The role of innovation in the competitiveness of an SME and the development of a framework and leadership strategy for successful innovation

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Abstract

This thesis attempts to develop a framework for innovation in small and medium businesses which if successfully implemented should allow the business to grow and develop. This framework was developed during the author's tenure as a Knowledge Transfer Partnership (KTP) associate at K C Engineering Ltd. Background information on innovation and its inputs and outputs is reviewed in order to gain a better understanding of what is involved in the innovation process. Firstly the role of innovation in economic growth is reviewed, then the small and medium business particularly in the North East of England is examined in order to gain an improved understanding of the constraints within which K C Engineering was operating. A framework for innovation is then proposed, this develops a guide which if used by the small or medium business, should facilitate structured and focused innovation activities which will add value to the business. The requirements of leadership and organisational structure are then discussed. Final conclusions are then drawn and recommendations for further work are made.

Acknowledgements

Thanks to Professor P. G. Maropolous and all the staff of the Agility Group at Durham University who assisted with the development of this work. Thanks to Dr Keith Chester of KC Engineering for allowing me to undertake this work within his business and the help and assistance he provided me. Thanks to Professor V. I. Vitanov for his assistance with completing and assessing this paper.

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Chapter 1

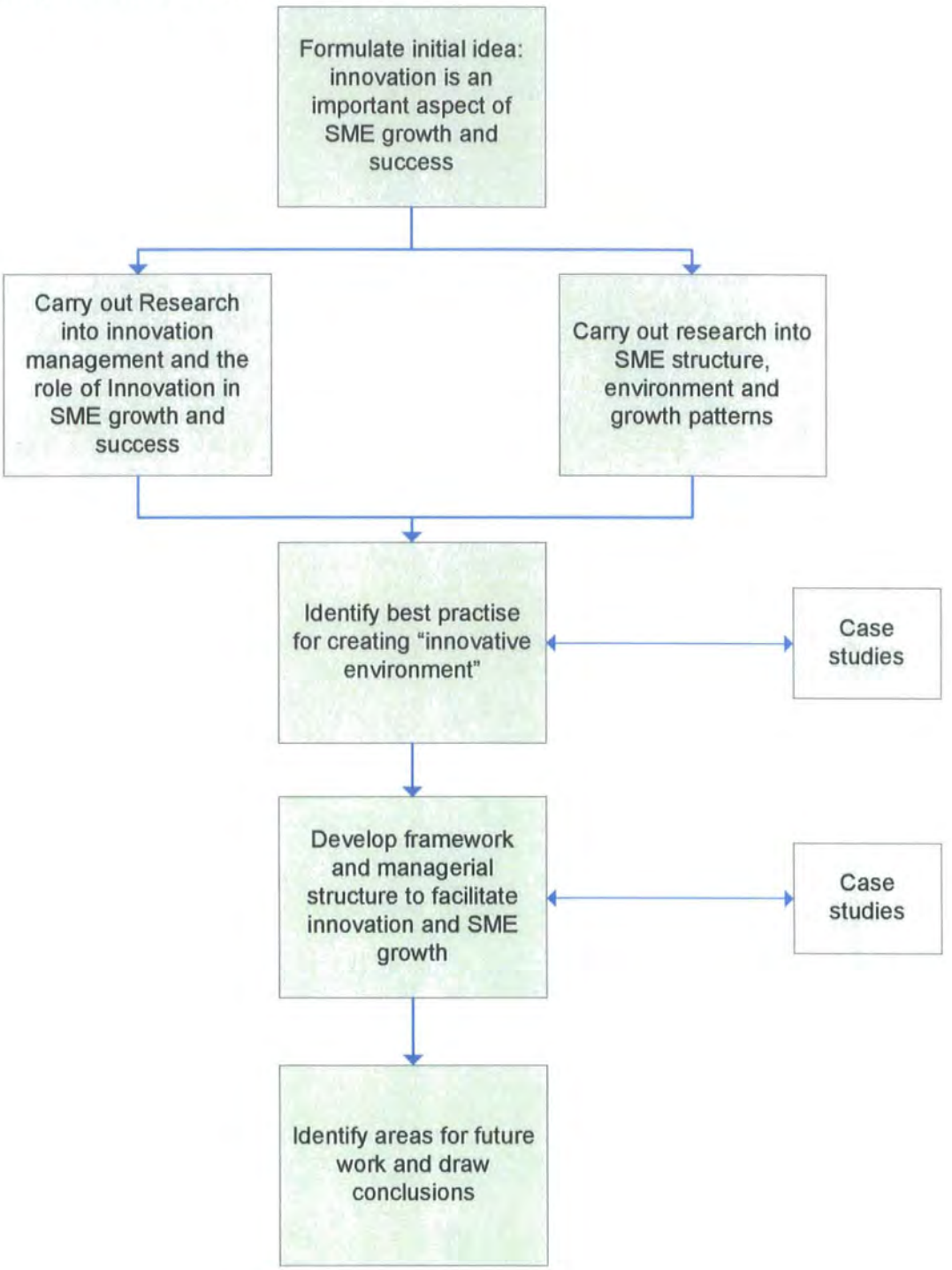
1.1 Introduction

This thesis examines the role of innovation in the competitiveness of small-to-medium sized companies (SMEs). It then goes on to develop a framework and leadership strategy to help create an environment within the SME which facilitates successful innovation and subsequent economic prosperity. The methods used are based around the concepts of the Toyota Production System but applied in a different way to the normal "Lean" concept.

Extensive research has been carried out by the author which is discussed in detail in following chapters that shows that SMEs are generally good at being innovative and that innovation is a key factor in business prosperity, and growth in the economy overall. Encouraging and commercialising innovation should therefore play a key role in the plans for growth of the typical SME. By its nature innovation is often difficult to plan and control and with limited resources the SME can find this a challenging task. The relationship between economic growth and innovation is not always clear and an SME with limited resources often finds it difficult to fully exploit its innovative ability.

It is hypothesised by the author that, although small companies employ some highly innovative individuals their ability is not always efficiently harnessed to help grow the company.

Figure 1.0 Structure of Work



1.2 Industrial Background

This thesis was prepared whilst the author was employed as a Knowledge Transfer Partnership (KTP) associate at K C Engineering Ltd (KCE). KCE is a specialist manufacturer of white metal lined bearings which are used in large rotating machinery such as steam turbines and large electricity generators. KCE principally manufactures bearings to customer specific designs, and the main focus of its activities is its manufacturing operation. The company had no dedicated research and development capability and the majority of innovative activity within the company was undertaken by the Managing Director, Dr Keith Chester. Dr Chester originally established the business after being frustrated with the lack of freedom allowed to him for implementing innovative ideas as the divisional metallurgist at one of KCE's competitors. This fact becomes important later on in this project as KCE represents what is commonly known as a lifestyle business, i.e. the driving objective in establishing the company was not the generation of profits for its founder(s) (as is normally presumed to be the case with any commercial organisation) however as the business has grown over the years, the commercial reality of changing from a life style business to a serious profit generating business has become apparent to KCE. The KTP programme was established by KCE with the specific objective of developing a new product and facilitating knowledge transfer between KCE and Durham University. The ultimate purpose of the KTP programme was to allow the company to enter new markets and increase its profitability. Prior to taking on this position the author was employed by KCE as Business Development Manager with specific responsibilities for internal business improvement activities such as

implementing elements of lean manufacturing. Before working for KCE the author gained a BEng in Mechanical Engineering from UMIST. The author has also worked in the automotive industry as an engineer in a wide variety of environments from the motor racing to component manufacturing. During this time the author has gained a wide range of relevant industrial experience.

This thesis was developed as a direct result of the KTP programme. As previously mentioned the initial objective of the KTP programme was to develop a new product that would allow KCE to enter new markets and increase its profitability. The KTP programme was structured such that the associate, who would be employed by Durham University, but based at the company, would undertake research to develop this new product, carrying out mainly laboratory based testing and development type activities. This would be done using the associate's creative thinking backed up by the expertise and resources of the University of Durham. It had been decided that KCE needed a dedicated resource to develop this new product, and the KTP programme provided that resource. One of the principal aims of the KTP programme is to facilitate knowledge transfer between academic and industrial partners, with the aim of stimulating economic growth in the industrial partner and knowledge capital growth in the academic partner. After the first KTP local management committee meeting, it became clear that the project brief lacked focus. The main problem was that although there was already a wealth of innovative ideas within KCE the needs of the market place were not fully understood so the company did not know which ideas to focus on in order to generate the best chance of a successful commercial project. This relates back to the initial founding of KCE, Dr Chester was a highly

innovative and creative individual but his knowledge lay in metallurgy, not sales and marketing. KCE had managed to achieve organic growth due to quality of product, technical support, and reputation rather than through targeted sales and marketing activities. The company was used to customers presenting it with problems which it would duly set about solving. However a wider knowledge of the market place was missing from the business. The direction of the KTP programme was altered to put systems in place to allow KCE to gain a better understanding of its market place in order to better use this stock of ideas and to improve the business planning, marketing, and product realisation processes in order to fully exploit the creative ability of the company. During the course of this work KCE underwent significant change both in the structure and business systems of the company and in the physical make up of the business. The company went from an inward looking organisation concentrating all its efforts on surviving the day to day rigors of business to an outward looking company that opened itself up to competitors and new customers alike and began seeing opportunities instead of threats. This involved wide spread changes in the structure, physical resources and personnel of the company. This turned out to be far more challenging and rewarding than the initial project both for the author and for the business.

1.3 Aims and Objectives

The main aim of the work carried out was to introduce a framework to K C Engineering to allow it to harness its creative ability, and become more profitable. The main aim of this thesis is to:

- Identify the key factors that would allow a SME to maximise its capacity to be innovative and to grow through successful capitalisation of innovative activities.

The main objectives of this work were to:

1) Develop a better understanding of innovation, and the processes involved
2) Develop a better understanding of the operation of a typical SME
3) Develop a better understanding of the relevance of innovation to the typical SME
4) Develop a framework to facilitate targeted innovation in the SME
5) Implement the framework within KCE in order to enhance the business

Chapter 2 Literature Review

2.1 Introduction

The purpose of this literature review is to establish a base knowledge of the research and current thinking around the subject of innovation management, to identify what is meant by innovation, how it is measured and why it is important in the context of a SME. It is has been proven that there is a relationship between innovation and long term economic growth at a micro, macro and country economic level, this will be discussed in more detail in section 2.3. Innovation generally takes place through research and development (R&D) activities. These R&D activities are discussed here in detail. Inputs to, and outputs from R&D are studied separately because there is not necessarily a clear relationship between the two, although there have been many studies and investigations which have endeavoured to do just that. Although it is not possible to establish an exact relationship because of the influence of random factors it is possible to derive some relationships and guides for best practice. The measurement of inputs for statistical purposes are performed in accordance with the Frascati definition of R&D, which is:

"*Creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of the stock of knowledge to devise new applications*"

The Frascati definition is discussed in more detail in 2.4. This is a model that is commonly used by governments and economists, however it is suggested here that this definition leads us to believe that large businesses, i.e. not SMEs are the most innovative. It is also suggested that many indicators of R&D output (such as the level of patenting) also lead to skewed results in

favour of large business. These measures are generally not relevant in the context of a SME where there are other inputs to and outputs from innovation and the creation of an innovative atmosphere in which R&D activities can take place which are not covered by these accepted measures.

Overall it is suggested that a new model for innovation inputs and outputs in SMEs should be developed that allows more appropriate measures to be made. R&D activity in small firms is underreported and there is a case for recognising that they are highly innovative and supporting them in their efforts. The management of R&D activities is studied here as there are curious anomalies between the level of R&D input in some firms and their overall survival rate. The adoption of improved measures will allow improved control on the innovation process and should form a key part of encouraging successful innovation in SMEs as this represents a significant opportunity for adding value to the economy as a whole. Improved measures, will lead to a better understanding of the effectiveness of innovation activities in a SME and increased success at commercialisation of that innovation. There are many examples of SMEs and large businesses that have failed at converting R&D inputs into commercial outputs and suffered as a consequence. This happens in both large and small business for example Kodak, which has not smoothly managed the transfer to digital imaging media despite a huge investment in R&D activities and KCE that has failed to successfully commercialise significant R&D in the past despite having all the classic inputs and outputs. It is suggested here that the ultimate success of an innovation depends on far more than the quality of the innovation and this relationship should be recognised as part of an organisation's innovation strategy.

2.2 The Potential Effects of Innovation

Innovation, by its very nature, is risky. For a given input, there is no guaranteed output. However the chances of achieving successful outputs can be improved by controlling the innovation process. Research and Development of products and processes (R&D) in response to customer feedback is the mainstay of innovation in business, however there are other activities that could be classed as innovative and that add value to a business that would fall outside the conventional definition of R&D, especially in the context of the SME.

Breakthrough innovations can cause dramatic shifts in the expectations of customers that can leave whole industries paralysed with no relevant products to offer. In this circumstance ways of working can change very rapidly in an entirely unpredictable manner. For example, the invention of the light bulb placed gas lighting companies into turmoil whilst more recently, the invention of the personal computer fundamentally changed the typewriter and mainframe computer markets (Hargadon, 2003). The digital photography market has developed in a little over 5 years and left many makers of conventional cameras in turmoil even including the one time revolutionary "Polaroid" products.

Breakthrough innovations can mean that long established firms in well developed markets can have their entire business model made obsolete in a very short period of time. These businesses are often very good businesses; they have been acting in a rational way developing incremental improvements to their products that respond to their customers' feedback.

This could lead to the argument that it is worthless to make such improvements as the value of the business could be destroyed at any moment by a disruptive breakthrough. However it is clear that this argument is at best irrational. What these businesses did wrong was to have a myopic approach to their innovation, they ignored new technologies that may have been relevant to their business in the future and treated these developments often with a hostile contempt whilst remaining arrogant about their own prospects. "That technology will never be good enough to replace our product" is often the attitude that has led to a subsequent business failure. This is often referred to as marketing myopia, and is widely documented. Christensen (1997) makes the distinction between sustaining and disruptive technologies where those classed as sustaining offer improved product performance and those classed as disruptive are those that bring to market a very different value proposition.

The economic advantage of innovation and "sound business ideas" has been clearly demonstrated by several case studies and reviews. For example Porter (1990) "The competitive advantages of nations" which launched a second study of how nation states compete and where their industrial wealth comes from. An example was Sweden which for a country of a few million people has two major automotive manufacturers, aerospace, and major commercial vehicle and off road manufacturers. The main conclusion for these events was that Sweden had more than their fair share of creative innovative individuals.

In summary innovation can lead to several outcomes:

- Incremental improvement to products and processes and a corresponding growth in business
- Disruptive developments in products and processes that can trigger entire markets to change
- Economic growth and prosperity at a local, regional and national level where the value of innovative ideas can be successfully converted into saleable goods and services.

2.3 The Contribution of Technological Advancement to Economic Growth

New Growth Theory has had a profound impact on policy in recent years demonstrated by the establishment of Europe wide targets for innovative activity. This has been stimulated by the belief that innovation and investment is closely linked to economic growth. This section looks at the background to New Growth Theory and the implications of this belief on the SME. It is suggested that the manufacturing sector is important to New Growth Theory because many innovations take place in manufacturing, where innovation is generally embodied in products and processes. Georghiou et al (2002) give an exhaustive account of macro-economic perspectives on technical change, it is used extensively in this section. This report is highly recommended for those interested in further reading.

It is now widely accepted that technological advancement is essential for reliable economic growth. However, this general acceptance has not always been the case. Advances in technology and their effect on the economy were largely ignored until the 1970s. Until then, economists had been viewed as

laggards in this area of study. As Freeman (1994, p. 463) wrote on the paradox in economics study;

"...the contrast between the general consensus that technical change is the most important source of dynamism in capitalist economies and its relative neglect in most mainstream literature [is surprising]."

Before the middle of the 19th Century the effect of technology on economic growth was largely ignored as being irrelevant to increasing the wealth of the nations. It was not until the industrial revolution took hold that the importance of technological progress to the capitalist system was fully realised. This realisation came with significant problems; classical economists did not view technological change as being part of the economic process. For example, they did not conceive the potential for trade-off between capital and labour and ultimately technology i.e. deindustrialisation due to automation. They saw technological advance simply as an outcome of capitalist forces rather than appreciating that it moulded the forces acting on an economy. They were not helped by the relative lack of empirical information due to the new field of economics they were operating in. It took the advent of the marginal utility school to start fully understanding the issues of technical advancement. In the latter half of the 19th Century the marginal utility school of classical economists began to appreciate how capital, labour, production methodology and technology could each be traded against each other to arrive at an optimum model for wealth creation; it was at this stage that production functions became the most popular method of analysing the progress of an economy. This technique gained in popularity throughout the 20th Century.

However, it was not thoroughly synthesised until the latter half of the Century assisted in part by the advent of structured R&D. Whist much work had been done looking at the effects of technological progress, little had been done to study the conceptual framework of advancement.

Schumpeter's introduction of the idea that technological progress could be represented as 'gales of creative destruction' proved to be the catalyst for modern economic theorising on the process of innovation, technological advance and its encapsulation within products, processes and firms. This new hypothesis caused further leaps in the understanding of technical progress so that economists began not only to study the effects of new technology but also the factors inducing technological change (Georghiou, 2002). However there were significant problems in modelling the innovative processes as stylised in Schumpeter's work. The explosion of technology has complicated the process of modelling, particularly if dynamics and all the interactions between market driven innovations, and internally driven innovations are introduced.

Many of these problems have been overcome to a certain degree in the 1980s and 1990s with the advent of New Growth Theory, where a pool of endogenous knowledge is believed to contribute to a degree of endogenous growth within an economy (Georghiou, 2002).

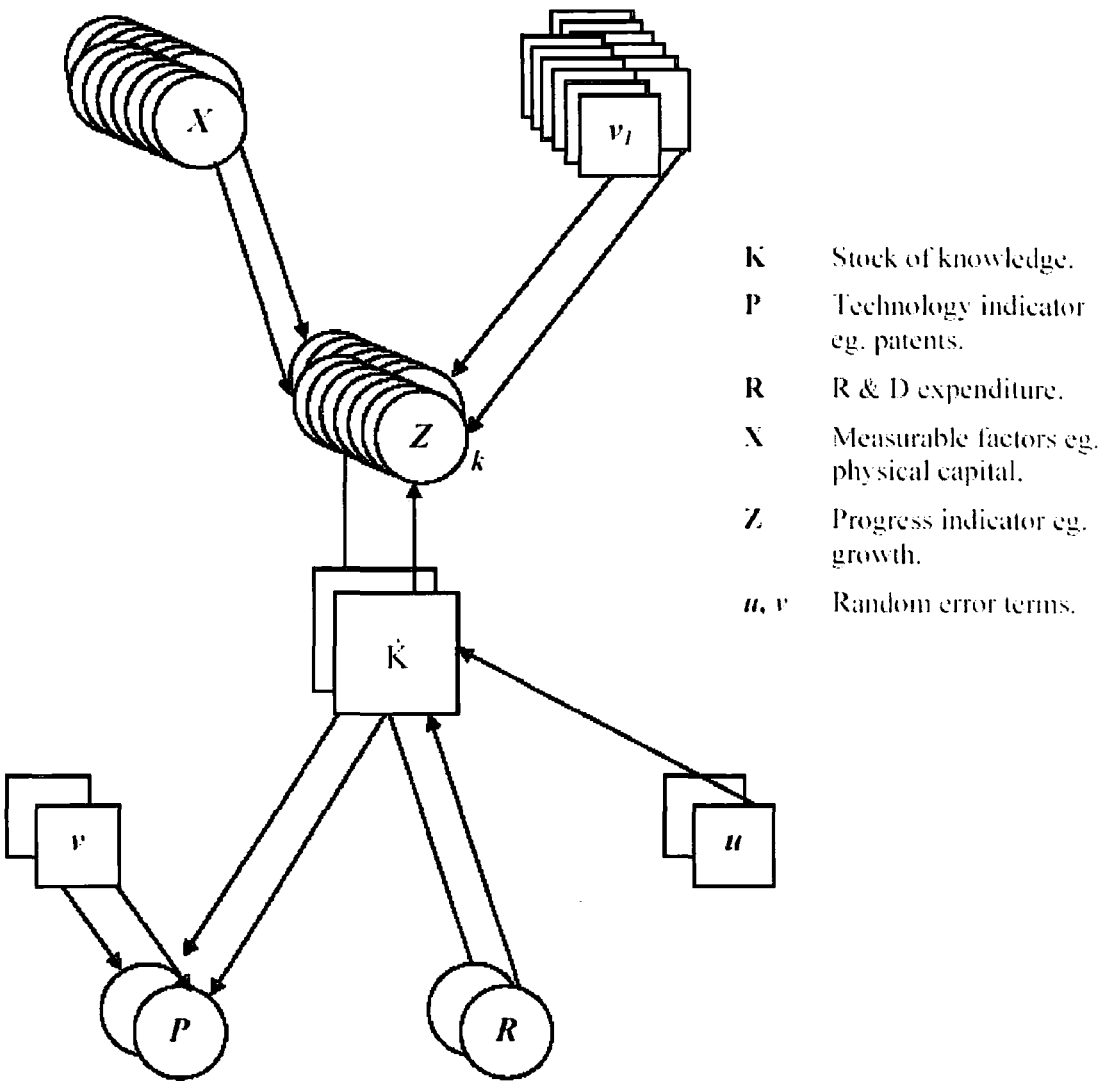
However this still presents many problems for policy makers and business alike who struggle to get to grips with establishing the return rate for an investment in research and development type activities. The difficulties in modelling the process of technological change are highlighted by Griliches

(1990) Figure 2.1. taken from his work attempts to show the relationship between:

R	*R&D expenditure*
K	*Technological knowledge stock*
P	*Technological indicators (e.g. the stock of patents)*
X	*Measure of value (e.g. physical capital, labour)*
Z	*Measure of the indicator (e.g. growth or productivity or the stock market value of the firm or industry)*
u and v	*Random components*

An attempt is made to estimate the direct relationship between **P/R** and **Z** i.e. How much economic is acheived for a given investment in R&D?

Figure 2.1: The knowledge production function a simplified path analysis diagram (Griliches, 1990)



The answer to this question is incredibly complex, and although many have claimed to have established an approximation it is the opinion of the author that a general knowledge of the relationship and the factors that impact on it is far more useful than an establishing an explicit relationship. The intermediate stage of arriving at **K** and transforming it into **Z** over time, as well as the complex interactions, (multidirectional causality), between **X**, **K**, and **Z** cannot be appropriately represented due to the lack of knowledge about the

behaviour of the factors determining **K**, that is, the lack of knowledge of the process of technological advance (Georghiou, 2002). In addition to these modelling problems, there is also a large problem with the lack of data available on the inputs and outputs of R&D, although this situation has improved dramatically since the early 1990s. Georghiou (2002) states:

"A lesson learned... is that no single approach can claim monopoly in explaining the relationship of technological advance and the economy. A complex, multi dimensional phenomenon like innovation requires multi-dimensional analytical approaches based on formal theory, aggregate empirical analysis (econometrics), acute observation and appreciative theorising to establish regularities, and data from diverse sources including large databases, surveys, and case studies." Georghiou, (2002) p. 28.

Lööf (2002) adds that the efforts to improve the quality and scope of data:

"include the eternal dream of getting hold of output indicators for innovative activity as well as reliable measures of innovation input and different factors contributing to the innovative process..." Lööf (2002) p. 63.

If a seasoned researcher describes these metrics as an "eternal dream" then it can be taken that analysis on this level will be beyond the reach of the typical SME, however an appreciation of the complexities and strategies for improving the chances for successful conversion of **R** into **K** can be more easily established at a level that is accessible to most SMEs this will form a key element of the framework developed in chapter 4. Despite the difficulties outlined thus far, there has been a renewed interest in the economics of

technological advance over the last two decades and it is believed this is due to the following factors (Georghiou, 2002):

1. Massive commitment of government resources in R&D during the war demonstrated that purposeful searches for technological solutions to specific problems can be organised.
2. Once they had engaged in the purposeful search for innovations, firms learned that this is an economic activity like any other, albeit with some peculiar characteristics and a fuzzy relationship between inputs and outputs.
3. It was quickly recognised that the impact of this activity transcended the conventional economic measures of performance.
4. Questions of international competitiveness, relating first to the dominance of the United States and then to the emergence of Japan and Europe as formidable powers, started to increasingly focus on scientific and technological capabilities.
5. A large group of newly established developing countries during the war were looking for ways to close the gap with industrialised countries. Technological and, more generally, innovation capabilities seemed to be key.
6. A rapid process of globalisation has had at its epicentre large corporations, the existence of which has been explained since the mid-1960s on the basis of intangible assets and related market failures. The foremost intangible asset is frequently argued to be technological capability and, more generally, the ability to innovate.

The advent of New Growth Theory has also served to raise the expectations of the output from R & D in terms of improved economic growth. New growth theorists suggest that it is likely to be possible to influence the rate of growth through increasing the level of investment in R&D activities. Although this is cautioned (Crafts, 1996b) by pointing out that given routine investment has diminishing returns, if faster endogenous growth is feasible, it will result from the success of raising the *rate* of technological change. Realistically, a policy to stimulate R & D cannot be expected to have dramatic effects. In his study conducted in 1996 Crafts found this to be true and states:

'A doubling in the share of industry financed R & D to 2 per cent would likely raise total factor productivity by only 0.4 percentage points' (Crafts,1996b)..

Policy-makers seem strong believers in the possibilities that new growth theory presents, and continue to invest strongly in state sponsored research activities, and a wide variety of schemes designed to encourage businesses to engage in more research and development. Despite this Bond (1996b) finds that the UK tax system as of the study date did not stimulate investment well, as it penalises investment from retained profits against investment from borrowings. In fact all OECD governments attempt to use a number of tools in order to stimulate private investment in innovative activities in order to stimulate underlying growth in their respective economies. Interestingly Georghiou, (2002) predicts that there will be technological convergence between nations leading to convergence in terms of growth. This has proved a relatively robust statement. Factors influencing this technological and economic convergence include:

- Sharing of IP between academics and businesses through world wide networks
- The wide spread use of outsourcing leading to a drag along effect on less technologically advanced economies
- The multinational nature of modern business
- The wide spread availability of information and research findings through the internet

The EU now has a specific target of raising expenditure on R&D throughout the member nations; this is portrayed as a means of increasing the prosperity of the region. This may prove a wise target to set however, as seen in the developing economies of India and China the process of technological catch-up appears to have a greater influence on growth than the generation of new ideas and IP so the importance of adopting and recombining existing technologies should not be forgotten as well. As Barro and Sala-i-Martin (1999) note new endogenous growth theory models are intuitively appealing as they are able to create a virtuous cycle of intangible investment, learning, physical investment and market pressure at the macroeconomic level, in itself this appeals to policy makers. However a challenger to new growth theory is emerging in the form of evolutionary theorising where firms are assumed to be constrained by past experience and form a certain degree of path dependence. It also attempts to explain the difficulty of replacing existing technology with new innovations which are superior. This is a much more complex theory for someone without a scientific background to understand, but it does go some way to answering the questions raised by the lack of sustainable business growth generated in the UK even though the UK

government has consistently invested strongly in research activities over the last 20 years.

Difficulties in understanding the innovation process should not detract from findings in the literature on R&D; that it contributes substantially to the growth of output in a variety of industries and that a strong link can be shown between high levels of R&D and productivity in businesses. It indeed remains widely accepted that a sustained level of investment in innovation activities is necessary for countries to maintain their comparative advantage. Griliches (1994) found that half of total factor productivity (TFP) growth at an aggregate level can be attributed to advances in knowledge commercialised as innovations with the other half being attributed to reallocations of capital between assets and industries, the quality of the labour force and economies of scale effects. Lööf (2002) suggests that R&D investment is found to be an important factor of influence for productivity growth and ultimately the competitiveness of firms. Many models of New Growth Theory have been proposed. For example, Aghion and Howitt (1998) develop a model predicting that long-run growth should be positively correlated with R&D productivity, the flow of patents and new products and should decrease with the rate of depreciation of human and physical capital. Whilst Klette and Griliches (1998), propose a model where R&D and innovations are engines of growth.

2.4 The Frascati definition of R & D

The Frascati manual is the overarching guide on the compilation of R&D statistics; it is on the basis of the Frascati manual that most OECD countries compile their R&D data. A definition of R & D is given in the manual as:

"Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications."

Education and training of personnel in schools or universities is typically excluded from R&D. However, research by students at PhD level is generally considered an R&D input. Collecting, encoding, recording and analysing of data which is carried out in order to support ongoing business activities is also excluded from this definition of R&D unless conducted solely or primarily for the purpose of R&D support, this can leave an unclear picture in the context of a manufacturing company as what data collection contributes towards R&D and what does not, as much of the important information collected to support production type activities. More specifically in a manufacturing context the US National Science Foundation (NSF) states:

"If the primary objective is to make further technical improvements on the product or process, then the work comes within the definition of R & D. If, on the other hand, the product, process or approach is substantially set and the primary objective is to develop markets, to do pre-production planning or to get production or control systems working smoothly, the work is no longer R & D."

This definition presents a problem in the manufacturing industries. Due to the increasing division and specialism of businesses manufacturing has become a specialist activity in its *own* right. A manufacturing business can employ a high level of specialist knowledge and expertise the main product of a

manufacturing business *is* a manufacturing process, so any R&D activity aimed at product improvement could be developing and improving production planning and control systems, or refining production systems. In an SME in this sector often this is the main type of innovative value adding activity undertaken by the business. Figure 2.2 shows the treatment of borderline cases.

Figure 2.2: Some cases at the borderline between R&D and other industrial activities

ITEM	TREATMENT	REMARKS
Prototypes	Include in R&D	As long as the primary objective is to make further Improvements
Pilot Plant	Include in R&D	As long as the primary purpose is R&D.
Industrial Design and Drawing	Divide. Include design required during R&D.	Exclude design for production process.
Industrial engineering and tooling up	Divide. Include "feedback" R&D and tooling up industrial engineering associated with development of new products and new processes.	Exclude for production processes.
Trial production	Divide. Include if production implies full-scale testing and subsequent further design and engineering.	Exclude all other associated activities.
After-sales service and trouble-shooting	Exclude. Except "feedback" R&D.	
Patent and licence work	Exclude. All administrative work connected with patents and licences (except patent work connected directly with R&D projects).	
Routine tests	Exclude. Even if undertake by R&D staff.	
Data collection	Exclude. Except when an integral part of R&D.	
Public inspection control, enforcement of standards, regulations	Exclude.	

Source: Frascati Manual 2002, table 2.3.

2.5 Indicators of Input to R&D

The definitions in the OECD Frascati manual allow reliable cross-border comparisons of R&D expenditure. Expenditure on R&D is a clear indicator of level of input; however it must be kept in mind that a high level of expenditure does not necessarily guarantee a large number of outputs of a high quality. Other factors should be taken into consideration such as the source of the finance and how it is spent; also the follow up activities must be recognised in the contribution to the success of R&D expenditure in adding value to a country's wealth. Figure 2.3 presents details of R&D expenditure in leading OECD countries for the year 2001 Figure 2.4 shows the trend in R&D expenditure between 1991 and 2001, assuming the data are not subject to economic cycle effects, it can be seen that there are significant differences in level between countries and there have been significant changes in R&D expenditure over time.

Sweden has the highest level of expenditure as a % of GDP, and has increased from second position just behind Japan in 1991 to a significant lead in 2001 at over 4%. The UK has reduced from just over 2% to 1.8%. This compares poorly with the countries at the head of the table that not only invest more, but are continuing to grow their investment.

Most countries have seen no significant increase in Gross Expenditure on Research & Development (GERD) as a % of GDP between 1999 and 2001 except Sweden and South Korea who continue to grow their investment significantly in this area.

In parallel to the increase (this is not true of the UK or Switzerland) in GERD there has been a continuing shift away from the support of the public sector based R&D. Between 1990 and 2000 the share of R&D expenditure provided by industry grew from an average of 58 per cent to 64 per cent while the figure for individual countries was over 70 per cent for Japan, Korea and Finland (ibid). This shows the importance of a successful private sector for high levels of R&D investment and may prove problematic for the UK in view of the findings of Bond (1996b) reported earlier in part II on the disincentives to investment provided by the UK tax system.

This would indicate that the UK is heading toward a significant shortfall in its reserve of innovation. Studies have shown that strong product market competition has a positive effect on R&D (Bassanini, 2002) so it may be the case that SMEs become more innovative as competitive pressure on them increases, and the domestic market for goods and services in the UK is certainly competitive, so this does not explain the shortfall in UK R&D expenditure. The relatively poor performance of the UK in terms of R&D investment (the input side) is believed by many to be hampering innovative activity, it has also been suggested by some that the low level of R & D expenditure is partly to blame for the stagnation of UK manufacturing activity (Eltis, 1996), however it could also be argued that the stagnation in manufacturing activity is causing the stagnation in R&D investment, as the majority of growth in the countries at the top of the table is due to increased private sector investment.

Porter (1990) identifies a lack of competition and the protectionist policies of post 1950s governments as having caused significant damage to the UK

industrial economy. More recently he identifies UK R&D expenditure as a proportion of GDP (1.19 per cent in 1986) falling way behind other comparable nations such as Japan (2.19 per cent) and Germany (1.60 per cent). However it should be noted that the UK consistently publishes more research papers (A key indicator of innovative activity) per capita than the USA for instance, but economic growth in the USA has outpaced the UK measured as an average over the last 10 years. This may suggest that there is still a core of very innovative work being carried out in the UK, but perhaps this is not targeted at generating economic growth. It is worth noting at this point that a key metric placed on UK universities is the number of research papers that they publish, this has a direct impact on the level of support they receive from the University funding bodies.

It is against this background of weak R&D expenditure that a European Union (EU) wide policy of R&D stimulation has been inaugurated (European Commission, 2003). The Lisbon European Council meeting of March 2000 set the goal for the EU to become the most competitive and dynamic knowledge-based economy in the world. Subsequent meeting established that an increase in R&D expenditure would be key to reaching this target and set the aim of raising R&D expenditure from 1.9 per cent of EU GDP to 3 per cent of EU GDP by 2010. This is to be achieved through a range of stimulation activities split between direct measures such as grants, through indirect measures such as adjustments to the tax system and through catalytic financial measures such as improving private industry accessibility to risk capital. However the commission has not fully explored the impact that the R&D needs to have, or the types of R&D that should be targeted. Ensuring

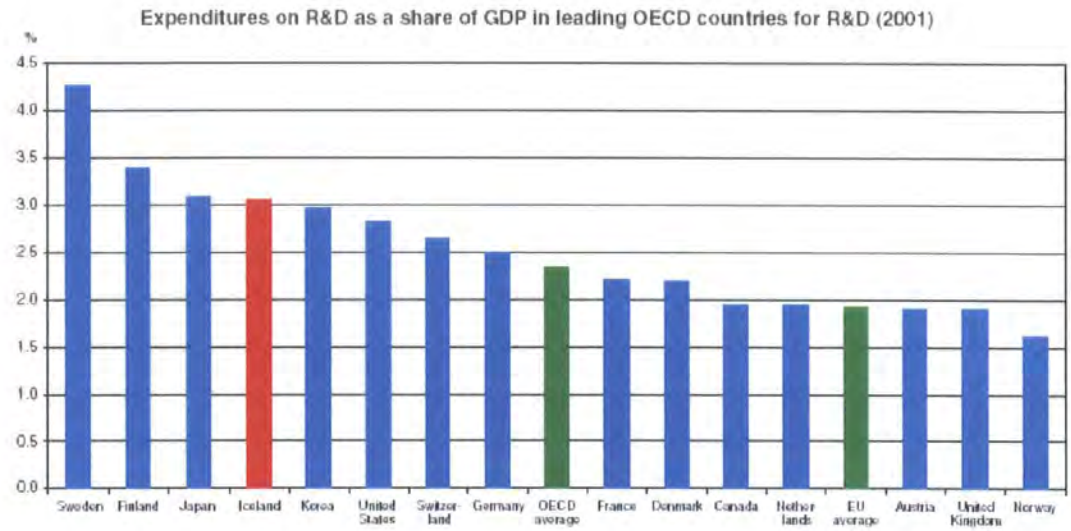
that R&D adds value to the organisation undertaking it is often overlooked as governments become obsessed solely with increasing R&D output, rather than successful commercialisation of a lower quantity of output. This can be seen from the UK where a high number of research papers do not necessarily translate to a high level of economic growth. In addition the "smart" award scheme, a government grant to aid research and development would only give money where the "commercial risk was very high". It identified the importance of the commercial aspects to the work but incorporated a negative approach, but if a good commercial case was made the funding would not be given.

As the OECD study "OECD, 2002b" notes intensification of investment in knowledge does not detract from the crucial role played by Gross Fixed Capital Formation (GFCF) in the economy. Investment in fixed capital grew faster than intangible investment in several OECD countries including amongst others, Ireland and the United States. Only Sweden and Finland experienced sharp growth in intangible investment and a decline in investments in fixed capital. This reflects the continuing importance in ascertaining the appropriate balance between technology and the capital required to gain the full benefits of investment in knowledge. Without the industrial base to exploit innovative developments the expenditure on R&D can not have maximum impact on the countries economy.

The impact of R&D is shown to vary across industries (Doctor, 2001) with low technology industries (eg. textiles) directing R&D effort at reducing cost and increasing efficiency whilst in high technology industries (e.g. consumer electronics) R&D effort is aimed at improving products to provide

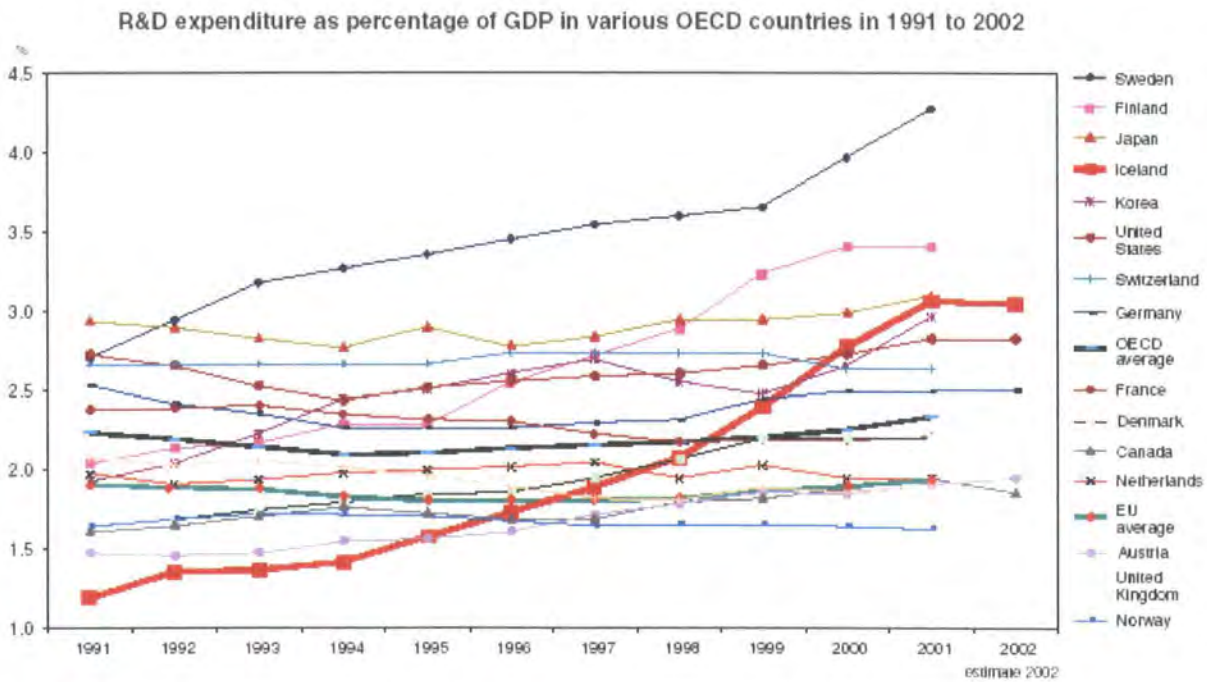
differentiation from the competition. Between these two cases there are those who operate in dominant technologies (eg. motor vehicles) who aim R&D effort at both reducing cost and improving products.

Figure 2.3 R&D as a Percentage of GDP Leading OECD Countries



Source: OECD Science and Technology Statistics

Figure 2.4 Trends in R&D Expenditure in Leading OECD Countries 1991 to 2002



Source: OECD Science and Technology Statistics

2.6 Indicators of R&D Output

The output of R&D investment is widely measured through counts of patents and scientific publications although this can prove rather crude in some circumstances. A patent confers, in theory, perfect monopoly of the invention for a limited time in return for a public disclosure that allows diffusion of the innovation after the patent runs out and subsequent follow on innovation. There are difficulties in the way patent data is collected and differences in the composition of outputs in different countries. In spite of this, they are generally an acceptable measure of innovative activity. Intellectual property rights (IPR) cover patents, copyrights, trademarks, trade secrets are protection agreements which are common place in developed economies in order to offer a degree of protection to those willing to take the risks involved in undertaking innovative activities. These arrangements are covered by international agreements but are enforced nationally so there can be discrepancies between countries about how the law is applied. The most widely patented products and processes come from the pharmaceutical, chemical, biotechnology, information technology and telecommunications industries. (OECD, 2002b) A good indicator of the overall level of *scientific* productivity in a country is to consider the number of scientific publications per million of population (Figure 2.5). The UK is shown to be more productive than the USA on this measure issuing approximately 800 publications per million of population against 700 for the USA in 1999. The Nordic countries, notably Sweden, Denmark and Finland score particularly highly on this measure with each issuing over 1000 publications per million of population. Although scientific productivity is strongly correlated with R&D expenditure, this is

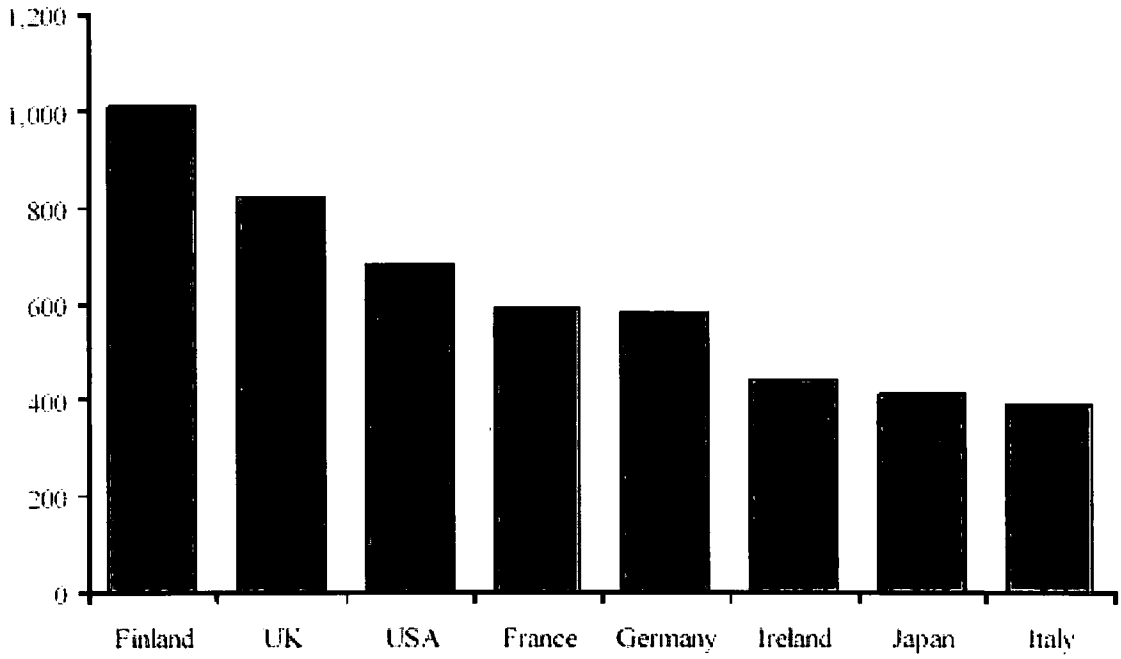
tempered by the composition of the expenditure. Publicly funded research tends to produce a greater output of published work than does privately funded research. This is particularly the case for the United States, Korea and Japan where a very high proportion of GERD is performed in the business sector (OECD, 2002b), so a lower proportion of this work is put into the public domain as businesses seek to protect their investment and are even inclined to avoid patents so as to prevent the required disclosure and simply rely on confidentiality. Rates of return have been shown to vary typically from 20 per cent to 40 per cent in the private sector with a significant number of outliers.

The case for public R&D is less clear-cut with some research citing the return from public R&D being insignificant and in some cases negative whilst some arguing that public R&D may crowd out private R&D (Georghiou, 2002). There is a general agreement that publicly funded R&D is less productive in terms of enriching the country in the short term than privately funded activities. Business tends to invest in R&D in order to meet more specific commercial goals, whereas the public sector is more "Blue Skies" and not market focused. However it is often the "Blue Sky" research that generates the significant innovations and new technology as the businesses focus on incremental improvements that will deliver financial results within the investment cycle. It could also be argued that a significant proportion of publicly funded R&D is serving to educate those that will go on to carry out industry funded R&D such as PhD students, and other university based researchers.

Georghiou, 2002 also generally found that high levels of R&D expenditure correspond with a high demand for capital but a decrease in the demand for labour and materials, this could be characterised by the widely understood de-

industrialisation due to technological progress that leads to a shift in the employment base of an economy from manual work to service as industry progresses and businesses become more automated.

Figure 2.5: Number of scientific publications per million of population, 1999.



Source: OECD, 2002b, figure 1.18, p. 39.

Criscuolo and Haskel (2002) have studied the linkage between R & D input and changes in Total Factor Productivity (TFP) by using the European Community Innovation Survey (CIS) and census data from the UK ONS. Whilst cautioning their results as preliminary, they find that there is a statistically robust correlation between process innovation and TFP growth, where process innovation is innovation directed at the manufacture of a firm's products, this is usually deployed to achieve greater levels of efficiency in terms of reduced labour input or a reduced number of defects. Yet no correlation between product innovation and TFP growth was found. It is also

found that process innovations are more likely in firms who devote resources internally to the innovation process (acquiring innovation related machinery for example) whilst those firms who cooperate with others and who are involved in patent disclosure are found to have a positive effect on innovation activity. The typical measures of R&D however rarely apply to the SME, and as SMEs represent the bulk of employment within most developed economies, this would imply that there is a gap in the data being collected.

2.7 The R&D Gap

There is mounting evidence to suggest that the headline statistics on R&D do not truly reflect the level of R&D in SMEs, yet these businesses create a significant proportion of the wealth and employment in the top OECD countries, as described in section 3. The R&D inputs and outputs measure best the activities undertaken by large businesses and public sector institutions. The activities of small firms tend to be less formalised, more responsive and more secretive, so are less likely to be recorded in official data. Publishing a research paper, or making a patent application would be a significant expense to a typical SME and often the cost involved in patenting and the potential returns to be had from the patented innovation do not make commercial sense (Levin, 1987). A European wide Patent would cost the inventor a minimum of £100,000 to put in place, which to an SME with a turnover of £10million would represent a significant proportion of their total R&D spend, just to obtain a patent. Also the Frascati definition of R&D could be seen to operate at a higher level than is relevant for a typical SME.

For example, the implementation of an ERP system at KCE fell outside the Frascati definition of R&D yet the project was clearly providing something new

for the business and an innovative approach was required to make the system and business practises compatible. The business had to undertake significant learning activities, and conduct extensive research into the operation of ERP systems and their successful implementation. Due to the nature of the business the approach taken was a novel one and the software used was adapted specifically for the purpose after a long period of development. If this project had then been written up and released as a scientific paper it would qualify for inclusion, as there was no commercial gain for the business by producing a paper it did not, so there are obvious inconsistencies.

A detailed sample survey of Dutch manufacturing firms (Kleinknecht, 1987) of the level of R&D activity found that there was a large difference between the results obtained from those of the official OECD R&D survey. Questionnaires were sent to a cross section of firms by size and were designed to quantify the input of 'bench engineering' in small firms to give a more realistic basis of comparison with large firms. The OECD survey estimated that 91% of R&D is performed in firms with over 500 employees.

However, the more detailed survey found this figure to be 82.4 per cent. The official Dutch survey did not include firms with fewer than 50 employees, when these were included the proportion of R & D performed in large firms fell further to 77.3 per cent. This suggests a significant proportion of R & D activity undertaken in the SME sector is missed by the official OECD surveys.

There are additional problems when using patents or publication statistics as indicators of R&D productivity. The propensity to publish or patent innovative activities varies across industries and size groups (Doudeyns and Hayman, 1993). For example, Criscuolo and Haskell (2002) found that the medium size

firms did virtually no patenting or external R&D whilst the 12 largest firms undertook 72% of (private sector) patenting. This is unlikely to reflect the true distribution of innovative activities as most firms perform some type of innovative activities, however limited.

Official surveys appear to be biased towards the measurement of R&D activities performed in dedicated laboratories. These are easier to measure and do tend to truly reflect the activity of large firms. However although it is straightforward to suggest that the surveys miss R&D in SMEs, it is more difficult to suggest ways of improving the work.

SME R&D activity tends to be widely dispersed within firms with no group of individuals dedicated to innovative work. Pinch and Henry (1999) investigated the innovation activity of the cluster of British motor sport firms in Southern England and found that despite the emphasis on high technology, the industry did very little patenting. The main reason for this was that ideas and designs fell out-of-date very quickly so a patent would be of little use. The output of the R&D and its success is measured on the race track by performance, and by the next race there needs to be further developments ready for use to deliver the next performance. The R&D is very keenly focused on delivering a specific outcome. The type of work undertaken in the British motor sport industry is a combination of incremental improvements through trial-and-error and breakthrough designs. Yet it would be unlikely that any of this work would be recorded in any official surveys yet this is one of the most innovative industries in the world.

Many high technology SMEs share this approach to R&D outputs. There is no value to them in seeking patent protection as this would only delay the release

of the product to the market, and provide key information to their competitors, and anyway they could not afford to defend a patent in the courts. The output of their R&D is launching a new product or service to the market place, their success will be judged by how successful this new product is and how long it takes a competitor to offer something better. These SMEs support large firms by becoming expert in specific areas of design or manufacture, they are therefore of great importance to the economy, a level of importance that is not reflected by official surveys. The sector is very effective at allocating resources efficiently and is often responsible for some of the most profound breakthroughs.

However there are also many SMEs who undertake R&D in this manner without a specific end goal, the business operates under the assumption that it needs to carry out these activities but does not have the infrastructure to successfully commercialise the R&D output. Whilst their innovation may be valuable they fail to gain commercial advantage because it takes them too long to reach market, or they fail to convince their customers of the benefits.

KCE is a good example of a business that invests a lot in R&D, the company is continuously developing its manufacturing techniques and introducing new equipment and techniques. The company currently spends approximately £100,000 PA on R&D type activities which represents 5 – 6% of turnover. However KCE has not seen a return on this investment of 20 – 40% as is recognised for these activities. KCE has gained a patent on a unique bearing design, but then failed to commercialise this design and add any value to the business. It is suggested that these problems are not unique to KCE and experience of other similar sized firms would indicate they suffer from the

same problem. The company has seen its best results from incremental improvements to its products that have contributed to the ongoing quality and process improvement processes. However much of this activity would not be classed as R&D by the Frascati model.

2.8 The Management of R&D Activities

As stated earlier in this section, the total R&D effort of a firm has long been held as a key indicator of the likely success of firms, industries and even nations. This however, ignores how the research and development expenditure or effort is deployed and does not take into account the decreasing returns to scale associated with R&D expenditure. There are a number of differing views on how R&D is best executed and what returns can be expected from innovation. The neoclassical approach suggests that investment in R&D should be maintained until the cost matches the marginal discounted cash flow from the inventions produced by the R&D expenditure. This is an effective way of sorting between product and process innovation because if one type of investment is projected to produce a greater return than another, investment flows are likely to be directed to that particular type. Others hold the belief that R&D of any kind in any area is likely to be of some benefit.

One of the most influential voices on industrial prosperity in recent years has been Porter (1990) who identified the UK as having invested too little in research to improve factory processes and too much in 'blue skies thinking' leading to a fall in industrial competitiveness. This, he maintains, has led to a lack of diffusion of technologically sophisticated ideas down to production level. The traditional linear model of R&D reflects the belief that there is very

distinct process to research and the returns from R&D expenditure are difficult to estimate. This suggests that research starts with a 'blue skies' phase, moves to small scale experiments, then to pilot trials before being integrated into larger trials and finally going through a diffusion phase leading to complete adoption. This is likely to have been true of some highly structured industries where innovation took place to improve sustaining technologies such as in the chemicals industry, or textiles industry; however it does not seem a valid representation of the fluidity of innovation in the likes of the electronics industry or the software industry where there is no obvious sequence to activities, and new developments spill over into new products of markets with relative ease.

However this traditional approach is not always followed. For example, the mobile 'camera-phone' is the product of integration of two technologies into one small unit, those of the mobile telephone and the camera. However, there is nothing intrinsically new in the technologies. Often R&D sections within a large organisation exist to predict the trajectories of innovation and to anticipate the future requirements of the organisation rather than to get involved in 'blue skies' work. Indeed, in many firms this more recent approach takes the form of defensive R&D where firms will simply perform R&D to avoid being caught-out by the competition. Whilst some large organisations will perform 'product R&D' by buying licensed technology from other firms for integration into their own products.

This introduces a second approach to R&D where there is no formal distinction about different types of research or development or what it should produce or entail; the approach is that of innovative clusters. These clusters

may be within an organisation or operate between multiple organisations such has been suggested by Porter (1990). The theory of innovation clusters suggests that a mix of skills and disciplines is required before successful innovation can take place. This may lead to new invention in terms of products or process but the distinction is not important at this level, it is simply the coalescence of ideas which is important in improving the likelihood of successful innovation.

Intel, the world's largest semiconductor manufacturer, has been pioneering a new way of organising R&D effort (Chesbrough, 2001). In the fast paced business of semiconductor manufacture where products can have a typical life of less than one year Intel spends a large proportion of its sales revenue on innovation to maintain its product base (12 per cent of sales revenue in 2000). However, much of this research is externalised or sub-contracted. Indeed Intel records relatively few patents and does not contribute to scientific journals; yet remains at the forefront of its technology. This is achieved by outsourcing R&D activities to universities, running several projects concurrently and carefully nurturing and managing the most successful through to production. This allows Intel to innovate faster than the competition and has demonstrated that large firms do not need to own their intellectual property in order to profit from it. This is generally seen as a technique which may help the dissipation of knowledge in UK universities into industry. Where Intel excels is in the commercialisation of technology through effective marketing, which is something that its innovative partners can not do well internally.

The organisation of R&D activities and how this relates to outcomes in terms of new products or processes has been extensively studied. The management of disruptive technologies is investigated by Christensen (1997) who provides case studies of the disk drive and mechanical excavator markets. It is found time and again that incumbent firms had great difficulty in transcending from one technology to the next. There was, by example, a move from 14 to 8 then 5 ¼ and 3 ½ inch disks in the disk drive market and a move from steam to diesel power and cable operation to hydraulic actuation in the excavator market. At each shift in technology it is shown that the market leaders fail to appreciate or manage the threat from the new technology.

Christensen suggests that this is a result of managers acting in an entirely rational manner and not moving into markets which are initially too small to gain the approval of shareholders or senior management. For example, hydraulic actuation in the excavator market first only appeared on very small machines which could not satisfy the demands of existing customers. The market was highly competitive so incumbents could not allow resources to be redirected into what, in effect, was a completely different market for risk of losing their dominant position of the market they were in. This allows the niche players to raise their level of sophistication relatively unchallenged from the large mechanical excavator manufacturers (after all they were in a different market with different customers). Eventually hydraulic technology became sufficiently developed to allow the niche players to start tackling the larger market of the large mechanical excavators and very quickly take market share. The change was not particularly gradual and had the characteristics of a tip-over point which could not have been predicted. It is concluded that traditional

firm structures do not cope well with disruptive technologies however good they may be at managing sustaining technologies.

As Christensen concludes on the mechanical excavator case:

"The patterns of success and failure we see among firms faced with sustaining and disruptive technologies are a natural or systematic result of good managerial decisions. That is, in fact, why disruptive technologies present innovators with such a dilemma. Working harder, being smarter, investing more aggressively, and listening more astutely to customers are all solutions to problems posed by new sustaining technologies. But these paradigms of sound management are useless – even counterproductive, in many instances – when dealing with disruptive technologies." Christensen 1997.

Solutions and characteristics of successful firms are identified by Christensen (1997) with the following suggestions:

1. Organisational segments managing disruptive technologies were matched in size to the initial potential market so that they got sufficiently excited about small opportunities and small wins.

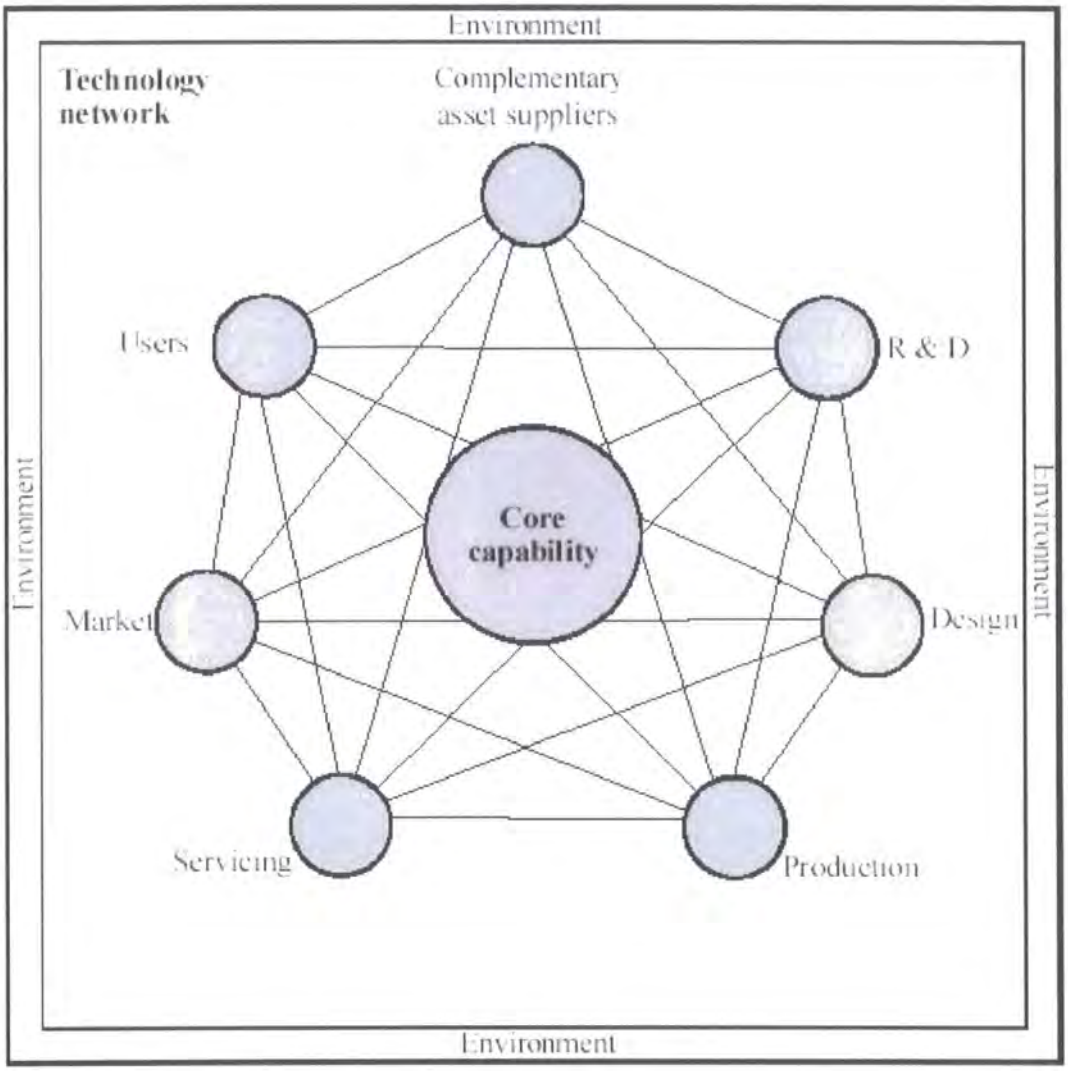
2. Initially new markets were identified and exploited for disruptive technologies before larger mainstream markets were addresses.

3. Trial and error was used to a degree when developing new technologies and new markets, it was important that it was recognised that projects can fail, but that they should be managed so they do so inexpensively.

This supports other assertions that networks are very important in ensuring firms are able to identify and cope with new technologies. There needs to be complete concurrency between all people and all levels both within and outside an organisation. The innovative system needs to be structured in such a way that ideas can be developed and new technologies combined, with speed. There is new evidence to show that there is a growing tendency to acquire technology from networks (Edler, 2002). This is represented in Figure 2.6.

Figure 2.6 The Network organisational system.

Source: Rycroft, 1999, figure 4.5 (from Rycroft, 1994, p.619).



Hargadon (2003) also follows the theme of innovation occurring where different technologies and disciplines coalesce as shown in Figure 2.6. It is noted that technologies are generally far older than many people believe and that technologies in the form of products today are usually the product of many stages of evolution and aggregation of well proven technologies. A good example of this is Henry Ford who is seen as being highly innovative in

the design of a flow system of production for cars. Not to belittle his achievement, it is worth noting that this work was a coalescence of existing technology where the flow principle of a soup canning plant were combined with the (dis)assembly process in a slaughter house and the standardisation of parts in a sewing machine factory to produce a revolutionary way of working which in retrospect was on some measures, incremental (Hargadon, 2003).

2.9 Summary

Innovation is an important factor in sustained economic growth. The UK falls behind other similar countries in terms of R&D expenditure as a proportion of GDP, Germany spends 25 per cent more and the United States spends 35 per cent more than the UK. There is also a shortfall in capital investment to exploit the outputs of any R&D. The UK is furthest behind in Industry financed R&D, which is proven to have the greatest impact on wealth creation. This could be seriously damaging to the long term prospects of the UK and the Government's aspirations to grow a knowledge based economy. Policymakers recognise that R&D is critical to future economic prosperity and have devised a Europe-wide target for increasing the level of R&D expenditure. However there are still factors to be addressed in ensuring that the R&D output is of a high quality and adds value to the economy.

These problems are partially countered by the findings here that much R&D effort appears to be missed by official statistical studies; they seem particularly poor in reflecting innovative activities in SMEs. This is partly because of the Frascati definition of R&D being too stringent and biased towards the measurement of large scale R&D activities and partly because those in SMEs do not immediately view their work as being innovative, even when it is. This underreporting of the contribution of SMEs is further reflected in indicators of R&D output where patent data and scientific publication statistics are used as proxies for R&D activities. These tend not to reflect the work of small firms as many do not patent their technologies, either because of the issue of the low volumes over which to spread the cost of the patent or because the innovations are likely to be superseded by further innovations in

a relatively short period of time. SMEs are likely to be more important to R&D, innovation and therefore growth than many appreciate. They participate keenly in clusters and are often closely integrated into networks of firms and universities (Van Looy, 2003; Charles, 2001). Many large firms are even establishing smaller subsidiaries to perform their most innovative work as they are seen as better able to harness and appreciate the potential of new ideas and designs.

The risk is that as policymakers strive to make an environment in which the classic indicators of R&D activity such as patent applications, technical papers and direct investment can increase an area of real potential for wealth creation and innovation in the SME sector will be overlooked. The SME sector seems able to capitalise on ideas quickly through the operation of specialist niche players, these firms are very flexible whilst resources are allocated efficiently through the share of knowledge and ideas. Many are now emphasising the importance of networks for good innovation, this is particularly the case for Christensen and Hargadon who see networks and a mixing of disciplines and knowledge as key to innovative success. Whilst one SME may not possess the capability to fully exploit a piece of IPR participating in an effective network can give it access to another SME that may be better positioned to do so.

It is widely recognised that direct intervention by governments in R&D, i.e. by directly funding research is not an effective method of growing the economy, as this does not create the industrial will needed to capitalise on the R&D outputs. So the solution to the UK's R&D shortage should not be for governments to provide additional finance to public institutions to spend

internally on R&D. Policymakers need to work on creating an environment in which innovation can flourish, this should reflect the needs of the SME up to the large organisation.

The next chapter focuses on the SME sector in the UK, its size and its composition. This then feeds on to a case study where KCE and Durham University have worked together in order to enhance the competitiveness of KCE, and add some value to the University in the North East of England and the work that Durham University has undertaken with other SMEs in order to enhance their competitiveness and encourage innovation.

3 An Analysis of Innovation in SMEs

3.1 Introduction

The purpose of this section is to identify what an SME is, why SMEs are important to the economy, and how the innovative activities, inputs and outputs discussed in section 1 are relevant in the context of an SME. Firstly this chapter looks at the Small and Medium Enterprise (SME), how they are defined, created and financed. The importance of the role played by SMEs in the UK economy and more specifically, in the North East of England is also examined. The manufacturing sector in the North East is highlighted and the trends in regional employment and the relative benefits this has brought are also detailed. The role of the SME in R&D and the difference between SME R&D inputs and outputs and those of larger organisations is examined. Business assistance provided to SMEs by the government is examined, and specifically the work of Durham University and their Agility project and the Knowledge Transfer Partnership programme is also analysed as examples of successful government backed scheme to encourage innovation and business improvement in the SME sector, the relative benefits and negative impacts of this are examined in detail.

3.2 What is an SME?

The SME sector by its very nature is turbulent with a continual churn of firms and employment. This should be viewed as positive as it allows for the most efficient allocation of labour and capital. The most rigorous and widely used definition of a small or medium firm in the UK now comes from the European Commission where a medium firm is classified as one with fewer than 250

employees and a small firm as one with fewer than 50 employees. There are also restrictions on turnover and balance sheet totals which are summarised in figure 3.1.

Figure 3.1 EU Definition of Business Size Classifications

Enterprise category	Headcount	Turnover	or	Balance sheet total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
small	< 50	≤ € 10 million		≤ € 10 million
micro	< 10	≤ € 2 million		≤ € 2 million

source: http://europa.eu.int/comm/enterprise/enterprise_policy/sme_definition/index_en.htm

When compiling statistics on the SME sector it is widely accepted that an enterprise describes an ownership unit while an establishment refers to a productive unit. The DTI's definition of a 'business' is 'a legal unit, person or group of people producing goods or services under their own control and with their own legal identity. A branch or office of a larger organisation is not in itself a business' (ONS, 2002b).

Small and medium enterprises account for by far the largest proportion of UK businesses by number; they also employ over 55 per cent of the population involved in non-government business. Most SMEs are private limited companies and have been formed with a structure that dates back to the late nineteenth century when the House of Lords made the decision to extend the option of incorporation to sole traders and small partnerships. (Cook, 1999) The original companies' legislation (the Limited Liabilities Act 1855 and the

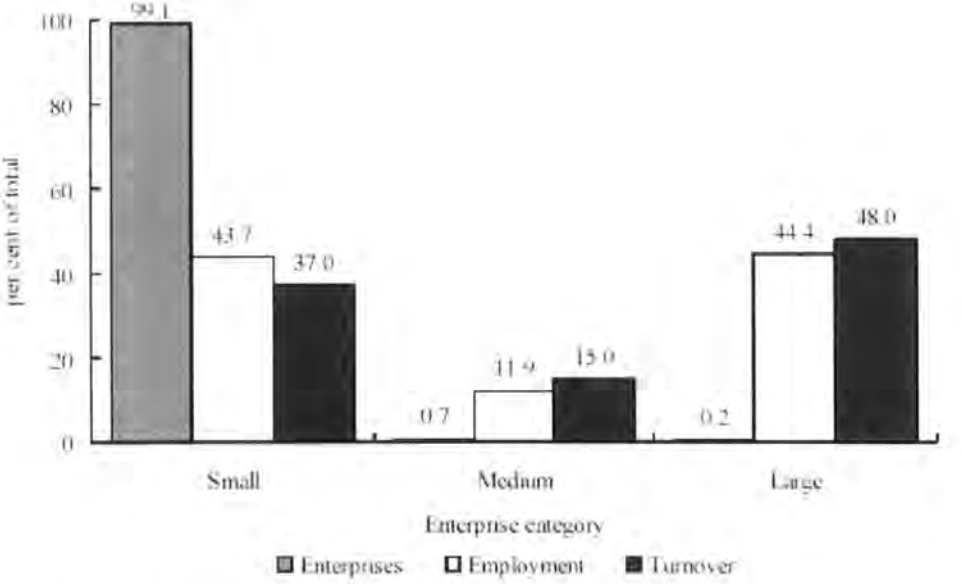
Joint Stock Companies Act 1856) was intended to spread large investments and spread risk in a manner that is comparable to that of a public company. The development of companies' legislation was in general rather haphazard when compared to the structures formed on the continent. (Hicks, 1995). The original purpose of limited liabilities legislation was to encourage investment through mitigation of the risks to individuals. Passive investors were therefore exempted from all liability for company failure except the loss of their investment. This is, of course, only possible through a regulatory framework that manages the risk for creditors through not being able to hold owners liable for outstanding debts where managers are under an obligation to be accountable to a group who have an interest in the continued survival of the firm (Cook, 1999). However, interestingly Hicks et al. (1995, p. 65) note that 'since few small companies attract any share capital other than from active participants... the vast majority of companies are... not achieving the original objective for which limited liability was intended.' (Ibid.). This perhaps ignores the fact that because of this the active participants are likely to have an even greater interest in the survival of the company as they stand to loose both their investment and their means of employment if the company is forced to close. It can therefore be assumed that those working in small firms have a great deal of enthusiasm for the firm's survival.

3.3 The Importance of the SME

Figure 8.1 shows that in 2002 small firms accounted for 99.1% of all firms in the UK. Small firms employed 43.7% of an estimated total business employment of 22.7 million therefore they represent a very significant proportion of the economy and employment in general. Small and medium

enterprises account for just over half (52%) of business turnover in the UK whilst employing 55.6% of the business total, this would suggest that in general, smaller firms employ higher numbers per unit of turnover when compared to larger organisations. This, however, may be explained by differences in gross capital employed between the two types of organisation i.e. large organisations tend to have more automation and machinery than small firms.

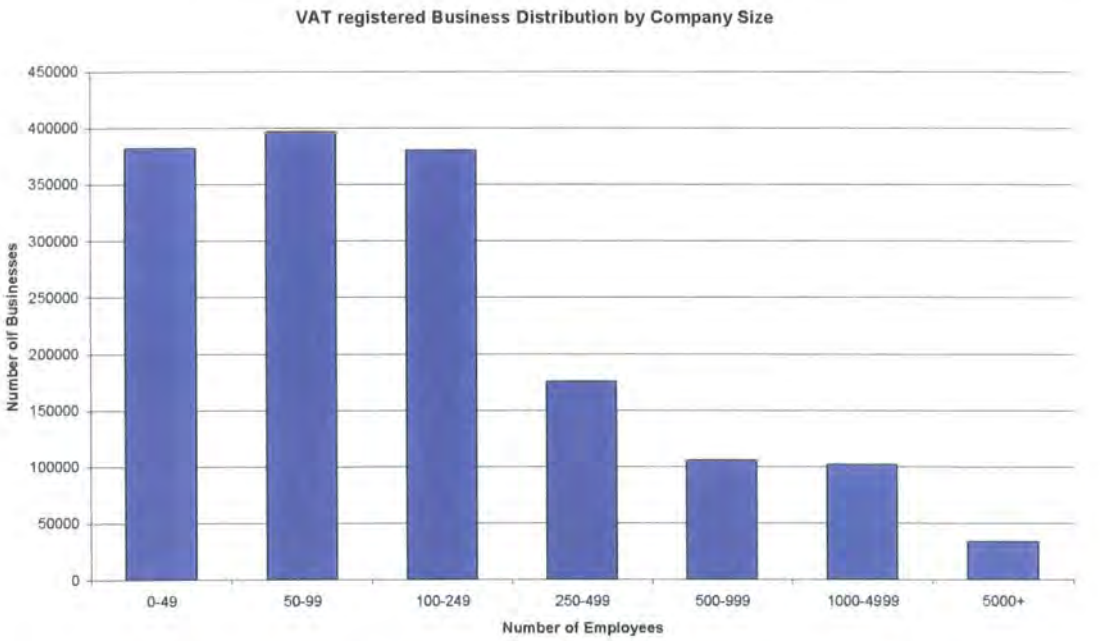
Figure 3.2 Share of businesses, employment and turnover by size of business UK, start of 2002.



Cook (1999) studies the number of firms filing accounts at Companies House (Table 2.1) who are in the small and medium size categories who submit abbreviated accounts with the aim of identifying the effect of changing registration legislation. Small and medium firms submitting modified accounts are shown along with those filing full accounts and group, dormant, interim/initial accounts (G/D/I). Since 1994-95 there has been an overall decrease in the proportion and absolute number of small firms submitting

abbreviated accounts whilst there has been a corresponding increase in the number of companies submitting full accounts. The dramatic increase in those submitting modified accounts between the accounting periods 1993-94 and 1994-95 with the corresponding decrease in the number of full accounts submitted may be indicative of companies taking advantage of the audit exemptions granted to companies falling into the small-firms category. This shows small firms changing rapidly to take advantage of an improvement in their operating practise.

Figure 3.3 Vat registered Businesses Distribution by No. of Employees



Source: Office for National Statistics Survey 1998

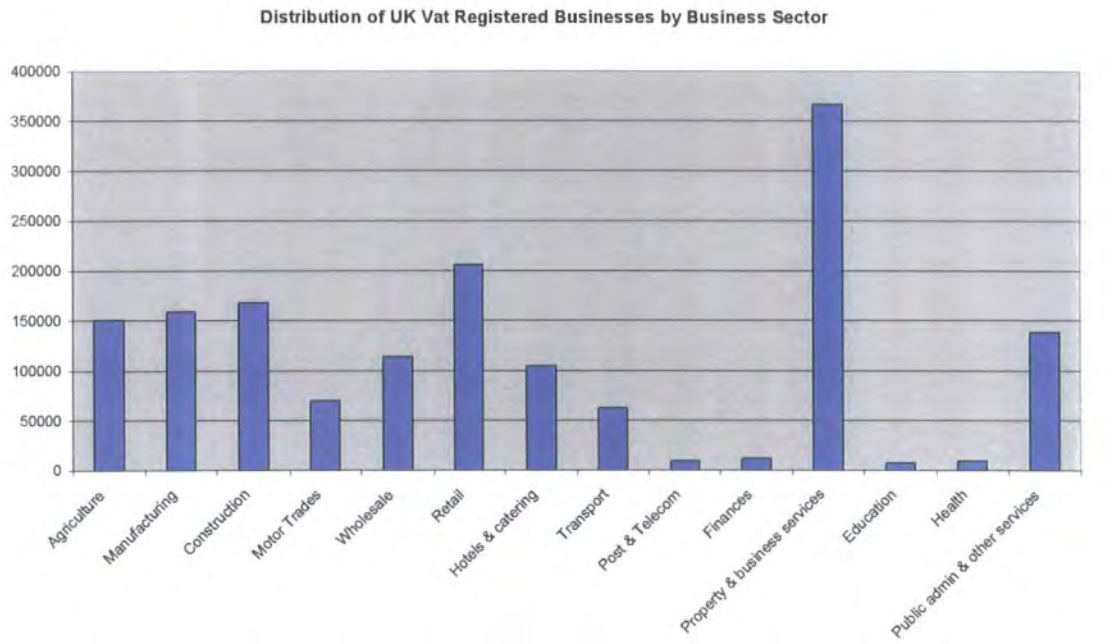
A more detailed breakdown of the number of enterprises in the UK by size is given in Figure 3.3. At the time of the survey the UK had over 1.5 million VAT registered businesses employing more than one person of which 381,890 are micro and small enterprises, 776,475 are medium enterprises and only 415,570 are large enterprises. This raises some interesting dilemmas; in order to stimulate the most economic growth per pound of money invested, which

size band gives the greatest return in terms of increased employment? It has been shown in many studies that SMEs are most effective at translating assistance into employment (Hart, 1996), (Cook, 1999), (OECD, 1997); this is addressed in more detail later in this chapter.

3.4 The Manufacturing Sector

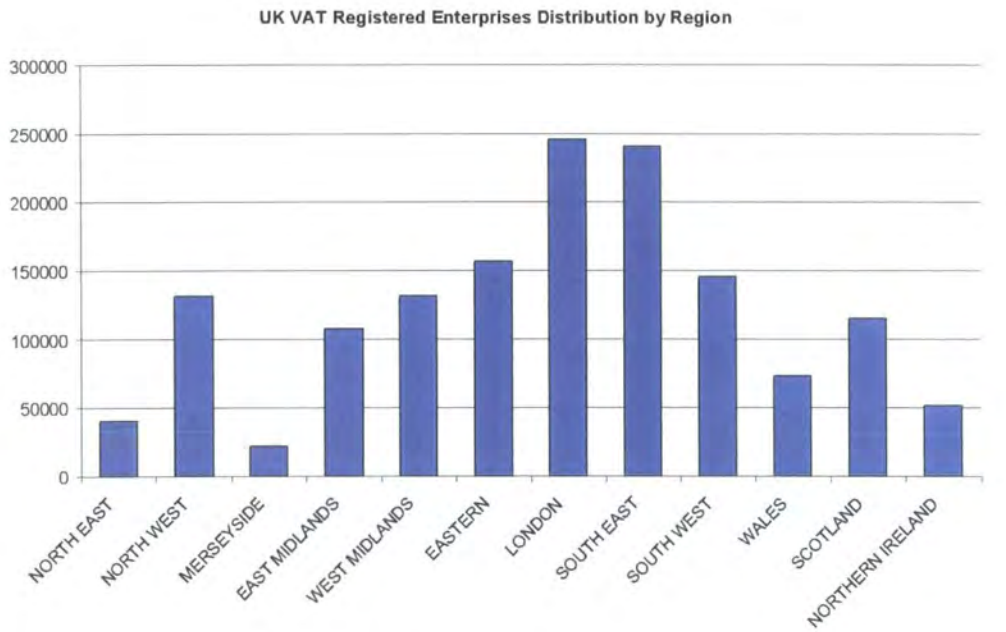
The manufacturing sector has a total of 158,715 Vat registered businesses that have employees (Figure 3.4) and represents a significant contribution to the national balance sheet. In terms of employment almost 50 per cent of manufacturing employment comes from large firms and 46.1 per cent comes from the SME sector with a total number of employees of 1.9 million in 2001 (excluding businesses with no employees). There is a higher concentration of large firms in industry sectors C, D and E (mining & quarrying, manufacturing and utilities) this may be due to the primary and secondary sectors of the economy being fully mature.

Figure 3.4 Distribution of UK Vat Registered Businesses by Business Sector



Source: Office for National Statistics Survey 1998

Figure 3.5 Distribution of UK VAT Registered Businesses by Region



Source: Office for National Statistics Survey 1998

3.5 Geographical Distribution of SMEs

Figure 3.5 shows that a larger proportion of firms are located in the South East than any other geographical region in the UK, in particular there are 245,485 VAT registered businesses based in London compared to 40,245 in the whole of the North East. Other research (Keeble, 1998) has shown that there is a difference in distribution between manufacturing and business services firms. The South East contains nearly half the UK's business services and professional firms whilst the Midlands, North West, North East and Yorkshire contain a significant concentration of manufacturing firms. It is also noted that more SMEs are located in small towns and rural areas than in cities which reflects the general shift of SMEs away from cities over the last three decades (Phelps, 2001).

3.6 The Evidence on Growth

There is widespread evidence that small firms grow more rapidly than large firms (Hart, 1996) and that small firms are associated with high levels of employment growth. Cook (1999) again highlights a rich seam of evidence on this point noting that research evidence for the period 1987-1991 finds that net job creation was dominated by the smallest SMEs (1-19 people). Small firms tend to be quick to exploit new opportunities and be flexible in the products and services they offer however the way they grow is often characterised by uncertainty. The success of small firms appears to be governed to a large degree by a random wake of success or failure with some firms continually 'striking lucky' and becoming 'gazelles' of the business world (OECD, 1997). Gibrat's law states that the probability of a given proportionate

change in firm size during a specified period is the same for all firms in a given industry – regardless of their size at the beginning of the period. For example, a firm with sales of $100 million is as likely to double in size during a given period as a firm with sales of $100 thousand. Put differently, by Mansfield, (1962) who found that although broadly correct Gibrat's Law has been found not to hold when studying small firms who are found to be more likely than large firms to increase in size. The notion of turbulence captures the notion of unpredictability of the small firm sector; this applies to both employment and firm survival. In the UK 62% of new firms survive to three years whilst this falls to 47% at 5 years. This is consistent with the United States at 60% and 50% respectively and France at 62% and 48% (ibid). This picture of turbulence is supported in other recent studies of entrants and exitors to the manufacturing sector (Disney, 2003; Martin, 2003). Survey data shows that within this size category employment growth was dominated by relatively few firms with the fastest 5 per cent of growers accounting for 44 per cent of all SME employment growth. Many studies have shown that small firms are growing faster than large firms and there is some evidence that policymakers believe this to be the case. There is a lot of emphasis on the support of small firms in implementing growth strategies. Hart (1996) verifies these conclusions using a dataset of over 50,000 firms. It is found that the data is highly skewed for each distribution. For example, the top 1 per cent of firms account for 69 per cent of total employment, 86 per cent of sales and 92 per cent of total assets. The highly skewed characteristic is consistent with the data analysis in Chapter 7. Hart finds that the dataset used does not fit Gibrat's law; and supports the case that small firms do grow more quickly than

large firms, this is particularly true of firms with fewer than 8 employees who created most jobs. However, it is cautioned that as the study does not look at birth and death rates. The evidence should be further checked before basing policy on these findings.

Evidence suggests this high level of turbulence is one of the positive features of the SME sector which allows it to rapidly adapt to change. Turbulence in employment allows the cross fertilisation of ideas between small firms whilst turbulence in terms of firm survival allows finance to be continuously distributed towards the most successful firms. This is part of the reason cluster groups of small firms have been shown as important to growth (Van Looy, 2003). The geographic proximity of groups of similar firms allows this continual redistribution of capital and labour to work with a high level of efficiency. It is for these reasons that Hart (1996) is incorrect when he cautions that the turbulence of the SME sector makes it an unattractive means of generating employment until such time as it is possible to identify the factor causing the turbulence. Dunne (1992) cites research evidence for the UK which shows that 'in the medium term between a quarter and a half of all new jobs created by a given cohort of new firms will be generated by less than 2 per cent of businesses started'. This type of evidence would support Hart's viewpoint except it is not possible to know in advance which group of firms will be the 2 per cent who create most employment. It is therefore important to be supportive of all firms to give the potential 'gazelles' the best chance of success. Wren (1998) offers support for this by stating that the support of SMEs is more effective than the support of large firms in creating new jobs.

3.7 The Issue of Finance

The finances of small firms and the issue of whether they are constrained by a lack of available funds in terms of borrowing is covered in a widespread manner in the literature. Hughes (1997) identifies the following financial characteristics of small companies when compared with larger companies:

- Small companies have a relatively low ratio of fixed to total assets
- Small companies have a relatively high proportion of trade debt in their asset structure
- Small companies have a higher proportion of total liabilities in current liabilities than larger companies
- Small companies are more reliant on short term bank loans and overdrafts than large companies
- Trade and other creditors constitute a higher proportion of total liabilities for smaller than for larger companies
- Small companies are less reliant on shareholders' interests to finance their assets
- Gearing is higher for smaller companies than for larger companies
- Total loans to total assets are very similar for large and small companies

There are also some observed differences in profitability between large and small companies in manufacturing and non-manufacturing sectors, although many of these differences reflect the different measures of profitability, which are a function of some of the above observations (eg. reliance on trade credit)

This evidence supports the claims that small firms suffer disproportionately more than large firms through the late payment of invoices as they have a less flexible cash flow structure and rely more on short term bank borrowing. However, there is less evidence to suggest that SMEs are constrained by their access to finance at start-up, although many policy makers assume this is the case, Cressy (1996) and OECD (2002c) find that human capital is the primary reason for the survival of small firms whilst the correlation between financial capital and survival is weak. From a large random sample of UK start-ups it was found that decisions regarding the provision of finance were demand driven and that firms self-selected for funds with better businesses more likely to borrow. This is supported by evidence from the United States that small-scale start-ups are typically financed through their own funds and loans of various forms. When surveyed about the difficulties small firms face the average rank for obtaining long-term or short-term loans as only 63rd and 64th (OECD, 1997). There is little to suggest the UK would be out of line with these findings. Indeed, it is suggested that an appropriate government policy would be to make start-ups more difficult rather than less which would lead to a lower proportion of bank write-offs and a lower cost of capital for the remainder. This is supported by Hughes (1997) who notes that little evidence exists to support the claim that there is a general gap in the financing of small firms.

3.8 Firms in the North East of England

The North East of England was once dominated by large manufacturing and mineral extraction firms and raw material production. A large proportion of the local population was employed either in the coal mining industry, steel

production or the ship building industry. The jobs were generally either low skilled or manual crafts type employment. This has shifted dramatically in the last 25 years with the almost complete demise of all of these three sectors however alternative employment has been created and the region continues to build on an economic development policy that concentrates on the growth and development of successful SMEs. The economic development of the region has been badly timed on a global scale in terms of attracting large scale inward investment from big multinational corporations. The North East was very dependant on primary industry and a few very large heavy manufacturing businesses until the early 1980s. Now that the region is trying to attract new businesses to replace these industrial giants it finds itself in an uncompetitive position on a global scale when compared to low cost economies in Asia and Eastern Europe, so there are relatively few recent investments from large multinational companies, they are much more likely to decide to target large investments in new manufacturing capacity in Asia or Eastern Europe, this was also true of Spain during the late 1980s and early 1990s. Spain was successful in attracting many new manufacturing facilities due to its relatively weak economy and low labour rates at that time, this means that Spain is now well equipped with manufacturing facilities that were built during the 1990's. However the North East has relatively few such facilities as most new business space that has been created is for the SME sector. Some headline projects that have aimed to create inward investments from large multinationals have also been unsuccessful. Notably Samsung at Wynyard Hall and Siemens at North Shields. Both of these projects suffered a similar fate, the goods that the facility was created for were highly cost

sensitive and so production was transferred to a low cost economy before the factories in the North East were even fully complete.

For these reasons the shift in the North East has not only been away from heavy manufacturing but also away from large organisations. Where there were once enormous factories and industrial sites there are now industrial estates and technology parks built to provide accommodation for many small businesses. The local economy has lost its dependence on primary industry and heavy manufacturing and a growing service sector is now present in the region. Although the North East remains uncompetitive when compared to Asia or Eastern Europe in terms of basic labour rates it is competitive in comparison with the rest of the UK, and mainland Europe. The region makes an ideal location for an SME with either a European or Local customer base. Manufacturing still plays an important part in the regions economy with a significant number of small and specialist engineering firms in the region. The region has developed several informal specialist clusters of similar small manufacturing companies that have grown out of each other, of which KCE is one.

The region has 5 large Universities, these Universities form an integral part of the region's economy both in terms of direct employment, and supporting infrastructure but also due to the support that the Universities provide to local businesses through:

- Provision of high quality graduates
- Training for existing staff
- Outreach programmes (e.g. Agility)
- Spin out companies

The growth of these Universities is an important consideration in the economic success of the region.

However one area that the region is still weak in is the retention of graduates. the North East has one of the lowest graduate populations in the entire country, despite having top quality Universities producing large numbers of graduates each year, there is a drain of graduates who follow a perception of improved employment prospects to other regions of the country, specifically the South East.

A declining trend in small firms throughout the post-war period was reversed in the 1980s for a number of reasons including an increase in the availability of capital for investment and a renewed support of capitalism from the government of the day. In addition to this, Shutt (1987) finds that a general increase in the number of small units can be partly explained by the changing policies of larger firms towards outsourcing certain aspects of production to small firms, allowing large firms to become more flexible. In the cases where this occurs, there is also a transfer of risk from the large firm sector to the small firm sector which may provide one part of the explanation for the high failure rate in small firms. Of course this need not necessarily be a problem for the economy at a macro scale as the self selection of high productivity plants is likely to *improve* the sustainability of the business sector (Disney, 2003).

3.9 Research and Development in the SME Sector

Research and development in small firms is another extensively studied area. Larger firms do not have a specific advantage *per se* in the output of R&D efforts, however they do benefit from the ability to spread their R&D cost over a greater output thereby reducing their R&D input cost per unit of output

(Cohen, 1996a). Who also found that large firms actually generate fewer innovations per dollar than smaller firms this is interpreted as small firms having an advantage over large firms. Also firms will generally not assume any increase in output due to additional R&D effort thereby limiting their expenditure, this is especially applicable in a SME where activity tends to be keenly focused on the tasks of today, and senior management will be actively involved in the day to day running of the business whereas in a larger organisation the senior management will be mainly responsible for strategic planning for the future. This suggests that all R&D expenditure is closely tied to the output and hence, size of the firm. If there was a more reliable market for innovations, it is argued that this link would break-down as firms would be able to licence new innovations over a wider range of output (ibid). This is commensurate with the evidence on clusters of similar firms benefiting from being involved in similar R&D projects whilst working in close geographical proximity (OECD, 1997; Pinch, 1999; Porter, 1990) it is likely more recent policies of putting universities at the centre of clusters in the UK will be of some benefit. The cost spreading advantage of larger firms also provides justification for the longevity of large firms against that of small, they are better able to benefit from their innovations and are less susceptible to failure from unrelated measures. Hannah (1998) looks at the survival rates of large firms in the 20th century in a number of developed countries and finds that in the UK almost half of the 100 largest firms identified in 1912 remained in the top 100 in 1995 in contrast to smaller firms who had an insignificantly small chance of surviving for the entire period. This pattern is repeated (to a lesser degree) in

the USA suggesting that larger firms do indeed have advantages simply from being large.

3.10 SME Innovation Assistance from Government

The DTI has an extensive range of support schemes for small and medium firms. It operates with the broad aim of driving up productivity and competitiveness. It has been recognised that the UK's approach to collaborative R&D could be significantly improved as Adams (2004) pointed out:

"In some sectors, technologies and regions, the UK has addressed knowledge transfer issues in successful ways. It is however evident that the mechanisms and initiatives for transferring knowledge in the UK are many and disparate."

Technology and innovation have been identified as the cornerstone of a successful SME sector, whilst universities are seen as key to helping disseminate knowledge throughout the economy. It is believed universities have a significant amount of unexploited knowledge capital. There are a number of programmes that have the objective of getting Universities involved with small businesses either by providing direct support, sub contract research services, or skilled employees. Two good examples of this are the Agility Project run by the University of Durham, School of Engineering and the Knowledge Transfer Partnership scheme.

It is the aim of Agility to provide subsidised consultancy services to SMEs with the objective of improving their competitiveness. Agility employs a number of highly skilled people either from an industrial or academic background from a number of disciplines covering:

- Manufacturing Engineering

- Supply Chain Management
- Human Performance and Strategy Management
- Specialised Engineers and Scientists

The skill sets of these individuals would normally be beyond the reach of an SME. Added to this the consultants also have access to the University's resources and facilities and are gathering a large amount of knowledge as they work between several different SMEs and create informal networks to share appropriate knowledge. It is very common for Agility to identify a SME that is achieving best practice in one particular area, and then to bring other SMEs to visit the business to see and learn from a peer.

The Knowledge Transfer Partnership (KTP) scheme places a graduate within a company for a period of between 6 months and 3 years. The graduate works on a specific project in the business which is of strategic importance and will enhance the competitiveness of the business. KTP associates have an academic and company supervisor and full access to University resources. The project team have regular meetings and the academic becomes involved in the project. KTP's are an excellent way of stimulating growth within the SME as the graduate is employed specifically to work on the strategic project rather than being tied up in the day to day activities of the business. The regular meetings give the academics access to the company and there is a flow of knowledge and information in both directions.

The UK government also offers tax incentives to businesses undertaking R&D activities however there are some serious flaws in this system as illustrated by Tyler (2005):

"The Government's attempts to encourage small firms to invest in more research and development are a "shambles", industry experts have claimed. Untrained tax inspectors are

handing out millions of pounds in tax relief and cash without knowing whether the project is a technological advance or not. And, realising mistakes have been made, the Inland Revenue is trying to recover the money by questioning up to two thirds of the applications it has approved over the past two years. The uncertainty this creates is undermining future R&D spending plans and in some cases means loss-making technology companies being asked to return cash years after it has been spent. This critique of the Research and Development Tax Credit scheme, first launched by the Chancellor for small and medium size firms in 2000, comes from those working with companies and the Revenue to try to make the scheme work. One insider says: 'The process is a shambles, especially when it's so easy to consult with people and know how to get it right.' The crux of the problem, the insider says, is that when the Government launched the scheme it decided against hiring a team of scientists and engineers with a solid understanding of the underlying science base, as has been done for similar schemes in Canada and Australia."

Previously the Tax credit for R&D expenditure was only claimable if expenditure was over £10,000 per annum, which was highly prohibitive for many SMEs. The credit is claimable against Corporation Tax payments and is equivalent to about £7.5 for every £100 spent on R&D, however the definition used for R&D is the same as the Frascati model, which as discussed in 2.4 does not necessarily cover all of the innovative activities that actually happen and genuinely contribute to growth in an SME.

3.11 Summary

Small and medium enterprises are a significant contributor to overall output of the economy; they account for over 99% of all firms by number and provide 44% of total business employment. SMEs have also been shown to be more likely to grow quickly than large firms whilst also being more flexible and better at allocating resources. This is not to say that the sector is without downsides. They suffer from an inability to cost-spread innovative work over high levels of output which often constrains their level of R&D expenditure. The sector is also characterised by a high level of turbulence with many entrants and exitors in any given year, on average 62% of SMEs survive to three years of age. Many view this turbulence as a major problem however; there is significant amounts of evidence to suggest that it allows the sector to

be highly flexible in the overall allocation of labour and capital to ensure efficient production. Low productivity firms are more likely to exit when compared to high productivity firms helping to raise the overall level of productivity in the economy. In terms of assisting SMEs, many believe that the sector is constrained by market failures in obtaining capital but the evidence does not bear this out. SMEs are able to get ready access to overdraft facilities and there is a good deal of evidence that investment projects self-select on their individual merits. Where SMEs do have difficulty is the area of process innovation where they are less able to spread the cost of process improvements across large production runs when compared to large firms. It is viewed that there is too little to be gained from process improvements although it is likely that SME owner/managers underestimate the potential returns available as a result of such work.

SMEs have been shown to be more likely to invest in R&D if they are profitable as it is less risky to invest cash than to have to borrow for this type of high risk investment.

It is therefore likely to be most effective for Government to act to assist in raising the level of productivity through process improvement assistance allowing profitability to rise and freeing cash for further investment. Government is already actively involved in this and it seems to be successful, the case study in the next chapter looks at this area.

There is evidence to show that SMEs account for a high proportion of new employment and that they respond more positively to government assistance; where a large firm may use assistance funds to renew production facilities

with more productive plant (reducing labour requirements), smaller firms are more likely to use additional capital to expand, increasing employment.

A cautionary point to this is that there is little evidence for *very* poor firms ever becoming *very* good firms, this is often because of the way individual businesses are managed. It must be accepted that some firms will fail but that this is not a huge problem because the sector is so good at reallocating resources. This allows good firms to take on the work of poorer firms which will raise the overall competitiveness of UK industry. A second cautionary point is that there is little distinction made between *small* firms and *new* firms yet this is likely to be particularly important when looking at growth rates. Those who grow most quickly are often *new* and it is more a matter of coincidence that they are small. This adds weight to the suggestion that some firms should be left to fail allowing new entrants to the sector. Overall it may be better for Government assistance to focus on making good firms excellent rather than focusing on raising poor firms to a mediocre level as is happening presently. In fact it could be argued that a certain rate of attrition of poor firms is in fact good for the economy at a macro level as it keeps the labour market fluid and allows for a flow of ideas and knowledge.

4 An Innovation Framework for Product and Process Development

4.1 Introduction

The purpose of this section is to identify the benefits of a structured approach to innovation and the various strategies that can be employed in the context of an SME to encourage innovation and to increase the chances of achieving a successful outcome from an innovative project. The importance of innovation in the context of the SME has been thoroughly discussed in the earlier sections of this thesis. This section will identify the key inputs to innovation in the SME so that the outputs of any innovation activity can be exploited to maximum effect. A 5 step approach to developing a framework has been developed and will be discussed:

1. Setting innovation as a key objective of the business (4.2)
2. Creating a structured business system (4.3)
3. Developing and better exploiting the creativity of individuals (4.4)
4. Developing strong networks for collaboration and the diffusion of ideas (4.5)
5. Basic marketing tools to create inputs to the R&D process will be suggested. (4.6)

4.2 Setting an Agenda for Innovation

The first step in developing the innovation framework is to establish innovation as key objective of the business. This may seem like an obvious statement, but it is easily overlooked. In order to lift the organisational culture to a point where it can accept innovation as a core value the senior company

management should make it clear to all employees that the company wants them to be innovative in the way they work, learn from their experiences, share their ideas with co workers, and finally listen to ideas from colleagues, customers and suppliers. In most SMEs the key objective of the business is often survival, being innovative presents too great a risk and uncertainty so traditionally workers are encouraged to follow procedures and instructions exactly and not think about or question what it is they are being asked to do. The needs of the individual are discussed at more length in section 4.4. When the author first started work at KCE workers on the shop floor repeatedly commented that solving problems wasn't their job, they didn't get paid to think or other similar statements, this was also reflected in the company management. The culture of the whole company was to get on with your work and get product out the door, fire fighting as necessary, only to repeat the same experiences and often mistakes again the following day. The company responded to customer demands but there was little forward planning in place to help the company grow and develop in the future.

The decision was made to try and change the culture of the company and move to an innovative and learning environment where everyone was encouraged to contribute innovative ideas and solve problems; this had previously been seen as only the responsibility of the Managing Director, Dr Keith Chester. Dr Chester is a highly talented and creative individual and was a very capable problem solver this ability was generally directed at solving day to day problems in order to meet customer needs rather than developing ideas which would allow the company to grow. There was also a wealth of ability in the other members of the business which could be better used. The

message was communicated to the work force that the company was about to undertake an ambitious plan to change, that the focus of the company was going to shift to growth and improvement. So the agenda was set, the message was well received by the workforce, but this was only the beginning it would take a lot of work to achieve the transformation. Work began to highlight the problems which were preventing the company from achieving its full potential in this area. Several different studies were carried out during this phase, which are discussed in more detail in chapter XX. From this work it was established that the potential was there however the daily business of producing parts for customer orders was consuming all of the company's energy. It was identified that the main reason for this was a lack of structure and standard processes to the way the company conducted business on a daily basis, this was causing a lot of additional work and using all of the available management time and resources. A plan was developed to put in place a basic business system to better organise the routine activities of the company, this is discussed in more detail in the following section.

4.3 Creating a Structured Business System

In order to better organise the day to day activities of the company the author developed a business system "the 5 core pillars" (Adapted from the Valeo Group's 5 axes) the pillars of this new system were:

- Involvement of Personnel – Develop skills and versatility, encourage people to take responsibility for their work and build strong teams.

- Supplier Development – Work with suppliers to learn from them and share knowledge with them, reduce the supply base to a few good suppliers.
- Constant Innovation – Constantly think of ideas to improve products, processes and the business. Look for new opportunities and develop them where feasible.
- Lean Systems – Use a cellular pull process for all operations from admin to production and seek to reduce waste in all operations.
- Total Quality Management – The use of controlled systems and procedures to ensure customer expectations are met, and all of the above objectives are met.

The 5 pillars were set as the corner stones of business development achieving excellence in these areas would lead to a better organised business that was capable of using its ability to be innovative to achieve growth. All members of staff were trained in their meaning, and posters were placed around the company to remind everyone about them. This created a distinct shift in the culture of the business, the focus became learning from what the company did and doing it better, instead of just struggling to survive day by day. The people in the company now understood that they were expected to improve, put forward ideas, and look for opportunities. Crucially they also understood that this behaviour would be encouraged and rewarded. The Managing Director put his full support behind the 5 pillars which definitely helped to bring innovation and improvement to the centre of the business's attention. All business development tasks were related to these pillars, a development plan was posted on the canteen wall next to the 5 pillars poster

so all employees could see what development activities were happening and which pillar they related to. Although the importance of the pillars Lean Systems, and Total Quality Management is not immediately obvious in the context of this thesis achieving excellence in these areas was essential. Adopting well organised lean production systems allowed the business to operate in a smooth and well organised manner, reducing management time spent fire fighting. Using the quality management system to document work processes and provide robust procedures for employees to follow greatly simplified the day to day operation of the business. It should also be appreciated that neither of these could be successfully achieved without a good deal of innovative thinking from the people in the business who were enabled to do this through the enthusiastic promotion of the other pillars. There are wider reaching impacts of the business system which will be discussed in more detail in 5.3

4.4 Developing and Better Exploiting the Creativity of Individuals

This area was so important to the change process that it became the first pillar of the business system "Involvement of Personnel". The process of innovation is inherently dependant upon the individual, either working independently or as part of a team. Innovations can not be created by any other means; they always require the creative input of an individual. So one of the key aspects of a successful framework for innovation will be the deployment of the right people and creation of an environment in which they can succeed at being innovative. This is directly related to the pillar; Involvement of Personnel. Harnessing the creativity of the individual has been recognised as a key strength of a modern successful organisation. In fact the

classic 7 wastes as identified in the Toyota Production System (TPS) have recently been enhanced with the addition of an 8th Waste – Loss of creativity of the individual (Liker, 2004). TPS characterises a structured business operating system that encourages creativity and innovation at all levels of an organisation. TPS philosophy was created to allow the small Toyoda Loom Company to produce vehicles cost effectively in competition to the highly automated large companies producing vehicles in North America at that time such as Ford. Creating an atmosphere that involves and encourages innovation not only generates great ideas and R&D outputs, but it also brings people closer to the business, people like to make a contribution and feel part of something, creating an environment where they can safely contribute to innovation and development of the business without risk of harm will enable this. In an SME there are additional pressures on the individual that can reduce their ability to innovate that may not be present in a larger organisation. In an SME financial resources are limited; therefore individuals involved in the creative process may be less likely to take risks with the expenditure they have, deploying resources on more certain and conservative projects which will generate short term returns rather than more abstract and risky but potentially more rewarding challenges. In an SME people often work within small teams and if the culture of the organisation does not support creativity, even if innovations are not successful then people may be unwilling to run a risk of making a "bad" suggestion. The innovation strategy of the SME should be built with particular consideration to the individual.

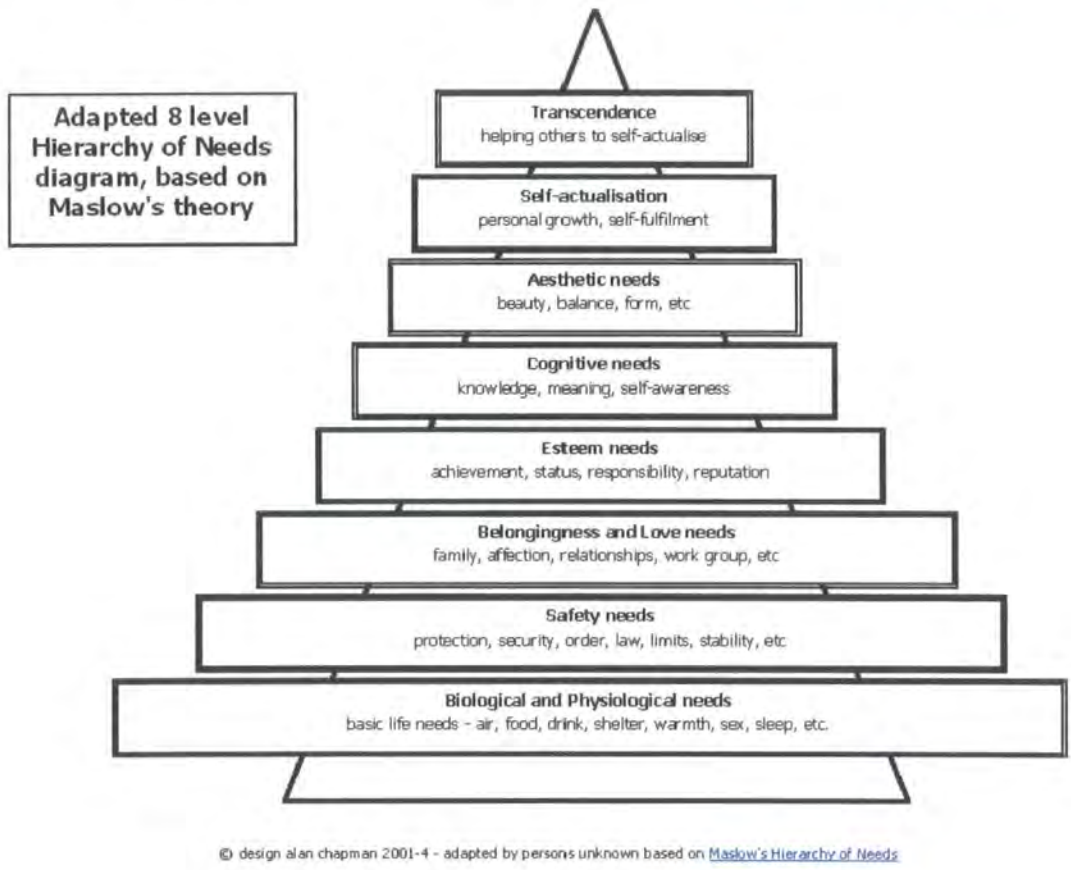
In order to establish the needs of the individuals at KCE an Agility consultant was engaged who was an expert in people management. The consultant

conducted a structured survey of the workforce at all levels in the company in order to establish their feelings about developing the business and what was required to ensure they could meet the company's new objective. Whilst the full results of the survey are confidential it was found that:

1. There was a deep mistrust of any change as this was associated with potential job loss
2. People were uncomfortable making suggestions which may be viewed as controversial, because they feared this may result in job loss or reduced prospects for progression
3. People did not see improvement as possible because they were so busy fighting the daily fires that there was no time to improve
4. People did not feel that their contributions would be rewarded or recognised
5. People did not feel appropriately qualified or empowered to make comment on development plans and activities

These findings were consistent with Maslows hierarchy of needs, see figure 4.1, if the business can take these needs into consideration then this will further encourage individuals to be creative. The innovation framework should build on these needs to create an environment where creativity is encouraged, recognised and rewarded, even if the outcome is not as originally anticipated. This will encourage the individual to put forward more risky innovative ideas. Problems should be seen as positive opportunities for improvement and documented as such, this will encourage people to bring problems forward so that they can be addressed rather than buried for fear of causing disruption.

Figure 4.1 Maslows Hierarchy of Needs from www.businessballs.com



If the organisation has a systematic method of identifying opportunities and providing security to the individual then the perceived risks of the more technically challenging projects can be reduced. This is summed up by Drucker:

"Successful innovators are conservative. They have to be. They are not 'risk focused'; they are 'opportunity focused.....Purposeful, systematic innovation begins with the analysis of opportunities." Drucker (1999).

Therefore the framework must work to elevate the capable individuals to a level in the business where they can identify opportunities. What this means is that the innovation framework must be built to support the individual and to

make them feel comfortable enough to take some risks by presenting their ideas, but there must also be a high level of communication within the business to make sure that as many individuals as possible are aware of the ideas that are being proposed, and the problems and opportunities that are facing the business. This is the role of the business leader to facilitate this communication, and is discussed in more detail in the next chapter. Another key consideration is that the right to be innovative should not be restricted to an elite few in the business; this is particularly true in the SME where resources are limited. Everyone in the organisation should be exposed to ideas and creative thinking so that they can have an opportunity to contribute.

4.5 Developing Strong Networks

It has already been identified that one of the limiting factors to the creativity or inputs to R&D in a SME is the sales value of the company over which expenditure on innovation could be spread, so obviously any expenditure on R&D is more significant pound for pound than it would be in a larger organisation. However this also applies to other inputs. The SME has a finite resource of people to be innovative, and opportunities that their innovations can be commercialised in. It was suggested during a business meeting with some venture capitalist's in Canada in October 2005 that "Innovation is a contact sport" The author whole heartedly agree with this statement. The importance of networks was summed up by DFES (2002):

"In an increasingly knowledge-driven global economy invention and innovation are critical to Britain's long term competitiveness. This requires a virtuous circle of innovation: from the very best in science, engineering, and technology in universities and science labs to the successful exploitation of new ideas, new science, and new technologies by businesses"

Networks provide an opportunity for the SME to gain access to new people, resources and new opportunities. They can be established at several levels:

- Informal between groups of similar companies or companies and other institutions
- Informal between people with similar interests
- Formal between related groups of companies or companies and other institutions
- Formal between people with similar interests

Value can be gained from both informal networks and formal networks, the exchange of ideas, and learning from others experiences in unrelated areas can be highly valuable however in order to achieve a more measurable outcome participating in formal networks has the best impact, this was confirmed by Adams (2005) in a study conducted for the DTI into barriers to innovation for business was a need for coordinated networking opportunities for the SME. In answer to this the DTI has established two main programmes:

1. The collaborative research and development programme
2. The knowledge transfer networks programme

There are a plethora of other schemes organised at a regional and national scale. There are also a lot of less formal networking opportunities for business, and individuals such as trade organisations, professional institutions, networking clubs, etc. For formal networks there are useful resources like the Lambert Agreements, which were a product of the Lambert Review of Business and Academic collaboration in 2003. The aim of these agreements was to provide standard documentation to simplify the collaboration process, Lambert (2003):

"The best forms of knowledge transfer involve human interaction, and the Review makes several recommendations designed to encourage more frequent and easy communications between business people and academics. It suggests that research collaborations might be made easier to agree if model contracts could be developed on a voluntary basis to cover the ownership and exploitation of intellectual property (IP)."

The agreements were drafted and are now provided free of charge on the DTI website to ease collaboration between business and academic institutions. Great emphasis has been placed on collaboration between academic institutions and business, and there is much to be said for developing this area, but these collaborations tend to be unidirectional with business providing finance for academics to engage in research on the behalf of the business. The costs involved in this form of collaboration can also be prohibitive to the SME. Some universities have embraced this and have tailored outreach services to specifically meet the needs of the SME; a good example of this is the Agility group at Durham University. However there is also a significant potential in collaborations at a business to business level. However this is often neglected in the UK. In the USA there are many organisations which facilitate peer to peer networking with business such as NBIS (http://www.nbis.org/). In Derwentside, the Derwentside Engineering Forum provides owner managers of SMEs with an ideal opportunity to discuss opportunities and ideas at their regular meetings amongst other issues affecting local business; however this is not an explicit objective of the forum. Pittaway (2004) found that there was little information on business to business networking especially on the manufacturing industries however what evidence there was did highlight that the use of networks was important to stimulate growth in small businesses. There is also a tendency to focus solely on

radical breakthrough technology developments when considering innovation and returns on innovation activities within the SME network however there are significant gains to be made from business to business networking where knowledge of sustaining improvements to the business can be transferred.

The decision was made at KCE to build strong networks, with suppliers (2nd pillar "Supplier Development") with customers through improved communication and with the wider market place through a number of different methods this is discussed in more detail in section XX. Developing these networks is an ongoing process, but has paid great dividends to the company which now has a much improved ability to respond and solve problems by understanding the capabilities of the supplier network, and an improved awareness of the opportunities that exist in the market place.

4.6 Using Marketing Tools to Define R&D Goals

4.6.1 General

In section 2.5 the classic measured input to R&D was analysed. However there are other inputs to R&D that have a significant impact on the success of the outputs. When embarking on a new R&D project one of the most difficult things to do is to home in on the real problem that needs to be solved, this was the case during the initial phases of the KTP programme at KCE. This is often difficult in an SME because the voice of the customer is not present; there is no sophisticated marketing department collecting data on customer needs and market opportunities. In an SME this generally is a function of the Sales department, or the owner manager. It is also generally the case in the SME that the founder or owner of the business will not be from a marketing background, it is much more likely that their background is related to the

activity of the business (an obvious exception being a marketing company). They will have little or no formal experience in harvesting marketing information, and may also struggle to see the relevance of the information when compared to the challenges of day to day business. There are some simple tools that the SME can employ in order to better collect marketing information, and this information should be used to feed the R&D activities in order to better define R&D goals which relate to opportunities in the market place.

The main emphasis of this marketing activity is simple. Increase the capacity of the business to listen to the market place and analyse requirements in order to define R&D goals that will give successful commercial outcomes. The marketing tools most useful in an SME are:

- **Benchmarking**
- **SWOT Analysis**
- **Customer Surveys**
- **Networking & Market Research**

4.6.2 Benchmarking

Benchmarking is being aware of the capabilities of competitors and their products and services. Knowing their products and the differences between competitors as perceived by the customer is crucial to the success of this activity. This is often referred to as "Unique Selling Point" or USP for short. Understanding what the competition offers, and where it's value is made up, i.e. its USP can be of enormous benefit when trying to differentiate the company's products from those of the competition. Benchmarking should also form the basis of incremental product development activities, establishing the

costs of competitor's products and their functionality can be an excellent way to identify an opportunity to offer something unique to the market place, or to reduce the cost of the product or service, by removing some non-valued elements.

Benchmarking should be extended past the confines of the businesses particular sector or market place, looking at product or service offerings in other business areas is essential as there may be opportunities to transfer new technologies from other business fields across into your own. This can be done by reading technology and general business publications, networking with people who are involved in other industries through professional forums such as the institutes, attending university PhD poster days and conferences.

The information from benchmarking should also be used to guide the questioning on customer surveys, to find out if the additional features that competitors offer actually perceived as adding value by the customer.

Benchmarking can be carried out in a number of ways, for example a number of competitors' products or service offerings could be analysed and the results placed into a comparative table for analysis, this can provide an excellent reference document for product development activities. Benchmarking can also have the effect of identifying there is no gaps in the market place, and this can also be useful to prevent wasted R&D effort. See figure 4.2 for a suggested format which was successfully used by the author during the KTP programme. Time should be spent thinking about all the key product features which are important to the customer, and also the benefits that can be derived from these features, such as longer life and lower operating costs. These features can be given arbitrary weightings to allow a ranking system to be

developed so it is possible to see which competitor has the overall most attractive product offering, this is kind of ranking research is known as Parametric Analysis some highly sophisticated techniques for assessing scores are available but for this work the author adopted a simple qualitative approach.

Figure 4.2 Benchmarking Comparison Grid (Adapted from work carried out by the author during the KTP project)

Feature or Benefit	Competitor A	Competitor B	Competitor C	Our Product
Price £	150	200	175	180
Lead time weeks	8	2	2	6
Weight Kg	0.5	0.8	0.5	0.9
General Material Used	Aluminium	Steel	Aluminium	Steel
Material Cost	0.5 x cost of AL/Kg	0.8 x cost of steel/Kg	0.5 x cost of AL/Kg	0.8 x cost of steel/Kg
Visual appearance	Low quality M/C marks visible	High polished	High polished	High polished
Max Temperature deg C	110	120	110	140
Min Temperature	-5	-5	-5	-5
Durability Hours till replacement	100000	200000	100000	200000
Operating cost £/hour	0.0015	0.001	0.00175	0.0009
Component Analysis				
Component A Material	Aluminium	Steel	Aluminium	Steel
Component A Weight Kg	0.1	0.15	0.1	0.2
Component A description	Machined widget	Pressed widget	Pressed widget	Machined widget
Component B Material	Plastic	Plastic	Plastic	Steel
Component B Weight Kg	0.01	0.01	0.01	0.05
Component B description	moulded plastic pressing	moulded plastic pressing	moulded plastic pressing	turned steel pin

4.6.3 SWOT Analysis

Strengths, weaknesses, opportunities and threats (SWOT) analysis is a simple exercise that can help a SME to better understand its own capabilities. A SWOT analyses will take the form of a 2 by 2 grid, a small team of people from the SME should complete the SWOT together, ideally this should combine at least one person from each "department" or area in the business, as different groups will have their own view on SWOT. SWOT is a very simple tool that will provide an empirical view of the business. The main benefit from carrying out a SWOT analysis is drawing together a team of people from the business and getting them to discuss in a rounded way the current situation of the company, its customers and competitors. The information gathered in customer surveys can be used to guide the SWOT analysis, and ideally there should be at least one member of the SWOT team that represents the voice of the customer. Often the views expressed by different people in the business will be entirely contradictory, for example the people working in sales may have a different set of problems to those working in production, and see a different set of opportunities. Bringing these people together can allow for a better flow of ideas and innovative thinking. Figure 4.3 shows an example of a SWOT analysis adapted from a SWOT session which the author ran at KCE. The SWOT session should be conducted alongside other activities because the company will not fully understand its strengths and weaknesses until it has become more aware of the strengths and weaknesses of the competitor. Perceived internal weaknesses may not relate to actual weaknesses in comparison to the main competition, accordingly the same can be said of strengths. SWOT analysis should be conducted on a regular basis.

Figure 4.3 Example SWOT Analysis

STRENGTHS	WEAKNESSES
Responsive to customers needs Quote fast delivery times Higher quality than competitors Strong customer relationships Product knowledge Good stores and warehouse dept.	No new products under development High labour costs Poor management structure Always late with deliveries Poor at solving internal quality problems Slow to respond to new enquiries No staff cover for bill's holidays
THREATS	**OPPORTUNITIES**
Competition from low cost economies Forth coming environmental legislation Products may become obsolete Price pressure from competitors Customers reducing supplier base	Exploit product knowledge in other areas Improve delivery performance Reduce quality problems to improve price competitiveness Offer more products to existing customers Take on agencies for other products Improve responsiveness to customer

4.6.4 Customer Surveys

Although often closer to the customer than a large organisation, many SMEs are often to preoccupied with the day to day tasks of running the business to take the time out and have a through discussion with their customers about what they think of their service, or if there are any additional opportunities to add more value to it. Also ensuring that sales and marketing staff are feeding back information from the customer to the rest of the business on a regular basis will allow the business to keep in tune with the customers requirements. Taking the time at least once per year to conduct a formal customer survey is a very efficient and enlightening way to gather information about the performance of the business. It is interesting to compare the information gathered in a survey to that generated internally from SWOT analysis to see

how they measure up. Often the things that are perceived as the big issues within the SME are not the things that cause greatest concern to the customer. The survey should be gathered in such a way that it provides:

- Feedback on current performance
- Feedback on customers experience with competitors
- Targets for improvement to current products and service offerings
- Feedback on trends in the market place
- Information about other needs, requirements and opportunities

This information can then be fed into internal departments and used to help:

- Establish business improvement priorities
- Identify opportunities for new products
- Identify opportunities for diversification
- Identify USP from competitor
- Establish trends in the market place

The survey information should be reviewed by all key personnel in the business. One of the more obvious sources of information that is often overlooked is the customer visit. Many businesses visit their customers on a regular basis, and spend time discussing current orders and sales matters. However these visits are often not recorded and the information gained is not fed back to the rest of the business. For instance how organised a customer is, how busy they are, did they mention any competitors, did they mention any other problems they are currently having with other suppliers. Creating visit reports and sharing them with the rest of the business is a very valuable tool for recording customer feedback that can be used to trigger innovative ideas. This information should also be fed back into the SWOT analysis.

4.6.5 Networking and Market Research

Most SMEs are run by owner managers, within the SME it is very easy to become inward looking concentrating only on the problems of today and fire fighting. The benefits of taking time to speak to other businesses may not be immediately apparent but the opportunities for cross fertilisation are huge. Participating in professional associations, attending conferences and seminars and visiting other businesses are invaluable if approached in the correct manner. The opportunity to learn and identify opportunities is enormous in these situations. Systematic market research is rarely undertaken by the SME due to the perceived high costs involved, however market research can be something as simple as making time to read the relevant industry magazine or website on a regular basis, this can be very useful and informative. Many industry associations carry out systematic market research, the costs of which they spread across their membership making it more affordable to the SME, many local chambers of commerce also provide a similar service and membership of these organisation's is generally very low cost.

The internet provides a wealth of resources for market research on potential customers and competitors. On line portals can be used to find most information about competitors and customers for free. For overseas markets where information is more difficult to find the UK Trade and Investment service offers market analysis services at a very low rate. The European

Patent office offers a service where new patents can be tracked in specific technology areas. There are a number of professional market research companies that now offer very low cost email based technology update services. The google news service is excellent and free, similar services are offered by Yahoo and the other major portals where news from a number of different sources is displayed on one page. There are also various government, and international body websites that provide statistics and relevant information. Some useful links for these organisations are:

www.statistics.gov.uk (The UK Office of National Statistics)

www.bls.gov (The US Bureau of Labour Statistics)

www.europa.eu.int (The European Union main Portal)

www.iso.org (The International Organisation for Standards)

www.oica.net (The international organisation of Motor Vehicle Manufacturers)

www.sae.org (The society of automotive engineers)

http://www.european-patent-office.org (The European Patent Office)

http://www.espacenet.com/ (Patent searching database)

Whilst it is not possible to constantly monitor all of these sources of information a well balanced business should at least:

- Become a member of their own trade association
- Carry out some basic research into their market place to identify size, potential customers and potential competitors via an online directory
- Establish a link into the local relevant university department
- Try to attend one trade conference or seminar per year

- Keep track of new relevant advances in technology

The information gathered should be shared with all members of the business to aid the learning process.

4.7 Defining the Project; Improving Project Definition Through the Use of Marketing Tools

Ensuring that the project is well defined, and that the right questions are being tackled is important to the success of any innovative activity. If this is not established at the start of the project, and revisited throughout the course of the project it is possible to lose sight of the initial objectives. Figure 4.4 shows the 14 factors for success, any R&D project or in fact innovative activity could be evaluated against this table, and scored for each line on a rating of 1 - 10. This will give an indicator of potential success of the project, and may also provoke thought about how the project can be improved. The information gathered using the marketing tools should be employed here to help achieve specific project goals, set targets and creates milestones. This table was developed by the author in order to prioritise R&D activities at KCE. During the initial phases of the KTP programme a great number of possible technical projects were suggested by the academic and industrial supervisors, it was necessary to develop a method of weighting these proposals against possible commercial return relative to the overall needs of the business. The author has integrated this table into the design request and review process at his current company to allow design and development requests from the sales department to be prioritised.

Figure 4.4: 14 Factors for Success

Factor	Rating
How big is the customer demand? (£££ potential)	
Is the technology solid? (Technology Assessment pro grid)	
Is it possible to protect the technology? (Barriers to entry patents etc)	
Where is the available know how? (internal expertise of technologies)	
Is there a clear path of commercialisation?	
Is the innovation scalability has manufacturability been considered?	
How long will the product life cycle be?	
Who will be the champions of the technology?	
Does the project have management support?	
How much will the project cost?	
Do we have any similar knowledge or experience?	
Is the potential customer base defined and understood?	
How is the product delivered to the market?	
Is there a strategy for growth and future development?	

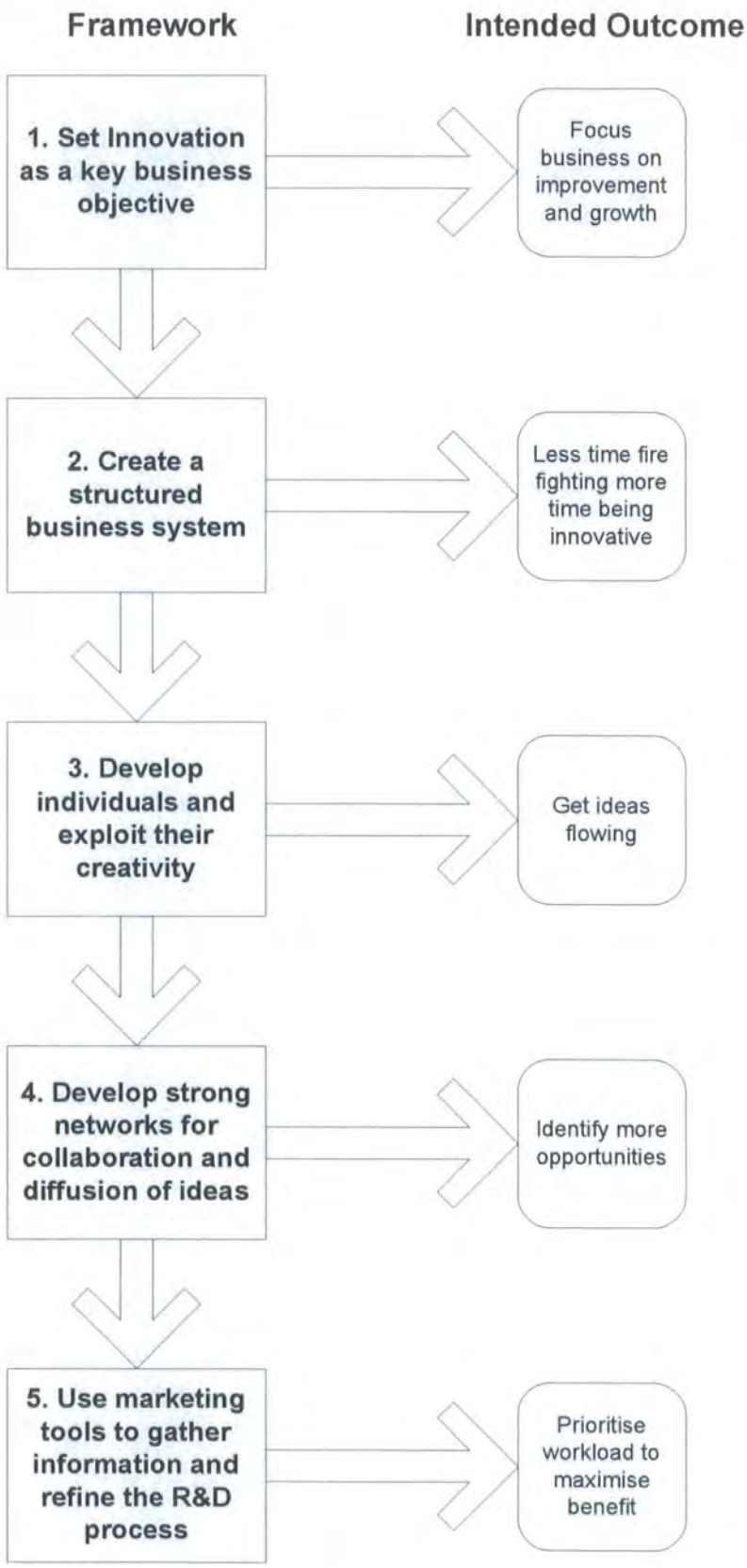
4.9 Summary

The need for a coordinated approach to innovation and business growth is clear. There are many factors that have an impact on the potential successfulness of an innovation, and by having at least an awareness of all of these factors the SME can greatly increase its opportunities for innovation and growth. The SME must work hard to build on its strengths; it will do this by setting a clear agenda for innovation in the organisation, harnessing the ability of the individuals within the business and developing strong teams, being outward looking and seeking out opportunities to network with other businesses and making a conscious effort to listen to and understand the market place they are operating in.

SMEs always run the risk of becoming inward looking and defensive as they are consumed with the day to day difficulties of surviving. However it is an essential role of the manager in the SME to ensure that the company is

outward looking and that it does not become myopic in its approach to the market place this will be discussed in more detail in the following chapter. SMEs have a unique opportunity to become much closer to their customers and partners than large businesses the SME can use this to its advantage to find new opportunities for growth. The complete framework is shown in figure 4.5. This framework will form a solid foundation on which new products can be developed, processes can be improved, waste eliminated and opportunities identified using the extensive number of "Lean" tools now available. The next chapter goes on to discuss the role of the business leader and organisational structure in the innovation process, and formulates a leadership approach to ensure that the framework developed in this chapter is successfully deployed.

Figure 4.5 Innovation Framework



5 Developing Leadership to Facilitate the Framework for Innovation

5.1 Introduction

The mechanism of innovation in the context of the SME, the role of individuals, the role of networks and the importance of integrating simple marketing tools into the innovation process in order to create a framework for successful innovation has been discussed in previous chapters. However it is observed that none of these activities will occur by themselves in the SME. This chapter goes on to examine the role of leadership in successful innovation and the role of the business leader in building an environment in which innovative activities are encouraged and used to successfully enhance the business.

It has been identified that the individual is important, and that participation in networks is important. However it takes more than these two things to create an atmosphere for innovation that will add value to the business. Simply having well supported innovative individuals working within the business is a good start but to ensure that their abilities are put to work to deliver innovations that can be used by the business it is important to create some structure to their environment.

5.2 Approaches to Leadership for Innovation

The importance of individuals and the requirements of management to ensure that they are motivated and feel able to be innovative were discussed in the previous chapter. It was recognised during the course of this project that without good leadership even the best individuals will falter. This is especially true when attempting to put the framework discussed in chapter 4 in place.

Research has shown that leaders both motivate employees and design effective organisations (Munshi, 2005). It is found that there are, broadly speaking, two leadership styles that appear in organisations:

- Transformational Leaders
- Transactional Leaders

Transformational leaders seek to inspire people with a sense of purpose and direction, to unite teams and promote successful interaction and sharing of ideas. Transformational leaders rely on motivating people with the upper half of Maslow's hierarchy of needs i.e.

- Promoting Self Esteem
- Encouraging learning and self awareness
- Creating a good working environment
- Encouraging personal growth and self fulfilment
- Self Actualisation – doing what makes you feel fulfilled

The transformational leader asks individuals and teams to make decisions for themselves, and manage their own activities in return for praise and personal growth. These rewards are less tangible than those offered by a transactional leader who will concentrate on tangible benefits such as salary increases, larger offices etc in return for cooperation with their requirements, i.e. you do something for me and I will do something for you.

Although it can be argued that one style of leadership should be dominant over the other, it was observed whilst carrying out this work at KCE that in the context of the SME what is actually required is a combination of transactional and transformational leadership. The SME is a dynamic and constantly changing environment. The transactional leader is required to ensure the day

to day operations of the business are successfully achieved in a timely manner and the constant state of flux present in the SME, which employees can find disturbing, is managed in such a way that they feel comfortable in their environment. The transformational leader is required to provide the vision and future prospects for the business and its employees. It was observed at KCE that individuals who were managed in a purely transactional manner achieved all that was asked of them, but after a period of time the lack of exposure to the upper most half of Maslow's pyramid caused anxiety and concern as they realised that there were no opportunities for progression or advancement. The only reward that those employees recognised was an increase in pay, which even though they were already paid significantly above the local average for their skill set they still demanded pay increases. Conversely it was also discovered that KCE employees managed in a purely transformational manner while generally achieving the desired results lacked the coordination and structure that is required to meet the ever changing needs of the customer in the fast moving SME environment, they also felt anxiety and a lack of direction.

The same person can be both structured and transactional, and also provide the more abstract transformational leadership required in an SME, but it is more likely that this will come from two separate leaders. However most of the transactional side of leadership can be met by creating systems and structures in which to operate, freeing up the business leader to spend more time concerned with the overall direction of the business. This business structure or organisational architecture is key to the success of the innovation framework.

5.3 Developing Organisational Structure to Facilitate the Framework

Lean Manufacturing is now commonplace within many UK companies; however few really understand the real meaning and philosophy behind it. Lean Manufacturing as a system concept has sprung out of the enormous success experienced by Toyota in its use of the "Toyota Production System" (TPS) as discussed by Liker (2004) Most businesses that try to implement "Lean Manufacturing" concentrate on the tools that make up the system, rather than the fundamental underlying philosophy of the system, Liker (2004 p 10):

"I have visited hundreds of organisations that claim to be advanced practitioners of lean methods. They proudly show off their pet lean project. And they have done good work, no doubt. But having studied Toyota for 20 years they are rank amateurs."

It is easy to get bogged down in the details of implementing lean techniques in a business, such as 5S, or installing a new kanban system, or reducing waste without realising what the big picture of TPS really means. People associate Lean Manufacturing with reducing head count and removing people from the organisation, yet Toyota have a policy of never making compulsory redundancies which they have managed to do for over 50 years. With the recent demise of MG Rover cars in the UK, and the current difficulties of Ford and Daimler Chrysler you could be mistaken for thinking that the automotive world was very gloomy, yet Toyota delivered record profits of £5.5Bn for 2004, and has overtaken Ford to become the worlds second largest manufacturer of

vehicles, as reported on www.bbc.co.uk, 10th June 2005. Toyota has been more successful than their competitors in several key areas:

- Developing new vehicles that fit the needs of the market place
- Producing vehicles which are perceived as being of superior quality
- Optimising their processes to minimise waste and reduce costs

This success is a product of the careful application of TPS throughout the business. Although called a production system, really TPS is a structured approach to the overall business. TPS creates an atmosphere in which individuals come together to form strong teams, Toyota extensively uses multi disciplinary teams to ensure that ideas are cross fertilised. TPS builds networks inside and outside the business, supplier development ensures that the supplier network is strong and that Toyota people get to visit other businesses to see and learn as much as they help and teach. Where people are encouraged to experience the whole of the organisation instead of being pigeon holed into specialities, it is widely recognised that Toyota carry this out more effectively than any other business, virtually all Toyota engineers have to spend time working in a car dealership so they can gain first hand experience of the customer so they can better understand the product development process. Sales and marketing strategy at Toyota makes extensive use of bench marking, market research, and long term development goals, meaning that Toyota is often the first to market with a new type of vehicle because they have set such a long term strategy for their business to meet the future needs of their customers. When Toyota first began selling cars in Europe and America they quickly got a reputation for "copying" American and European designs and technology, however what Toyota were

actually doing is benchmarking, taking a concept from a competitor and improving on it. Toyota released vehicles with improved technology and features that were more reliable, if they had been copying they would have simply released the same vehicles with the same defects and problems as their US and European competitors.

The key to TPS is the atmosphere and culture it creates in and around the business. Setting strategic goals for the business and communicating those goals to the employees, ensuring that creativity from all levels of the organisation is harnessed and rewarding and recognising achievement. Although Toyota is a large organisation now, it started as a very small business; the philosophy behind TPS is as relevant to a SME as it is to a multi national corporation. In fact the way Toyota operates its multi national corporation is as a collection of medium sized businesses with a high degree of autonomy. The architecture provided by the Lean Business system that is TPS provides the foundation that will support the innovation framework developed in chapter 4, and allow the business leader to move to a more transformational leadership style and dedicate more resources to business growth and strategy. The tools and structure provided by TPS should be at the heart of the organisation. Instead of thinking of Lean business as reducing head count and improving productivity it should be approached as a strategy to allow the business to find innovative solutions to reduce waste and improve performance, and free up resources for development.

At KCE the TPS model was developed into the 5 core pillars of the business system:

- Lean Systems (5S, Kaizen, Kanban, Value Stream Map, Cellular Production)
- Involvement of personnel (Training, Team Building, Kaizen, Regular Meetings, Communication)
- Supplier Development (Intelligent purchasing from suppliers, reducing supply base)
- Continuous Innovation (Product and Process development, Kaizen)
- Total Quality Management (ISO9001:2001, suitable procedures to describe what was actually done and understood by all)

This has been mentioned previously in 4.3 and will now be examined in more detail with respect to the company leadership.

The implementation was started by carrying out training with all members of staff in the key areas of TPS beginning with the 7 Wastes (+1 added recently for lost creativity) to help all members of the company understand the type of activity that is wasteful and how this could be reduced. Then the Quality System and Health and Safety were guidelines were covered so everyone understood the relevant systems and procedures that were already in place. This basic introduction provided a solid base to build upon. This was essential to ensure that full participation from all members of the business could be achieved. After this basic general grounding 5S and Value Stream Map (VSM) training and activities were carried out within each area of the business. Through 5S and VSM many of the issues with day to day operations of the business were identified and action plans for improvement were created. The leadership role in these activities was essential in order to ensure that the work was approached with energy and enthusiasm so that the message sent

to the people in the business was a positive one, and also to ensure that action was taken on the problems that were identified.

The company's Quality System was examined next, possible improvements were identified and action was taken. The improvements to the quality system were aimed at making the system more useable and reflecting the improvements that had been made during the earlier activities. At the same extensive work was carried out with the production teams and team leaders to improve their abilities to schedule and manage day to day operations. Putting the Architecture of TPS into place simplified the management task at KCE, however it required a strong leadership to ensure that the business system was successfully implemented and that the outcome was positive. An ongoing process of waste reduction and process simplification was started, freeing up more resources to concentrate on innovative activities and business development.

5.4 Leadership Processes and Systems for Innovation

Many authors have tackled the subject of leadership processes, systems and structures to achieve innovation; generally the theory that is developed involves a structured approach to innovation such as the "Stage Gate" model (Cooper 1998). This involves formalising the approach to product or process development to ensure that the necessary Inputs, such as the customers needs, employees ideas, business objectives etc are fed into the system, this then undergoes a structured review by a development team, where the project is assessed for feasibility, and measurable outcomes are decided upon. The project will then progress whilst being constantly managed and reviewed to

ensure that a successful outcome is reached. It has been found that firms who employ this type of approach to innovation activities are generally more successful than those who don't. However it has also been observed (Chapter 3) that many firms who follow this structured approach do not manage to identify disruptive or new market opportunities, because the current needs of the customer may not be in line with the future needs of the customer when the project is developed, or a radical innovation is dismissed because it is deemed to be financially unviable due to a lack of customer desire. This very systematic approach to innovation is very well suited to a large organisation where corporate accountability is required and many people are involved in the innovation process and need to be managed appropriately. A rigidly structured approach however is not well suited to the dynamic SME environment. However some lessons can be learned from the stage gate process, which when used in the context of the framework for innovation discussed in chapter 4 provides a logical path to follow when developing products.

1. Identify a need for product or process development
2. Form a project team which should be multi disciplined and include the "voice of the customer"
3. Write project brief, objectives and milestones
4. Collect ideas for suitable solutions
5. Review ideas, technical feasibility, commercial feasibility
6. If feasible continue with development, carrying out reviews at suitable intervals in order to manage the project and ensure that items set out in 3 are met

7. Complete development project, release outcome
8. Review impact of project set tasks for further work if required

Following this routine fits in with the Deming cycle "Plan, Do, Check, Action" which is a key feature of TPS and should ensure that the process is not so cumbersome as to hamper the creative ability of the SME.

6 Results

6.1 Case Study; Use of a Network to Gain Access to Knowledge

KCE had a close relationship with the University of Durham's Agility Group, which is a group that is part of the school of engineering set up to assist businesses in the North East of England. The author was employed by Durham University as a Knowledge Transfer Partnership (KTP) Associate to work within KCE to encourage growth and development of the business and to facilitate knowledge transfer. The Agility Group work within many local businesses and assist with a wide range of problems. This provided many opportunities to build networks both within the university and with other businesses that worked with the university. A good example of this can be demonstrated by the selection process for the Enterprise Resource Planning (ERP) system which was introduced to KCE during 2004 to automate much of the administration processes and provide centralised control of its data. ERP systems are complex, and there are many options available. KCE only had a finite budget and time to install the system. The company management had previously thought that it was not possible to use an ERP system due to the cost of the systems, and the complexity and specialist nature of the work carried out by KCE. The use of an ERP system had been identified by the author as a key element in efficiently organising the businesses administration tasks and the need was demonstrated during one of the value stream mapping events as previously discussed. The author was given the responsibility of implementing the system. The opportunity to gain knowledge and experience from the Agility teams network was very valuable to this process. Another KTP associate was working at a business in Darlington and

had spent 12 months studying ERP systems and just finished a successful installation at their company although the business was completely dissimilar to KCE the installation and knowledge of ERP systems was highly relevant. Because of the link with Durham University KCE was able to draw on the experience of the KTP associate and get impartial advice about the various options available on ERP systems and the implementation process. This enabled KCE to effectively select a suitable ERP system, and thoroughly plan the system implementation to allow a timely and on budget installation. When the system was fully installed at KCE a consultant from the Agility Group who was working with a company that was in the process of deciding if they should install a similar ERP system arranged for the new company to visit KCE, the consultant introduced the new company to KCE. The new company visited KCE and discussed the recent ERP installation and the experiences gained during the process. This assisted the new company who subsequently went on to install the same ERP system with the insight of the experiences of KCE.

KCE had also made the decision to implement lean manufacturing methodologies to the business in order to enhance productivity and competitiveness of the business. However some key members of staff at KCE had severe reservations and were obstructing the improvement process. KCE is a business producing low volume specialist products for a very niche market. No matter how much training was undertaken the key personnel would not accept that lean techniques could be applied to a business such as KCE, because they had not directly experienced it themselves. The individuals had worked at KCE for many years and had no experience of how other companies operated. A decision was made to arrange for a visit to

another business in the area which was similar to KCE, in that it made low volume specialist products for niche markets, but different products to KCE and was not a competitor. Through contacts made through Durham University a visit was arranged and the host business showed a party from KCE around their site. The work that the host company had carried out was thoroughly examined and discussed at length during the visit. This gave the key personnel at KCE the confidence that Lean techniques could work in a similar business and it gained their support for the projects. KCE has now successfully implemented key lean tools throughout the business, and cellular manufacturing. The company is working on one piece flow systems and holds regular kaizen productivity improvement events.

6.2 Case Study; Improving Project Definition Through the Use of Marketing Tools

KCE has been established for 20 years and has built up a good customer base with both manufacturers of rotating equipment, and companies that service rotating equipment. The market for white metal bearings is well established. There have been many sustaining improvements to the materials used and the design of the components over the years. But the general requirements of the market place are currently being well served by existing materials and bearing designs. KCE does not currently offer all of the materials and bearing designs that are available in the market place. KCE decided to undertake a Knowledge Transfer Partnership programme in order to develop a new product to enable it to enter new markets and add value to the business. This was a normal R&D task. The KTP project at KCE began with the objective of developing a new material and production process. The

intention was to develop a material with superior performance characteristics than conventional products. This material would allow KCE to offer bearings of higher performance than those of its competitors. It had been suggested that the combination of Aluminium and Lead would make an alloy that had excellent bearing properties, but that was suitably hard to manufacture that competitors would struggle to copy its design. The first problem presented by this project was caused by the abundance of ideas that the project team had to solve the problem. This was not what was originally perceived would be the problem. After the first project meeting over 50 possible solutions to the project had been put forward, the difficulty was deciding which to pursue. This was compounded as there was no specific application or customer in mind so it was very difficult to determine exactly what characteristics the new material should have, or what type of bearings it should be applied to. Trying to produce a solution that answered all of the points initially raised would have provided an endless supply of work for the project team, however as the resources were limited it was quickly realised that a better picture of where the opportunities lay in the market place was required. The decision was made to carry out some basic marketing tasks in order to gather information from the market place in order to create a more clear specification for the project. A decision was made to carry out several basic activities:

- Market research with existing customers
- Attending trade shows to gather market intelligence
- Gathering details of prospective customers and talking to them about their needs

The study of existing customers found that KCE's market is currently satisfied with the performance of existing materials and services, and that KCE should focus on reducing the cost and lead time of its service by implementing sustaining improvements to the resources and structure of the company that would allow it to operate more efficiently. This was identified by KCE's customers as the most significant area they would like the company to improve its performance in. This was also found to be the case in prospective customers. The main driver behind this is the mature and conservative nature of the established rotating machinery bearing market, a factor that had not been identified during the initial stages of writing the project brief. The project team used this information to direct internal business improvement activities and improve the operations of the business.

Further market research into potential new customers was carried out next, in order to find opportunities for new product development. Prospective customers were canvassed by telephone, and at trade exhibitions. During this process two unique opportunities were identified where customers were dissatisfied with the performance of their current supplier or bearing technology for a particular product, this presented KCE with two R&D projects to develop new products. One project was to develop an improved bearing material for a new application and another project was to develop manufacturing techniques to allow KCE to produce a new range of thin shell bearings. These opportunities were classic opportunities for a disruptive technology as their markets were particularly underserved by the existing technology and suppliers available which meant that the risks involved for any

customers in adopting new technology were low. This market condition was identified in chapter 2 as a prime area for new technology to be tried out. Development projects aimed at solving these customers' problems were initiated. The information gained through the market research allowed a very detailed project brief to be set in each case, with known targets and milestones because the customers needs were understood in terms of a time scale for a solution much more clearly as well.

6.3 Case Study: Building an Organisational Architecture for Innovation at KCE

During the last 2 years at KCE a significant step for the company has been the formalisation of sustaining improvement activities to the core of the business operation. i.e. the continuous improvement of the company's manufacturing processes and operations through the use of tools such as Kaizen workshops and 5S. In order to do this some fundamental changes to the business were required. This began by implementing Lean tools in a systematic manner. Initially using 5S workplace organisational methods and implementing production cells, it became clear that the work force did not fully support these changes. In fact a great deal of resistance was given by the work force, as it was perceived as ideas from "management" being forced upon them. The decision was made to stop pushing the implementation so hard and try to understand why the improvements were being met with such resistance. To do this time was spent speaking with workers and the services of one of the Agility consultants who specialised in "Soft" management skills was engaged. The agility consultant conducted a work force survey. The

consultant interviewed key members of staff, getting feedback on the management and improvement activities. When the results of this survey were reviewed and combined with observations made by the Managing Director and the author, it became clear that there were several problems that were interacting to prevent the success of the lean implementation, these were:

- Employees did not fully understand the nature of the changes that were proposed.
- There were other problems that the employees were more aware of and thought more important than the issues the lean implementation was attempting to solve.
- Some employees were harbouring longer running dissatisfaction with management; they targeted this at the highly visible lean implementation.
- Employees did not feel like they had any opportunity for progression through the company, so did not want to commit any extra effort than necessary to their jobs.
- Employees did not feel secure in their jobs and were highly suspicious that these activities were designed to eliminate them.

Some analysis work was carried out to identify how to get over these problems. The result of the analysis was that peoples basic needs were not being met, which was consistent with Maslows hierarchy of needs (see figure 3.1 Maslows Hierarchy of Needs). It was decided to address the "soft" issues by implementing the Investors in People standard, this involved:

- Improving communication with the work force, through newsletters and meetings
- Putting a skills matrix and clear pay structure in place
- Putting appraisals and making sure all employees had personal development plans
- Clarifying the management structure

Regular meetings were held and the production workers were given opportunities to discuss their problems. Much to the amazement of some of the management at KCE many of the problems that the production people were raising were the same as the problems the management were trying to address. By offering 5S and Kaizen to the production people as a solution to their problem that would make their work environment better it was accepted and embraced by them. In fact it was embraced more fully by the production workers than by the managing director, who had a lot of catching up to do when it came to sorting! This was the beginning of what is now a very good working relationship, production people know they can raise problems and be thanked for it, the problems will be addressed in due course and they can make a real contribution to improving the business. The management has a closer relationship with the production workers and the workers feel more involved in the business. This whole process took almost 2 years, so was not fast. However it has resulted in a lasting effect on the business, and has had the added benefit of creating an atmosphere where all employees now freely put forward their innovative ideas for improvement as a part of everyday activities.

6.4 Summary

During the course of this work systems and structures were introduced that allowed K C Engineering to become more dynamic, creative and subsequently profitable. Developing leadership skills and an organisational architecture to support innovative activities was identified as key to the success of this initiative. Leadership styles were explored and it was observed that no one leadership style was preferential, and in fact in a SME a blend of transactional and transformational leadership styles is required to manage a dynamically changing environment. The importance of individuals discussed in chapter 4 is reinforced through strong leadership, it should be noted that leadership does not necessarily have to come from senior figures in the company and that creating a structured organisation should encourage dispersed leadership at all levels of the business.

It is suggested that the structure, or architecture of the Toyota Production, or a "Lean Business" System will form a solid foundation for the innovation framework proposed in chapter 4. However it is noted that the trend in the UK is to concentrate on the mechanics of TPS or Lean Manufacturing rather than address the underlying philosophy and soft management issues. It is however observed that it is much easier to make a small business "Lean" than a large one, so this can further be used to the SMEs advantage. There are many inter relations between the activities carried these relations were causal and multi directional. The success of KCE was determined by being successful in all areas.

7 Discussion and Further Work

This work demonstrated that there was a wealth of innovative ideas and ability within the personnel at KCE that was ready to be used. But the culture of the company did not support individuals who wanted to be innovative. The business processes at KCE had evolved over time and as a result were cumbersome and were restricting the core business activity rather than facilitating it. There was significant potential at KCE which by implementing lean principles to create a strong organisational architecture, and promoting innovative activity was released. As a result the company benefited significantly. Applying these techniques to another business would be of significant interest.

A significant characteristic of KCE and most small engineering businesses was that the founder of the business originally established the business due to his interest in the work undertaken. He had significant knowledge of the technical aspects of the business, but he had very little formal training in management techniques, sales and marketing and business administration. This was also true of the front line managers in the business, who were technical personnel who had been promoted into management positions. Giving these people formal training in management techniques, sales and marketing, and business administration as well as problem solving and lean methods added significant value to the business as it was able to operate much more efficiently, actively seeking out internal problems and solving them rather than simply struggling to meet the daily demands of the business. Investigating the management capability in other similar SMEs and identifying opportunities for targeted training and development for all levels of

management in the framework and architecture discussed in this thesis would also be of benefit.

8 Conclusion

8.1 The link between innovation and business growth

During the course of this work they key factors affecting the relationship between innovation and successful business growth at K C Engineering were identified. These factors were found to affect a number of similar businesses. Innovation or creative ability are of no use without the correct structures in place to ensure that the creativity contributes to the businesses bottom line. However the evidence of a pervasive link between innovative activities and business growth appears very robust. The implications of this are far reaching. It must be understood however that there is no fixed formula for delivering a return on investment in innovation, and that there are many factors which can affect how successful a business is at converting innovative activities into growth. This is largely driven by the unpredictability of the process of invention whereby an input in the form of R&D need not lead to an output of a determined size, indeed there may be no output at all from some elements of R&D. New growth theory links innovation and R&D to growth. Earlier chapters have presented findings that show much innovation takes place in the manufacturing sector where innovative work is embodied in manufactured products and manufacturing processes particularly in the SME. Therefore it is easy to characterise innovation that will deliver growth will involve the development of these products and processes. This connection is less apparent in the services sector however anecdotal evidence would suggest that there is significant opportunity for service sector companies to achieve growth and commercial gain by improving their internal processes and service offerings through innovative activities.

8.2 The Framework for Innovation and Leadership Strategy

It has been shown that developing innovation as an organisational objective, and a simple framework of tools to help the business focus on using that innovation to add value is a sound strategy for a SME in the manufacturing sector. However good leadership at all levels of the business is required to ensure that the individuals within the business are able to be creative, and that the business is opportunity focused. It has been suggested that the structure provided by the "Toyota Production System" will provide the necessary business architecture; however it is crucial when implementing this structure to fully consider the human aspects, building strong teams and leaders within the business. The proposed framework for innovation will set the agenda for innovation in the business and introduce some simple tools that the business can use to focus that innovative activity on tasks that are more likely to add value to the business. Providing a sound structure to the business for day to day operations, front line training for all levels of managers and changing the focus of the business made the necessary changes to allow the business to fully exploit its potential. A cautionary note is added due to the ease with which a business can become totally focused on incremental improvements to existing products and processes, therefore missing out on new opportunities that are disruptive to established technology. The importance of being aware of new and emerging technology and new opportunities through increased business networking is stressed to prevent the business from becoming myopic in its approach to product and process development.

During the course of this work it became clear that the SME involved was not short on innovative ideas, what they were lacking was the necessary structure and focus to turn these innovations into added value for the business. This would suggest that the best way to support growth and innovation in the SME would be to provide training and support to business leaders in business administration, management techniques and sales and marketing, better equipping them to deal with the day to day tasks of running the business and freeing up more of their time for innovative activities. The author has experienced first hand being completely focused on business survival, as many SMEs are, is not a good environment to be creative in. This is one of the main objectives of the Knowledge Transfer Partnership (KTP) programme, which provides excellent training for future front line managers and business leaders, whilst at the same time growing the networks of all partners involved. KTP is identified as an excellent tool for business to develop its innovative activities and future leaders.

8.3 General

Policymakers have begun to understand the importance of R&D expenditure to technological and, more widely, economic progress. Despite these rapid developments in the understanding of the economics of R&D there are still many gaps in the understanding and modelling of the innovation process. If it is indeed the case that innovation leads to economic growth then a strong manufacturing sector with high levels of innovation and strong creative SMEs should lead directly to strong economic growth for the nation as a whole. This therefore establishes a link between the manufacturing sector and growth.

Now, this is nothing new in itself, except that this link is formed through the mechanism of offering innovation, rather than through the more traditional link of manufacturing simply providing high levels of employment. The best way of stimulating growth at a macro economic level would therefore be to encourage innovation within SMEs the anecdotal evidence collected would suggest that this would have a better rate of return than funding increasing levels of public sector R&D which is known to have little overall contribution to a nations economic growth. The current system of tax breaks and the various programmes that are in place, such as the Knowledge Transfer Partnerships do go a long way to addressing the problem of a lack of innovation in the SME sector, however policy makers must take care to observe outputs from this investment as bottom line growth in the business, rather than the more traditional measures of R&D output. Simplifying the tax break scheme and allowing more activities that are genuinely useful for the SME to qualify as R&D expenditure would be of further assistance to this effort.

8.4 Summary

The SME is an important feature of the UK economy. SMEs are capable of adding tremendous value, and their size and flexibility makes them ideally suited to responding quickly to changing market conditions and new technology. SMEs generally lack the formal structures of larger business and a lot can be gained from introducing a more structured business system in the SME environment. This should focus the SME on the needs of its customers and develop the necessary structures to grow the personnel within the business. Lean business systems are generally focused on eliminating waste

which is typically embodied in the reduction of man power, however using a lean business system to reduce waste, and then redeploying the freed up human resources to activities which will continue to deliver sustaining improvements to the business is a more sound use, and will have a more long lasting effect on the business.

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