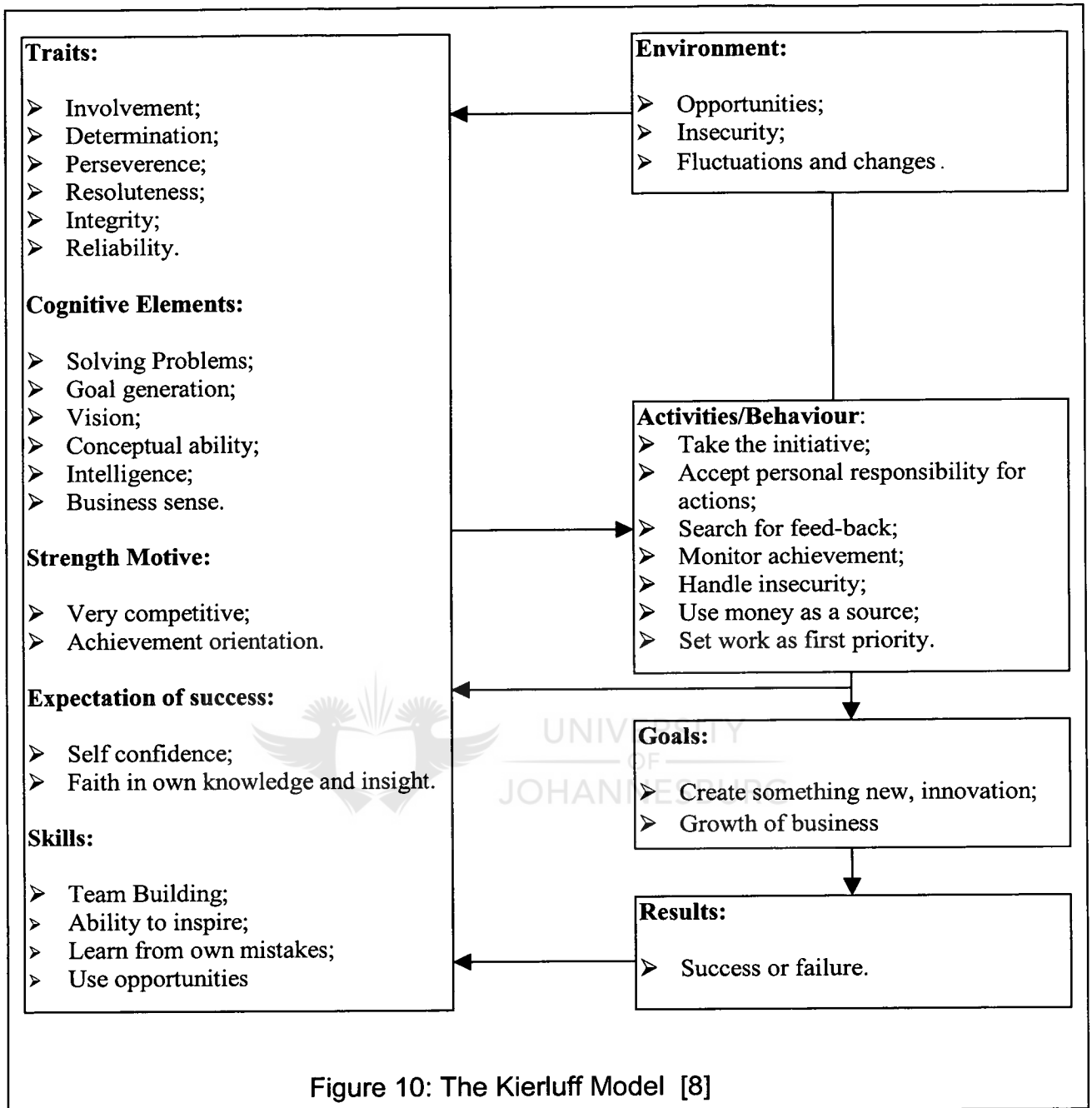


Figure 10: The Kierluff Model [8]

Referring to figure 10, the Kierluff model should be interpreted as follows:

- The environment is regarded as the point of departure. What is the environment of the engineer (corporate structure, manufacturing enterprise, retail business, service business)?
- Next, there is consideration of the personality traits, skills and motivation. Do the engineer's traits, skills and motivation correlate with those of the Kierluff model (i.e. with that of entrepreneurs)?

- Thereafter, what are the behavioural responses and activities of the engineer, and do they match the Kierluff Model?
- Subsequently, the goals of the engineer should be assessed. Are these goals entrepreneurial in nature, according to the definitions discussed earlier?
- The final objective of using the model is to reach a point whereby one may make a decision on whether the engineer possesses the prerequisites for entrepreneurial success or failure (and take steps to acquire these if they are lacking), based on the inputs to the model.

This model has been used in drafting the questionnaire used in the field research of this dissertation (discussed in Chapter 5).

### **3.3.3 The psychological characteristics of entrepreneurs**

It has been suggested that the understanding, explanation and prediction of human behaviour should be preceded by an analysis of the individual's interaction with his or her environment, which is influenced by the environment and the factors influencing the role of the individual at a particular instance [8]. The behaviour of the entrepreneur in this context is depicted in figure 11.

The following items are considered as primary characteristics of entrepreneurs [8][23]:

#### **3.3.3.1 The ability to take risk**

- Entrepreneurs are not gamblers, but calculated risk takers (this correlates with our assumption made earlier about the engineers approach to risk);
- Entrepreneurs attempt to reduce risk by doing their homework and retaining as much control of the outcomes as they can;
- Entrepreneurs tend to have a backup plan in the event of failure.

#### **3.3.3.2 The desire to compete**

- Entrepreneurs possess a competitive spirit;
- They enjoy the challenge of starting a new enterprise and competing in the marketplace;
- This competitive spirit helps entrepreneurs overcome the obstacles inherent in starting a new venture

### **3.3.3.3 The ability to handle stress**

- Entrepreneurial activity can be very stressful as a result of the weight of decision making, responsibility for people and jobs, the long working hours and the endless negotiations with customers and suppliers; entrepreneurs who have developed ways to deal with the stress over the course of their career seem to be much more effective than those who succumb to the pressure.

### **3.3.3.4 The ability to make work enjoyable**

- Entrepreneurs regard work as play, and play as work;
- Successful entrepreneurs seem to get a great deal of enjoyment out of their work; this ability to make work enjoyable serves the entrepreneur well during difficult and stressful times, particularly during the early phases of their career.

### **3.3.3.5 The ability to creatively solve problems**

- Entrepreneurs possess the ability to identify and solve problems in creative ways, which contributes toward their success;
- Entrepreneurs seem to display most of their creativity and innovation as they engage in problem solving.

### **3.3.3.6 The ability to recognise opportunities**

- Entrepreneurs have the ability to determine or create value;
- Entrepreneurs seem to be able to anticipate trends and recognise opportunities that others are unable to see.

### **3.3.3.7 Commitment to the business**

- The successful entrepreneur is seen as someone who is totally dedicated to the business;
- Their commitment to success can help them succeed when others fail.

### **3.3.3.8 Goal orientation**

- Entrepreneurs have a strong emphasis on the importance of having and achieving goals;
- Entrepreneurs tend to focus on the ends they are seeking, rather than on the means to those ends;

### 3.3.3.9 Realistic optimism

- Entrepreneurs approach new business ventures with optimism - and a sense of humour, as compared with a fear of failure;
- Optimism and faith in oneself seem to be essential for success as an entrepreneur, but such faith should be tempered by realistic expectations.

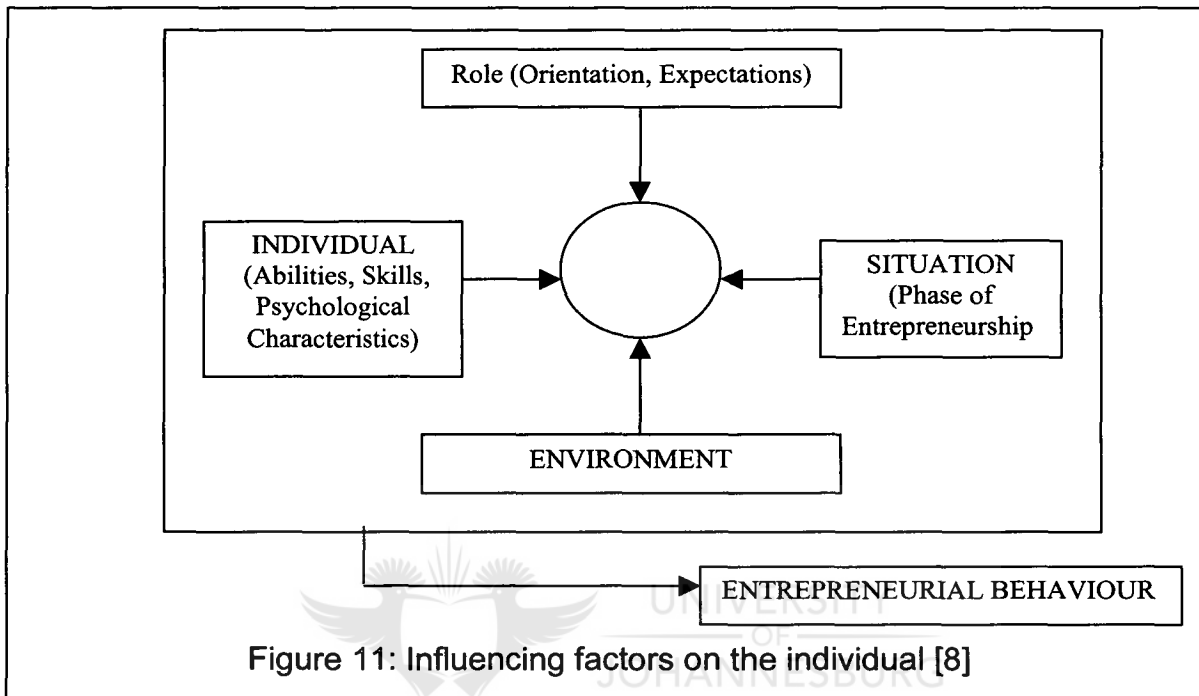


Figure 11: Influencing factors on the individual [8]

In addition to these nine core-characteristics, the following are considered as relevant psychological characteristics associated with entrepreneurs [8]:

- strong mental ability and conceptual skills;
- striving for independence;
- business and personal leadership style;
- self knowledge;
- sense of responsibility;
- positive attitude to money.

Amongst these, the distinguishing characteristic of the entrepreneur is their ability to establish new enterprises [23].



### **3.4 Entrepreneurship as a Career**

This segment aims to define the scope of entrepreneurship, which provides the framework in which entrepreneurial engineering activity may be conducted.

Engineering activity is widespread, covering many fields (electronics, construction, manufacturing, system support, consulting engineering, information technology etc) and the aspects discussed in this section aims to identify the advantages and disadvantages that arise from pursuing an entrepreneurial career, irrespective of the environment and field of the engineer.

#### **3.4.1 Motivation for starting an entrepreneurial career**

This section outlines the main primary influences that have driven people into an entrepreneurial career.

In a study conducted wherein 200 entrepreneurs were interviewed [23], the study indicated the following:

- 80 percent of those individuals had not started their careers as entrepreneurs;
- 55 percent did not choose their first jobs in preparation for a career in entrepreneurship;
- In general, most entrepreneurs did not envisage pursuing a career in entrepreneurship at the outset.
- Those individuals who chose an entrepreneurial career early in life or took their first jobs to prepare for an entrepreneurial career had the longest (and presumable the most successful) careers.
- 90 percent of the entrepreneurs that were studied started their careers before age forty;
- After the age of forty, there was a great reluctance to start a new venture, and those who tried later in life tended to fail more often than those who started in their twenties or thirties.

Taking cognisance of the above study, the following are regarded as the most common factors that affect the individual's tendency toward entrepreneurship:

##### **3.4.1.1 Early childhood experiences**

During childhood, the individual is impacted by many norms and conditioning that affects the individual's motivation, perception and leadership attributes. The following childhood experiences are regarded as especially significant for entrepreneurship:

- Childhood experience where hard work is the norm [8][23];
- Theme of self-reliance, determination to succeed, and the ability to identify and develop opportunities [8][23].

#### **3.4.1.2 The need for control**

- Entrepreneurial behaviour viewed as an attempt to gain control over one's world.
- Entrepreneurs relish the excitement of being one's own boss; to be in control of one's destiny [8][23][34]
- The need for control motivates the entrepreneur to accept the risks of such a career [23].

#### **3.4.1.3 Frustration with traditional careers**

- Dissatisfaction with traditional careers that involve working for someone else, often in a large organisation (e.g. slow career progress, the inability to effect quick changes within the organisation, low wages, and office politics), is a motivating factor toward an entrepreneurial career [23];
- Studies show that 70 percent of entrepreneurs start their own businesses due to dissatisfaction with their jobs, 13 percent because they had been fired from a previous job and 17 percent because they wanted to seize a new business opportunity [23].

#### **3.4.1.4 Career challenge and excitement**

- Entrepreneurs possess excitement and enthusiasm about their careers, with each day seeming to provide a new challenge; the challenge is the driving force for entrepreneurs [23].
- The *need for achievement* motivates entrepreneurs to succeed [8][23].
- Although money is considered important and viewed as a way of measuring how entrepreneurs are doing, it is the challenge and excitement of the career that stimulate them [23].

#### **3.4.1.5 Role models**

- Entrepreneurs often describe being inspired to start their entrepreneurial career by another entrepreneur - a parent, local businessperson, or a famous entrepreneur. Watching others' successes, they developed a desire to emulate them [23].
- Highly visible role models seem to stimulate entrepreneurial activity.

#### **3.4.2 Types of entrepreneurs**

Whilst previous definitions of the entrepreneur necessitated the ownership of a business, the modern approach incorporates employees in big business, the corporate sector, and informal sectors who possess typical entrepreneurial characteristics [8].

In broad terms, the entrepreneur may be categorised as follows [8]:

#### **3.4.2.1 The intrapreneur**

The intrapreneur is the individual who possesses typical entrepreneurial characteristics yet functions within a corporate environment. This individual has the ability, the creativity and the freedom to implement new ideas within the organisation; the Intrapreneur starts a business within the business.

#### **3.4.2.2 The extrapreneur**

Whilst the intrapreneur may not always have the opportunity to implement unique ideas within the organisation, due to management constraints and organisational limitations, the extrapreneur is the individual who initiates a new business in order to implement the idea outside the original organisation.

#### **3.4.2.3 The novopreneur**

This is the individual who has remarkable creative ability and initiative to develop the *simple* but *vital* things in life, that are often overlooked by others. The novopreneur exists both within the organisation and outside; he/she also starts a new business to realise a unique idea.

#### **3.4.2.4 The interpreneur**

This is the person that who creates a new business by combining resources (e.g. other smaller businesses), with a definite motivation toward making a profit. The interpreneur possesses outstanding planning skills and creative power.

#### **3.4.2.5 The renovator**

The renovator is regarded as the *saviour* of a failing business, redirecting the business toward success. This person usually uses components of the existing business and couples these with a unique catalyst, which will effect positive change. The renovator is often only very active for a short period, with a desire for quick results.

In addition to the above classification, the entrepreneur (the broader definition that includes individuals functioning within an organisation) may be further categorised into one of the following:

- Technical entrepreneurs: these individuals possess strong technical orientation. They enjoy inventing things and developing ideas for new products. Developing new markets and even new industries based on modern technologies is generally the goal of those with this technical orientation, and the creation of an organisation is merely the means by which they achieve their goals, not an end in itself [23]. Entrepreneurial engineers typically fall under this category of entrepreneurs [7][23].

- Organisation builders: Some entrepreneurs appear to start their own businesses because they like to build organisations. They enjoy seeing their businesses grow in terms of profits and people. Such entrepreneurs also generally take pleasure from working with people and wielding power and influence. This is in contrast to the technical entrepreneur, who often prefers working alone and dislikes participating in organisational politics [23].
- Deal makers: these individuals enjoy the excitement of negotiating a new agreement. They enjoy making the initial deal to start a new venture and often derive joy from some of the start-up activities. However, unlike organisation builders, they dislike having to manage and commit themselves to an organisation over the long run [23].

These three categories seem to encompass most entrepreneurs [23].

### 3.5 The Dilemmas of an Entrepreneurial Career

Although the advantages of an entrepreneurial engineering career are distinct and overwhelming, there naturally exists a negative component in choosing this as a career route. The common dilemmas of an entrepreneurial career are listed in table 2 below.

**Table 2: Dilemmas of an entrepreneurial career [23]**

	Personal	Business	Family
Early Career	Am I an entrepreneur?	How do I get Started?  How do I manage problems with partners and boards?	How do I balance work and family?
Mid-Career	Why is it so lonely at the top?	How do I stay in control of my business?  Should I hire professional managers?	Should I employ family members?
Late Career	Should I retire?	How do I prepare my business for the future?	What should I leave to my family?

In general, there are three career stages that entrepreneurs appear to go through [23], namely early, mid-career and late career dilemmas.

### 3.5.1 Early career dilemmas

Most entrepreneurs start their businesses during the period between their late twenties and late thirties, and these early-starters commonly experience four dilemmas:

- The first problem is of a personal nature, involving determining their identity as entrepreneurs - "Am I an entrepreneur?" is the initial question asked. Many doubt whether they are capable of succeeding and are uncertain of the requirements for success.
- There are also two business dilemmas, as indicated in Table 2 above, which are encountered on initiation of the new business. The first involves finding the resources necessary to start (e.g. labour, capital, raw-materials etc) whilst the second dilemma concerns the management of the business - who runs the business?; many entrepreneurs have recorded problems with partners or board directors[23] etc.
- The final dilemma in early careers is the control of needs between work and family - most entrepreneurs begin their businesses and families at about the same time and thus frequently encounter conflicting demands between these two and regularly have feelings of guilt regarding their family life.

### 3.5.2 Mid-career dilemmas

As the business grows, the problems experienced concern the building and sustaining of the business. There are four significant dilemmas encountered at this time (see Table 2):

- Feelings of loneliness often disturb entrepreneurs involved in a growing business - as the business expands the pressures and responsibilities increase and more employees are dependent on the entrepreneur for their income; it is at this stage that many entrepreneurs report feelings of isolation from employees and family [23]. If such feelings are not addressed they could overwhelm the entrepreneur and transform the career from a fulfilling experience into a stressful burden.
- The ability of the entrepreneur to maintain control amidst an expanding enterprise is another dilemma commonly encountered. As the business grows it becomes more difficult for the entrepreneur to claim an intimate knowledge of or direct control over each area of the business; new ways of organisation and control are necessary to avoid emotional pain and discomfort [23].
- The decision on whether or not to import *professional managers* to run the business is a notable mid-career dilemma. Many entrepreneurs demand

the skills of those trained in business schools in areas such as finance, market research, and production planning, however they feel opposed to the values supported by those with formal business training - the entrepreneur is thus required to obtain these skills while at the same time maintaining his or her personal vision and values for the business [23].

- The dilemma of hiring family members should be handled skilfully, since business and family norms and practices are often at odds with each other [23].

### **3.5.3 Late career dilemmas**

Late career dilemmas involve detaching oneself from the entrepreneurial career and planning for one's personal, one's family and the business' future. Dilemmas encountered at this stage include the following questions:

- Should I retire?
- How should I prepare my business for the future?
- What should I leave to my family?

The answers to these questions depend on the entrepreneur's approach toward retirement and succession. Developing an estate plan, grooming a successor for the business, teaching values to the next generation, and developing new interests are activities that require attention by the entrepreneur in the late career [23].

Although the above dilemmas are not always applicable, they appear to be the most common problems encountered [23].

## **3.6 Entrepreneurship in Practice**

This section aims to discuss: the relationship between an entrepreneur's academic and work background, and his/her accomplishment in a new venture; how development and training of entrepreneurial engineers is being approached presently; innovation and how this relates to entrepreneurship, and the processes that promote good innovation.

### **3.6.1 The relationship between an entrepreneur's background and performance in a new venture**

Whilst managerial experience is obtained by managing a firm or organisation prior to one establishing a new venture, entrepreneurial experience refers to the experience which one obtains during the course of founding and organising the previous firm as an entrepreneur [24].

#### **3.6.1.1 The relationship between education and performance**

Education is associated with the profitability of the new venture but not with the growth thereof [24]. It is the entrepreneur's education and experience in the line of business that has the most positive effect on profitability than all his other experiences [24].

#### **3.6.1.2 The relationship between managerial experience and performance**

In most cases, managerial experience has a negative impact on performance. At the same time successful entrepreneurial experience affects profitability most favourably, whilst unsuccessful experience least favourably [24]

Experience may have two distinct and even contrasting effects on entrepreneurial performance. On the one hand it can provide the entrepreneur with a set guidelines and knowledge favourable to increased performance; conversely, it may create behaviour that is hard to change and that may act as an obstacle to change and achievement [25].

#### **3.6.1.3 The relationship between industrial experience and performance**

Experience in the line of business shows a positive effect in general, and specifically shows a close connection with firm growth. i.e. Experience gained working as an employee in the related field plays an important role in developing the firm [24].

- Entrepreneurs with high-growth experience, perform worse than the reverse case [24]

### **3.6.1.4 Summary of entrepreneurship in practice**

The conclusion from the above is that if one starts a firm with only a basic experience of management and with a good understanding of the new product, the firm may become unsuccessful as a result of a rigid management pattern that may hinder flexibility of management that is essential to a new organisation. On the other hand, if a firm is built upon a full knowledge of a product, it will surely achieve a better result than in the former case [24].

### **3.6.2 The training of entrepreneurs**

The current trend amongst first world nations such as Japan and the United States is to develop entrepreneurial engineers through a broader academic base which incorporates technical, business and management material - the case study below serves to provide insight on how this is being achieved.

#### **3.6.2.1 The current trend in the training and development of entrepreneurial engineers [26]**

As a case study of engineering programs that have *diversified* to develop the essential business skills amongst technical students, Stanford University, Michigan and Carnegie Mellon have embarked upon a program to teach students that product design and product sales are interdependent.

Considering a specific project [26] at Stanford, the main objective was to eliminate the barriers experienced between engineers and business people; barriers that lead engineers to call their opposites "bean counters" and business types to call engineers "propellerheads" - the objective of the project was to develop in M.B.A's an appreciation for the process of design and manufacture and to develop in engineers an appreciation of the constraints placed on design and manufacture by a competitive economic environment [26].

One particularly interesting course in the Stanford program is called *Integrated Design for Manufacturing and Marketability*. The course is open to MBA and engineering-only students, as well as those in the dual-degree program. The course simulates real life by having each team do a market survey to determine what product attributes are most valued by customers and what price they would be willing to pay for this. Based on that information, the teams begin to make design decisions. e.g. "Will a more sophisticated device at a higher price be more profitable than a simple lower-priced one that would sell in higher volume?"[26]. Later, each team's completed product is displayed to a group of the potential customers originally surveyed, and those customers are then asked which products, if any, they would buy. A figure for the sales of each product can then be projected. Subtracting the cost of goods sold produces a gross profit for each product. The evaluation of success of the team is determined largely by that profit.

The above serves to illustrate the changing trends within the engineering sphere in the United States with respect to the approach to education in engineering and business. Whilst the creativity and innovation skills in



engineers are relatively well-developed, institutions are beginning to realise the need to branch out their purely-technical programs to include business related courses with the objective of preparing engineers with entrepreneurial skills and an entrepreneurial approach toward engineering.

### **3.6.3 The innovation process**

From the viewpoint of engineers aiming to start-up a new venture, this section aims to discuss the *ingredients* deemed necessary for the start-up business and the successful management of the business thereafter.

#### **3.6.3.1 Innovation**

According to the source "Innovation and Entrepreneurship"[21], the period of swift change that is expected over the next decade will require that a business innovate in order to prosper, if not to survive.

In order to achieve this it is necessary that innovation itself should be structured as a systematic activity and that the business is structured to be a successful innovator [21]. The success of the Japanese implementation of this objective is quoted; they have made innovation and entrepreneurial strategies systematic, purposeful and disciplined which has contributed toward their huge entrepreneurial and innovative advantage over the West during the second half of this century [21].

The events that stimulate entrepreneurship within an economy, stems from changes in values, perception, attitude and education, and the vehicle of this change, particularly in behaviour, is a *technology* called *management* [21]. It is claimed that the success of the entrepreneurial economy in the United States is based on new applications of management on *new* enterprises (whether businesses or not), on small enterprises, on non-profit businesses (health care, education etc), on activities that were traditionally not regarded to be enterprises (such as restaurants) and to systematic innovation. The latter refers to the search for and exploitation of new opportunities for satisfying human wants and needs.

The need and the possible impact of management on the small entrepreneurial organisation is also stressed, with management having as much to contribute to the new organisation as to the ongoing *managerial* one. In summary, management is empowered as the *technology* that will create an entrepreneurial *society* [21].

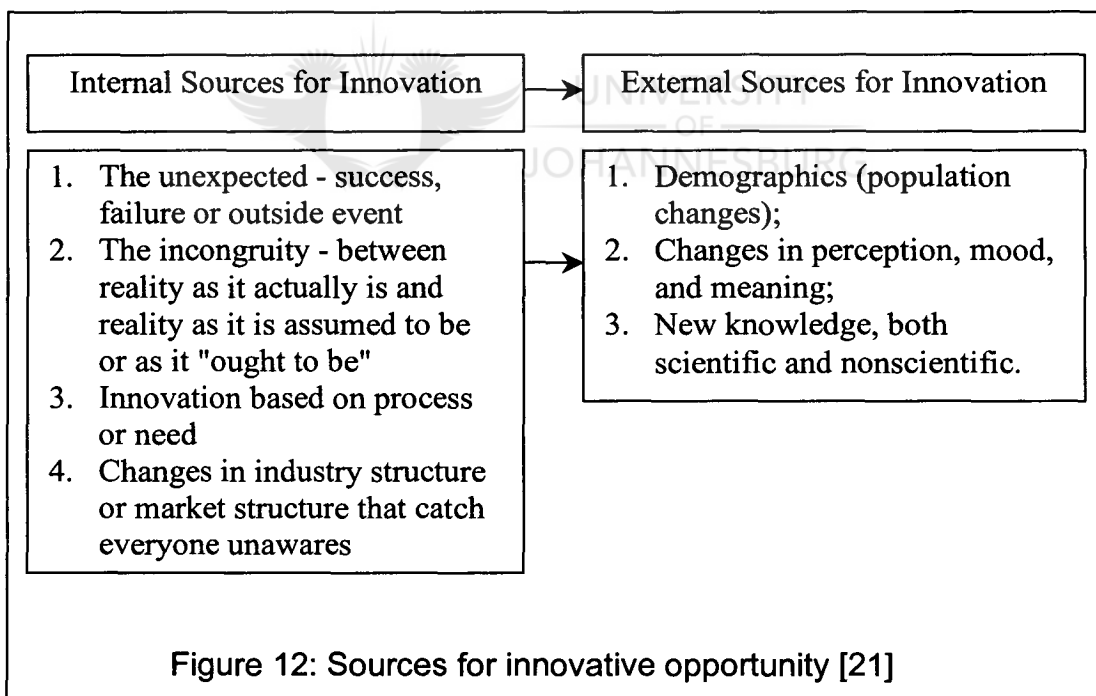
#### **3.6.3.2 The seven sources for innovative opportunity**

With reverence to the definition of innovation made in chapter 1, innovation may be regarded as the specific tool used by entrepreneurs in order to exploit change [21], as an opportunity for a different business or service. It is the "act that endows resources with a new capacity to create wealth - it infact creates a resource"[21].

Innovation may thus be thought of as the changing of value and satisfaction derived by the consumer - anything that alters the wealth-producing potential of current resources is viewed as constituting innovation.

"Successful entrepreneurs, irrespective of their individual motivation - be it money, power, curiosity, or the desire for fame and recognition - try to create value and to make a contribution; they aim high and try to convert a material into a resource, or to combine existing resources in a new and more productive configuration"[21].

Systematic innovation thus embodies the intentional and structured search for changes, and in the systematic analysis of the opportunities such changes might offer for economic or social innovation [4]. Specifically, systematic innovation is classified as the monitoring of "the seven sources for innovative opportunity"[21]. The first four of these lie within the enterprise and are thus visible mainly to people within that industry or service sector. They are basically symptoms, but highly reliable indicators of changes that have already happened or can be made to happen with little effort. The second set of sources for innovative opportunity, a set of three involves changes that occur outside the industry concerned. These sources are indicated in figure 12 below.



The order of these sources is based on descending order of reliability and predictability, each requiring separate analysis.

In summary, new knowledge and notably new scientific knowledge, is not the most reliable or most predictable source of successful innovations. "For all the visibility, glamour, and importance of science-based innovation, it is actually the least reliable and least predictable one"[21]. Conversely, the ordinary and

unglamorous analysis of such symptoms of underlying changes as the *unexpected success or failure* carry reasonably low risk and uncertainty, and the innovations that arise from them, typically have the shortest lead time between the start of a venture and its measurable results, whether success or failure [21].

#### 3.6.4 The management process

The concept of entrepreneurship and the rules that apply to its successful implementation are regarded as generally fixed between all business endeavours, whether small or big, including the kinds of innovation and where to find them.

The discipline of entrepreneurial management is thus considered as *universal law* [21]. Distinction is made between the existing business and the problems, limitations and constraints that it is confronted with, and that which is associated with the individual entrepreneur. "The existing business, to oversimplify, knows how to manage but needs to learn how to be an entrepreneur and how to innovate. The nonbusiness public-service institution, faces different problems, and the new venture needs to learn how to be an entrepreneur and how to innovate, but above all, it needs to learn how to manage." [21]

The text below outlines briefly the context of the existing business, the public-service institution and the new venture, as mentioned above:

- Whilst in the existing business the operative word in entrepreneurial management is *entrepreneurial*, for the new venture it is *management* [21].
- In the existing business it is the existing policies and approach that is the main obstacle to entrepreneurship, whilst in the new venture it is the lack thereof [21].
- The new venture is created from an idea, and whilst it may have a product or a service, sales, costs, revenues and even profits, it does not have a *business* - a viable, operating, organised *present* in which people know where they are going, what they are supposed to do, and what the results are or should be. "Unless a new venture makes this transformation, and makes sure of being *managed*, it will not survive irrespective of how brilliant the idea, how much money it attracts, how good its products, nor even how great the demand for them" [21].

According to Drucker [21], the following are essential for entrepreneurial management in the new venture (see figure 13 below):

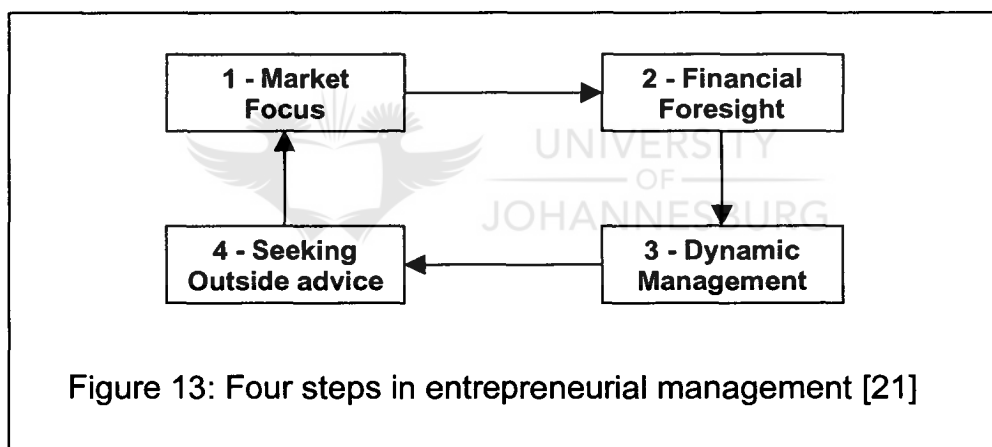
- It requires a focus on the market as the first step;
- It requires financial foresight, with emphasis being placed on cash flow and future capital needs ;

- The third requirement is the development of a top management team, well in advance of its actual need by the new venture and well before the venture can actually afford it;
- The final requirement is a decision from the founding entrepreneur with respect to his or her own role, area of work, and relationships.

These requirements are explained in further detail below.

### 3.6.4.1 The need for market focus

Whilst the textbook prescription for a new product in the market is *market research*, it is argued that one cannot do market research for something that is genuinely new and not as yet on the market [21]. The new venture should thus begin with the assumption that its product or service may find customers in markets that current do not exist, for uses that has not been envisaged when the product or service was designed, and that it will be bought by customers outside its field of vision and even unfamiliar to the new venture [21].



If the business does not have such a market focus from inception, then it will only success in creating a market for a competitor. Building market focus into the new venture demands that the new venture should methodically seek out both the *unexpected success* and the *unexpected failure* [21]. Entrepreneurs should seek out the unexpected and analyse it as a distinct opportunity. The new venture should be willing to experiment, in order to be market-driven. If interest is shown in the new venture's product or service from the consumer side that was not originally targeted, one should then aim to identify possible candidates in that market or area that are willing to test the product and investigate potential application it may have.

In order to determine whether an unexpected interest indicates real potential requires sensitivity and a little systematic work, rather than a large capital investment [21]. Most important though, is that the people who are running the new venture should spend sometime outside, within the marketplace, with customers and with their own salesmen, looking and listening. "The new

business needs to build in systematic practices to remind itself that a product or service is defined by the customer, not by the producer." [21]

Furthermore, it is essential that the new venture continuously challenge itself regarding the utility and value that its products or services contribute to customers. According to Drucker [21], the danger lies in the *know better than the customer* syndrome regarding what the product or service is or should be, how it is purchased, and what is its application. It should conform to the saying that "businesses are paid to satisfy customers, not reform them" [21].

#### **3.6.4.2 The need for financial foresight**

The next stage of growth regards the deficiency of suitable financial focus and the financial policies as the main threat to the new venture. It is a threat specifically to the rapidly growing new venture [21].

The causes of failure due to this threat includes:

- The lack of cash.
- The inability to raise the capital needed for expansion.
- The loss of control, with expenses, inventories, and receivables in chaos.

Whilst entrepreneurs who start-up new ventures are rarely averse to money matters; "greed shifts the focus on profits, which is the wrong focus for a new venture. The focus on profits should come last rather than first" [21]. Cash flow, capital and controls should be the primary concern initially. Growth has to be promoted by improving financial resources rather than taking them out as profits. Growth requires more cash and more capital. Thus, any profits made by the new venture should be reinvested in order to promote growth. The stronger the new venture is and the faster it grows the more financial resources it demands. It is necessary that financial trends and resources are monitored and managed in this phase, to avoid trouble. The new venture thus requires cash flow analysis, cash flow forecasts, and cash management. An overly conservative attitude, "planning for bills to be paid sixty days earlier than expected and receivables will come in sixty days later" [21], will ensure protection against cash flow problems. It is prudent for the growing new venture to plan the source and application of its funds, almost a year in advance. With such a lead-time, it will be relatively easy to finance the cash needs.

In general, as the venture grows, it becomes necessary for the company to access larger pools of capital (in addition to owner's equity or outside capital) by going public, by finding a partner or partners among established companies, or by raising finance from insurance companies and pension funds. If the financial requirements and capital structure are realistically planned for three years in advance, with provision being made for the maximum need instead of the minimum, then the business should have no problem obtaining finance at the time it is required and in the form desired.

Alternatively, if it waits until its capital base and structure is outgrown, it is exposing its survival and independence to risk [21].

Finally, the new venture should plan the financial system that is necessary to manage growth. The variables such as receivables, inventory, manufacturing costs, administrative costs, service, distribution etc. that becomes vulnerable to loss of control are especially important. "Fast growth always makes obsolete the existing controls"[21]. Identifying the critical areas of the business, which may include product quality, service or manufacturing costs may prevent the loss of control. The new venture should then establish current controls in these areas that will be required in three years time. What is of particular importance is that management becomes aware of the critical areas and is sensitive to changes in them so that they may respond quickly to control them if needed.

### **3.6.4.3 Building a dynamic management team**

After a specific market has been penetrated by the new venture and it has established the financial structure and system needed, then *management* is regarded as the greatest risk to the business. The business has most likely outgrown being managed by one or two people, and actually needs a top management team, if it is not already too late. The absence of such a team exposes the business to poor decisions, which could threaten its position in the market and potentially its survival. Ideally, the management team should exist before the business arrives at the point of its need. Since a top management cadre is generally unaffordable for the small business, the solution is for the founders to establish a team where tasks are shared. The steps that should be followed are:

- The founders and other key personnel will have to define the key activities of their business, classifying the areas of the business, which determine its survival and success. Any deviation should be seriously questioned.
- The members of the group should then objectively analyse their individual contributions to the business and as well as that of their colleagues, defining those aspects in which they excel individually.
- The team should then identify those activities that each member should take on as his or her primary responsibility, based on that individual's strengths.
- In order to build the team it is then necessary for the founders should curb the urge to handle people and their problems, if this is not the key activity that fits that individual best. The CEO has his or her own key activities that include ensuring that all the other key activities are sufficiently accounted for by the team.

- Finally, it is necessary to define the goals and objectives of each individual and the level of achievement that the team expects from that individual.

"The founder must learn to become the leader of a team rather than a star with helpers"[21].

The team building requirement is regarded as probably the single most important exercise toward entrepreneurial management for the new venture [21].

#### **3.6.4.4 Seeking outside advice**

Finally, it is considered essential for the entrepreneur in the new and growing venture to ask advice from independent and objective outside sources. The founder needs to consult people that he or she will listen to for advice on basic decisions. This necessitates that the person from which advice is being sought is someone *outside* the business; someone who is not part of the problem. It is required that this consultant should ask questions, review decisions and strive to have the long-term survival needs of the new venture satisfied by incorporating the market focus, supplying financial foresight, and creating a functioning top management team.

This is the final requirement of Drucker's [21] entrepreneurial management philosophy in the new venture. According to him, "The new venture that builds such entrepreneurial management into its policies and practices will become a flourishing large business"[21].

### **3.7 Legal Issues Concerning the Start-up Business**

This section aims to outline the following: the business-form alternatives available when starting up the new venture; some of the obvious legal obligations of the new-venture and the legal requirements of the selected business form.

#### **3.7.1 Selecting the appropriate business form**

In starting up the new engineering business, the first legal process would be to decide on an appropriate business form. These include the following [28][29]:

- The Sole Proprietorship - this is the simplest form of business, which has the advantage that no formal processes are necessary for its formation, administration and termination. This is typically a *one-person* business where the business owner carries liability.
- The Partnership - this is a more formal business operation, consisting of two or more partners (not exceeding 20) who work together and share profits or losses according to a special agreement, which should also cover issues relating to who should be contacted on behalf of the partnership, who will be responsible for keeping the

books, and what will happen if one partner leaves the partnership. The disadvantage of this business form is that partners are held jointly and severally liable for all debts incurred by the partnership.

- The Close Corporation (CC) - this business form is a separate legal entity from the members who own it. Members are thus not personally liable for its debts, and the CC is itself liable only to the extent of its assets. A CC is inexpensive to incorporate (as compared to a company). A formal requirement though is that an accounting officer should be appointed to execute financial reporting.
- The limited Liability Company - this business form is also regarded as a separate legal entity, responsible for the debt incurred by it. The owners or shareholders liability is limited. Legal registration and financial reporting obligations make this business form relatively expensive, and is ideally suited to medium and large businesses (annual turnover in excess of R5, 000,000).

### **3.7.2 Tax considerations [28]**

According to the South African Tax Law, tax is levied on all taxable income of the business, which are arrived at after deduction of expenditure incurred in the production of income.

The following are basic obligations of the business with regards to tax:

- Financial statements as well as a tax return form should be submitted to the Receiver of Revenue at the end of the businesses financial year. Examples of normal deductible expenditure items include salaries and wages, purchase of stock and consumables such as rent, telephone, rates and taxes and travel expenses.
- A business is required to keep all documents (invoices and statements) for three years from the assessment of the last tax return.
- The business is also required to register for value added tax (VAT) if its annual turnover exceeds R150, 000. VAT impacts on a business since it must be levied on every sale that takes place (output tax). It must also be accounted for separately in the accounts of the business, as a liability owed to the Receiver of Revenue. Purchase/sales invoices must substantiate any VAT claims. VAT that is paid on purchases (input tax) should be accounted for separately and is refundable by the Receiver of Revenue.



### 3.8 Planning and Conceptualisation of the Business Venture

The above discussion addressed important aspects of entrepreneurial engineering *management*, for the existing or new business venture. This section aims to outline the specific requirements and steps that should be followed in order to realise the new venture.


#### 3.8.1 The entrepreneur's formula for success [30]

This section describes the *formula for success* for the entrepreneurial engineer. The formula incorporates the input factors of idea/innovation, money, market, management and a desire to succeed. The formula should not be interpreted from a mathematical perspective, since the variables in this equation do not have a common base (unit of measurement); the formula serves mainly to quantify the requirements for entrepreneurial success. The logic followed is that the *desire to succeed* (Passion) is vital for entrepreneurial success. This desire, together with a combination of the right idea (I) and the correct money-management-market (M<sup>3</sup>) mix, are the primary determinants of entrepreneurial success.

The formula is:

$$ES = (I + M^3) P \quad (3.1)$$

Where:



ES	= Entrepreneurial success;
I	= Idea or innovation;
M <sup>3</sup>	= Market x Money x Management
P	= Passion

The section below stipulates the requirements of the individual input factors (I, M<sup>3</sup> and P) that should be fulfilled in order to achieve entrepreneurial success.

##### 3.8.1.1 The idea or innovation

At the outset, the entrepreneur must have a viable *idea* that is [8][30]:

- original;
- unique;
- leading edge;
- and appropriately protected by patent, copyright, trademark or trade secret laws to stay ahead of competition and attract investors.

It is also necessary that the product is developed into a good working prototype, and an independent testing firm should prove the performance of the product.

### **3.8.1.2 The market**

It is essential that a market exist for the product or service [30][38].

The product (idea or innovation discussed above) should be defined first, and then the market. Market factors that should be assessed include the following:

- Who will want to buy the product?
- Do they know they want the product? (If the user needs to be educated then the market potential is greatly diminished and marketing costs greatly increased).
- How many of the product will the public purchase and how often?
- What price are they willing to pay?
- After market research, can you afford to make the product and be profitable within three-years?

### **3.8.1.3 Money**

Money is the commodity that a start-up business cannot *afford* to be short of.

If one needs to raise financing, it is essential to draw up that a business plan with three to five year financial projections. Financing sources include:

- Friends and relatives;
- Small Business Development Corporation Loans;
- Lines of credit from banks;
- Investment bankers and venture capitalists.

Investment bankers and venture capitalist will usually only invest in the business after they have been convinced that the entrepreneur is completely dedicated to the business, has full confidence in its potential to succeed and has invested all of his or her resources into the business venture. When approaching venture capitalists, the entrepreneur should do so by way of an advisory body who can prepare the entrepreneur and the company for presentation to the professional investors [30].

### **3.8.1.4 Management**

Management is regarded as the most important element in the money-market-management (M<sup>3</sup>) component of the success formula [30][21].

The management team is responsible for:

- producing the product;
- marketing the product;
- selling the product;
- managing the money.

As discussed in the section 3.4.4, it is necessary for the dynamic team to be organised so that each member of the team is proficient in his or her area of responsibility. It is an advantage for the team members to have worked together previously. Lastly, the team should be capable of taking advice from experts.

In the management process, the founders should employ specific mechanisms to motivate employees to be productive and feel a commitment to the business. This could include a profit sharing plan or a stock option, which gives each employee an incentive to contribute to the development and success of the business.

### **3.8.1.5 Passion**

Passion is believed to be a determining ingredient for entrepreneurial success or failure [30][8].

- The entrepreneur should have the drive and determination to succeed.
- He or she should be constantly optimistic (realistically).

Despite the formula though, a true passionate entrepreneur is one who takes the risk.

### **3.8.2 The business plan**

In starting up the engineering venture, it is extremely important that the entrepreneur invest his or her time and effort in the development of a concise business plan. Three major reasons are quoted for this need [31]:

- The formal process of defining the objectives of the business, the means to arrive at those goals, the threats and opportunities foreseen (in addition to the thought that the entrepreneurial engineer has made prior to writing the business plan) forces him or her to take an objective, critical, unemotional look at the business project in its entirety;
- The finished product - the business plan - is an operating tool which when used correctly will assist the entrepreneur to manage the business and work effectively towards its success;
- The completed business plan document serves as a means by which the entrepreneur may communicate his ideas to others (especially potential investors).

Taking an objective look at the business allows one to identify areas of weakness and strength; it allows one to pinpoint needs that might otherwise have been overlooked; it allows one to identify opportunities early, and begin planning how one can best achieve the business goals. The business plan also assists in the identification of problems before they grow large and helps

identify their source, thus suggesting ways to solve them. This correlates with Drucker's [21] approach to entrepreneurial management.

The business plan can assist in avoiding going into a business venture that is doomed to failure, by quantifying the requirements and risks involved. If the proposed venture is merely on the border of success or failure, the business plan will indicate why and it may assist in "avoiding paying the high tuition of learning about business failure"[31].

Finally, the business plan provides the information needed by others to evaluate the proposed venture, especially if the entrepreneur needs to seek outside financing. A thorough business plan can quickly become a complete financing proposal that will meet the requirements of most lenders.

In order to meet the business plan objectives stipulated above, one should ensure that every aspect of the business is taken into consideration, including marketing, research, design, development, manufacturing and financial factors. As a reference, a basic business plan checklist is included in appendix 1 that includes the essential components of a business plan. This checklist should be considered in conjunction with the principles discussed in this chapter.

### 3.9 Chapter Summary

In summary, this chapter has aimed to discuss most aspects that characterise the entrepreneur (including the entrepreneurial engineer) and his or her environment. Various *types* of entrepreneurs have been considered, and the dilemmas of pursuing an entrepreneurial career have been outlined. The chapter has also outlined some practical aspects that impact on the entrepreneurial engineer and his or her potential for success, including the individual's development, training, innovation, management and implementation processes. Finally, the chapter has endeavoured to quantify certain legal aspects that should be considered, as well as the necessity and requirements of a formal business plan prior to starting up the new venture.

The following chapter discusses the *engineering process*, which includes the process of engineering thinking, the product design process from an entrepreneurial perspective, product development for production and selling and marketing of engineering products. In addition, it discusses the profession of *consulting engineering* as an entrepreneurial engineering route.

# Chapter 4

## The Engineering Process

### 4.1 Introduction

The preceding chapters have discussed various concepts that relate to the entrepreneurial engineer including discussions on engineering management and entrepreneurship. This chapter aims to identify the following:

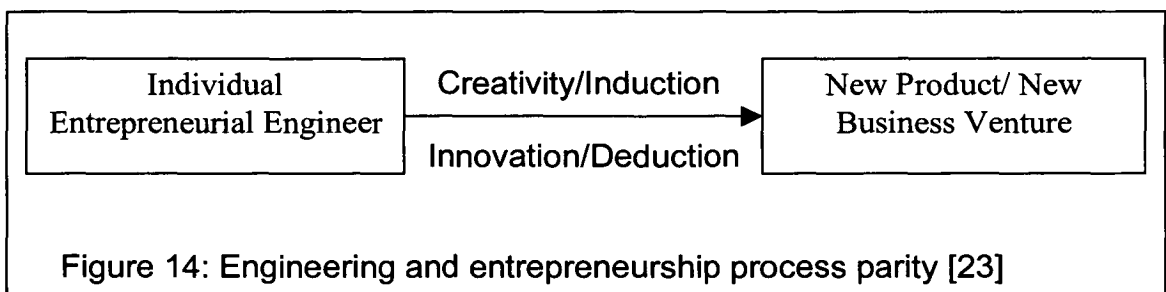
- The considerations of the engineering process;
- The impact of this process on the entrepreneurial objectives.

### 4.2 The Process of Engineering Thinking

By definition the engineer's role is to "create the foundation of desirable effects, useful to mankind" [23]. In essence, engineers work to alter basic materials and as a result produce new products that possess greater value and usefulness.

Since engineering is the application of science, much of *engineering thinking* evolves from inductive and deductive processes [23]. Inventions that lead to new products or processes are ordinarily the results of induction (e.g. Sony Walkman and Dolby's noise-reduction circuit), whilst deductive thinking is used to improve the products of induction and to develop variations of them (innovation).

Engineering is regarded to be mainly a process of deduction, which encompasses the progressive improvement of product ideas, refinements in accuracy and precision, and developments in methods of production. Inductive developments are generally a result of inspiration. These developments are patentable, where it is necessary to show that the idea is *new*, and not just an improvement on an existing patent.



Finally, engineering ideas must be based on knowledge and logic [23]. They must be holistic in nature, with cognisance of relevant factors such as economics, production, markets, and timing.

From the entrepreneurial perspective, the processes of induction and deduction experienced by the engineer are similar to the respective processes of creativity and innovation that are experienced by the entrepreneur. This similarity may be referred to as the *engineering and entrepreneurship process parity* (see figure 14 above) [23].

## **4.3 Engineering from an Entrepreneurial Perspective**

### **4.3.1 The product design process**

*Engineering design* may be regarded as essentially a creative process of identifying what needs to be produced, and the method by which it is to be produced [12]. The *development* process differs in that it concerns those activities that are required to show that the design will achieve its objectives, as well as to illustrate the need for certain design changes.

#### **4.3.1.1 The market for engineering products**

From the entrepreneurial perspective it is necessary that the product that is to be designed should fulfil an existing or foreseeable market need. The products of engineering design and development serve primarily two market areas [12]:

- The market for engineers or other professional buyers - in this case the suppliers and purchasers are able to communicate easily, having a good understanding of the requirements, possibilities and limitations of the designs;
- The market for customers or consumers who are not professional in terms of their buying decisions (e.g. products ranging from cars to cigarette lighters) - here the customers' choices are based predominantly on factors such as style, fashion, marketing and price.

As a result of analysis of various successes and failures in design, it is prudent for product designers to create "what people will buy, and not just what the what the designers find intriguing or challenging - the false challenge of misdirected innovation can be appealing to product managers and designers, but can lead to expensive failures" [12]. In order to avoid failure and maximise success, it is necessary for the initial design to be based upon existing or potential market needs. In addition, product innovation should be coupled to the marketing strategy that emphasises the features that differentiate the product from the competition [12].

#### **4.3.1.2 Product strategy**

It is necessary for the product design and development to be conducted within a strategic framework [12], which must determine which kinds of products will be created. The strategy will enable resources, training, and priorities to be

determined, and provide the basis for longer-term planning. Ideally, product strategy should be derived from the engineering strengths that are available in relation to the strengths of the competition and of suppliers. These strengths include knowledge (mainly patents held), capability, and position in the market.

#### **4.3.1.3 The decision to make or buy technology**

When designing any product comprised of other parts or subassemblies, one has to decide whether to buy the subcomponents or make them. This decision should be based on the strategic evaluation of the core technologies of the company (and similarly the core business of the company).

Components that can be supplied by many potential manufacturers whose competence *matches or exceeds* that of the final product manufacturer, should be *bought*, since competition between suppliers should ensure satisfaction in terms of innovation, price, quality and service [12].

One should only endeavour to manufacture items that are considered to give a competitive advantage [12]; this decision should be based on consideration of the factors that distinguish the product in the marketplace (e.g. performance, cost, quality etc).

Finally, it is essential to maintain a strong connection between the make or buy strategy; research should be concentrated on the core-technologies.

#### **4.3.2 Development for production**

As far as development for production is concerned, the following principles of production are essential for the entrepreneurial engineer:

- The first principle of engineering production is the necessity to transform designs into products, *at the lowest cost possible* [12].
- The second principle of engineering production is that "processes inevitably generate variation, and this is increased by human involvement. Therefore items can be produced which are imperfect, or defective. The proportion that is defective and the extent of variation affects productivity and costs"[12].
- The third principle of production is that, as far as practicable, nothing should be made that cannot be charged for as it leaves the factory. "Ideally, every item made should have a customer"[12].

With these principles in mind, product design and production should be approached in the following manner:

- The processes that will be used for production should form an integral part of the design and development activity [12].

- Design teams should know the processes that are required, the methods available for implementation, and their advantages and limitations in relation to the quantity produced, cost objectives, diversity etc. "The product must be designed and developed for the processes that will be used, and the processes must be designed and developed concurrently with the design and development of the product [12].
- Designs should be made with the concern of how it will be manufactured, assembled, and tested. There is a strong connection between the ease of manufacture and the ease of maintenance and repair, which affects costs [12].
- When designing for manual assembly, it is important to pay attention to *mistake-proofing*, by designing the product and the processes so that defects will always be detected and prevented from being passed to the next production stage [12].

The main impact of implementing such an approach to product design and manufacture is that designs are optimised for production, with the result that costs are minimised.

### 4.3.3 Selling and marketing engineering products

#### 4.3.3.1 Selling

Since sales and profits eventually measure every project's success, it is essential to manage selling (marketing, forecasting, advertising, support, etc.) by aiming at the target customers (engineers and non-engineers)[12].

The performance features of the product that are deemed important by the customer should be the main selling points for the product [12]. If engineers are the target customers, then it is necessary to provide full technical and performance information. The sales personnel facing the customers should be capable of providing such information as well as to answer the questions that customers will ask - they should thus understand the product, its capabilities and its limitations in relation to competing products.

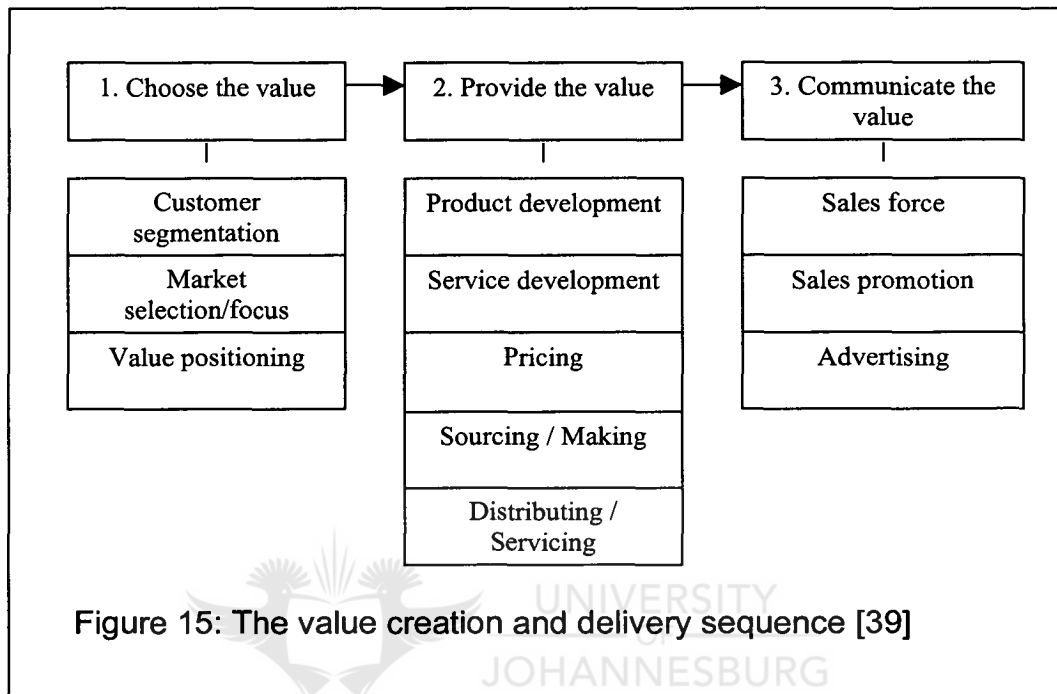
#### 4.3.3.2 Marketing

The concept of *marketing* is defined as follows:

"The management of the relationships between an organisation and its customers and potential customers. Marketing aspects of a corporate strategy include the mix and volume of products, pricing, distribution methods, guarantees and servicing, advertising and promotion, and sales force management. Market research seeks information on the characteristics of customers, potential customers, and competitors" [40].



From the entrepreneurial engineering perspective "the smart competitor must design the offer for well-defined *target markets*"[39]. This view is illustrated in figure 15 below, which places marketing at the beginning of the business planning process. Instead of a make and sell approach, the business process should consist of *choosing the value, providing the value, and communicating the value* [39].



*Choosing the value* represents the marketing research that should be done before any product is developed. This includes *market segmentation*; identifying *target markets* and developing the offer's *value positioning*. The next step is then to *provide the value* - the actual product and service must be specified in detail, a target price must be established, and the product must be made and distributed. The final step in this process is to *communicate the value*, by utilising the salesforce, sales promotion, advertising, and other promotional tasks to inform the market about the offer [39].

The marketing process is thus the necessary ingredient, which may determine the product's success or failure in the market.

The main difference between the functions of marketing and selling is: "an organisation must learn to think of itself, not as producing goods and services but as buying and selling customers, as doing the things that will make people want to do business with it"[40].

This approach is summed up quite nicely in the following example which uses a drill as the product to be marketed [40]:

- The correct approach is that *one is not trying to sell quarter inch twist drills, but quarter inch holes*, and this carries with it the implications of performance, quality, customer satisfaction, and durability;
- It is not the price of the drill that matters, but the cost per hole (customers perspective);
- It is not the cost of making the drill, but its value (and price) to the customer (drill maker's perspective).

In the domain of marketing engineering products or services, the general trend has been the convergence of ideas on performance and quality. High levels of reliability are now expected in technical goods, whether for use by consumers, in commercial applications, or by the military.

In general, the supplier must become familiar with the conditions of use in the market to which he or she sells the product, and must satisfy the following [40]:

- He or she should supply a well designed product that has been improved as a result of feedback obtained from previous customers
- The supplier should make adequate resources (both men and materials) available to the customer for maintenance of the product;
- It must be possible to operate and maintain the equipment within the technical infrastructure of its location.

The marketing and sales organisation is the link that must provide this communication.

Finally, it is important to approach product development and marketing with a view on global markets - "the concept of national markets is rapidly disappearing. Today every manufacturer must be customer oriented and develop a global strategy based on adequate market research"[40].

#### **4.4 Consulting Engineering as an Entrepreneurial Engineering Route**

It is deemed necessary specifically discuss the realm of consulting engineering, as a result of its popularity as an entrepreneurial engineering choice for many engineers who wish to leave a corporate or organisational structure and form their own business. This section aims to briefly outline the environment, roles and services, business development and career prospects of the consulting engineer.

#### **4.4.1 The role of the consulting engineer**

By definition, a consulting engineer is regarded as an independent, professional engineer who performs professional engineering services for clients on a fee basis [32]. Most consulting engineers operate in firms, as independent contractors in a legal sense because they own and manage their own businesses and serve their clients on a contract basis. They are thus regarded as the entrepreneurs of the engineering profession. The actual business form varies from a sole-proprietor to corporations.

In order to function as a consulting engineer, it is necessary that the individual be qualified by education *and* experience [32]. Furthermore, they must be registered as professional engineers. Historically, ethical consulting engineers have few commercial affiliations with manufacturers, material suppliers, or contractors and therefore no conflicts of interest. The compensation of ethical engineers consists primarily of fees paid by their clients for services rendered.

#### **4.4.2 Services performed by the consulting engineer**

The field of endeavour and scope of the work may classify the services that are performed by the consulting engineer. The scope of services offered depends to a degree on the type of clients served; it also fluctuates with the size of the projects that are handled.

The range of services that are performed by the consulting engineer include the following [32]:

- Consultation: this occurs when a client seeks the expert knowledge and the experience of a consulting engineer. Consultation may be brief or extended.
- Investigation: most consultations encompass some thought and investigation on the part of the consulting engineer. They may involve a review of studies, reports, investigations, or communications prepared by other engineers or by the client's management.
- Feasibility reports: this is one of the primary activities of the consulting engineer. These reports are often referred to as project, planning or engineering reports and are concerned with determining the feasibility and plan of development of some project, product, machine, system or structure and presenting the results of surveys, studies, and investigations. They are usually involved in the engineering feasibility, as well as the economics of the project and financing alternatives.
- Impact statements: as a result of the increasing sensitivity to the environment, consulting engineers frequently prepare environmental impact studies, which deal with environmental, social, agricultural, and economic impacts of a proposed project on the local community.

- Design work: this is perhaps the primary role of most consulting engineers. "Engineering design is concerned with the conceptual, functional, operational, and physical characteristics of a device, structure or system to be manufactured or constructed" [32]. Design usually involves the comparison of arrangements and layouts from economic, engineering and architectural perspectives to determine the most advantageous and cost-effective alternative.
- Procurement phase: this is the post design phase, during which the consulting engineer assists the client to evaluate, select and purchase equipment or materials and the award of construction contracts. It is often referred to as the *bidding and negotiation phase*.
- Construction phase: in this phase, the consulting engineer who has designed the project is normally responsible for representing the client in relations with contractors during the construction period.
- Resident representation: this involves the consulting engineer stationing one or more resident representatives and assistants at the project site. Through on-site contract administration and more continuous observation of work in progress, the consultant endeavours to provide further protection for the client against defects or delays in the work of the contractor.
- Construction management - this service is often offered by consulting engineers as a part of a package on projects they design or in connection with projects designed by others. It aims to lighten the client's administrative burden and to facilitate the quick and satisfactory completion of a project.
- Testing: consulting engineers are often responsible for testing or witnessing tests of equipment, apparatus, or complete plants; such tests are customary when new projects are completed and turned over to the client for operation.
- Valuations and rate studies: this activity is concerned with the determination of worth of plant or property. It is used to establish a proper basis for insurance or for purchase or sale of property.
- Geotechnical engineering: this involves investigating subsurface conditions as a prerequisite to design of structures or other engineering works.
- Operation: consulting engineers are often involved in rendering operating services pertaining to newly completed projects to familiarise the client's personnel with the project. These services may include the preparation of operations manuals, training courses for the client's staff, and consultation with the client's management.

All the above functions directly involve engineering management.

#### **4.4.3 Consultancy business development**

To function as a truly entrepreneurial engineer and to obtain contracts amidst fierce competition necessitates that consulting engineers employ continuous sales and marketing strategy to familiarise prospective clients with their talents and availability. This is a necessary first step in placing marketing activity on an effective and ethical level [32].

Business development activities consist chiefly of contacts with prospective clients, supported by the use of professional publicity. Aspects of the consulting engineer that are considered important in business development are [32]:

- Reputation: a good reputation is viewed as the single most important factor in determining the success of a consulting practice. This may be achieved by giving good service.
- Repeat engagements: every consulting practice should aim to maximise the number of repeat contracts, which enhance reputation and provide a measure of the quality of its engineering work and human relations.
- Public relations: careful and discrete use of public relations services can enhance a consulting firm's visibility and reputation. Such efforts, when done well, bring to the attention of the public and potential clients the existence, availability, and, in a general way, the qualifications of a consulting engineer.
- Personal contacts: most consultants maintain ongoing contacts with potential clients. Such contacts, which are supplemented by recommendations from satisfied clients and supported by the consultant's reputation, are the primary avenue to contracts.
- Visits by prospective clients to successfully completed consulting engineering projects.
- References.
- Brochures: most consulting engineers prepare brochures for prospective clients to acquaint them with the firm's experience, personnel, and qualifications.
- Building a clientele: as a practice develops, careful consideration should be given to the type of clients that are approach. One criterion is the limitation of solicitation to those clients whose consulting needs are of the type the consultant is prepared to handle. Equally important is project size; the consultant is advised against soliciting contracts

that may require staff in excess of what the firm can reasonably provide by recruiting or by affiliation with other firms.

- Market research: owners and managers of every consulting firm must be familiar with the potential markets for their services as they guide business development programs and build a clientele.
- Salesmanship: competition among consulting engineers focus on two elements: qualifications and salesmanship (the ability to market their services by advertising, word-of-mouth, seminars etc).
- Ethical principals: professional engineering societies has prepared many codes of recommended ethical practice.
- Market expansion - the market can only be improved by engaging in an educational effort that targets potential clients.

A general comparison of the above activities with those that involve the entrepreneur, as discussed in chapter 3, shows a definite correlation. It should be born in mind that consulting engineering as an entrepreneurial engineering route has its focus on the provision of excellence in *service*. The consulting engineer is selling his or her *knowledge and services*, rather than a material product. In this context the marketing process of value creation and delivery discussed earlier refers to the development of service.

#### 4.4.4 Consulting engineering as a profession

Whilst many professional engineers may decide to approach entrepreneurship via the consulting engineering route, the potential volume of work available in the future really depends on the quantity and size of projects that require the services consultants offer and the decisions of clients to utilise consulting engineers for such services. The future opportunities for consulting engineers, measured by the market for their services, depends both on the domestic and international economic climate and on the performance of consulting engineers [32].

Nevertheless, consulting engineering offers opportunities to design new systems and facilities, to analyse existing engineering works and evaluate economic prospects, and to administer contracts or manage projects. "It is an excellent career choice for the engineer who likes working with people to develop concepts, solve problems, improve the environment, enhance the quality of life, and bring together all of the skills and solutions that technology can provide"[33].

In general consulting engineering is an example of entrepreneurial engineering that is service orientated. This profession boasts independence and demands integrity and technical competence [32].

In conclusion: "consulting engineering provides engineers in all disciplines with a rare opportunity to practice engineering as a true profession, to be a

manager, and to aspire to become, and eventually to become, an entrepreneur" [33].

#### **4.5 Effective Entrepreneurship and Engineering Management**

In an analysis of the technological gap that has developed between Japanese manufacturers and their European and American counterparts, it has been found that this advantage may be attributed to the effort of constant improvement of Japanese products, reduction in prices and increase in the range of tastes that they cater, which ultimately has resulted in broad market penetration [35].

The approach has result in a culture where the world demands more of Japanese products and as a result less of that of their competitors, and the process seems likely to end only when either the Japanese have taken 100% of world markets for manufactured goods or when governments of competing nations increase protection of their own industries [35].

The criticism the European and American approach is that in addition to the shortcomings in the value creation and delivery process, the accounting profession is deemed as having a marked effect on this difference from the Japanese, since the decline in manufacturing in Europe and America has coincided with the growing dominance of accountants in industrial management [35]. Regressing to Deming's proposal for management that was discussed in chapter 2, Deming pointed out the advantage of using engineers to manage technical-based processes.

In management research done relating to the different practices between the UK and Japan [35], it has been found that whilst the UK have a strong regard for rank and power structure within an organisation, the Japanese contrast this with their more democratic and consultative culture (McGregor's theory-Y).

A fundamental difference noted between the US and Japanese accounting practice is the *discount or hurdle rate* for projects (standard used to accept or reject opportunities based on risk; the higher the hurdle rate the riskier the project). Whilst the United States' rates fell normally between 15% and 25% [35], with the occasional high risk project being measured at 30%, the average hurdle rate in Japan was around 10%. As a result of this fact alone, the Japanese are likely to accept many more projects than the Americans (and British) and thereby start to open up a technological gap - the Japanese thus have a greater risk factor (entrepreneurial advantage).

Furthermore, the investment strategies of each is considered to have a significant impact on their performances: "The Japanese demand less, and achieve more, while the UK demands more and achieves less"[35].

The three prime reasons quoted for this huge difference in hurdle rates are:

- the cost of capital;
- the expectations of growth;
- and the treatment of risk.

The cost of capital in Japan is lower than in the United Kingdom. Not only are interest rates considerably lower, but as earnings are higher the cost of capital is also lower. The lower costs of capital enables lower hurdle rates to be used [35].

Expectations of growth are another major cause of the differential in hurdle rates. For example, if a project is based on a market growth assumption of 10% per annum, it will clearly achieve a much higher internal rate of return than a similar project based on an assumption of zero growth. Here the issue is regarded as being one of government concern - governments should act in the interests of local industries rather than in the interests of foreign competitors [35].

The third cause of this inequality, and perhaps the most important, is the treatment of risk. Whilst United Kingdom and United States' accountants commonly increase the hurdle rate by means of risk premiums of between 5% and 10%, the Japanese accountants do not use a risk premium at all [35]. Since most cost reduction investments contain risk, this premium is regularly used, which explains the differences between the returns required in Japan and those required in the United Kingdom and the United States.

It is argued that the false justification for a risk premium lies more in the logic of statistical decision theory than in accounting methods [35]. This theory maintains that if a firm is confronted with two courses of action, one with a pay-off of 100 and a probability of 0.8 and the other with a pay-off of 800 and a probability of 0.1, the *expected outcomes* are the same. The expected outcome is the value of the outcome times the probability of it occurring. Thus a project with a probability of less than 1 needs to earn a higher return for it to be considered as attractive as a risk-free project. This increase in return is the risk premium [35]. The fallacy arises in that in theory the expected returns from a project is comparable with those from a group of competing projects and, subject to achieving some slanted risk profile, expected returns can be maximised [35]. In practice, a firm mainly evaluates projects individually and compares the outcome if the investment is made with the outcome if it is not made. Thus the risky component of the project will either occur or not occur. If it does, it will either damage the outcome or it will not.

In this context a risk premium is thus regarded as irrelevant, since it can only serve to change a firm's risk profile by rejecting risky projects – it can have no other effect. If all projects are risky, then it only serves to limit investment [35].

It is considered more important to follow through the details of the project analysis and see precisely what it is that makes it risky. For example, in the case of a new product, one should evaluate whether there is a probability of a punitive competitive reaction? If so, it is then necessary to assess what can be done to limit or avoid that reaction? What marketing or production tactics



might make the short term competitive advantage sustainable in the long term? What will each of the main competitors do? What will the effect be? What can be done about it?

Research [35] identifies this to be the Japanese approach. Their practice is to discuss the project in detail at all levels of the organisation (- the *Empowering Leadership* model discussed earlier advocates this process) and investigates risk in every aspect and devise programmes to circumvent it. If a credible programme for such circumvention can be devised, then the project is likely to go ahead, because it will not be blindly hindered by the imposition of an arbitrary risk premium.

In summary, it is suggested that projects should be assessed in greater depth [35]. The investor should know the problems that might arise in manufacturing, in marketing and even administration. They must discuss the options at each stage of the project with every member of the organisation concerned, and if an adequate programme for dealing with probable eventualities is defined then the project should be appraised as though it was risk free.

The entrepreneurial-management perspective regarding this is that by investigating and planning thoroughly, the risk profile of the project or business venture is decreased considerably as a result of its conversion from a hindrance and obstacle to development, to a *calculated risk* with appropriate alternate action available to circumvent such obstacles.

## 4.6 Chapter Summary

This chapter has attempted to outline the *engineering process*, which includes the process of engineering thinking and the parity with entrepreneurial thinking, the product design process, product strategy, the make or buy decision, product development for production, selling and marketing of engineering products from the entrepreneurial perspective. These have embodied the most important considerations that are needed when the entrepreneurial engineer approaches the engineering process. The chapter has concluded with In addition, it discusses the profession of *consulting engineering* as an entrepreneurial engineering route.

## Chapter 5

# Practical Assessment of Entrepreneurial Engineers

### 5.1 Introduction

In the context of this dissertation, research was conducted to identify the practical tools regarded by entrepreneurial engineers as relevant for success. The research includes relevant case studies.

### 5.2 Case Study of Successful Entrepreneurial Engineers

In a study conducted by the IEEE Spectrum [34], nine flourishing entrepreneurial women engineers (of which 4 were MBA graduates) have been interviewed to identify what they regarded as essential milestones and characteristics necessary for successful entrepreneurship.

At the most basic level, the women feel that the requirements for entrepreneurial success are the same for women and men. The consensus amongst these engineers is that in addition to the requirements of aptitude, determination and independence in order to succeed as entrepreneurs, there is a need for experience and contacts, which is best gained by spending a few years working in industry.

The main results from this survey are the following:

- Before going into your own business, it is necessary that you have a secure skill set and that you *have something to offer* to industry.
- Anyone wishing to go into business as an entrepreneur needs contacts.
- To become a successful entrepreneur one has to learn to overcome the obstacles.
- Initially, one has to do a type of SWOT (strengths, weaknesses, opportunities and threats) analysis on oneself, as well as identify potential markets.
- When starting a business, it is necessary to go through the process of figuring out what skills does one have, who does one know, where has one worked, what does one like, and where is the need? What's different about the individual compared with what everybody else knows? It is necessary to take the time to evaluate what the market is and what is changing.

- As an entrepreneur, to be successful one has to have a good name in the marketplace - credibility in the marketplace is as important as the skill set. One has to work in another environment first to gain experience on what works and what doesn't work in order to determine the environment that is right for the individual.
- One should educate oneself with the commitment that is required in order to become a successful entrepreneur.
- Every individual should identify his or her capacity for risk and take appropriate action - The ways of financing a business depend partly on how you can do it, but it also depends on how you feel comfortable - using debt capital or not.
- Being an entrepreneur means taking responsibility. Accepting and committing to the investment of time and effort, in addition to the monetary demands.
- Being an entrepreneur means being one's own boss. Having control of one's time, money and destiny.
- Being an entrepreneur presents new challenges constantly.
- Generally, engineers are very good at seizing opportunities, looking for solutions, and then moving on to the next challenge.
- Being an entrepreneur is emotionally risky.
- Being an entrepreneur carries high business risk.
- As an entrepreneur with one's own business, it is *bet-your-company* time all the time.
- Being an entrepreneur requires management of personnel - it is difficult to handle human issues when one is trained technically.
- Being one's own boss requires strict financial management - avoid being undercapitalised.
- Being an entrepreneurship demands the ability to learn and develop within one's environment - figuring out all the regulatory matters e.g. tax issues.
- Being an entrepreneur requires one to work long hours.
- In seeking a business partner, one should identify one's skills and limitations and find a partner that can enhance and complement them. As a partnership develops, one should be aware of its limitations and another party should be found and brought into the

circle of trust. A successful partnership is created by diverse personalities.

- Being one's own boss provides one with the flexibility to manoeuvre and manage one's resources of time and money.

The results of this study correlate the characteristics of the entrepreneurial engineers with the theoretical characteristics of entrepreneurs as discussed in chapter 3.

## 5.3 Field Research

The objectives of the field research are twofold:

- To test whether the personal characteristics of the engineer (the corporate engineer) are congruent with those specified by theory as requirements for successful entrepreneurship;
- And to assess the specific traits and attributes of engineers who have successfully entered into an entrepreneurial career.

### 5.3.1 Research questionnaire for entrepreneurial engineer identification

The field research questionnaires have been drawn up based on the suggested methodology stipulated in *Business Research Methods* [1].

#### 5.3.1.1 Level 1 - the management question

This *management question* refers to the basic research objective of the field study. This objective is to answer the following question:

- In general, can engineers become successful entrepreneurs?

#### 5.3.1.2 Level 2 - the research question

The *research question* reflects the general purpose of the research. The purpose is to establish the following:

- In general, do engineers possess the skills or ability to become entrepreneurs? If not, what are the specific skills that are lacking for such an evolution to occur?
- Are there any engineering-related experiences or skills that have assisted in the success of existing entrepreneurial engineers?
- Does the experiential background of the engineer influence his or her potential to succeed as an entrepreneurial engineer?

### **5.3.1.3 Level 3 - investigative questions**

Level 3 refers to the specific questions that must be answered in order to answer the broad research question defined in level 1 above.

The investigative questions have been divided into two separate components, aimed at engineers working in a corporate environment (corporate engineer) and private business (entrepreneurial engineer) respectively.

The specific questions targeted toward the corporate engineer are:

- Are the personality traits of the engineer similar or congruent with that of the typical entrepreneur?
- Are there similarities between the motivational factors of engineers and entrepreneurs?
- Is there an awareness of, or tendency toward an entrepreneurial career as a career path?
- In general, do engineers possess skills necessary to start-up or run a business?
- If the desire to pursue an entrepreneurial career has been identified, are there specific obstacles that hinder such progress?

The specific questions targeted toward the entrepreneurial engineer are:

- Are there specific academic skills, in the opinion of the entrepreneurial engineer, that has contributed toward his or her success, and if so, when were these skills acquired?
- Has the entrepreneurial engineer's work experience contributed to his or her success, and if so, in which way?
- What are the specific obstacles that entrepreneurial engineer's have encountered that hindered entrepreneurial success?
- What are the decision/risk-taking processes that promote success?
- Did the entrepreneurial engineer seek outside assistance in starting-up the business and what were these sources?

### **5.3.1.4 Level 4 - measurement questions**

Level 4 is the final step in drawing up the research questionnaire; it refers to the questions that make up the actual questionnaires.

These questions are listed below:

#### **A. Corporate Questionnaire:**

- Are there similarities between the characteristics of engineers compared with those of entrepreneurs

- a) Does the engineer possess a strong competitive spirit?
- Are you generally competitive in nature?
  - Do you enjoy the challenge of new opportunities?
  - In general, does your competitive spirit assist you in overcoming obstacles?
  - Do you enjoy taking risks?
- b) What is the engineer's attitude toward work?
- Do you regard work as fun?
  - Do you actively make your work more enjoyable?
  - How do you manage your work during difficult/stressful times?
- c) What level of commitment does the engineer have, and what is his/her driving force?
- Are you committed to success?
  - What is "success" for you? Money, Career, Independence, Other?
  - How do you rank your desire for success?
  - How do you rank your current skills as a requirement for success?
- d) Is the engineer goal directed?
- Are you goal directed?
  - Do you plan towards achieving your objectives?
  - Do you focus on the ends rather than the means?
  - Do you review your goals regularly?
  - How far ahead do you plan your goals: 1w/1m/1yr/3yr/5yr/10yr?
  - Are you sure of what you hope to achieve (what your final objective is)?
- e) Is the engineer generally optimistic and realistic?
- Do you consider yourself an optimist?
  - Do you fear failure?
  - Do you possess a good sense of humour?
  - Do you believe in yourself?
  - Are you realistic in your goals?
  - How do you manage failure and how will you go about after you failed?
- f) Is the engineer capable of taking risks?
- Do you make wild decisions or are you a *calculated* risk taker?

- Do you reduce risk by "doing your homework" beforehand?
- Do you try and retain control of as much of the outcome of your decisions as possible?
- In general, do you have a backup plan in the event of failure?
- How do you handle uncertainty?
- Does taking risks upset you unduly?
- To what extent do you rely on extensive information before making decisions?
- How do you rank your preparedness to take risk?

g) How does the engineer confront/handle stress?

- What is your attitude toward responsibility for your actions?
- Do you encounter considerable work-related stress or pressure?
- How do you handle/control stress?
- Are you generally a patient person?
- Do you partake in any extra mural activities?

h) How does the engineer approach problems?

- Do you identify problems readily?
- Do you solve problems creatively?
- Do you solve problems by innovating?
- In general, do you strive to improve things?
- How do you rank your potential to implement innovations?
- How do you rank your ability to conceptualise thoughts and ideas?
- What techniques do you use to solve problems?

i) How does the engineer fare in recognising new opportunities?

- Do you identify opportunities readily?
- Do you create opportunities?
- Do you exploit opportunities promptly?
- Do you anticipate trends and opportunities that are not generally apparent?
- How do you rank your attitude toward new opportunities?
- How do you rank the utilisation of opportunities rather than resources?
- How do you go about changing threats into opportunities?

j) What are the general self-attitudes of the typical engineer?

- How do you rate your mental ability?
- How do you rate your conceptual skills?
- Do you strive for independence?
- Do you possess your own leadership style?
- Do you monitor your position relative to your goals?
- What is your attitude toward money?

- Would you like to be your own boss?
- Are you in control of your future?
- Do you have a strong need for control?
- Does inefficiency agitate you?
- Do you expect change to occur quickly?
- Do you have a strong desire to get involved in affairs that concern you?
- Are you a perseverant person?
- Do you possess resoluteness/decidedness?
- Do you demand honesty/righteousness?
- How do you rank you "business sense"?
- Do you possess strong team-building skills?
- Do you enjoy inspiring others? How?
- Do you learn from your mistakes?
- Do you strive for independence?
- How do you rate your personal integrity?
- How do you rate trustworthiness as a requirement for success?

k) What are the environmental factors that influence the engineer?

- Are you satisfied with your current financial position?
- Are you satisfied with your career?
- Do you envisage a long career within an organisational environment?
- In what position do you see yourself in 3-5 years; 5-10 years (i.e. short, medium and long term goals!)
- Do you approach each day with renewed vision and mission?
- Does the challenge and excitement of your career stimulate you?
- Who is your role model? What is his or her profession?
- What is/was your fathers primary profession?
- Do you have a career path planned out yet?
- Do you continuously upgrade your skills via training/studies?
- Do you interact with outside company's (suppliers, sub-contractors etc)?
- Do you actively seek out to expand your network of business-contacts?
- Do you have a mentor?
- What resources do you use to keep yourself abreast with the latest trends in the engineering field?
- Are you currently studying? What course/direction?

l) What is the engineer's attitude toward time?

- Do you regard time as a resource?
- How do you rank your utilisation of time?
- Do you plan the utilisation of your time? (Hourly, Daily, Weekly?)



- What time management systems do you utilise?
- m) Is there an awareness of, or tendency toward an entrepreneurial career as a career path?
- Have you considered starting up your own business?
  - Is the nature of this business related to your engineering field?
  - Have you consulted (or considered) external sources in order to develop the idea further? (e.g. SBDC, Banks, Business Consultants)
  - How far are you from implementing/starting up the new venture? (Business Plan, Partners, Business Registration, Market Survey etc)
  - If you had the opportunity now, would you leave your current job to enter into self-employment?
- n) In general, do engineers possess skills necessary to start-up or run a business (business acumen)?
- Do you have any experience in running or starting-up a small business?
  - Have you ever had *any* business related training (e.g. business management, financial management, course on starting up your own business, attended seminar etc)?
  - Have you ever invested in someone else's business - with the objective of making a profit?
  - Do you feel that you are capable of managing a business on your own?
- o) If the desire to pursue an entrepreneurial career has been identified, are there specific obstacles that hinder such progress?
- Are there any skills that you can identify, as currently lacking, which may assist you if you decide to start your own business?
  - What resources are you lacking at the moment? Market Intelligence, Money, Personnel, Technology, Other?
  - If you wanted to start your own business, can you identify specific points that the government could implement to encourage or promote the development of such a business?

## **B. Entrepreneurial Engineering Questionnaire:**

- a) What is the entrepreneurial engineer's background?
- What field of engineering?

- What academic qualifications?
- What work experience prior to setup?
- Current age?
- Age at which the entrepreneurial engineer entered an entrepreneurial career?
- Number of successful start-ups?
- Existence of a family business and the influence of this on entering an entrepreneurial career?

b) Identify the specific nature of the company and the initial start-up constraints?

- When did you decide you wanted to setup your own business?
- What was the primary factor that influenced the decision to start your own business (desire for independence, financial incentives, "calling", peer-pressure etc)
- What influenced your selection of the nature of your business? (Engineering field, experience etc.)
- What form of business did you start-up with? (sole proprietorship, partnership etc)
- What was the source of your start-up capital? (own funds, bank finance etc)
- What is the current size of the company?
- Did you have a business plan in place when beginning the new venture?
- Where did you start-up the new venture (at home, garage, office, within company)?

c) Are there specific academic skills, in the opinion of the entrepreneurial engineer, that has contributed toward his or her success, and if so, when were these skills acquired?

- How did your engineering background assist you in your business?
- What competencies (skills, attitude, and knowledge) do you view as necessary for running a business? (business management, financial management, "how to run your own business", personnel management, accounting etc)
- How did you rate the need to understand the basic business functions (finance, marketing, human-resource etc) prior to starting up the new venture?
- What is your attitude toward planning for goals/objectives, and how do you organise you activities to meet those goals? (goal review, time-management, milestones, "project-planning" etc)
- How do you approach the relation between work activities and the financial implications that stem from such activities (effective resource management, aim to minimise costs, improve productivity etc)

- d) Has the entrepreneurial engineer's work experience contributed to his or her success, and if so, in which way?
- Did you work in industry prior to starting up your own business? If so, did this experience contribute to your success and in which way?
  - How do you rank experience as a contributory to entrepreneurial success?
  - What aspect of experience do you regard as particularly important? (people networking, technical skills development, trade and market intelligence etc)
  - If you could pre-plan your career path, what would it look like?
- e) What are the specific obstacles that entrepreneurial engineer's have encountered that has hindered entrepreneurial success?
- What specific obstacles hindered your development? (Finance, experience)?
  - How did you overcome these obstacles?
  - Do you think it is possible to avoid or reduce the risk of entrepreneurial failure? If "yes" - how?
- f) What are the decision/risk-taking processes that facilitated success - management traits?
- What is your attitude toward taking risk?
  - How do you make decisions? (based on information, hunch etc)
- g) Did the entrepreneurial engineer seek outside assistance in starting-up the business and what were these sources?
- Did you seek out outside assistance in starting up and if so what was the nature of this assistance? (advice, financial support, partnership - shared responsibility etc, legal assistance, technical assistance)
  - Did you consult any professional organisations for assistance? (SBDC, Consultancy etc)
  - If the nature of your business was technologically based did you buy-in existing technology and develop on that or did you develop unique products or services?
  - If your company took a technology transfer, what advantages/disadvantages do you attribute to such development?
- h) Does the entrepreneurial engineer still function as an engineer or is he/she primarily involved with management?
- Do you still do engineering work?

- Do you manage the business yourself, and if so then which form? (general, marketing, director etc)
  - If in management, have you had formal training and if so did such training benefit you?
  - What is your management approach? (consultative, democratic, authoritarian)
- i) What are the leadership traits of the entrepreneurial engineer?
- What mechanisms do you employ to motivate others in your organisation?
  - Do you delegate most of your tasks?
  - Do you assume leadership in the event of a crisis?
  - Do you create the conditions wherein the work may be executed?
  - Do you listen to staff grievances and do you offer support where you can?
- j) How has an entrepreneurial career affected the entrepreneurial engineer's personal life?
- How has an entrepreneurial career affected your family?
  - How do you manage your business and personal life?
  - What is your first priority in life? (business, family, to-enjoy-life etc)
  - What is your second priority in life?
  - How do you manage your time resource?
  - How do you measure your success?
  - How do you handle stress? (sport, holidays, don't handle it etc)
  - Do you seek out new opportunities?

After the basic questionnaire was drafted (based on the methodology described above), it was given to a human resources consultant [41] for review and criticism. This was done to ensure that the psychometric nature of the questionnaire was suitable, as well as if the investigative questioning was appropriate. The final document was then generated.

Refer to appendix 2 and appendix 3 for the respective corporate questionnaire and engineering questionnaire, which were handed to the participants concerned.

### **5.3.2 The sampling plan**

The *corporate engineering questionnaire* was circulated amongst eleven employed-engineers working in a corporate environment; to achieve the objectives discussed above. For the purpose of this research study, the sample size is considered suitable, however for a more accurate study which could be the scope of future research, it would be preferred that a much wider sample be taken.

An *entrepreneurial engineering questionnaire* was circulated amongst seven successful entrepreneurial engineers; to answer the questions described. Over a 6-week period, only four of the seven candidates responded with a completed questionnaire. The study has thus been based on a sample size of four. Again, the sample size of four (in viewed in conjunction with the case study discussed in section 5.2) is deemed suitable for this research study, however for more accurate conclusions (statistically) it would be preferred that a much wider study is conducted, which could form part of future research.

The questionnaires were distributed by hand-delivery, facsimile and by electronic mail where available.

Toward the end of this research study, an html (Internet-Web based questionnaire) format research questionnaire was investigated. It is suggested that for future data collection from sources that have access to the Internet, a web-based questionnaire should be considered as a viable option. This should allow data to be collected from any source worldwide, with little time and expense invested.

### 5.3.3 Results of field research

The questionnaires were distributed on the 23 March 1998 and requested back by the 31 April 1998. The conclusions derived from these tests are discussed below.

#### 5.3.3.1 Corporate questionnaire results

##### Discussion of Sample

- A total of eleven corporate engineers were tested (five engineers from Eskom Ltd. and six from Transtel (Division of Transnet Ltd.)).
- The fields of study, age group and work experience of the engineers tested are indicated in table 3 below.

**Table 3: Corporate field research participants:**

<b>Engineer Qualifications</b>	<b>Age Range</b>	<b>Work Experience (Years)</b>
Electronic B.Eng.	21-30	4.5
Electrical Bsc.Eng.	31-40	7
Electrical B.Ing.	21-30	1.4
Electronic Bsc.Eng.	31-40	6
Electrical Bsc.Eng.	21-30	1
Electrical Bsc.Eng, Msc.Eng.	21-30	3
Electrical B.Ing.	21-30	1.25
Mechanical B.Ing.	21-30	1.5
Industrial B.Ing.	21-30	1.5
Electrical B.Ing.	21-30	2
Chemical B.Ing.	21-30	1.33

## Statistical results from questionnaire

With Reference to the tally sheets in appendix 4 which summarises the answers from the engineers tested, the following general conclusions may be made (based on the sample taken); "a" through "n" below, refers to the questions defined in section 5.3.1.4 above; the notation cq-XX used below is the answer to question XX in the *corporate questionnaire*:

- a) 90% of Engineers possess a highly competitive spirit.
  - Most engineers are competitive in spirit (cq-25).
  - Most engineers utilise their competitive spirit to overcome obstacles (cq-26).
  - Most engineers enjoy the challenge of new opportunities (cq-28).
  - 59% of engineers enjoy taking risks (cq-27).
  
- b) 89% of Engineers have a positive attitude regarding work.
  - 95% of engineers consider work to be fun (cq-29).
  - 91% of engineers actively attempt to make their work enjoyable (cq-30).
  - 82% of engineers actively manage their work during stressful times (cq-31).
  
- c) 73% of Engineers are committed toward becoming successful.
  - 91% of engineers are committed to success (cq-32)
  - 32% of engineers measure success by money or personal independence (cq-33).
  - 91% of engineers have a high desire for success (cq-34).
  - 77% of engineers rank their current skill as adequate to become successful (cq-35).
  
- d) Defined goals and objectives direct 66% of Engineers efforts.
  - 91% are goal directed (cq-36).
  - 64% formally plan to meet specific objectives (cq-37).
  - 45% of engineers focus on the ends rather than the means (cq-38).
  - 64% regularly review their goals (cq-39).
  - 55% plan for the medium to long term (3Years+) (cq-40).
  - 77% of engineers are certain what they hope to achieve (final objective) (cq-41).
  
- e) 61% of Engineers are optimistic and realistic in their approach to things.
  - 82% of engineers are optimistic in attitude (cq-42).

- 45% of engineers do *not* fear failure (cq-43).
- 91% of engineers possess a good sense of humour (cq-44).
- Most engineers have confidence in themselves (cq-45).
- 91% of engineers have a realistic approach to things (cq-46).
- 86% of engineers actively manage failure (and learn from their mistakes) (cq-47).

f) 78% of Engineers are capable of taking risk;

- 91% of engineers take calculated risks (cq-48).
- 91% attempt to reduce risk by prior research (cq-49).
- 90% try and retain control of the outcome of their decisions (cq-50).
- 82% have a backup plan in the event of failure (cq-51).
- 73% of engineers do not feel uncomfortable with taking risk (cq-52).
- Most engineers handle uncertainty by attempting to quantify the situation and then taking a decision (cq-53).
- 45% have the potential to take risk based on limited information (cq-54).
- 50% Engineers have an above average risk taking potential (cq-55).

g) 71% of Engineers actively manage stress via some mechanism (sport, relaxation etc.).

- Most engineers take responsibility for their actions (cq-56).
- 64% of engineers function in a stressful environment (cq-57).
- 91% of engineers actively handle stress via some form of stress-release (cq-59).
- 27% of Engineers are impatient (seek quick results) (cq-59).

h) 82% of Engineers try and find creative and innovative solutions to their problems.

- Most engineers identify problems promptly (cq-62).
- Most engineers attempt to solve problems creatively (cq-63)
- Most engineers attempt to solve problems by innovating (cq-64).
- Most engineers strive to improve things (cq-65).
- 45% of engineers have the potential to implement their innovations (cq-66).
- 64% of engineers are highly confident in their conceptualisation skills (cq-67).
- 68% of engineers use common sense and/or formal logic/analysis techniques to solve problems (cq-68).

i) 60% of Engineers recognise opportunities readily.

- 82% of engineers identify opportunities readily (cq-69).

- 55% of engineers seek out to create opportunities (cq-70).
  - 55% of engineers take advantage of opportunities promptly (cq-71).
  - 36% generally identify trends and opportunities that are not obvious (cq-72).
  - 59% of engineers have the motivation to take advantage of opportunities (cq-73).
  - 71% of engineers actively change threats into opportunities (cq-75).
- j) 83% of Engineers possess self-attitudes that correlate with that required for successful entrepreneurship.
- 91% of engineers have confidence in their mental ability (cq-76).
  - 86% of engineers are confident about their conceptual ability (cq-77).
  - 59% of engineers consider themselves to possess a good sense for business (cq-78).
  - Most engineers have a high regard for their personal integrity (cq-79).
  - 95% of engineers regard trustworthiness as a requirement for success (cq-80).
  - Most engineers strive for independence (cq-81).
  - 86% of engineers considers themselves to have their own leadership style (cq-82).
  - 64% of engineers regularly assess their performance relative to their future goals (cq-83).
  - 91% of engineers would like to be their own bosses (cq-84).
  - 90% of engineers believe that they are in control of their destiny (cq-85).
  - 55% of engineers have a strong need for control (cq-86).
  - 45% expect change to occur quickly (cq-87).
  - 91% of engineers involve themselves in issues concerning their future (cq-88).
  - 95% of engineers consider themselves to be perseverant (cq-89).
  - Most engineers are resolute/decided (cq-90).
  - Most engineers demand honesty/righteousness in their affairs (cq-91).
  - 86% of engineers considers themselves to possess strong team-building skills (cq-92).
  - Most engineers enjoy inspiring/motivating others (cq-93).
  - Most engineers attempt to learn from their mistakes (cq-94).
  - 27% of engineers regard money as a measure of success (cq-95).
  - 86% of engineers seeks to reduce/eliminate inefficiency (cq-96).



k) 73% of Engineers in the corporate environment intend on following some form of entrepreneurial activity (private business or consultancy) in the medium to long term (3 years ahead).

- Most engineers are comfortable with their current financial situation, yet welcome the challenge of earning more money (cq-6).
- 36% of engineers employed in the corporate environment are dissatisfied with their careers (cq-7).
- 32% do not envisage a permanent career in an organisational environment (cq-8).
- 64% of engineers plan to be in private business in the medium to long term (3 years +) (cq-9).
- A defined vision and mission in life (cq-10) drive 45%.
- 80% of engineers approach each day with a vision and mission (cq-11).
- 68% of engineers have a general career path planned out (cq-14).
- Most engineers seek to continuously upgrade their skills via studies or training (cq-15).
- Most engineers interact with external companies (external to the organisation) (cq-16).
- Most engineers actively seek to expand their business contacts (cq-17).

l) 87% of Engineers regard time as a vital resource.

- Most engineers regard time as a scarce resource (cq-21).
- 55% of engineers attempt to optimise their time usage (cq-22).
- 91% of engineers plan their use of time in advance (cq-23)
- Most engineers make use of a time management system (cq-24).

m) 56% of engineers have already considered starting up a business with some basic planning in place, and 75% of engineers are willing to enter into self-employment immediately if the opportunity arises.

- 64% of engineers have considered starting up their own businesses (cq-97.1)
- 29% of engineers have already consulted external sources regarding starting up a business (or exploiting an idea) (cq-97.2ii).
- 75% of engineers are prepared to leave their current job to enter into self-employment, if the opportunity arises (cq-97.3)

n) 53% of engineers feel that they possess adequate skills to start-up a business.

- 20% of engineers have previous experience in running a business (cq-98).
- 85% of engineers have had business related training (cq-98.3).

The above statistics are derived from the results of the questionnaire conducted amongst engineers working within the corporate environment. The results for question a) to n) are summarised graphically in figure 16 below (expressed as a percentage of the total engineering population, based on the sample taken).

### **Corporate engineer and entrepreneur deviations:**

The entrepreneurial characteristics which engineers (on average, based on the sample) lack or deviate from, are the following:

- Only 32% of engineers measure success by money or personal independence (cq-33).
- Only 45% of engineers focus on the ends rather than the means
- Only 45% of engineers do not have a fear of failure (cq-43).
- Only 45% of engineers are prepared to take risk based on limited information (cq-54).
- Only 27% of engineers require immediate performance/quick results (cq-59).
- Only 45% of engineers have the potential to implement their innovations (cq-66).
- Only 36% generally identify trends and opportunities that are not obvious (cq-72).
- Only 27% of engineers regard money as a measure of success (cq-95); entrepreneurs in general regard money as a success.
- A defined vision and mission in life (cq-10) drive only 45% of engineers.

### **Discussion of results**

Since the questionnaire has aimed to establish a basis for comparison between the characteristics of corporate engineers and entrepreneurs (as discussed in chapter 3), the above statistics indicates that engineers are ideal candidates for an entrepreneurial career.

The *capacity to take risk* is deemed particularly significant in this discussion, since this is one of the distinguishing criteria for success. The results indicate that engineers in general are not inherently risk averse, yet they prefer to quantify most situations and take a risk best on a *calculated assessment*.

# Entrepreneurial Engineering Potential

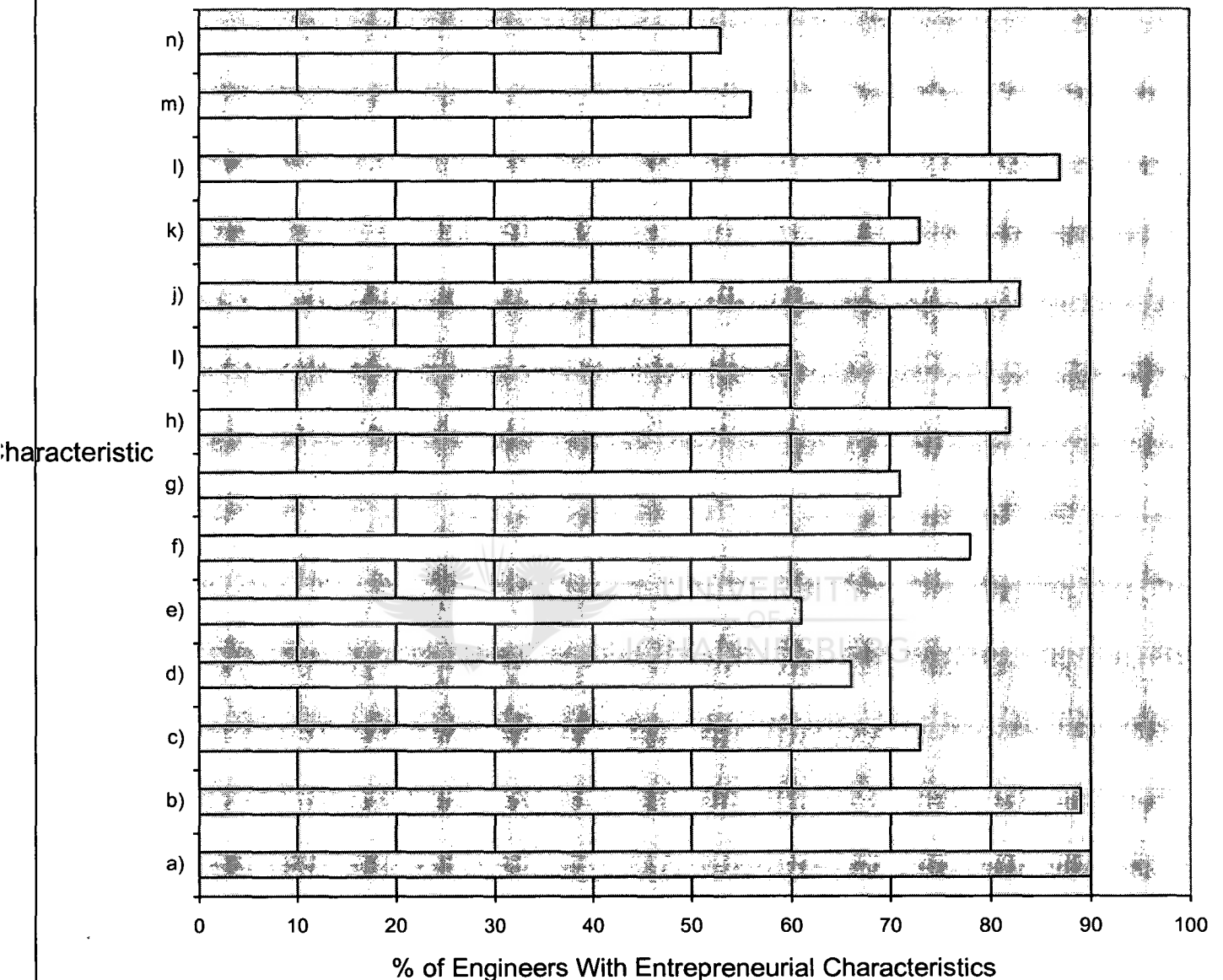


Figure16: Entrepreneurial Characteristics Profile of the Engineering Population in the Corporate Environment

In addition, the results show that money is not the primary measure of success for engineers (whilst for entrepreneurs money is the primary measure of success). This difference in measurement of success may be related back to Maslow's pyramid discussed earlier (chapter 2), and the level at which the engineer is categorised. The results also indicate a lack of defined vision and

mission in life (in about half the engineering population). This lack of focus on goals/objectives and the identification and exploitation of opportunities are issues that could be addressed by suitable training programs and exposure, as discussed in this document (through Drucker-style management, an organisation may encourage innovation and creativity in the workplace). Perhaps Universities could formally target the development of creativity and innovation processes via formal programs to enhance these faculties as well as to equip the engineer with skills which will enable him or her to exploit these.

In general however, it may be concluded that more than half of the engineers working within the corporate sector satisfies the requirements for successful entrepreneurship.

### 5.3.3.2 Entrepreneurial engineering questionnaire results

#### Discussion of the sample:

- Four engineers in private business responded, from a targeted sample of seven candidates;
- The field, age and work experience profiles of the engineers tested are listed in the table 4 below.

**Table 4: Entrepreneurial engineering field research participants:**

<i>Candidate</i>	<i>Engineer Qualifications</i>	<i>Age Range</i>	<i>Age Range at which entered into entrepreneurial career</i>	<i>Work Experience Prior to Entrepreneurial Career (Years)</i>
1	Electronic Ph.D.(Eng.)	41+	30-40	14
2	Electrical Ph.D.(Eng.), Postgraduate Diploma in Marketing Management	31-40	31-40	15
3	Mechanical M.Eng.	31-40	31-40	7
4	Electrical Bsc.Eng.	41+	31-40	12

#### Results of questionnaire

(Items *a* through *j* below refers to the investigative questions discussed in section 5.3.1.4 above; the numbers below correlate with the respective question numbers in the entrepreneurial engineering questionnaire in appendix 3.

#### a) Candidates' Background

- 6) The number of successful start-ups of the candidates studied:

- Candidates 1 and 3 had no other start-ups besides the existing one.
- Candidate 2 had 2 prior start-ups. One successful/One not successful.
- Candidate 4 failed to answer this question.

7) Existence of a family business and the influence of this on entering an entrepreneurial career?

- No family business/influence on the entrepreneurial career of the participants.

b) The specific nature of the company and the initial start-up constraints:

9) Primary factors influencing candidates to start their own businesses:

- The nature of business of all the participants was influenced by their engineering field of study and the work experience derived in industry.

10) Business form of the start-up business:

- Participants started their businesses as a company or close corporation.

11) Source of start-up capital:

- Candidates 1 and 2 identified a funding/sleeping partner.
- Candidates 3 and 4 used their own capital to finance their businesses.

12) What is the current size of the company?

- Candidate 1's business has 100+ employees
- Candidate 2,3 and 4's businesses have 1-25 employees.

13) Existence of a business plan prior to initiating the business?

- All candidates had some plan in place (detailed /partial).

14) Reason for going into entrepreneurial career:

- Desire for independence.
- Opportunity to offer something unique to market.
- Realising a dream.

c) Specific skills that has contributed toward entrepreneurial success:

22) Academic background:

- All candidates identified this as being essential;
- Academic background provides strategic direction;
- Academic background essential due to the high technological inputs required by the business.

23) Competencies (skills, attitude, knowledge) deemed necessary for running a business:

- All candidates identified business management, financial management, experience, personnel management, accounting etc as important, though at varying degrees depending on the stage of development of the business.
- In the initial stages, decision making, selection of opportunities and resource constraints are most important.
- In addition, the need to understand legal and labour law was mentioned.

24) The need to understand the basic business functions (finance, marketing, human-resource etc) prior to starting up the new venture:

- Candidates 1 and 3: Important, though it can be learnt whilst running the business.
- Candidate 2 and 4: Essential

25) The need for prior formalised planning for goals/objectives:

- All candidates identified that it is essential to have goals and a planned path by which these may be achieved.
- Candidates review of goals and use time-management systems;
- Project management approach is also used to organise activities.

26) Approach to work activities and the financial implications that stem from such activities:

- Candidates 1, 2 and 4 identified effective resource management as the method of managing work and financial issues.
- Candidate 3 identified the improvement of productivity as the method of approach.

d) Has the entrepreneurial engineer's work experience contributed to his or her success, and if so, in which way?

17) Ranking of experience as a requirement for entrepreneurial success:

- Candidates 1, 2 and 4 identified experience as essential for success.
- Candidate 3 identified experience as important, but can be learnt whilst running the business.

18) Specific experience that is considered important:

- Candidates 1 and 2 have identified technical skills, market-intelligence and marketing as essential.
- Candidates 3 and 4 identified people networking as particularly important.

19) Possible planning of career path toward entrepreneurship:

- Candidate 1: No change
- Candidate 2: Technical studies, technical work, business studies, business work experience, business venture.
- Candidate 3 and 4: studies, work experience, then business.

e) Specific obstacles that entrepreneurial engineer's have encountered that has hindered entrepreneurial success:

42) Specific obstacles that hindered development:

- Candidates 1 and 2 identified inexperience in market strategy as a hindrance; also cash flow implications of new ventures. Overcome by continuous learning and seeking professional advice.
- Candidate 3 identified personnel problems as a hindrance. Overcome by greater self-reliance.
- Candidate 4 failed to answer this question.

43) Advice that may assist in avoiding or reducing the risk of entrepreneurial failure:

- Adequate strategy and planning.
- Know as much as possible.
- Listen to everyone but you must make your own decisions based on your own vision.
- Consult many experience people in field of business.
- Be prepared to work harder for longer periods and possibly for a lower salary than you would expect as an employee.

46) Suggestions for new start-ups:

- "Believe in yourself and your product/service otherwise you will give up when the going gets tough".
- Have a well thought out strategy and thorough marketing.
- "Work harder and smarter than your competition!"

- "Thorough preparation in all aspects, specifically business management, law and sources of finance are essential."
- "Don't rely on banks, financial institutions or government bodies for financial help."

f) Advice on decision/risk-taking processes that facilitated success - management traits:

44) Attitude toward taking risk:

- Quantification and management.
- Risks is essential, but don't bet the company on every project because it won't be too long before you fail. Rather have a number of smaller lower margin projects than one big one with an associated higher risk i.e. diversify the risk.

45) Decisions process:

- Decisions are based primarily on information (and sometimes on a hunch depending on the information available).

g) Outside assistance:

20) Outside consultation in starting up:

- Candidates 1, 2 and 4 sought Legal, financial and/or business advice prior to starting up their businesses.
- Candidate 3 - no outside advice taken.

21) Nature of technology/product:

- All candidates provided unique products for a specific market.

h) Involvement of the engineer:

27) Involvement:

- Candidates are involved in both engineering and management.
- Form of management involvement: Marketing management, technical management, financial management, strategic management and general management.
- Formal training in management: Candidate 1 and 3 had no formal management training but rather on-the-job experience in management. Candidates 2 and 4 had formal training prior to starting up and whilst running the start-up business, as well as on-the-job experience in management. Candidates identified prior management training as advantageous in



providing a good foundation, especially financial management.

28) Management approach:

- Candidates 1,2, and 3 have a consultative approach to management.
- Candidate 4: Delegation of tasks and making employees accountable for the success of their tasks.

i) Leadership traits of the entrepreneurial engineer:

29) Mechanisms employed to motivate others in the organisation:

- Productivity and performance evaluation.
- Team building.
- Create conditions wherein work may be executed.
- Encourage strong communication throughout the organisation.
- Share scheme.
- Financial incentives.

30) Task management:

- Delegate where possible.

31) Crisis handling:

- Assume leadership.

j) Impact of entrepreneurial career on entrepreneurial engineer's personal life:

34) Family impact:

- Candidates 1 and 2: Tough of family and many sacrifices.
- Candidate 3 and 4: Positive impact on family.

35) How do you manage your business and personal life?

- It is necessary to treat family like any other business meeting, booking time to the family, including weekends and holidays.
- Business tends to get preference.

36) Priorities in life:

- Candidates 1 and 2: First priority is the business, then family;
- Candidate 3 and 4: First the family, then the business.

38)Management of time:

- Diary and task lists.
- Computer software.
- Personal assistant.

39)Measurement of success:

- Money, Personal achievements, family, business achievements, client-satisfaction and enjoying what you are doing.

40)Handling stress:

- Sports
- Short breaks between work.

41)Seeking out new opportunities:

- Active business intelligence scans.
- Always on the look out. Friends and business associates.
- Once established, people also suggest ideas.

**Summary of results:**

The general attitudes, characteristics and management behaviour of the entrepreneurial engineers tested correlates with those discussed in earlier chapters as requirements for successful entrepreneurship.

## 5.4 Proposed Model for Entrepreneurial Engineering Development

The following model is proposed as a development path whereby the individual (engineer) may progress toward an entrepreneurial career, that is based on the characteristics and environmental factors identified in this dissertation as a result of the literature and field studies:

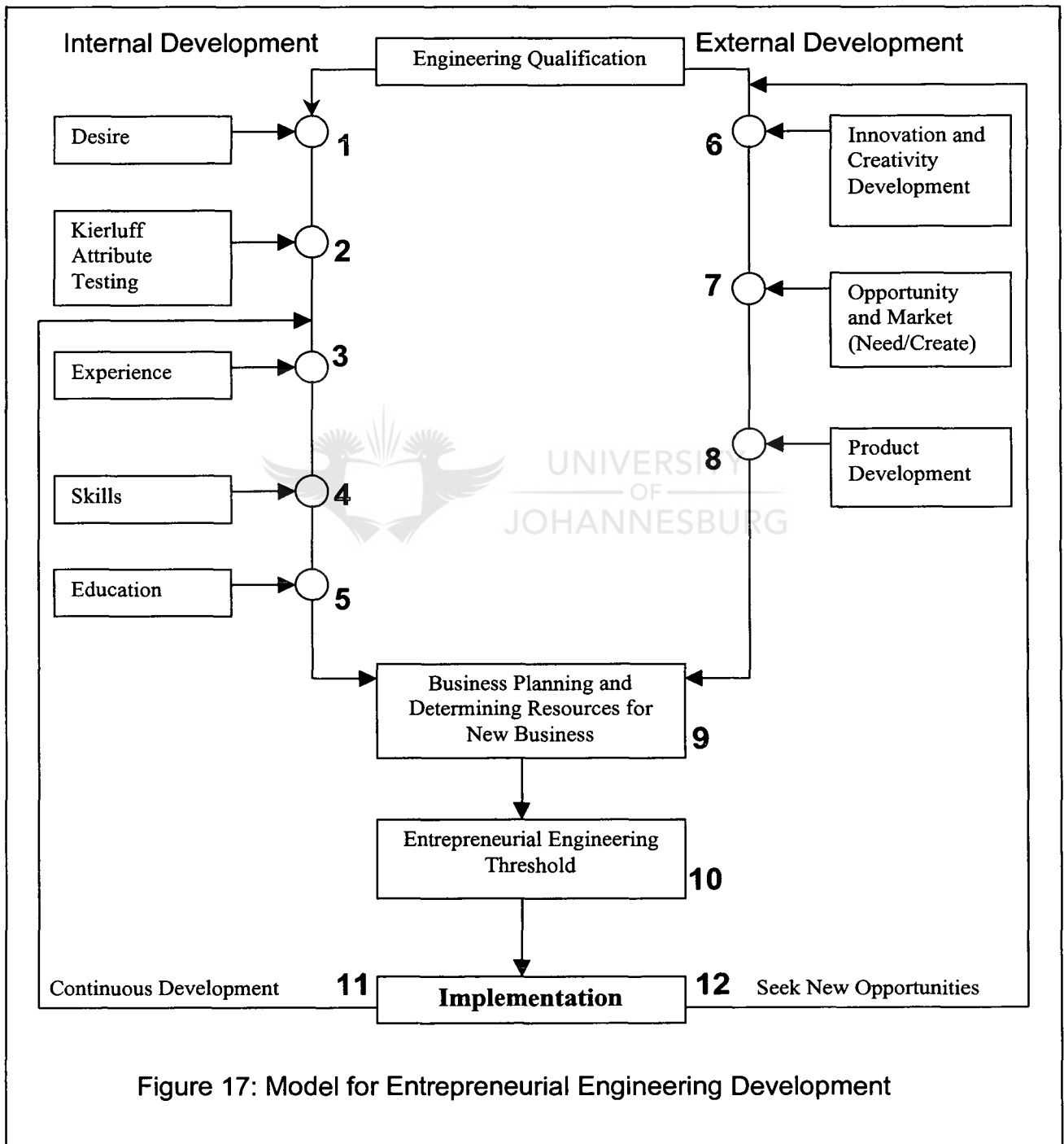


Figure 17: Model for Entrepreneurial Engineering Development

Figure 17 aims to incorporate the major input factors that contribute toward successful entrepreneurship. Taking the engineering qualification as the point of departure (although some texts regard entrepreneurial development as being partially influenced by the childhood years, as discussed in chapter 3, it is regarded as being beyond the control of the engineer and thus outside the scope of this model), the development process is categorised into *internal development* and *external development processes*.

Internal development refers to the input factors that determine the individuals personal characteristics, attitude, motivation, education, skills and experience. External development concerns the external factors that directly impact on the success of the entrepreneurial activity.

The model is interpreted as follows:

1. Upon graduation as an engineer, the individual has to identify the desire to pursue an entrepreneurial career. This decision is unique to every individual; the desire to pursue an entrepreneurial career could stem from the desire for independence, control of one's destiny, or one of the other factors discussed earlier.
2. Once the desire has been identified, it is necessary for the individual to conduct an analysis of oneself based on a model as proposed by Kierluff (discussed in Chapter 3), which tests the traits and characteristics of the individual as a measure of the potential for entrepreneurial success. The outcome of this test should highlight any shortcoming in the characteristics of the individual compared with the theoretical characterisation of an entrepreneur. The individual may then act on this information to evaluate and reduce possible weaknesses.
3. Once the basic personal characteristics and traits required have been assessed, one should then seek work within industry with the objective of obtaining experience, market intelligence and building contacts.
4. In conjunction with (3) above, the engineer should actively seek to enhance his or her set of skills, and identify a specific field that the individual has particular interest in; that he or she enjoys and is challenged by.
5. Once the specific field has been identified, the individual should aim to maximise his or her academic and experiential education in this field, making he or she a specialist in the identified field.
6. In parallel to the internal development, it is necessary for the individual to actively seek out to develop and enhance his or her creativity, and attempt to solve problems via innovation, as discussed in chapter 4.
7. The engineer should also become aware of market trends, market demand/needs and learn to identify opportunities readily. Such

identification is enhanced by work experience, market exposure, contacts and heightened creative and innovative potential.

8. Once a market/need has been identified, the engineer can then proceed to develop a product that meets the need, based on the developmental approach discussed (chapter 4). The individual should be sensitive to both the engineering and business related factors influencing the product design. These include price competitiveness, time to market, competitors products, needs, value, features etc.
9. At this point the individual should anticipate entrepreneurial success, having reached the end of the internal and external development processes. It is now necessary for the individual to quantify the business issues pertaining to the manufacture of the design for the identified market. This quantification process should be in the form of a business plan (see appendix 1), which incorporates every aspect of the business, including the source of finance, labour and skills for the business.
10. Once the business plan has been generated, the individual is now on the *entrepreneurial engineering threshold*. The engineer has the personal skills to succeed; he or she has identified a market for a specific product; he or she has developed the product; he or she has conceptualised a business plan to deliver the product to the market. It is now necessary for the engineer to take the *risk* attached with starting up the new business, based on the knowledge obtained from the internal and external development processes and the business plan. Once this risk has been accepted and the engineer has decided to implement the business plan, then the *entrepreneurial engineering threshold* has been overcome and the engineer is now considered an entrepreneurial engineer. The success or failure will be determined by the market's response to the product and the success of the business plan.
11. Upon implementation of the business plan and the resulting success or failure thereof, it is necessary for the individual to continue to upgrade his or her skills, experience and education in order to maintain his or her speciality and incorporate newer developments into his or her existing pool of knowledge.
12. It is also necessary to continue to develop the external creative and innovative processes, and seek out markets, opportunities and products in order to ensure the survival and growth of the business. At this stage, the above model becomes a "life cycle" for entrepreneurial engineering activity.

## 5.5 Chapter Summary

This chapter has discussed the case study of research conducted on entrepreneurial engineers, practical aspects of effective entrepreneurship and management and the field research that was conducted to test and compare the characteristics of engineers with the entrepreneurial characterisation from literature that was discussed in previous chapters. The primary conclusion of such evaluation has been validation that in general, most engineers working within the corporate environment possess the capability to become successful entrepreneurs and current entrepreneurial engineers' characteristics correlate with the characterisation in literature. The following chapter summarises the conclusions derived from this dissertation, as well as recommendations for future research based on conclusions made from this study.



## **Chapter 6**

# **Conclusions and Recommendations for Future Research**

### **6.1 Conclusions**

In conclusion, this dissertation has aimed to outline the concept of entrepreneurship and the merits of engineers pursuing such a career. The study has aimed to outline the broad management aspects that apply to engineers, particularly from the entrepreneurial perspective, and it has ultimately aimed to test the entrepreneurial potential of engineers who are working in an organisational structure and the characteristics of engineers who have successfully become entrepreneurs, in order to arrive at a conclusion on the viability of engineers functioning as entrepreneurial engineers.

Based on the data derived from the field research that was discussed in chapter 5, it is apparent that engineers in general (assuming that the small sample size does not subject an overly negative bias on the conclusions that have been made) have psychological profiles that make them ideal candidates for entrepreneurship. Apart from the exceptions discussed, the research question discussed earlier has thus been answered – “In general, engineers can become successful entrepreneurs”.

More specifically, it may be concluded that:

- In general, engineers possess the skills/ability to become entrepreneurs;
- Engineering-related experiences have assisted in the success of existing entrepreneurial engineers;
- The experiential background of the engineer does influence his or her potential to succeed as an entrepreneurial engineer.

### **6.2 Recommendations for Future Research**

As indicated, although the corporate and entrepreneurial engineering questionnaires were conducted on a suitable sample for the purpose of this dissertation, it is suggested that a greater sample should be taken in the future, to improve the statistical confidence of the data obtained. It is also recommended that an internet-based (World Wide Web) questionnaire should be used as an alternative. Many of the candidates, particularly amongst the entrepreneurial engineers, have access to the internet. The entrepreneurial engineers tested have indicated their constraint on time, which it is deemed is the reason for the poor success rate of data received, compared to the amount of candidates selected for the entrepreneurial questionnaire. Having

an internet-based questionnaire will eliminate the time taken to deliver the questionnaire to the candidate and the time taken for the candidate to return the questionnaires, as a result of its immediate nature. It is also advantageous in that software can be written to digitally process the results. Finally, by using an internet based questionnaire, there is effectively no real limit to the number of candidates that can be targeted for the questionnaire, since there is limited real cost and the scope is global.

It is further recommended that research should be conducted into the academic programs for undergraduate studies in engineering, particularly from the perspective of development and implementation of creativity and innovation processes. It is suggested that more business oriented courses be incorporated into undergraduate engineering programmes, particularly in areas of strategic marketing and business administration. This should result in new graduates having an enhanced background that may assist in their entrepreneurial careers, if chosen.

Finally, it is suggested that universities/government implement regular low-cost workshops wherein engineers and other technical workers may continuously learn new skills (hands-on), which will facilitate the experience process, enhance development and possibly accelerate the time taken for engineers to consider an entrepreneurial career as a viable alternative.





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## Appendix 1 - Business plan checklist [31]

	<b>Key Questions to Answer</b>
<b>1.</b>	<b>Executive Summary</b>
	<ul style="list-style-type: none"> <li>- Why will the business succeed?</li> <li>- What do you want to start (or change)?</li> <li>- How much money is required?</li> <li>- What is the return on the investment?</li> <li>- Why is the venture a good risk?</li> </ul>
<b>2.</b>	<b>Business Description</b>
	<ul style="list-style-type: none"> <li>- What type of business are you planning?</li> <li>- What products or services will you sell?</li> <li>- What type of opportunity is it (new, part-time, expansion, seasonal year-round)?</li> <li>- Why does it promise to be successful?</li> <li>- What is the growth potential?</li> <li>- How is it unique?</li> </ul>
<b>3.</b>	<b>Marketing</b>
	<ul style="list-style-type: none"> <li>- Who are your potential customers?</li> <li>- How large is the market?</li> <li>- Who are your competitors? How are their businesses positioned?</li> <li>- What market share do you anticipate?</li> <li>- How will you price your produce or service?</li> <li>- What advertising and promotional strategies will you use?</li> </ul>
<b>4.</b>	<b>Research, Design and Development</b>
	<ul style="list-style-type: none"> <li>- Have you carefully described your design or development?</li> <li>- What technical assistance have you received?</li> <li>- What research needs do you anticipate?</li> <li>- Are the costs involved in research and design reasonable?</li> </ul>
<b>5.</b>	<b>Manufacturing</b>
	<ul style="list-style-type: none"> <li>- Where will the business be located? Why?</li> <li>- What steps are required to produce your product or service?</li> <li>- What are your needs for production (e.g. facilities and equipment)?</li> <li>- Who will be your suppliers?</li> <li>- What type of transportation is available?</li> <li>- What is the supply of available labour?</li> <li>- What will it cost to produce your product or service?</li> </ul>
<b>6.</b>	<b>Organisation</b>
	<ul style="list-style-type: none"> <li>- Who will manage the business?</li> <li>- What qualifications do you have?</li> <li>- How many employees will you need? What will they do?</li> <li>- How will you structure your organisation?</li> <li>- What are your plans for employee salaries, wages, and benefits?</li> <li>- What consultants or specialists will you need? How will you</li> </ul>

	<p>use them?</p> <ul style="list-style-type: none"> <li>- What legal form of ownership will you choose? Why?</li> <li>- What licenses and permits will you need?</li> </ul>
<b>7.</b>	<b>Critical Risks</b>
	<ul style="list-style-type: none"> <li>- What potential problems could arise?</li> <li>- How likely are they?</li> <li>- How do you plan to manage these potential problems?</li> </ul>
<b>8.</b>	<b>Financial</b>
	<ul style="list-style-type: none"> <li>- What is your total estimated business income for the first year? Monthly for the first year? Quarterly for the second and third years?</li> <li>- What will it cost you to open the business?</li> <li>- What will your personal monthly financial needs be?</li> <li>- What sales volume will you need in order to make a profit during the first three years?</li> <li>- What will be the break-even point?</li> <li>- What will be your projected assets, liabilities, and net worth on the day before you expect to open?</li> <li>- What are your total financial needs?</li> <li>- What are your potential funding sources? How will you spend it?</li> <li>- How will the loans be secured?</li> <li>- What is your relationship with other interested parties (shareholding, profit-sharing etc.)?</li> <li>- How much of your business are you prepared to give away to interested parties?</li> </ul>
<b>9.</b>	<b>Milestone Schedule</b>
	<ul style="list-style-type: none"> <li>- What timing have you projected for this project?</li> <li>- How have you set your objectives?</li> <li>- Have you set up your deadlines for each stage of your venture?</li> <li>- Is there a relationship between events in this venture?</li> </ul>
<b>10.</b>	<b>Appendices</b>
	<ul style="list-style-type: none"> <li>- Have you included all important documents, drawings, agreements and references?</li> </ul>

**Appendix 2 - Research questionnaire for engineers working in the corporate sector**

# Corporate Engineering Questionnaire

Name:

Company:

.....

1. Engineering Background (Electrical, Mechanical, Civil etc)?

.....

2. Academic Qualifications

.....

3. Age-range?

21-30

31-40

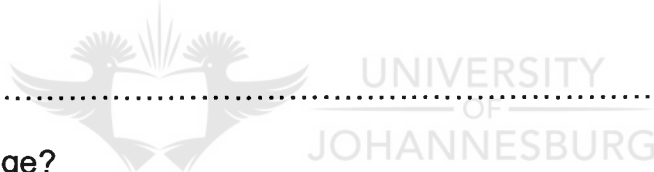
40+

4. Number of years working in the organisation?

.....

5. Number of years working in industry since you have stopped studying full-time?

.....



In the following questions, please tick off the response that best reflects your opinion:

6) Are you satisfied with your current financial position?

- Yes I am financially comfortable
- Yes I am comfortable but earning more money is a challenge for me
- No I have a shortage of capital
- No One can never be satisfied

7) Are you satisfied with your career?

- Yes I am following my planned out game plan of establishing a secure career within my company
- No I am unsure of my future career
- No I am dissatisfied with my current career and I am looking for an alternative

8) Do you envisage a long career within an organisational environment?

- Yes I enjoy the corporate environment - climbing the corporate ladder is a challenge for me
- Yes I enjoy the comfort and job security that a corporate structure offers
- No I intend

.....  
Please fill in your long term objective

9) In what position do you see yourself in 3 to 5 years; 5 to 10 years (i.e. short, medium and long term goals)?

- Short Term .....  
Career Objective Please fill in your objective  
(<12 months)
- Medium Term .....  
Career Objective Please fill in your objective  
(3 to 5 years)
- Long Term .....  
Career Objective Please fill in your objective  
(5yrs+)

10) Do you approach each day with renewed vision and mission?

- Yes My environment motivates and challenges me to define/review my mission daily and I actively plan my day for new challenges in working toward my vision
- No Each day is similar, with no major/new challenges steering me to success

11) Does the challenge and excitement of your career stimulate you?

- .....
- Yes Please provide more detail - in which way does it stimulate/excite you?
  - No My work is boring and routine, which and does not leave much room for career development.

12) Who is your role model? What is his or her profession?

.....  
Role-model Name: \_\_\_\_\_ Profession: \_\_\_\_\_

13) What is/was your fathers primary profession?

.....  
Profession: \_\_\_\_\_

14) Do you have a career path planned out yet?

- Yes I know exactly what my goals are and I know where I will be career wise in 5 to 10 years time
- No I don't have a plan
- No I'm still finding my feet

15) Do you continuously upgrade your skills via practical training or studies?

- Yes I actively seek out to learn new skills
- No I don't get many opportunities for training or time to study
- Yes I experiment regularly with new technology to stay with trends as they happen



16) Do you interact with outside companies (suppliers, sub-contractors etc)?

- Yes Sometimes/Often
- No Never

17) Do you actively seek out to expand your network of business-contacts?

- Yes
- No Contacts are not needed in my field

18) Do you have a mentor?

- Yes
- No

19) What resources do you use to keep yourself abreast with the latest trends in the engineering field?

- Attend Seminars
- Attend Exhibitions
- Research material, read, magazines, internet etc.
- Other:

.....  
Please specify



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20) Are you currently studying? What course/direction?

- .....
- Yes please specify
  - No

21) Do you regard time as a resource?

- Yes It is a scarce resource that has to be optimised
- No It is a something that continuously evades my control
- No I have free-time available often

22) How do you rate your utilisation of time?

Bad

Average

Good

23) Do you plan your utilisation of time?

- Yes Hourly
- Yes Daily
- Yes Weekly
- No I don't plan

24) What time management system do you use?

- Diary
- Digital or Desktop organiser
- Other

.....  
Please specify

25) Do you consider yourself to be competitive?

- Yes I enjoy competition
- No Makes no difference to me

26) Do you find that a competitive spirit assists one in overcoming obstacles?

- Yes Competition and challenge forces me to rise to the occasion
- No Creates more problems

27) Do you enjoy taking risks?

- Yes I love the challenge of the unknown
- No I prefer a predictable outcome

28) Do consider new opportunities to be a challenge?

- Yes
- No

29) Do consider work to be fun?

- Yes
- No

30) Do actively seek out to make your work more enjoyable?

- Yes
- No

31) How do you manage your work during difficult and stressful times?

- I maintain control, and overcome the difficulty
- I ask for assistance
- Other

.....

.....

Please specify

32) Are you committed to success?  
(i.e. do you invest most of your resources toward become successful?)

- Yes
- No

33) What is success for you?

- Money
- Good career
- Independence
- Other

.....

Please specify

34) How do you rate your desire for success?

- Low
- Medium
- High

35) How do you rate your current skills as a potential contributory for success?

- Bad
- Average
- Good

36) Are you motivated by goals?

- Yes
- No

37) Do you usually plan-out how you intend achieving your objectives?

- Yes
- No

38) Do you focus on the ends rather than the means?

- Yes
- No

- 39) Do you review your goals regularly?
- Yes  No
- 40) How far ahead do you plan your goals?
- 1 Week  1 Month  1 Year  3 Years  5 years+
- 41) Are you sure of what you hope to achieve - what your end goals are?
- Yes  No
- 42) Do you consider yourself to be an optimist?
- Yes  No
- 43) Do you fear failure?
- Yes  No
- 44) Do you have a good sense of humour?
- Yes  No
- 45) Do you believe in yourself?
- Yes  No
- 46) Are you realistic in your goals?
- Yes  No
- 47) How do you manage failure; what do you do after you have failed?
- Pickup the pieces (learn from mistakes) and start again
- Try something new
- Give up
- Other

.....  
Please specify

- 48) Do you make hasty decisions or do you think out the situation (calculated risk taker)?
- Hasty decisions  Calculated risk taker

- 49) Do you reduce risk by "doing your homework" beforehand?  
 Yes  No
- 50) Do you try and retain as much of the outcome of your decisions as possible?  
 Yes  No
- 51) In general, do you have a backup plan in the event of failure?  
 Yes  No
- 52) Does taking risks upset you unduly?  
 Yes  No
- 53) How do you handle uncertainty?  
 I'm not sure  
 I quantify the problem/situation and make a decision  
 I avoid uncertain situations  
 Other

.....  
Please specify

- 54) Do you require extensive information before taking decisions?  
 Yes  No
- 55) How do you rate your preparedness to take risk?  
 Bad  Average  Good
- 56) Do you take responsibility for your actions?  
 Yes  No
- 57) Do you encounter a lot of work-related stress or pressure?  
 Yes  No

58) How do you handle/control/overcome stress?

- Sport and leisure
- Break from work
- Other

.....  
Please specify

59) Are you generally a patient person?

- Yes
- No

60) Do you partake in any extra mural activities (specify)?

- Sport
- Leisure/Relaxation
- Other

.....  
Please specify

61) Do you take responsibility for your actions?

- Yes
- No

62) Do you identify problems readily?

- Yes
- No

63) Do you seek out creative solutions to your problems?

- Yes
- No

64) Do you solve problems by innovating?

- Yes
- No

65) In general, do you strive to improve things?

- Yes
- No

66) How do you rate your potential to implement innovations?

- Bad
- Average
- Good

67) How do you rate your ability to conceptualise thoughts and ideas?

Bad

Average

Good

68) What techniques do you use to solve problems?

- Common sense
- Analysis/Logic
- Other

.....  
Please specify

69) Do you identify opportunities readily?

Yes

No

70) Do you create opportunities?

Yes

No

71) Do you exploit opportunities?

Yes

No

72) Do you anticipate trends and opportunities that are not generally obvious?

Yes

No

73) How do you rate your capacity to take advantage of new opportunities?

Bad

Average

Good

74) How do you rate the utilisation of opportunities rather than resources?

Bad

Average

Good

75) How do you go about changing threats into opportunities?

.....

- 76) How do you rate your mental skills?
- Bad                       Average                       Good
- 77) How do you rate your conceptual skills?
- Bad                       Average                       Good
- 78) How do you rate your "business sense"?
- Bad                       Average                       Good
- 79) How do you rate your personal integrity?
- Bad                       Average                       Good
- 80) How do you rate trustworthiness as a *requirement* for success?
- Bad                       Average                       Good
- 81) Do you strive for independence?
- Yes                       No
- 82) Do you possess your own leadership style?
- Yes                       No
- 83) Do you continuously monitor your current position relative to your future goals?
- Yes                       No
- 84) Would you like to be your own boss?
- Yes                       No
- 85) Do you control of your future?
- Yes                       No



- 86) Do you have a strong need for control?  
 Yes  No
- 87) In general, do you *require* changes to occur quickly - are you impatient with regards to change?  
 Yes  No
- 88) Do you normally involve yourself in issues that involve your future?  
 Yes  No
- 89) Are you a perseverant person?  
 Yes  No
- 90) Do you possess resoluteness/decidedness?  
 Yes  No
- 91) Do you *demand* honesty/righteousness?  
 Yes  No
- 92) Do you possess strong team-building skills?  
 Yes  No
- 93) Do you enjoy inspiring others? How?  
.....  
 Yes please specify  
 No
- 94) In general, do you learn from your mistakes?  
 Yes  No
- 95) What is your attitude toward money?  
 Measure of success  
 Necessary for living but not my main measure of success  
 Not that important  
 Other  
.....  
please specify

96) How do you respond to inefficiency?

- Annoys me
- Doesn't bother me, as long as it doesn't involve personal issues
- I try and eliminate it as much as possible
- Other

.....  
please specify

97) Have you ever considered starting up your own business?

- Yes  No

If so,

Yes  No Is the nature of this business related to your engineering field?

Yes  No Have you consulted (or considered) any external sources in order to develop the idea further? (e.g. SBDC, Banks, Business Consultants)

How far are you from implementing/starting up the new venture?

- Business plan
- Partnership
- Business registration
- Market survey
- Other

.....  
...  
please specify

Yes  No If you had the opportunity now, would you leave your current job to enter into self-employment?

Yes  No Is the nature of this business related to your engineering field?

Are there any skills that you can identify as currently lacking, which may assist you if you decide to start your own business?

- Business management skills
- Financial management skills
- Personnel management skills
- Other

.....  
...

please specify

What resources are you lacking that is preventing you from starting up your business at this stage?

- Market intelligence (experience)
- Contacts
- Money
- Personnel
- Other

.....

...

please specify

If you wanted to start your own business, can you identify specific items that the government could implement to encourage or promote the development of such a business?

.....

...

please specify

98) Regarding the running of a business....

- Yes  No Do you have any experience in running or starting-up a small business?
- Yes  No Have you ever invested in someone else's business, with the objective of making a profit?
- Yes  No Do you feel that you are capable of managing a business on your own?
- Yes  No Have you ever had any business related training? Which
  - Business management course
  - Financial management course
  - Course on starting up your own business
  - Business seminar
  - Other

.....  
please specify

---

End

Thank you

References: [23][8][34]

**Appendix 3 - Research questionnaire for existing entrepreneurial engineers**

# Entrepreneurial Engineering Questionnaire

Name:

Company:

1. Engineering Background (Electrical, Mechanical, Civil etc)?

.....

2. Academic Qualifications



.....

3. Current-age?

.....

4. Age range at which you entered an entrepreneurial career?

- 21-30
- 31-40
- 40+

5. Number of years work experience before entering entrepreneurial career?

.....  
6. How many other start-up businesses have you successfully created? (If possible please indicate what type of businesses these are!)

- i) .....
- ii) .....
- iii) .....

7. Before you entered an entrepreneurial career, was there a *family business* in existence and did this influence you in any way? (E.g. direction of business, joined the family business, work experience etc)

Yes .....

.....

No

8. When did you decide that you wanted to setup your own business?

.....

9. What influenced your selection of the nature of your business?

- Engineering field of study
- Industry/Work experience
- Market study
- Other:

.....

Please specify

10. What was the business form of the start-up business?

- Sole-Proprietor
- Partnership
- Close Corporation
- Company

11. What was the source of your start-up capital for the business?

- Own Capital
- Bank Finance
- Government Grant/Subsidy/SBDC
- Other (specify) .....

12. What is the current size of the business (number of people employed)?

- 1-25
- 25-50
- 50-100
- 100+

13. Did you have a business plan in place when beginning the new venture?

- Yes (Detailed)
- Yes (Partial/Conceptual Plan)
- No

14. What was your reason for going into an entrepreneurial career (starting-up your own business)?

- Self-employment
- Providing jobs for family
- Realising a dream
- Controlling own destiny/ desire for independence
- To be wealthy and famous
- Other (please specify)

.....  
.....

15. Where did you start-up the new venture? (Garage, home, office, within another company etc.)

.....

16. Did you work in industry before starting up your own business?

- Yes
- No

If "yes", did this experience contribute to your success and in which way?

- Yes    .....
- No      please specify

17. How do you rank experience as a contributory to entrepreneurial success?

- Essential
- Important, but can be learnt whilst running the business
- Less important
- Other:

.....  
Please specify

18. What aspect of work-experience do you regard as particularly important?

- People-networking
- Technical skills development
- Trade and market intelligence
- Other:

.....  
Please specify

19. If you could re-plan your career path, what would it look like? (e.g. studies > work > business )

.....

20. When starting up, did you consult others regarding your new venture?

- Yes Sought business advice (Business Consultant, SBDC, Department of Trade and Industry etc)
- Yes Sought legal advice (Business Nature, Tax Implications, Labour Law etc)
- Yes Sought technical assistance (Consultants, Technology Transfer etc)
- Yes Sought financial advice (Banks, Partnership etc)
- No No outside advice taken

21. If the nature of the start-up business was technologies based, did you buy-into existing technology (technology transfer) and develop on that or did you develop unique products or services?

- Technology transfer
- Own innovative products
- Other:

.....  
Please specify

If the company took a technology transfer, what advantages or disadvantages do you attribute to such a process as a means to develop products?

.....

.....

.....

22. Did your academic background assist you in your success in starting up the new venture? If so, in which ways?

Yes

No

23. What competencies (skills, attitude, and knowledge) do you view as necessary for running a business?

- Business management
- Financial management
- Practical/Hands-on experience (product design/manufacture etc)
- "How to run your business"
- Personnel management
- Accounting
- Other:

.....  
Please specify

24. How do you rate the importance of understanding business management (personnel, financial, marketing etc) *before* start-up?

- Essential
- Important, but can be learnt whilst running the business
- Less important
- Other:

.....  
Please specify

25. What is your view toward formal planning of goals and objectives (short, medium and long term planning)?

.....

How do you organise your activities to meet those goals?

- Frequent review of goals
- Time-management
- Milestones
- "Project Management" approach
- Other:

.....  
Please specify



26. How do you approach the relation between work activities and the financial implications that stem from such activities?

- Effective resource management
- Aim to minimise costs
- Improve productivity
- Other:

.....  
Please specify

27. Do you do engineering-related functions or are you dedicated to the management of the business?

- Engineering only
- Engineering & Management
- Management only
- Other

.....

If in management, in what form of management are you involved?

- General management
- Marketing management
- Technical management
- Financial management
- Other



.....

If in management, have you had formal management training?

- Yes Prior to setting up Business
- Yes Whilst Running the Business
- No No formal training, but on-the-job experience

Did such formal training benefit you, and if so in which way?

- Yes .....
- No .....

28. What is your management approach?

- Consultative
- Democratic
- Authoritarian
- Other

.....  
29. What mechanisms do you employ in order to motivate others in your organisation?

- Financial incentives
- Share scheme
- Productivity/ performance evaluation
- Team-building
- Other

30. Do you delegate most of your tasks?

- Yes
- No

31. Do you assume leadership in case of a crisis?

- Yes
- No

32. Do you create the conditions wherein the work may be executed?

- Yes
- No

33. Do you listen to staff grievances and do you offer support where you can?

- Yes, I encourage strong communication throughout the organisation
- No

34. How has an entrepreneurial career affected your family?

.....

35. How do you manage your business and personal life?

.....

36. What is your first priority in life?

- Business
  - Family
  - Enjoy-life
  - Other
- .....

37. What is your second priority in life?

- Business
- Family
- Enjoy-life
- Other

.....

38. How do you manage your time resource? (e.g. diary, personal assistant etc)

.....

39. How do you measure your success?

- Money
- Personal achievements
- Family
- Other

.....



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40. How do you handle stress?

- Sports
- Holidays
- Don't handle it
- Other

.....

41. Do you *seek out* new business opportunities? How

Yes .....

No .....

42. What specific problems hindered your development toward entrepreneurial success (e.g. financial constraints, competition etc)?

.....  
.....  
.....  
.....  
.....

How did you overcome these hindrances?

.....  
.....  
.....  
.....  
.....

43. Do you think that it is possible to avoid or reduce the risk of entrepreneurial failure? If "yes" - how?

- Yes .....
- No .....

44. What is your approach toward taking risk?

.....

45. How do you make your decisions?

- Based only on information
- Sometimes on a hunch depending on available information
- Always on a *hunch*
- Other

.....

46. Suggestions for new start-ups:

.....

.....

.....

.....

.....

.....

---

End  
Thank you

References: [23][8][34]



## Appendix 4 - Tally sheets for corporate questionnaire

Questionnaire:	1	2	3	4	5	6	7	8	9	10	11	/11	
Question Number													
K- 6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
K- 7	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	4	36
K- 8	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3.5	32
K- 9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	7	64
K- 10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	5	45
K- 11	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	8/10	80
K- 12													
K- 13													
K- 14	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7.5	68
K- 15	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
K- 16	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
K- 17	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
K- 18													
K- 19													
K- 20													
<b>Average K-Group</b>													<b>73</b>
L- 21	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
L- 22	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6	55
L- 23	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
L- 24	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
<b>Average L-Group</b>													<b>87</b>
A- 25	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
A- 28	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
A- 26	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
A- 27	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6.5	59
<b>Average A-Group</b>													<b>90</b>
B- 29	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.5	95
B- 30	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	91
B- 31	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9	82
<b>Average B-Group</b>													<b>89</b>
C- 32	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
C- 33	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	3.5	32
C- 34	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
C- 35	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8.5	77
<b>Average C-Group</b>													<b>73</b>
D- 36	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
D- 37	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	7	64
D- 38	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5	45
D- 39	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	7	64
D- 40	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6	55
D- 41	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	8.5	77
<b>Average D-Group</b>													<b>66</b>
E- 42	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9	82
E- 43	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5	45
E- 44	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
E- 45	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100

E- 46	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
E- 47	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.5	86
Average E-Group													61
Questionnaire:	1	2	3	4	5	6	7	8	9	10	11		
Question Number													
F- 48	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	91
F- 49	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	91
F- 50	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9/10	90
F- 51	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9	82
F- 52	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
F- 53	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8	73
F- 54	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	5	45
F- 55	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	5.5	50
Average F-Group													78
G- 56	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
G- 57	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7	64
G- 58	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	91
G- 59	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	3	27
G- 60													
Average G-Group													71
H- 62	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
H- 63	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
H- 64	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
H- 65	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
H- 66	<input type="checkbox"/>	Ø	Ø	<input type="checkbox"/>	<input type="checkbox"/>	Ø	Ø	Ø	Ø	<input type="checkbox"/>	<input type="checkbox"/>	5	45
H- 67	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	Ø	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	7	64
H- 68	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	Ø	Ø	Ø	Ø	<input type="checkbox"/>	Ø	Ø	7.5	68
Average H-Group													82
I- 69	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9	82
I- 70	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	6	55
I- 71	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input checked="" type="checkbox"/>	?	5.5/10	55
I- 72	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	4	36
I- 73	Ø	Ø	<input type="checkbox"/>	Ø	Ø	<input type="checkbox"/>	Ø	Ø	Ø	Ø	Ø	6.5	59
I- 74	Ø	Ø	Ø	Ø	<input type="checkbox"/>	<input type="checkbox"/>	Ø	Ø	Ø	Ø	Ø	6.5	59
I- 75	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	?	<input type="checkbox"/>	?	?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	?	5/7	71
Average I-Group													60
J- 76	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	10	91
J- 77	<input type="checkbox"/>	Ø	Ø	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.5	86
J- 78	Ø	<input type="checkbox"/>	<input type="checkbox"/>	Ø	Ø	<input type="checkbox"/>	Ø	Ø	<input checked="" type="checkbox"/>	Ø	Ø	6.5	59
J- 79	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 80	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	10.5	95
J- 81	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 82	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.5	86
J- 83	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	7	64
J- 84	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10	91
J- 85	<input type="checkbox"/>	?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	9/10	90
J- 86	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	6	55
J- 87	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5	45
J- 88	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	10	91
J- 89	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.5	95
J- 90	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 91	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 92	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Ø	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.5	86

J- 93	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 94	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11	100
J- 95	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	3	27
J- 96	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	∅	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9.5	86
Average J-Group													83
Questionnaire:	1	2	3	4	5	6	7	8	9	10	11		
Question Number													
M- 97-1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	7	64
M- 97-2-ii	?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	?	?	<input checked="" type="checkbox"/>	2/7	29
M- 97-2-iii	?	S	S	?	?	S	B	?	?	?	?		
M- 97-3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	?	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	?	?	<input type="checkbox"/>	6/8	75
M- 97-4	E	O	E	?	E	O	O	E	?	?	O		
Average M-Group													56
O- 97- 5	B F P	P	B	?	B F P	B F	B	B	?	?	B F P		
O- 97-6	I C M	I	?	?	I M	I	C M	I	?	?	I M		
O- 97-7	T	?	L	?	L	L	L	?	?	?	?		
N- 98-1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	?	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2/10	20
N- 98-2													
N- 98-3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	∅	<input type="checkbox"/>	<input type="checkbox"/>	8.5/10	85
N- 98-4													
Average N-Group													53

Data Sheet Key:

- = Good correlation with entrepreneurs (Weighting =1)
- = Not correlated with entrepreneurs (Weighting =0)
- ∅ = Partially correlated with entrepreneurs (Weighting = 0.5)
- ?

- O = Other
- E = Engineer
- S = Market Survey
- B = Business
- F = Financial
- P = Personnel
- I = Market Intelligence
- C = Contacts
- M = Money
- L = Labour and Legislation Issues

Questions left blank in the data sheet have been omitted from the final evaluation.