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Final Project/Thesis Submission

‘A study of innovation measurement and innovation management at Irish medical device SME’s’

David Ronan

A Research Dissertation submitted in partial fulfilment for the Degree of Masters of Science in Technology Management of the National University of Ireland, Galway.

Research registered in the College of Engineering & Informatics, National University of Ireland, Galway.

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Certification of Authorship:
I hereby certify that I am the author of this document and that any assistance I received in its preparation is fully acknowledged and disclosed in the document. I have also cited all sources from which I obtained data, ideas or words that are copied directly or paraphrased in the document. Sources are properly credited according to accepted standards for professional publications. I also certify that this paper was prepared by me for the purpose of partial fulfillment of requirements for the Degree Program.

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All of the busy people who gave freely of their time and made this research possible.

David Ronan

1st September 2009
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title Page</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>Certificate of Authorship</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Acknowledgments</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Table of Contents</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Chapter 1</td>
<td>Introduction</td>
<td>9</td>
</tr>
<tr>
<td>1.0</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>The Primary Objective</td>
<td>10</td>
</tr>
<tr>
<td>1.2</td>
<td>The Primary aim of the research</td>
<td>11</td>
</tr>
<tr>
<td>1.3</td>
<td>The Significance of the research</td>
<td>12</td>
</tr>
<tr>
<td>1.4</td>
<td>Objectives</td>
<td>12</td>
</tr>
<tr>
<td>1.5</td>
<td>Chapter Overview</td>
<td>14</td>
</tr>
<tr>
<td>1.6</td>
<td>Conclusion</td>
<td>19</td>
</tr>
<tr>
<td>Chapter 2</td>
<td>Literature Review 1 – Innovation Measurement</td>
<td>20</td>
</tr>
<tr>
<td>2.0</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>What is Innovation</td>
<td>21</td>
</tr>
<tr>
<td>2.2</td>
<td>Types of Innovation</td>
<td>23</td>
</tr>
<tr>
<td>2.3</td>
<td>Process Model of Innovation</td>
<td>25</td>
</tr>
<tr>
<td>2.4</td>
<td>How can Innovation be Measured</td>
<td>30</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Patent data</td>
<td>32</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Literature based indicators</td>
<td>32</td>
</tr>
<tr>
<td>2.4.3</td>
<td>Financial measures</td>
<td>32</td>
</tr>
<tr>
<td>2.4.4</td>
<td>Productivity Data</td>
<td>34</td>
</tr>
<tr>
<td>2.5</td>
<td>An Innovation Management Toolbox</td>
<td>34</td>
</tr>
<tr>
<td>2.5.1</td>
<td>Innovation Audit</td>
<td>34</td>
</tr>
<tr>
<td>2.5.2</td>
<td>Best Practice Modelling</td>
<td>35</td>
</tr>
<tr>
<td>2.5.3</td>
<td>Balanced Scorecard</td>
<td>36</td>
</tr>
<tr>
<td>2.6</td>
<td>Barriers to Innovation</td>
<td>36</td>
</tr>
</tbody>
</table>
2.7 Limitations to the Literature 38
2.8 Conclusion 39

Chapter 3 Literature Review 2 – Innovation Management
3.0 Introduction 40
3.1 What is innovation (2) 42
3.2 How can innovation be managed 44
3.3 Why should innovation be managed 48
3.4 Corporate governance and innovation management 50
3.5 Linkages and innovation management 51
3.6 Failure tolerance and innovation management 52
3.7 Innovation measurement and innovation management 53
3.8 Strategic management and innovation 54
3.9 Personnel management and training 54
3.10 Creating an atmosphere for innovation 54
3.11 New products development process 55
3.12 Motivation and reward management 55
3.13 Is innovation part of company culture 56
3.14 Top management commitment to innovation 56
3.15 Are SME’s better at innovation 57
3.16 Barriers to innovation at SME’s 58
3.17 Best management style for SME’s 58
3.18 National system of innovation 60
3.19 Conclusion 61

Chapter 4 Research Methodology
4.0 Introduction 62
4.1 Research questions 64
4.2 A mixed-method approach 67
4.3 Data collection 68
   4.3.1 Primary data collection 68
   4.3.2 Empirical data collection 68
4.4 Selection of organisations 69
4.5 Selection of candidates 69
4.6 Questionnaire design 70
4.7 Limitations of the research 72
4.8 Reliability of the data 72
4.9 Conclusion 73

Chapter 5 Findings
5.0 Introduction 74
5.1 Quantitative data – innovation measurement 76
5.2 Quantitative data – innovation management 77
5.3 Quantitative data – innovation activity 77
5.4 Qualitative data – innovation measurement 78
5.5 Qualitative data – innovative management 78
5.6 Qualitative data – innovative activity 79
5.6.1 Senior management support 79
5.6.2 Access to lead users 79
5.6.3 Linkages – Academic 80
5.6.4 Linkages – Government 80
5.6.5 Strategy 81
5.6.6 Culture 82
5.6.7 Failure tolerance 82
5.6.8 Diversified portfolio 83
5.6.9 NPD Process 83
5.7 Limitations within the findings 83
5.8 Conclusion 85

Chapter 6 Discussion
6.0 Introduction 86
6.1 Irish medical device SME’s 86
6.2 Measuring innovation 88
6.3 Managing innovation 89
Appendices

Appendix 1  Innovation audit questionnaire results  115
Appendix 2  Innovation audit questionnaire  125
Appendix 3  Kuczmarski’s ten insights  128
Appendix 4  Ten insights - company results  129
Appendix 5  Company details  130
Appendix 6  Interview findings (notes)  131
Appendix 7  List of acronyms used  136

Figures

List of Figures

Fig 2.0  Model of an Innovation Process (Davila et al)  25
Fig 2.1  IDEF0 Process model  26
Fig 2.2  IDEF0 Model of an innovation process  27
Fig 2.3  Process-based model of Innovation (Chiesa et al)  28
Fig 2.4  Matrix for innovation classification  29
Fig 2.5  Ansoff’s Diversification Matrix for Innovation  29
Fig 2.6  Oslo Manual Innovation Framework  31
Fig 6.0  Commercial scope of technology SME vs. MNC  87
Fig 6.1  Innovation business model  92
Fig 7.0  Porters Five Forces Model  99
Fig 7.1  Problem-Statement Matrix  100
Fig 7.2  TOWS Matrix  101
Executive Summary

The objective of this dissertation is to discuss the current state of innovation measurement and innovation management at Irish medical device SME’s.

Irish medical device SME’s are often founded as spin-out companies from MNC’s and are styled on scaled down versions of an MNC. The resulting culture, strategic management and innovation management is not considered best practice.

The word ‘innovation’ has lost its currency through over-use and this study will explore a toolbox of techniques to implement innovation management best practice. The management structures, cultures and corporate governance policies of small companies are often an ad hoc mixture which don’t support innovation management or in the worst cases, are detrimental to it. This report will develop tools which can be used to measure the innovation activity so that the company can start to actively manage it.

The study uses a mixed method approach with an innovation audit questionnaire to gather quantitative data on innovation activity and an interview to gather qualitative data. Case study data will be included for the purpose of supporting the qualitative and quantitative information.

The study found that there are varying levels of innovation activity across the sample of organisations. The quantitative data found that innovation management was predominantly passive; the qualitative data found that innovation management was mostly an aspiration of management.

Setting up an SME to commercialise a technology is difficult enough, however the installation of innovation management and an innovation culture at the outset greatly enhances the chances of success.
1. Introduction

1.0 Introduction

This thesis is primarily a study of Innovation Management activity in Irish SME’s. It incorporates the findings from interviews with managers directly responsible for innovative processes and harvesting creative outputs with innovation audit questionnaires and case study data from their organisations.

“Innovation is the process through which productive resources are developed and utilised to generate higher quality and/or lower cost products than had previously been available.” (O’Sullivan, 2009)

“Innovation is all about finding new ways to do things and to obtain strategic advantage.” (Tidd, 2009)

“Innovation is more than just coming up with good ideas, it is the process of growing them into practical use.” (Edison; in Tidd, 2009)

New product development as a process is poorly understood (Nicholas, 2008) and poorly executed (Mjoset, 1991). The ability of a cluster in a geographical location to operate in a highly efficient way depends on several factors and the one which receives attention in the Forfas Knowledge Economy Action Plan (2004) is the development of a national pro-innovation culture.

Since Mjoset (1991), it is known that Ireland has a poor National System of Innovation (NSI) (Lundvall, 1994) and the ability of our entrepreneurs to harness innovation, novelty and creativity is limited by this.

Innovation has become the panacea for all business ills. Application of ‘innovation’ at all stages of product development, from concept to product marketing campaigns means that the term has different meanings to everyone in the
organisation. This results in people receiving different messages when the CEO directs people to ‘think innovatively’. In order to increase the contribution which innovation makes to the organisation requires clear understanding of the meaning of the term how it applies to the business and how it can be managed.

The first step in managing or improving anything is to measure it and this study discusses measurement techniques as well as using an audit questionnaire to compare a range of Irish medical device SME’s innovation activity.

1.1 The primary objective

I wish to distil my empirical experience from ten years of medical device R&D bringing concepts from R&D to product realisation with maximum success and use it to develop a series of recommendations for innovation management in medical device SME’s within the Irish context.

It is a strongly held belief that simply starting a company shows entrepreneurial spirit and innovative capability. Irish SME’s, and specifically medical device SME’s are predominantly spin-outs from MNC’s. MNC’s have significant resources available for R&D and corporate cultures which support R&D. In an SME, this infrastructure doesn’t prevail and resources are scarce.

The use of Kuczmarskis Ten Innovation Insights (1996) as the foundation for an innovation audit is considered to be an effective way to measure a wide range of company features. The ten insights frame a set of questions which can be customised for every organisation and the results delivered in complex or simple ways to get the innovation message across to everyone in the organisation.

Innovation is generally viewed as inherently risky by senior managers working to short timelines. Innovation is often considered a luxury at SME’s which results in poor performance and limited differentiation between competing companies. In SME’s, the skills and knowledge to measure innovation and use the information to
manage it effectively is much lower than in MNC’s. This research will assess whether this is in fact the case.

1.2 The primary aim of the research - Innovation management and Innovation measurement in Irish SME’s

Models for new product development are varied. Ullrich and Eppinger (2008) proposed a five step process which has multiple feedback/review loops built into it. Cooper, Edgett and Kleinschmidt (2004) suggested a selection of tools for managing the new product portfolio. Tidd et al, (2009); Wheelwright and Clarke (1992) made recommendations for planning and mapping the product development process. The variety of techniques is broad, but it makes one aspect clear; NPD, R&D and the creative processes by which innovative activity contributes to them must be actively managed. Left to traditional management techniques or to evolve of their own accord, the contribution of innovation to the entire organisation will be low.

Irish SME’s claim innovation as a core competence, with little understanding of the real meaning of the term, or how it evolves or decays. Very few of these companies have innovation management as part of training, culture, metrics or business model.

Any company which has been set up with the intention of developing a novel product should have innovation management policies as a foundation of its culture. The majority of SME high potential start-up companies (HPSU) claim to be all about innovation, yet are managed by entrepreneurs who have little understanding of the importance of nurturing an innovation culture.

One of the best ways of nurturing an innovation culture is to enshrine a set of policies in the management practices of the company and measure the effects of innovation in a manner appropriate to the business sector and technology requirements of the company.
1.3 The significance of the research

The bulk of the published knowledge on harnessing innovation is based on empirical information and data derived from large corporations (Drucker, 2004; Tidd, 2009; Storey, 2005, Utterback, 1994; Prahalad and Hamel, 1989, Leibold et al, 2005). The findings and recommendations are focussed on how companies like 3M, Canon, Proctor and Gamble, Apple and Caterpillar tapped into their sources of innovative energy and used them to create products, processes and markets which ensured long term success.

There is a shortage of data relating to SME’s and how they should approach innovation management. This study will investigate the best practices recommended for innovation management and using information from the interviews and case studies, produce a series of recommendations for SME’s to improve their chances of success.

Irish SME’s are the lifeblood of the Irish economy and so their success depends on their ability to create a product which delivers an unmet need or a market for a novel product; technology push vs. market pull. Innovation is the key to ensuring organisational success and sustained competitive advantage.

1.4 Objectives

This study will distil current literature and combine it with study results to derive recommendations for the company, which in turn shape its structure too increase innovation activity and deliver NPD success with greater accuracy. It is important that the work delivers a series of recommendations for company founders and managers to help them improve their innovation management skills.

Case study research will be taken from interviews with R&D managers, product development managers and engineering managers with Irish SME’s, combined with the use of a questionnaire to gather quantitative data about innovation. A case
study of one Irish medical device SME will be included to detail the organisations experiences of innovation management.

Innovation is a creative process which defies forecasting in the traditional sense. In many cases, the application of an innovative solution requires the combination of technologies in a way which has not been proven. Irish medical device SME’s have a good track record of success in generating novel medical devices (Enterprise Ireland website). This study will examine the contribution of any level of innovation management to overall organisational success.

Ireland’s National System of Innovation will be discussed in the context of SME’s. Irish SME’s are disadvantaged as a result of Ireland’s continued poor NSI. The education system, culture and corporate structures/governance don’t support innovation i) because most companies are set up to produce ‘products’ and ii) companies whose output is mostly creative are on the periphery of manufacturing.

Linkages to academic research institutes, government bodies and industrial companies contribute greatly to SME R&D success (Etzkowitz et al, 2000; Peters et al, 1991; Lester et al, 2004). These linkages will be discussed briefly.

Technology Transfer Offices operate on many college campuses in the country to develop linkages between industry and academia. This study will briefly examine the successes and challenges for Irish SME’s when engaging with academic research institutes.

SME company managers are rarely exposed to the ‘IDEO, Nokia, 3M, Hewlett Packard, Xerox PARC’ atmosphere of pure innovation and often only exposed to ‘process development’ after the research and design has been completed elsewhere (Cogan, 1990). As a result, they apply Tayloristic or Shigoistic principles to the innovation stages or try to impose rigid project plans on unknown R&D outcomes. This means the culture of the SME is predominantly based around the metrics and
mechanisms of production – input, process, output and as a result are closed to the occasionally eccentric contribution which innovation can deliver.

The ability of Irish SME’s to build links into third-level research institutes is assisted by the work of the Technology Transfer Offices. Despite this assistance there are still challenges to SME’s successfully engaging with research institutes and valuable information takes longer to gather.

A brief examination of the experiences of several SME’s will be carried out in Chapter 5. The ‘triple-helix’ of government, college and company is viewed as an ideal model but in some cases it is necessary for the building of links to be incentivised (Etzkowitz, 2000).

1.5 An overview of chapters 2-7

Chapter 2 contains a review of the literature related to innovation measurement. It begins with definitions of innovation, explaining the contexts and phases of innovation. The difference between innovation, invention and imitation are explained. Chapter 2 develops the dynamic aspects of innovation to distil how SME’s need to approach innovation theory. Possessing a common understanding of the meaning of innovation and its processes is the foundation to being able to measure and appraise it accurately.

Measuring innovation is as much about picking the right metrics as it is about what the company does with the information. Effective innovation leaders will use the information to build confidence, reinforce the importance of constantly trying new things and looking for answers in the most unusual places.
Some of the commonly recommended metrics are:

- Number of patents applied for or granted
- Technology spread/diversity
- Radical vs. incremental innovation ratio
- Return on Investment (ROI)
- Five-year rolling profits from new product introduction
- Innovation audits
- Number of industry articles about a new technology, product or breakthrough
- Balanced Scorecard
- Best-Practice Modelling

The availability of a toolbox of measurement techniques to model the innovation landscape, combined with innovation audits to carry out longitudinal characterisation ensures the management of innovation is carried out in the most appropriate manner. A discussion on the various methods for measuring innovation activity and their suitability for use by SME’s will conclude Chapter 2.

Chapter 3 is a review of the literature pertaining to innovation management. The concept of innovation as a process or function which must be defined, contained and managed is one which has received much attention and there are diverse opinions on the best ways to harness the creative energy of innovation. Strategies for best-practice in innovation management recommend the use of a combination of diverse approaches (Tidd, 2009; Storey, 2005).

The chapter continues with a discussion of innovation management models, why innovation must be actively managed and some recommendations for how best to start managing it. Knowing how innovation processes work by modelling them for the organisational sector and how these models apply to each organisation is the starting point for managing them.
Factors for success in innovation have several common threads (Kuczmarski, 1996; Peters, 1990; Tidd, 2009; Utterback, 1994). Links with academic research institutes and government bodies are one of the strong factors contributing to long term success for innovation companies. A brief discussion of the literature pertaining to linkages is included and followed by discussion of the other major contributing factors.

Acknowledging that pure research requires a level of failure tolerance which is at odds with what is normally expected or experienced within Irish R&D organisations is a large part of innovation management. The differences between the corporate governance systems in Ireland (US/UK model) vs. those at work in Japan and Germany are discussed in relation to SME innovation management.

A heightened awareness of innovation management requires knowledge of the forces which act as a result of Ireland’s national system of innovation (NSI) (Mjoset, 1991). Is it possible that despite a wealth of academic theory and practical recommendations on innovation management that Irish SME’s fail to implement it for underlying cultural reasons? A brief explanation of Ireland’s NSI and its effects on SME’s concludes chapter 3.

Chapter 4 contains the research methodology and an explanation of the mixed method approach to this dissertation. A combination of qualitative and quantitative data was required and this data was gathered from appropriate industry professionals using questionnaires and interviews. The use of multiple detailed case studies, interviews and questionnaires is discussed in detail.

The use of Kuczmarskis’ Ten Innovation Insights (1996), combined with the recommendations of the Oslo Manual guidelines for collecting and interpreting innovation data (OECD 2005) with adaptations of the innovation audit questionnaires generated by Cormican & O’Sullivan (2004) and Tidd et al (2009) to build a simple questionnaire and elicit accurate information is a practical demonstration of innovation auditing to complete the research.
The questionnaire was devised in two sections, innovation management (Q.1-6) and innovation measurement (Qs. 7-10). Each section has a series of topics, each topic has multiple questions and a section for additional comments. The questionnaire was completed during the case study and interview in an effort to maintain a focus on innovation management within each company.

The main limitation to the methodology pertains to the rigour of the study, given the time and confidentiality of the information. A multiple method approach was taken in an effort to distil the aspects of innovation management which are specific to SME’s. There is a wealth of information carried out on behalf of large MNC’s by Boston Consulting Group, Harvard Business Review, Accenture and many others. There is less information related to Irish SME’s and innovation management available and this study attempts to redress this.

Chapter 5 explores the findings of the primary research, the opinions expressed in the interviews and an analysis of the quantitative data is presented. All of the quantitative data is included in Appendix 1.

Chapter 6 is a discussion regarding the findings and case study aspects of the thesis. The research questions are explored and the links between the academic literature and the findings are detailed. An examination of the impact of the use by the companies polled, of any combination of Kuczmarksi’s ten insights as well as any evidence of adherence to established ‘best practice’ is detailed.

Chapter 7 develops the research findings into a series of recommendations and a conclusion. It outlines suitable policy for SME’s wishing to implement the highest levels of innovation within their organisations.

The study found that there are varying levels of innovation activity across the sample of organisations polled. The management of innovation at almost all of the
organisations was passive with little consideration for the creative nature of innovation.

The quantitative data found that each of the companies had some aspects of innovation management behaviour incorporated into its routines but few displayed excellence in most or all of the behaviours.

The qualitative data found that innovation management was at best an aspirational aspect of organisational management, with respondents admitting that they knew what they should be doing but couldn’t implement their plans for resource reasons.

The study concluded that the greatest resource shortage in Irish SME’s was money and access to working capital during development stages. Strategically, most of the companies did not consider innovation management to play a big part of their overall plans.

The use of wider linkages into academic research institutes and government agencies found that the experience of many SME’s in dealing with colleges is poor. The study found that intellectual property ownership was the primary reason for SME’s not engaging with universities and colleges.

The report concludes with recommendations for national, local and individual policies for innovation management and measurement.
1.6 Conclusion

This dissertation was developed from the knowledge that the majority of Irish SME’s are at a disadvantage in the early stages of organisational growth due to resource shortages. The ability of an SME to build its product offering depends on its strategic positioning, its ability to create a market for its product offering and its use of innovation to sustain competitive advantage. One in three SME start-up companies fail in the first three years of operation and the reasons for failure are diverse (Heraty/IMI/EI report 2005). Being able to remain competitive, manage an R&D portfolio or intellectual property portfolio and attract investment are the greatest challenges. Being able to inject the maximum amount of innovation into the company at all levels and stages of development will ensure the best chance of success.
2 Literature review 1 - Innovation measurement

2.0 Introduction

‘If you don’t measure it, you can’t improve it’ the famous quotation from economist and quality management academic, W. Edwards Deming forms the fundamental basis for this research. Many companies claim to be innovative, creative and ahead of their competitors despite the fact they are not using appropriate metrics for innovative processes and outputs. There must be organisational support for the development of more accurate policies to ensure innovation cultures are developed from company inception.

There are many approaches which a company can take to control or improve their manufacturing or business processes. Entire industries have grown around the delivery of manufacturing improvement methodologies such as Lean, Six-Sigma, TQM and TPM. Even service industries have their own disciplines for implementing change based on best practice analysis with a host of Business Process Re-engineering manuals available.

The selection process for a system for managing innovation is the same as the process for choosing any improvement methodology and embarking on organisational change. In-depth diagnosis of the state of the company, its resources and processes must be undertaken to ensure best-fit with the measurement metrics and management approach.

The first step to taking control of the innovation force in an organisation is to consider the various innovation models and then measuring the current state with the use of a suitable innovation audit. This is the first step to establishing a benchmarking or monitoring process which enables the stakeholders to strengthen the innovation capability of even the smallest company. Exposing an organisation
to ongoing benchmarking is one of the most effective ways of triggering deep, long-term improvement (Cormican, 2004, Andersen, 2007).

2.1 What is innovation

The value of the word ‘innovation’ has lost its currency as a result of overuse. It is sprinkled liberally as an adjective in almost every mission statement, marketing communication and website. The result is that everyone has a different perception for what the word means or how it affects them.

At its most fundamental level, innovation is the act of delivering something which was previously unknown to satisfy an unmet need. The level of novelty, the level of demand and the commercial value can vary, but the difference between invention and innovation is that there is a demand or market for the outcome of innovation, where invention brings novelty but not commercial exploitation. Innovation is accurately defined as “the commercial application of knowledge or techniques in new ways or for new ends” (Roper et al, 2003). Peter Drucker describes innovation as ‘…the act that endows resources with a new capacity to create wealth’ (1985; p.27)

Invention, the creation of something novel which may or may not be of value to anyone beyond possibly the inventor is different from innovation – it is more focussed on the creative aspect of researching an idea to assess what is possible. Schumpeter captured the difference very well when he said “Innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation, but produces of itself...no economically relevant effect at all” (1939: p.80).

The greatest innovators have not always been the greatest inventors. Very often, an invention had existed for some time but the inventor didn’t understand how to apply it to a problem or deliver it to its market correctly. The portable MP3 player was in existence for three years before the Apple iPod was launched and almost
instantly became the market leader through the innovative step of combining the player with a website from which to download music into it (http://www.apple.com/itunes/)

The use of metal scaffolding ‘stents’ to support diseased coronary arteries was an established technology in the mid-1990’s. Johnson and Johnson was an early market leader with its Cordis subsidiary holding a significant patent portfolio and many other companies competed with similar versions. Addressing an unmet need to prevent the stent being blocked by the bodies healing mechanism, J&J launched an innovative drug coated stent in 2001. Establishing an early market lead and following up with improved drug and coating technology in 2003 gave J&J the majority of the market while companies like Boston Scientific, Medtronic and Abbott Vascular developed their own versions of coated stent.

There is no doubt that innovation has been inextricably linked to the long term viability of organisations through sustained competitive advantage and for SME’s, any advantage which keeps them ahead of their competition must be nurtured.

There are as many models for innovation as there are definitions for it and while consensus is rare, the majority of innovation theories are process-based. Kuczmarski (1996) however claims innovation is an art. He argues that it is not a science, hence it is not possible to predict the success of an innovation until it is accepted by its market and its value judged by its consumers.

Innovation is a strategy: Hamel and Prahalad (1994) audited managers to find out if their organisations were predominantly focused on operational efficiency or innovation and growth. Their argument being that the management processes required for either core skill would be detrimental to the other.

Innovation is very hard to manage and predict, and failure is inevitable. It must never be viewed as a cost centre despite senior management’s unspoken belief that it is a ‘resource-eating monster’ (Kuczmarski, 1996).
Peters (1991) writing for the California Management Review produced a pair of articles called ‘Get Innovative or get Dead’. In these articles he chronicles the successes and failures of some well known companies and some less well known who failed to innovate. He gives some basic advice but the underlying advice is to put infrastructure in place to support innovation as quickly as possible and manage it actively.

Without the facility or will to measure it, how can an organisation assess its ability to be innovative? Simply putting the word ‘innovation’ in the companies mission statement or customer charter does not guarantee ‘innovativeness’ throughout the company and this is where the development of a series of policies which support the long and short-term objectives is key.

### 2.2 Types of innovation

Innovation is characterised along a continuum from incremental to radical (Wheelwright and Clark, 1992), (Cooper and Kleinschmidt, 1996), (Tidd and Bessant, 2009).

Incremental innovation is typically carried out to improve a product with some new feature which is easily integrated. Sometimes referred to as ‘extensions’ or ‘facelifts’, an incremental innovation is an almost obvious update to the product or service offering. Incremental innovations also incrementally increase the value of the offering to the consumer. There is minimal risk involved in updating a product with a clearly understood improvement. The customer interactions with the product and their purchase decisions are rarely upset, in fact usually enhanced by incremental improvements. Adding enhanced functionality to a mobile telephone by adding software which increases the uses to which the hardware can be put is one example of incremental innovation.

Radical innovation is generally associated with completely novel steps and unforeseen uses for existing technology. This type of innovation requires vision, determination and the ability to take the steps necessary to succeed with it.
The main problem with radical innovation is that it requires the support of radical strategy. For a small, traditional manufacturing company to adopt a radically novel process or way of doing business would require it to relearn all of its knowledge and could destabilise it. Very often, the implications of a radical innovation are not fully understood at the outset and the implementation brings a wealth of knowledge. However the application of previous experience to a radical change can result in the wrong conclusion being drawn.

Christensen (1997) explains how technology has a life cycle of incremental innovations which are successive and which eventually reach a point where a novel and radical technology comes to the fore and takes over the market.

This ‘disruptive technology’ is regularly beyond the scope of the majority of stakeholders in that particular market segment and is ignored until it becomes a significant threat to the existing market. By this stage, Christensen argues that it will be almost too late to adopt the disruptive technology as the companies who have developed it will have harvested the bulk of the knowledge related to it and have a long term competitive advantage as a result. The level of risk with radical innovation is often proportional to the level of reward which it can deliver if successfully implemented.

The ‘fuzzy front end’ of the early stage of development needs to run for longer in radical innovation than in incremental innovation where solutions are more obvious and risks are lower. The Product Development Managers Association supports a shift to increased activity at the front end of the development process and have organised regular conferences in conjunction with innovation consultancies to promote ‘Front End Innovation’. The complexity for an SME of remaining in the front end often requires access to sufficient funding in order to postpone entering product development but evidence from repeated studies by Cooper and Kleinschmidt (1986, 1990 & 1993) show that successful product launches depend on the time taken during the early stages.
The type of innovation undertaken by my Irish medical device SME’s is most commonly incremental due to the complexity, cost and time required to deliver a radical innovation (Christensen, 1997).

2.3 Process models of innovation

The first step in carrying out any measure of innovation activity is to consider modelling the processes by which innovation is delivered. No single accepted academic model exists however there is a contingency approach to the model which suggests that it should be applied as appropriate to the organisation. This study focuses on the process models of innovation.

The simplest model is the Input-Process-Output sequence which characterises any manufacturing process. Davila et al (2006) expand this with an Outcomes phase as shown in Fig 2.1

![Model of an Innovation Process](image)

**Fig 2.0** Model of an Innovation Process (Adapted from Davila et al, 2006)

A more advanced model is the IDEF0 model for processes. In addition to the Input and Output channels, it shows two further aspects to the process. ‘Mechanism’ refers to the resources needed to complete the process and ‘Controls’ refers to the
protocols, policies and regulations which dictate how the process should be run. An IDEF0 model for a single process step is shown in Fig 2.2 and as can be seen in Fig 2.3, the method becomes very complicated very quickly if the process involves a large range of variables.

Fig 2.1   IDEF0 Process model
Andersen (2007) does not recommend the use of the IDEF0 except in cases where high-level models with consistent notation and complete accuracy are required. They are graphically complex and it is hard to get an overall picture without careful studying of the model.

Chiesa et al (1996) produced a process-based model of innovation which supports the use of audits to measure an organisation's innovative output. Fig 2.4 shows the Chiesa model which has been designed to focus on technological innovation. They recommend customising the model according to the scope of the innovation to be explored, however it can be seen from first glance that this type of model captures all of the elements of the innovation process.
It should also be noted that before embarking on a study of innovation activity within an organisation that the sector and type of innovation being undertaken is acknowledged. This matrix (Fig 2.5) allows researchers to note the current position and monitor changes during a longitudinal study or period of engineered change. Having given consideration to the current position it is often valuable to consider the direction in which any change program will bring the company. The use of a diversification matrix such as Ansoffs (Fig 2.6) gives clear direction for the supporting innovation strategy to be implemented following the diagnostic phase of innovation measurement system design.

**Fig 2.3 Process-based model of Innovation (Chiesa et al, 1996)**
### Innovation classification matrix

<table>
<thead>
<tr>
<th>Product</th>
<th>Process</th>
<th>Service</th>
<th>Marketing</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig 2.4** Matrix for innovation classification

**Fig 2.5** Ansoff’s Diversification Matrix for Innovation Categorisation
2.4 How can innovation activity be measured

Kleinknecht and Mohnen (2002), Kleinknecht and Bain (1993), Lichtenthaler (2004), Chiesa et al. (1996) and Tidd et al. (2009) all propose a range of indicators for innovation measurement. While this list is not exhaustive, it examines the most common systems for assessing innovation activity and considers the relevance of each in the context of Irish SME’s. It is important before embarking on any research activity which measures innovation activity to understand the context under which the data will be gathered. Due to the complex nature of the concept of innovation, measuring it concisely and in a repeatable way is very difficult (Rogers, 1998).

In order to assess an organisation’s propensity for innovation, there has to be an appropriate way to measure it. The measurement system chosen must take a range of factors into account and organisation size is the most critical of these. As discussed earlier, SME’s produce different innovation data as a result of centralised decision making and lower resource availability. This difficult to capture, often intangible data requires a contingency approach based on company size, sector, strategy and culture (Davila, 2006). The contingency approach recommended is the use of a toolbox of innovation measurements designed to take stock of the organisation and its functions and combine them with a questionnaire-based innovation audit to gather a broader picture of the innovation activity data.

The Oslo Manual (2005, OECD) provides comprehensive guidelines for gathering innovation data. It proposes a framework for measuring innovation and draws a clear distinction between R&D and innovation. The view taken is that innovation ‘involves the utilisation of new knowledge or a new use or combination of existing knowledge’ whereas R&D is ‘basic and applied research to acquire new knowledge’. For SME’s, the acquisition of knowledge can be the most costly portion of the entire development process due to the uncertainty involved. The utilisation of new and existing knowledge to produce novel, commercially viable products, processes and services is less fraught with risk as the level of uncertainty
can be gauged to some extent based on the performance of other organisations and products.

**Fig 2.6** Oslo Manual Innovation Framework (OECD, 2005)

The concentration of performance measurement systems generated over the past fifty years has neglected innovation measurement and there is no clear system which fits all organisations or business sectors and this is leads Davila et al (2006) to propose the use of the Balanced Scorecard, Return on Investment and Cash Flow metrics. Tidd and Bessant (2009) recommend the use of innovation audits but caution that they must be part of an effective learning cycle and not simply implemented in order to be seen to be doing something. Cormican and O’Sullivan
(2004) propose building a best practice model around a framework based on five main factors derived from intensive study of technology companies. In the same way that innovation means different things to different observers, innovation measurement and benchmarking can be interpreted in different ways so it is important that everyone is clear about the process.

2.4.1 Patent Data: The use of patent submission data or publication of literature related to innovation as a measure of how innovative a company, industry or nation is has been debated at length by Kleinknecht et al (1993 & 2002). Most SME’s will not be in a position to file multiple patents for financial reasons. There is a shift in attitude among SME’s in regard to the value of patents as a part of the organisations intellectual asset portfolio. Where once a patent was held as the highest priority, many SME’s have come to value other intellectual property and guard it as carefully. Know-how and trade secrets are often greater protection in preventing a competitor copying or working around the patent claims in order to produce similar effects.

2.4.2 Literature based indicators: In an assessment of literature based innovation indicators, Cogan (1992, in Kleinknecht et al 1993 p.113) details the Irish experience and concludes that the use of literature based studies are limited due to the narrow scope of technology companies and the number of MNC’s who don’t carry out R&D in Ireland despite manufacturing here.

2.4.3 Financial measures to assess innovation activity
The level of R&D expenditure is a popular metric in MNC’s and all of the Irish medical device MNC’s have published figures for the percentage of company profit reinvested as R&D. Boston Scientific, a US MNC with manufacturing plants in Ireland in Letterkenny, Tullamore, Cork and Galway as well as a major R&D site in Galway spent $680 on R&D in 2005, representing 10.8% of sales reinvested in R&D (Source: BSC website – 2005 BSC annual report). This level of spending on development and acquisition of knowledge indicates the power of an MNC and
their ability to diversify and consolidate, but it is not possible to distil the amount of innovation derived as a result of this expenditure. As Adams et al (2006) state ‘High levels of R&D intensity are therefore not necessarily evidence of good innovation practice; they may simply mask process inefficiencies’.

For SME’s this is a more difficult task as the finance allocated to R&D and ongoing innovation activity often consumes working capital to the detriment of the long term viability of the company. Any financial measure outside of the budget projections is likely to be a historical measure and reflects the benefit derived from money already spent. The use of ‘profit reinvested as R&D’ metrics are not advised for any organisation wishing to calculate innovation activity as there is no direct link between expenditure and actual benefit to the company.

Cash flow as a result of new products is another popular financial measure but it is contingent on the flow of new products growing or at least remaining at a steady state. There is also a time lag between innovative activity and cash flow which could result in focus falling away from the product pipeline and in an SME this could spell disaster as the warning would come too late. There is no indication from cash flow metrics in regard to the type of innovation (incremental – radical) or whether the product delivering the benefit has a healthy life cycle or it is an easily copied product extension.

Profitability of a new product and its rate of return on investment may not be proportional to innovation activity and this is why the correct metrics are chosen for SME’s. In many cases, an SME won’t have a product on the market and may have spent several years operating with no income from sales. Technology adoption curves for new products from SME’s tend to take years to grow in the natural distribution bell-curve pattern described by Rogers (2003). Ensuring long-term viability of the company while growing sales is difficult enough without tying innovation success to metrics associated with this slow rate of rise.
Using such metrics as ‘profit to the organisation from new products’ depends on the company being able to constantly supply new products and doesn’t always reflect the level of innovation applied to deliver the new product. Counting the number of companies in a region, counting the number of these who have produced an innovative product within their market space and counting the number of these products which have been commercially successful is a good way to assess the characteristics of a nation or region (Mohnen, 2002). Incremental innovations to the original radical idea are often more profitable once a market has been established (Christensen, 1997) and don’t always give an indication as to the level of innovation which delivered the greatest return.

2.4.4 **Productivity data:** Schumpeter (1939) warns against measuring innovation in terms of improvements in organisational productivity. His argument is that productivity improvements as a result of innovation are not proportional to the innovative effort deployed and that the gains at a particular point may be lost due to changes incurred at a later stage.

2.5 **An Innovation Measurement Toolbox**

2.5.1 **Innovation Audit (Questionnaire):** Tidd 2009; Chiesa et al, 1996; Cormican and O’Sullivan, 2004 all offer versions of innovation audit questionnaire based on the critical success factors which must be considered for maximised innovation activity.

These questionnaires are designed to be completed by industry practitioners and those closest to the process. Questionnaires are circulated in hard copy by post or in soft copy via internet or intranet in order to gather data in a timely manner. Chiesa et al (1996) is a detailed instruction for designing an innovation audit and provides guidance for almost all contingencies, however as noted by Adams (2006), Chiesa et al is based on process innovation and does not give consideration for process or marketing innovations.
Cormican and O’Sullivan (2004) chose five key factors for success; Strategy and Leadership, Culture and Climate, Planning and Selection, Structure and Performance, Communication and Collaboration. The questionnaire they designed asked ten questions under each of the success factors to ascertain a score for each factor. This facilitated a graphical representation of the level achieved under each factor and the relative success in delivering innovation activity as well as allowing cross-sectional and longitudinal comparison of the graphical data.

Tidd (2009) also selected five factors (called ‘dimensions’) but doesn’t reveal them to the auditee. These dimensions are; Strategy, Learning, Linkages, Processes, Innovative Organisation and they are scored using a Likert (1932) scale.

The use of a single innovation audit as a stand alone indicator is worthless except to allow for benchmarking. In order to be certain that innovation management is constantly working and being improved is to carry out repeated innovation audits. Each audit is an opportunity for all of the stakeholders in the organisation to reflect on the findings and how they impact the business.

Once modelled, it is important to expand the diagnostic of the model to include all of the influences brought to bear on the process through customised innovation auditing.

2.5.2 Best practice modelling/Benchmarking: The use of internal scorecards to monitor the organisations progress as well as being able to measure it accurately and repeatedly is detailed in Cormican and O’Sullivan (2004) and Chiesa et al (1996). A framework of critical success factors which are linked to overall organisational strategy are used to derive a detailed questionnaire and the results are gathered in a way which allows graphical representation of the data.

The graphical data can be used to provide a single position for consideration, or detailed longitudinal or cross-sectional comparison of the innovation activity within an organisation. Tidd (2009) reminds users of best practice models that the
challenge to innovation management lies in the necessity to take a contingency approach in designing the audit. The type of innovation, business sector and other factors should be taken into account.

2.5.3 Balanced Scorecard

The system devised by Kaplan and Norton (1996) can be applied very effectively to SME’s. The advantage of the scorecard is that it uses carefully chosen metrics, uses up-to-the minute information and reflects industry best practice in linking overall company strategy to innovation activity. A carefully designed scorecard gives a holistic view of the organisations ability to manage innovation and monitor the process in real time.

2.6 Barriers to innovation measurement

Not measuring it in the first place is the greatest barrier, but once a diagnostic phase commences it is important to monitor other aspects. Not using the information once it has been gathered is a common fault of measurement systems, many performance improvement programs fail after implementation when old patterns return due to lack of attention. All change management programs suffer from backsliding and it is important to institutionalise the changes put in place when measuring innovation to prevent it (Cummings, 2005).

Tidd and Bessant (2009) make a very valid point in relation to innovation measurement and improvement programs. The system may be designed with the organisation in mind and the data being used in the best possible way but the most important information as to why the organisation is successful may still be missing. The most innovative companies can still fail as a result of organisational mismanagement. The incorporation of performance metrics into innovation auditing is recommended for this reason.

Davila et al (2006) list seven barriers to effective (innovation) performance measurement and these are summarised here:
1. If the basic business model is flawed, the organisation will focus on the wrong levers of value creation. SME’s invariably develop traditional business models and rarely consider more suitable alternatives. Strategic partnerships, outsource models and virtual enterprise models require significantly less resources in the early phases of development.

2. Avoid measuring the wrong variables. Choosing the wrong metrics, or focusing wholly on financial data could result in the wrong action being taken, or worse, delivering an innovation no-one wants.

3. Objective measures are attractive, but in a lot of settings they are of limited use and don’t always relate to innovation management performance.

4. Failure to use the power of the available information technology is a costly mistake

5. Don’t believe that information technology is more powerful than it is

6. Using a management system the wrong way is a common mistake. Don’t respond to every spike in the data but don’t ignore inexplicable trends. Validate the system occasionally to ensure it is being used as intended.

7. Using the wrong data. Garbage in, garbage out applies in the case of innovation measurement as much as it does in all other aspects of organisational measurement.

Adapted from Davila et al (2006 p.174)

While not exactly a barrier, it is important to bear in mind when designing a study that no-one wants to admit to being less than average. Everyone aspires to being innovative and most senior managers view their organisations as possessing innovative characteristics, to the point of ignoring detrimental factors which erode innovation.
Claiming innovation as a core competence is even more likely to cause the opposite effect. Tidd (2009) points out that what may have worked well when solving particular problems using innovative techniques can fail when applied to seemingly similar problems in a case of a ‘core competence becoming a core rigidity’ (Tidd et al, 2009).

Choice of candidate and choice of data gathering method, even choice of questions can influence or bias the interviewee to answer in an aspirational fashion rather than in total honesty and this will skew the results drastically.

2.7 Limitations of the literature
The majority of the literature pertaining to innovation measurement is highly prescribed and difficult to apply in the context of SME’s. The scarcity of SME-specific reports is an indication that further research and broader investigation are needed in the context of Irish innovation companies. This scarcity limits the cross-referencing of similar studies and heightens the need for organised research in this area.
2.8 Conclusion

Innovation is a complex concept, most often explained as a process but which requires an open-minded approach in the context of SME’s. Its accurate measurement is best managed through the use of a contingency approach and a set of measurement tools which provide a spectrum of data. Once gathered, the use of a balanced scorecard or framework to present and allow the organisation to act on the data is vital.

Financial indicators, patent data and publication data are all more suited to much larger organisations, industry clusters or even national contexts, these indicators may not even give clear linkages between input and expenditure and the innovation contribution to the company. The use of longitudinal studies to monitor organisational innovation on an ongoing basis ensures the company remains competitive.

The use of this new information to change the organisation in favour of innovative activity requires changes to how everyone in the organisation views innovation and a different way of gathering the data.
3 Literature review 2 - Innovation management

3.0 Introduction

When most people talk about managing innovation, they are generally referring to R&D management or product development management in the traditional sense. The notion that innovation is a changing feature of the organisations culture to be managed is alien to many senior managers. It is rarely viewed as an important asset which a business can develop and nurture. Innovation has been a strategic priority for most companies for decades, but in difficult times it is viewed as an expensive luxury and becomes less of a priority. SME’s, more than any other organisation need to exploit their innovative resources and manage them effectively (Boston Consulting Group Innovation report 2009).

Innovation is a precious resource to be exploited for long term gain or competitive advantage. Irish industry is predominantly made up of SME’s but there is no significant record of small companies growing to become global multinational companies (MNC’s). Irish medical device SME’s are most frequently formed as spin-outs from the larger companies, formed to develop and commercialise a related technology. The management of the technological development and the innovative activity in particular is poorly understood. Large corporations have established innovation management as a discipline and hired internal innovation-focused managers to nurture it. How do SME’s manage innovation to the same extent?

The importance to an SME of staying in business for long enough to become commercially successful is paramount. Progressing from start-up through the front end of the development phase and into product development and on to product realisation requires a steady stream of investment. Often this investment is contingent on the project reaching milestones in the development process. For a medical device SME, filing a patent, completing a clinical trial or receiving
regulatory approval for a product is a significant milestone and indicates to potential investors that the company has a viable offering. The development phases are often high risk, with radical innovations meeting existing technology and stringent performance expectations. These challenges are difficult to manage or predict, putting pressure on all managers to maximise innovation activity and deliver results on time.

The importance of innovation management to SME’s in light of the contribution to the organisations success as well as long term survival cannot be denied. Figures for the success of Irish medical device SME failures vary, but if the determinants of success count innovation in the top three then the importance of managing it is a given factor. This chapter considers a series of recommendations for new and existing Irish medical device SME’s based on a review of current and past literature.
3.1 What is innovation (2)

As described in the previous chapter, innovation is the lifeblood of an R&D enterprise. It should be ingrained in the structure of the organisation, working just below the surface to produce the best solutions with the available resources. Delivering innovative solutions is the primary way an SME can provide value to its customers and guarantee its long term success – Govindarajan (2001);

Joseph Schumpeter (1934) is widely credited for introducing the notion of innovation management to the world. His incorporation of innovation into his work on economic growth through technological lifecycles produced separate categories of innovation – Product, Process, Organisational as well as providing a clear distinction between innovation and invention.

According to Utterback (1994), the majority of industry-shattering innovations are developed by small firms and not the market leaders who spend the most on R&D. Agile SME’s have the ability to capture innovations, explore them with minimum bureaucracy and capitalise them quickly.

The use of a ‘funnel’ shaped process framework to conceptualise innovation and assist in managing it is common. O’Sullivan et al, 2009; Flynn et al, 2003; Tidd et al, 2009, Goffin and Mitchell 2005 all offer variations on the funnel theme with ideas entering the wide neck of the funnel, passing through the innovation process and bounded by culture and strategy on the outside to exit as a successful innovation. The action of the funnel is to allow strong innovations to pass through and weak ones to fall away. The use of simple graphics such as the funnel to represent the management model is helpful at the outset but care must be taken to change the model when the management process changes.

Cooper (1993) describes a linear innovation process which begins with the invention and progresses in six stages through a series of gates with go/kill decisions to the end stage of adoption by its market. Dooley and Van de Ven
(1999) propose a cyclical innovation process model with external enabling factors and constraining factors operating on the innovation process as it cycles through iterations of internal convergent and divergent behavioural stages. Each phase opens with enabling factors, exploration, learning and expanding until external rules or constraints begin to act to contain the process and there is contraction, convergence and focussing on the solution. The Dooley and Van de Ven model proposes that innovation management is about monitoring the position of the innovation during these iterative cycles and applying appropriate resource management contingent on the requirements at that time.

Flexible, agile, organic management of innovation teams requires a model which can adapt quickly and not constrain the organisation. Being innovative requires openness to structural change and architectural innovation in the way the organisation is run. Excessive planning, analysis and bureaucracy in the early stages of a start-up company can take away its agility.

Over-analysing ideas and concepts can delay market entry on the one hand (Bhide, 1994) while prematurely launching a product can have the opposite effect of causing product failure due to under-development (Reinertsen, 1994), or worse in the case of radical innovations the market entrant can struggle to gain market share, only to watch a late entry competitor maximise with an incrementally improved ‘me-too’ copy of the product (Christensen, 1997).
3.2 How can innovation be managed?

In order to even begin managing innovation, organisational leaders must be aware of what it is – as a concept it is possible to have any number of ways to define it. The most popular models of innovation are the process models which view innovation as a series of actions, producing the desired output from various inputs. What is often neglected is that innovation is a creative process and is neither predictable nor repeatable.

While there is ample evidence and documentation of the use of innovation management techniques at large companies (3M are routinely mentioned, but companies such as Nokia, Proctor and Gamble, Dyson, Honda, Apple and many others are at the forefront of innovation management), there is little evidence to suggest that smaller companies are using simple techniques to ensure they can stay ahead of their competition. Peters and Waterman (1995) began a trend for mapping success in companies by listing traits associated with their culture and management.

The bulk of this knowledge however relates to excellence in how corporations are run. The relevance of what made Boeing, Caterpillar, Intel, IBM, Proctor and Gamble, Apple, McDonalds and Hewlett Packard such successful innovators, to a start-up medical device company in the West of Ireland is certainly questionable. There is no doubt that extraordinary companies do better than ordinary ones, but do the guidelines by which Apple, Google and Toyota manage innovation apply to Irish SME’s?

From the establishment of his R&D organisation, Thomas Edison generated hundreds of patents in order to advance the available technology, but sought ‘killer applications’ for the technology so that markets would demand his products. His early grasp of the concept of innovation management and its importance to organisational success is still not diffused into the strategic foundations of many SME’s.
The actions of the CEO and senior management will have the greatest effect in driving innovation. Kuczmarski (1996) lists four daily requirements which CEO’s in SME’s should use to instil creativity and innovation in the organisation.

1) Trust your teams and functional managers: Empower NPD teams; monitor their progress but show that you trust them. Don’t micromanage or overpower them.

2) Ensure recognition, rewards and respect: Innovation is not easy and R&D is often demanding and frustrating. Express appreciation for the dedication and hard work as well as for the failures which contribute to the organisational knowledge base.

3) Be positive, buoyant and supportive: Genuine and sincere feedback with strong positive support for the work of all employees conveys a strong message of support. Employees who are mandated to deliver on the organisations goals and understand how their daily responsibilities deliver these are better contributors to innovation processes (Cavone, 2000; Cormican & O’Sullivan, 2004).

4) Don’t cut the funding: Innovation will not thrive under short time horizon project timelines. The financial structures to support long term investment in innovation will pay off when the need to deliver results arises. It is very difficult to energise a team which has been disenchanted over a long period through lack of funding.

Davila et al (2006) put so much importance on the need for innovation-centered leadership that they include a section in each chapter for ‘CEO Actions’. These chapter summaries list how the CEO is directly responsible for implementing the infrastructure, strategy and culture which feed an innovative enterprise.

Andrew Van de Ven (in Storey, 2005 p.8) talks about the challenges of managing innovation while maintaining existing business. His work focussed on building an
organisational infrastructure to support innovation but he warned of the ‘dualism’ of running it in parallel with a commercial venture which distracted the innovation engine. The advice of many experts on innovation management is to create an atmosphere which is conducive to innovation. Van de Ven, (1986) summarised the innovation management challenge; ‘While research has provided many insights into specific aspects of innovation, the encompassing problems confronting general managers in managing innovation have been largely overlooked’.

Utterback (1994) developed practical models of the dynamics of innovation with the purpose of dispelling many of the myths surrounding practical innovation management.

Andersen (2007) describes the three steps to implementing any improvement process, and these also apply to changes designed to improve a companies innovation processes.

1) Document the existing process (use a toolbox of modelling techniques)
2) Re-engineer the process
3) Develop recommendations for improvement

Without first knowing the current processes, it is impossible to assess what changes are necessary to improve them. Innovation auditing and modelling must always be the first step.
Sony Founder Masaru Ibuka set clear organisational goals which everyone in the organisation could understand. These three simple guidelines give meaning to the organisations work but also validation to the message that innovation is central to what the company stands for. He defined their mission as:

1) Establishing a place of work where engineers can feel the joy of technological innovation, be aware of their mission to society, and work to their hearts content.
2) Pursuing dynamic activities in technology and production for the reconstruction of Japan and the elevation of the nation’s culture.
3) Applying advanced technology to the life of the general public.

Simple directions such as these capture the essence of innovation management and SME’s should grow their vision, mission, strategy and objectives from such clear statements.

Cormican and O’Sullivan (2004) propose a ‘best practice model’ for innovation management and identify five key factors which are central to the process:

1) Strategy and leadership
2) Culture and climate
3) Planning and selection
4) Structure and performance
5) Communication and collaboration

These key factors form the basis for a best practice model and when combined with an innovation audit to measure each factor, will allow the organisation to manage innovation effectively.
3.3 Why should innovation be managed?
The concept that innovation within an organisation is its greatest source of long-term sustained competitive advantage has been known since Schumpeter (1934). A successful product which develops a market will always attract competition. Competitors will imitate successful products in order to gain a part of the market share and erode the original companies’ profits. Low-cost competitive strategies produce cheap copies of the product however innovation of the original product to produce an offering of higher perceived value ensures long term market domination.

Market dominance:
The portable MP3 player has existed in some form or another since the Saehan MPMan of 1998, yet the Apple iPod has dominated the market since 2001 and put Apple at the top of the BCG Top 50 Global Innovation Companies for consumer products. This is purely due to innovation management by Apple to combine the hardware and software and provide consumers with a single supplier of digital music experience. The sound quality, memory capacity, reliability, battery life and other features of an iPod are similar to those of competing products however the iPod had sold 173m units up to the end of 2008, holding 75% of the market share over its nearest rival, SanDisk with 6.2% of the market. This difference is attributable to innovation management at Apple by Steve Jobs who told his team to ‘produce products so good you’ll want to lick them’ (Tidd, 2009. p134).

Speed to market:
Strategic management of organisations according to Mintzberg (2003) requires consideration of intended strategy as well as emergent strategy. The innovation process is never clear, obvious or predictable (Tidd et al, 2009; Storey et al, 2005) and rigid strategies which force creative processes down pre-conceived paths will fail. Setting aggressive goals for a development program generally results in too little time spent on the early stage of development – this is called the Initiation/Development Period (Van deVen, 2008) or the ‘Fuzzy Front-end’ (Reinertsen, 1994). The time taken on the critical path from concept to market is
radically shortened if the fuzzy front end of the development is managed to ensure the concept is ready for product development (Ullrich et al, 2008).

Robust design:
SME’s don’t often get second chances once the development process derails and while there is no doubt that companies learn from failure, they don’t always survive them. The cost of running a clinical trial to prove medical device efficacy in humans is often in the range of millions of Euro and a device which is rushed into development with inherent flaws is much more likely to fail in clinical trial.

The US FDA (Food and Drug Administration) maintains a website (FDA - MAUDE) for reporting medical device failures which result in adverse events to patients. For an MNC to have its product listed is often cause for concern but rarely results in company failure.

For an SME to be cited on the MAUDE database is catastrophic as it often requires product recall and the end of credibility for a company with a very small product portfolio or worse, a single product.
3.4 Corporate governance and its influence on innovation management

Deming (1986) criticised US management for being focussed on the quarterly dividend and Irish SME’s are similarly short-sighted due to the structure of available funding. The ‘short-termism’ of venture capital investors leaves little room in a company’s culture for risk taking and this is the cornerstone of innovation.

Van de Ven (2008) and Peters (1996) describe failure as an important part of innovation, the sooner an innovation team begins making mistakes and learning about the object of their work, the sooner they will focus on getting it right. The regular involvement of managers and/or investors in innovation can result in premature product launches and market failure as a direct result of financially motivated mismanagement. Van de Ven (1989) criticises what he calls ‘management implementation’ for inappropriate intervention in the development process.

Managers and investors have a dual role to play in the support of innovation and it is a difficult balance. As resource providers they are responsible for driving innovation but as resource controllers they put pressure on their teams to produce premature results. This sub-optimal situation in which engineers filter the results to show adequate performance, denies management of the opportunity to make the best decisions in favour of innovation. Van de Ven (2008) says that this ‘impression management’ has the ability to cloud decision making processes as a result of ‘sugar-coated’ information. An informal saying at Company Z in this study is ‘You can have Good, Fast or Cheap – pick any two’, and this is borne out time and again when innovation projects run late. The triple constraints of time, quality and cost (ANSI PMBOK, 2004) must be balanced very carefully in R&D projects.

The predominant use in Irish financial management of the US corporate governance model for maximising shareholder value has no consideration for the long term requirements of an innovation infrastructure. Lazonick et al, (2000);
O’Sullivan (1997) contend that this system does not commit finance for investment in innovation, is overly risk-averse, short term and inflexible in dealing with innovation revenue streams. Intellectual property values become the currency by which an SME is judged rather than the measure of its innovative capability. A new system of corporate governance and new ways of managing SME’s within the constraints of the current system are needed so that a five year time horizon becomes the standard period for measuring success (Kuczmarski, 1996).

Availability of sufficient finance at the product development phase is the responsibility of senior management (Kuczmarski, 1996, Peters, 1996, Tidd et al, 2009) and the freedom to administer it in order to meet the organisation’s goals through the use of innovation is the key to getting the most from properly managed R&D teams.

3.5 Linkages and their effect on innovation management

SME’s which establish links with a university and a government agency have much better chances of success (Etzkowitz, 2000). The use of feasibility studies in the initial stages of research often open early relationships between SME’s and universities.

It is rare for an SME to contact a university in its early stages and usually first contact is made when a problem arises. This brings difficulty because the timing expectations of both parties are mis-aligned. An SME seeking a solution to a problem has a time horizon of days or weeks – a university department which is charged with a significant research project has a time horizon of years (Lester & Piore, 2004).

Long term research partnership between SME’s and Irish universities is hampered by the intellectual property policies of the research institutes. The focus on commercialising acquired knowledge has shifted in universities from establishing spin-out industries onto registering and licensing patents. The university builds a revenue stream provided there is a steady flow of patents and an active technology
transfer office to commercialise them; the main difficulty arises when an SME wishes to take control of jointly researched information and is unable to gain sole rights to the technology.

Enterprise Ireland, Intertrade Ireland, agencies such as Udarás na Gealtachta and the IDA have an important part to play in the triple helix model of linkages. Most SME’s establish a relationship with EI, and many receive funding or assistance from these government agencies at one time or another. The networking opportunities, access to technology, funding and assistance which such a relationship provides is often the lifeblood of an SME.

3.6 Failure tolerance and its effect on innovation management

Collins (1997) gives a different perspective on failure tolerance with ‘try a lot of stuff and keep what works’. This is in line with recommendations from Peters (1990), Behnken (2005) and Kuczmarski (1996) who advocate a system for managing innovation where failure is celebrated rather than condemned. The implication is that the sooner a team starts to make mistakes, the sooner it learns about what doesn’t work and takes a step closer to the solution which does work.

IBM’s chairman, Thomas Watson Sr. once said, “The fastest way to succeed is to double your rate of failure” (HBR, 2002). Empathic leadership coupled with open communication and a mandate to be creative when seeking solutions results in people seeing their mistakes as valuable learning tools.

James Dyson, the British inventor of the bagless cyclone vacuum cleaner tells how he built over 5,000 prototypes in his attempts to get the design right. Had he stopped at his 50th or even his 500th prototype he might have created a good product, but he certainly wouldn’t have the same level knowledge. In his own words, “I thought it would take me about six months. In fact it took me 4.5 years and I built 5,127 prototypes until I got it right. That sounds tedious. In fact it was absolutely fascinating. I mean each failure, the 5,126 failures taught me so much.”
Successes teach you nothing. Failures teach you everything. Making mistakes is the most important thing you can do." (Dyson, 2000)

For an entrepreneur or SME, it is not always possible to make endless mistakes unless there is endless funding. It is however important for everyone in the organisation to change how they react to mistakes and not to view them negatively, but to use defined methods to understand why they happened. A culture where mistakes are not tolerated will quickly stagnate with everyone afraid to try anything novel or unusual. This results in the same processes, methods and solutions being repeated over and over – innovation cannot thrive in such a culture.

3.7 Innovation measurement and its effect on innovation management

The mere act of measuring innovation activity will have an effect on the overall innovative capability of the company. Visibly promoting innovation at all levels in the organisation is the first step and this requires measurement. Caution is advised (Tidd, 2009) in innovation measurement to avoid ‘over-management’. Innovation capability is built slowly over time; it will not grow under constant scrutiny. A defined measurement system, a strategy which supports it and defined policy to ensure the information gets consistent treatment.
3.8 Strategic management and innovation
In order to have the strongest innovation strategy, the company must link innovation strategy and business strategy (Tidd, 2009; Davila, 2006). The business plan should clearly show where innovation links into the organisation and how it is supported across all functional areas. Innovation strategies must factor in an appropriate level of contingency based on a balance of incremental and radical innovation to support a diversified portfolio. Routine communication of the details of these strategies to everyone in the organisation and how they should interpret them is vital.

3.9 Personnel management and training needs
Hiring dedicated personnel with a track record of innovation and ensuring they are properly trained is one of the first steps to creating an innovative enterprise (Peters, 1990). It is possible for anyone to claim they are innovative; it is a difficult characteristic to measure and prove. The single trait which marks someone as innovative is a history of innovation and it doesn’t necessarily need to be in a discipline related to the companies business.

People who aren’t afraid to try unusual solutions or think creatively will do so in all aspects of their daily lives. People who don’t know how to be innovative will have difficulty accessing this core skill at short notice. In SME’s where every new employee is a carefully considered business decision, it is even more important during the selection phase to search for evidence of past innovations.

3.10 Create an atmosphere which is conducive to innovation
Innovation consultancies such as the US-based IDEO and UK company ?What If! are well known for their rapid pace of creative output. The workspaces they designed are carefully engineered to make the most of the people whose responsibility it is to be innovative. Both of these companies encourage people to ‘have fun’ while they work, knowing that innovation is hard work and that people should enjoy it where possible. Drucker (HBR, 2002) is more succinct when he says; 'Hire the right people, and get out of their way'.
Amabile et al (2002) carried out a study to investigate whether putting innovators under time pressure produced better results. The study concluded that extreme deadlines produced less creative results – innovators were less likely to take risks with the solution in order to meet the deadline. The common thinking in operational organisations is to use project plans and timelines to manage process flows; in innovation planning the use of project plans with little room for problems or contingencies will likely result in poor innovation or unplanned delays.

3.11 New products development process

Ullrich and Eppinger (2008); Cooper and Kleinschmidt (1996); Von Hippel (1986) describe the importance of gathering accurate market information and feeding it into a structured development process. An SME needs a systematically managed, well defined process which everyone understands (Tidd, 2009). The innovation team must know how to progress an idea through the process in a manner which produces consistent results.

Cooper (2001) details the Stage-Gate process for NPD management and in order for it to work it must be managed accurately. The go/kill decisions require in-depth knowledge of the organisation’s technology, resources, product portfolio and finances in order to program them correctly. The lack of a clear NPD process means new ideas require a champion to get them through initial selection and into development. The presence of a well defined process ensures all ideas receive fair treatment and a chance to move through the system.

3.12 Motivation, bonuses and reward management

Is everyone rewarded according to their effort? Motivation in creative organisations is dependant on individuals engaging with the innovation process and taking ownership of portions of it. The extent to which a team is aligned to the organisation’s objectives will have the greatest bearing on their ability to be innovative. People must find joy and fulfilment in their work; they will be more
creative if they are having fun than if they are under pressure. The greatest reward for most R&D personnel is simply being involved in an exciting project.

3.13 Is innovation part of the company culture?
Or do most companies just say it is? Which came first, the organisations culture or its ability to innovate? The most likely answer is that both arrived at the same time as they are mutually inclusive.

An SME cannot simply allow its culture to evolve and expect it to support long term innovation management, it must set out from the beginning with a clear vision, mission and objectives so that company strategy supports innovation above all else. This foundation will foster an innovative culture and ensure that innovation values guide behaviour.

Without clear innovation strategy, organisational goals and financial/political motivations guide behaviour and creativity falters as a result of risk aversion.

3.14 Top management commitment to innovation and its effect on innovation management.
This is the lynchpin on which innovation success is hinged. Managers set the pace of innovation in the way they manage. Every example of an innovative company has an enigmatic leader who champions innovation as a way of life. Nokia, Proctor & Gamble, Dell, Virgin, IBM, Microsoft are household names but so are the innovators who made them a success. SME’s must harness the same creative energy from their leaders in order to have the same chance of success.

Davila et al (2006) quote a series of surveys which suggest the most important factor given by investors when choosing a new investment is the strength of the management team; ‘Innovation management depends on the leadership at the top. The team at the top must want it to happen and trust its people to make it happen. It cannot be an espoused theory where top managers preach it but don’t believe it. Innovation has to be a theory in action’. (Davila, 2006 p.13)
Innovation leadership is the greatest contributor to innovation in SME’s. Kuczmarski (1996) reminds senior managers not to demoralise innovation teams with poor signals. He points out that managers should audit themselves to ensure their words and actions reflect the innovation message and remain consistent; ‘There is nothing more frustrating for employees that to spin their wheels on innovation activities, only to learn after months or years that senior management is not all that committed to it’ (Kuczmarski, 1996 p.9)

3.15 Are SME’s better at innovation than other companies?

Van de Ven (1989); Markides, in Mazzucato (2002); Storey et al (2005); Mintzberg et al (1982) all claim that organisation size has a huge part to play in how successful a company is at being innovative. One side of the argument is that larger, more established companies fail to maintain innovative thrust for fear of damaging their existing business, competencies and product offerings. “Established companies find it hard to innovate because of...a general lack of incentive to abandon a certain present for and uncertain future” (Markides, 2002 p.246). Van de Ven (1989) points out that SME’s can get started on innovation projects much faster due to organisational agility, but that lack of funding slows them in the long run.. Larger organisations with available internal venture funding were better able to sustain projects over long terms.

Mintzberg and Waters (1982) also linked organisation size and innovation capability. Their work discussed how small companies in the early stages of innovation activity performed as a ‘single informed brain’, later described as a ‘hive-mind’ where all of the people involved organise themselves as a cohesive unit aligned with the companies goals. Conversely, Schumpeter (1933) believed that larger organisations with vast resources would be better at innovation since they could dedicate entire departments to R&D which did not take resources from the organisational side of the business.
A recent Finnish study (Koski et al, 2009) concluded that SME’s did not show higher innovation output compared to larger companies. Organisational structure, ownership and leadership at the smaller companies had some effect, but employee involvement in decision processes as well as direct links between reward and success made very strong contributions to the level of innovation.

A comparison by Cogan (1992, in Kleinknecht and Bain; 1993) of innovation activity (in Irish-developed new products) by company size showed an inverse proportionality in the data. Companies with less than five employees had ten times the innovation activity of those with between 100-500 employees. This is likely to be a result of the lack of local MNC R&D, but it reinforces the argument that SME’s will have more innovative cultures.

3.16 What are the barriers to innovation faced by SME’s

Availability of resources; human, financial or technical knowledge are the greatest stumbling blocks for SME’s. The OECD Oslo Manual (2005) describes most of the factors which hamper innovation activity. These must be considered for all companies however the ones which it says specifically apply to SME’s are the ability to access sufficient financial investment, the ability to attract and retain skilled personnel and the lack of technical knowledge required to implement an innovation.

Storey (2005) describes an inverse proportional rule between organisational forces and innovation. The assumption is that increased levels of bureaucracy and formalised decision-making not only restrict innovation but also discourage team members from adopting an innovation due to excessive workloads.

3.17 What management style best suits innovation in SME’s?

No guidance leads to paralysis as people waste their efforts at activity which doesn’t contribute to the long term objectives. At the other extreme, too much guidance leads to suffocation. Davila, et al (2006) offer ‘Seven rules of Innovation’ and there is sufficient overlap with Kuczmariskis ‘Ten Innovation
Insights’ and the recommendations in Tidd et al (2009) to suggest that a contingency approach to choosing the tools and tactics that suit the organisation best should be implemented. Davila et al go so far as to mandate the CEO of an organisation with carrying out a routine ‘innovation health check’ and using it to see how well the senior management at the organisation are following the seven rules.


4) Exert strong leadership on the innovation strategy  
5) Integrate innovation into the companies basic business mentality  
6) Align the amount and type of innovation to the companies strategy  
7) Manage the natural tension between creativity and value generation  
8) Neutralise organisational antibodies which block change  
9) Cultivate an innovation network beyond the organisation (triple helix)  
10) Create the right metrics and rewards for innovation
3.18 A National System of Innovation (NSI) and Irish SME’s

Lundvall (1998) and others detailed how the national conditions under which an organisation existed contributed to its ability to be innovative. The notion that culture, communications, corporate governance and location all support innovation within an organisation to some extent has been detailed. Mjoset (1992) carried out an in-depth study of the Irish NSI and concluded at the time of his report that Ireland had a very poor NSI. He stated that the major task for Ireland through the 1990’s and beyond would be the need to stimulate its system of innovation. In hindsight it would seem that this opportunity was missed and that Ireland still has a poor system of innovation.

The recent period of economic growth was just an increase in the output from a narrow band of sectors (property and construction) and it failed to enhance the socio-economic development which Mjoset identified as the foundation for improved NSI. The Irish Government report ‘Building Ireland’s Smart Economy’ reflects many of Mjosets recommendations and re-states the challenges which were faced almost twenty years ago when Mjoset was compiling his original data.

Levels of innovation intensity in Ireland have been studied in detail during the CIS1 and CIS2 (Community Innovation Survey) studies up to 2000 and by the Irish Innovation Panel studies to 2006 (see IIP website link). These studies have gathered data for the levels of innovation activity attributable to SME’s in Ireland and produced a range of reports making recommendations for SME’s in the Irish context. The national context of these reports and the longitudinal basis of their reporting timeframes paint a bleak picture for innovation activity in Ireland in the time since Mjoset. Despite a brief spike in manufacturing output related to a series of high technology MNC start-ups in the mid 1990’s, the manufacturing sector has been in decline in Ireland to date. The level of R&D (and consequently innovation) being undertaken by traditional manufacturing SME’s has been in decline, in proportion to the decline in manufacturing.
The measurement methods employed by these national surveys are predominantly postal surveys of the companies polled. Roper et al (2003) use a series of measures related to sales of new products and processes based on Tobit equations.

The impact of company location and its ability to innovate have been considered in the Irish context by several writers, notably Roper (2001) in his study of 2,500 manufacturing firms with ten or more employees and his use of Tobit equations to calculate innovation activity. Tobit equations (Greene, 1993) calculate the contribution to company profit from new or improved products within a given time period. Roper concludes that location has little effect on innovative activity in Irish SME’s but that networking with other companies (or organizations) has a positive effect on the likelihood of a company being successful with product or process innovation.

3.19 Conclusion

If it is necessary to foster innovation as a priority in an organisation then a different approach which does not evolve from traditional theory must be taken. From the earliest stage in the companies’ formation, a strategy for innovation must be designed to suit the organisation. The links between innovation strategy and innovation management on the innovative capability of a company are undeniable. Regardless of company size, market sector or geographical location, innovation will only develop under the right conditions and these have been carefully detailed in this section.

Innovation management in SME’s is central to fostering an innovation culture. The best practices of MNC’s are well documented and a contingency approach to using the most appropriate of these is recommended at all SME’s
4 Methodology

4.0 Introduction

This chapter will detail the approach taken to designing the investigation and gathering appropriate data for analysis. A valid study is one which gathers accurate data and is able to show how the data supports the research proposal and the previously published knowledge. It is intended that this research will bring fresh insight to the innovation measurement and management techniques in use at Irish medical device development SME’s.

SME’s (small-medium enterprises) constitute the bulk of Irish businesses and by their nature must stay ahead in order to survive. Long-term sustained competitive advantage in a small economy such as Ireland requires businesses to constantly innovate to stay ahead of their competition. The ways in which SME’s apply innovation is often haphazard, generally sporadic and mostly ineffective. Entrepreneurs and owner/managers are often innovative in their approach to starting a business but rarely able to translate this into a long term cultural characteristic of the company.

The goal of this study is to provide a set of recommendations for understanding innovation and measuring it with a view to managing it properly. In order to do this, it is necessary to gather detailed information from a target group of companies and present it in the light of the existing literature. This rich data from the Irish SME context, presented in a structured case study format will provide a benchmark for carrying out innovation audits and familiarise readers with the various approaches to innovation management.

The ten companies chosen all have less than 75 employees, are headquartered in Ireland and their primary activity is the development for commercialisation of
novel medical device technology. The selected interviewees all work as R&D managers, product development managers or intellectual asset managers.

The case study approach uses questionnaires which will be completed at the same time as interviews to ensure consistency of approach. The interviews will be recorded with a digital voice recorder and interview notes taken during the questioning phase. The combined questionnaire/interview data will be presented in case study format with minimal conclusions drawn from statistical analysis of the data due to the sample size and cross-sectional nature of the study.

The data which is gathered from both the questionnaire and interviews will be tabulated for comparison and detailed in a separate chapter.
4.1 Research questions

The title of this dissertation is; ‘A study of innovation measurement and innovation management at Irish medical device SME’s’.

The purpose of the research is to assess the levels of innovation measurement and innovation management in place at Irish SME’s. The research is applied as opposed to basic (Saunders 2007, p13) in that it uses data gathered in collaboration with industry practitioners, and generates outputs which allow managers to apply the learned knowledge distilled from previously published literature and combined with the empirical knowledge gathered during this study. This is reinforced by the work of Starkey and Madan (2001) who comment that this amalgamation of academic research from the supply side of universities and the demand side of industry gives a hybrid view of the situation.

In Ireland, the majority of businesses are small. 97% of companies employ less than 50 people and account for the bulk of tax revenue from VAT, income tax and gross value added (GVA) according to the 2006 Report of the Small Business Forum. The medical device sector comprises some very large multi-national companies (MNC’s) and a broad cross-section of SME’s involved new product development. While MNC’s receive credit for their innovative breakthroughs, SME’s are rarely considered for their innovative capabilities and rarer still do SME’s feature in innovation audits or studies to assess their innovation activity (Tidd, 2009).

Irish Government policy on innovation is not firmly connected to the work carried out at management level in Irish SME’s and the result is a discontinuity of effort in the triple-helix of industry-academia-government linkages (Etzkowitz, 2000). This study was conceived as an effort to distil best practice in innovation measurement and innovation management from the published literature and produce a scorecard.
for use by SME owner/managers to use as a benchmarking process to improve innovation.

The use of in-depth case study analysis with a questionnaire to gather quantitative data, combined with interviews to gather qualitative data and cross-referenced with empirical data from one company in the group allows for some level of validation through triangulation of the data (Robson 2002, p174).

The study needs to comprise of a method to gather data about the innovation process at Irish medical device SME’s. Tidd (2009, p70) says that; “The majority of failures (in technological innovation) are due to a weakness in the way the process is managed” and this leads to questions about how Irish SME’s actually manage innovation. All companies have a structure, a hierarchy and a culture which defines how business is carried out.

The business has internal and external transactions which follow set patterns – these patterns evolve with the culture of the organisation and form the norms by which it exists. These routines or patterns become deeply engrained sequences of actions which the members of the organisation follow to deliver on the organisations vision, mission, objectives and strategy. The specific patterns of activity or routines are what marks out the differences between organisations and what makes one better than another at different things (Levitt and March – in Tidd 2009 p71).

To identify these routines and patterns requires in-depth analysis of the structures, norms and culture of the organisation to assess what works in each particular case. While it is possible to benchmark the pattern used by one company to achieve success, the likelihood of these same patterns working for another company is very low. Every company must develop its own sequences of actions to match its goals and strategy.
It is proposed that the study will seek to understand not only how the respondents interpret the meaning of the terms ‘innovation measurement’ and ‘innovation management’, but also to use the questionnaire as a scorecard for innovation within the organisation. The results of the scorecard will provide information on the strength of innovation measurement and management to understand the effect on innovation at the organisations. It will also provide information on the contribution of innovation to the long term success of the organisation. This type of approach, which assesses how respondents understand and feel about the subject being studied, is defined as an interpretivist epistemology (Saunders 2007, p315) and it requires suitable proportions of both qualitative and quantitative data to be analysed.

The study will be a cross-sectional analysis of a sample of organisations taken during July/August 2009. Due to time constraints and the complexity of the process for gathering information, it is not possible to have a longitudinal aspect to this study. Cross-sectional studies frequently use surveys to gather data (Robson 2002) and are a snapshot of the circumstances under investigation at a particular point in time.

The research questions could be answered using a number of techniques. The financial success of a firm, the creative output of an organisation or the value of intellectual property generated by a company are all valid methods for innovative output (Rogers, 1998). The use of innovation audits to assess the innovative strength of an organisation requires the use of a carefully designed and detailed questionnaire (OECD, 2005).
4.2 A mixed-method approach to the research

This study will use a research questionnaire designed to gather information about both innovation measurement and management. The work will combine the questionnaire with an interview taken at the same time as the questionnaire is completed in order to produce a company-specific case study. The compiled results will be presented in a separate chapter which also contains empirical data from a case study of one of the surveyed companies. An amalgamation of qualitative and quantitative data will provide mutually complimentary perspectives of the nature of innovation management at Irish medical device SME’s.

In order to conduct exploratory research of a small sample of organisations, the use of a structured case study with a combination of questionnaires and interviews will derive an accurate assessment of the situation at these organisations. Case studies require questions to be framed in different formats in order to explore context-specific data in sufficient depth. The questionnaire will provide quantitative data about the metrics, techniques, culture and management of innovation, the interviews will gather qualitative data and case study information from practitioners of innovation to assess their current attitudes and openness to change.

The qualitative data will assess whether R&D managers feel that measurement and management of innovation is as important as other skills and mindsets, as well as the extent to which the culture and strategy of the company supports innovation. Any aspect of the questionnaire which interests the interviewee can be discussed during this data gathering phase and will be reported on if deemed relevant.

It is acknowledged that the combination of qualitative and quantitative data can produce sub-optimal results in certain cases when the results are not combined cohesively (Creswell, 2003) however it is not possible to achieve the depth of understanding of the various organisational contexts without utilising some mixed method approach. The opportunity to explore aspects of innovation management beyond the scope of the questionnaire outweighs the risk of poor integration of the
findings in this report. The findings can be considered complimentary or contrasting depending on the level of detail reported (Bryman, 2007).

4.3 Data collection

4.3.1 Primary Data collection – questionnaires and interviews

The collection of unique data related to the topic, for use in this study will be analysed in the light of innovation measurement and management at Irish SME’s. The use of a research questionnaire designed to gather information about both innovation measurement and management is of primary importance. The questionnaire is based on the guidelines set out in the Oslo Manual (OECD, 2005) for gathering and collating innovation data. It uses the Ten Innovation Insights (Kuczmarski, 1996) as section headings and each heading covers a series of questions related to company behaviour. The ten headings are categorised under either Innovation Management (Sections 1-6) or Innovation Measurement (Sections 7-10).

4.3.2 Empirical data contribution – case study

The author has worked as an R&D Manager and Product Development Manager with several Irish medical device SME’s for over ten years. The contribution of case study data based on companies which were directly experienced will be included in Chapter 5, Findings and Results. The data contributed will be predominantly qualitative and verifiable where possible to minimise the risk of observer bias.
4.4 Selection of organisations

The organisations have been selected according to size and business sector. SME’s (Small and Medium-sized Enterprises) up to 75 employees within the medical device R&D sector were chosen to improve consistency across the sample. Much larger companies would have very different structures and these would skew the results if included (EU definition of an SME <250 employees).

All of the companies chosen are defined by Enterprise Ireland as high potential start-ups (HPSU) and all of the companies are less than ten years old at the time of this study. Nine of the companies are based in and around Galway City, one company is based in Dublin. The effect of location and local cluster effects on the results of the study are not considered relevant as each company is understandably secretive at the early ideation/innovation phase.

Each organisations selected is currently involved in medical device R&D. According to the age, financial strength and size of the company they have varying portfolios of products in development.

All of the companies contacted requested that their responses and details be kept confidential. Individual interviewees will be referred to as ‘Manager #' and references to their organisations will be in the form ‘Company X’, where the manager has a numeric identifier and company has an alphabetic identifier.

4.5 Selection of candidates

The interviewees were selected by job title and by their responsibilities within the target organisations. A brief discussion with each candidate before inviting them for interview ascertained their role and suitability for inclusion. In all cases, the interviewee must be directly involved in the management of medical device R&D, either at the early concept stage, the product development stage or the marketing and realisation stage. These phases are historically where most innovation takes
place and since the sample is confined, there will not be scope to investigate
innovative practices in the extended marketing or business organisation sectors.

4.6 Questionnaire design and interview topics

The questionnaire is based on a combination of innovation audit questionnaires and
designed to gather specific information related to innovation activity. The
questions are ordered into ten sections which are aligned to the Ten Innovation
Insights as proposed by Kuczmarski(1996) which are included in Appendix 3.

Each section is designed to gather a score for the organisation for that particular
insight. This allows for cross-comparison of organisations by section as well as
deriving overall scores for innovation measurement and management.

In each of the ten sections, there is a series of questions which have been chosen to
derive the strength of association with the topic. The use of clear questions to
determine the respondents association with the topic is central to the interpretive
epistemology approach and design. In addition to the scored questions, the
opportunity to comment further after each section allows respondents to add any
details which they consider might assist in interpreting the data. This makes up
each of the ten sections of the questionnaire and the questionnaire closes with three
questions related to the size of the company, the number of R&D employees and
the age of the company. The level of an organisations utilisation of each insight
gives an indication for how innovative it is in that area.

Chapter 5 Results and Findings shows the scores achieved by each organisation
under each section, as well as the overall innovation score. The use of a summed
rating scale (Likert, 1932) requires the respondent to give an opinion on their
feeling of association for the question being asked. The use of a Likert scoring
scale ensures the results of each questionnaire are consistent and systematically
tabulated. Each question has a scale from 1 (strongly agree) to 5 (strongly
disagree) which is considered to be more interesting for the respondent and which
gives detailed quantitative data and not just yes/no answers with scant detail. From tests carried out, the fifty questions in the questionnaire take an average of nine minutes to complete. Overly long questionnaires suffer from respondent fatigue and can induce apathy in the process if an interview follows the questionnaire as in this case.

The questionnaire is to be completed in the presence of the researcher to ensure consistency of approach. The questionnaire should not be viewed as a chore, and the respondent should be engaged with the data gathering process as much as possible. Self-completion of questionnaires brings the risk of variation in the results due to external influences which cannot be mitigated for. The presence of the researcher during questionnaire completion ensures that any questions which are unclear can be clarified at the time.

The interview portion following the questionnaire was chosen for several purposes; to gather qualitative data, to allow for additional information not covered in the questionnaire to be gathered and to probe more deeply into aspects of the questionnaire which the interviewee wants to discuss. The questions in the questionnaire are considered to cover a broad cross-section however it is acknowledged that there may be aspects which had not emerged and can only be included once the research process has started (McNiff and Whitehead, 2000).

The interview should take ten minutes with probing questions into the nature of innovation management at the organisation. The interview is prompted by a series of questions into the organisation’s culture, strategy, triple helix linkages (academia-industry-government) and future. The interview questions are attached in Appendix 2.
4.7 Limitations of the research

All of the organisations in this study are very different and may suffer contextual variations which are beyond the scope of this study. While they fit a certain profile for size, industry sector and business model, they all have different cultures and histories. The experience of an R&D manager at one company will be different to that of a manager at any of the other companies, and due consideration must be given during the interpretation of qualitative data for this type of bias.

Care must be taken to gather all of the required data within a short period of time and to maintain consistency of approach with the data gathering process to prevent any shift in focus as a result of early findings. Keeping the attention of the research clear and not allowing the purpose to change with time requires diligence throughout the questionnaire/interview phase (Robson, 2002) and (Saunders, 2007).

4.8 Reliability of the data

The results of the questionnaire will be kept confidential and this is to ensure that interviewees don’t colour their responses to show their organisations in a better light. The use of a scorecard to measure innovation activity is a common technique and provides a fast overall view of the activities in use to support innovation at the organisation (Chiesa et al, 1996) but for long-term management and in-depth analysis a more rigorous approach would be necessary. This study does not propose to develop the second type of in-depth audit proposed by Chiesa et al (1996) due to the cross-sectional nature and multi-organisation nature of the work.

Tabulation of the quantitative data will be undertaken and the results entered into a spreadsheet designed to make totalling the results as accurate as possible. To complete triangulation of the study data, the score will be compared with the opinions expressed during the interview to ensure there is cohesion between both qualitative and quantitative information.
The presence of interviewer accuracy or bias, combined with interviewee accuracy or bias can result in data being incorrectly reported and recorded (Saunders et al, 2007). In order to ensure the rigour of the study is sufficiently strong, a sample of ten respondents was chosen according to their job titles and the organisations they represented. A previous study for “Auditing best practice for effective product innovation management” (Cormican and O’Sullivan, 2004) carried out interviews with ten organisations to determine best practice in organisations for product innovation management. This sample size is considered appropriate for this study when combined with case study data, however it is acknowledged that larger sample sizes would give greater resolution to the gathered data (Saunders, 2007).

4.9 Conclusion

The research questions and the method by which they will be addressed have been selected to achieve a measured level of rigour for this type of applied research into innovation practices at Irish medical device SME’s. The use of a questionnaire combined with interviews and case study data is appropriate for the information being gathered due to the relative ease of data gathering and interpretation within the time frame of a cross-sectional study.

The use of secondary and empirical data to support the research questions will be incorporated as part of the mixed-method approach taken by this study. The findings are presented in Chapter 5 and a discussion regarding the findings is on Chapter 6. Recommendations and Conclusions are in Chapter 7.
5 Findings

5.0 Introduction

This thesis is a study of innovation management activity at Irish SME’s and there are two research questions under consideration. One relates to innovation management, the other to innovation measurement, each question is gathering information about innovation activity at an organisation. Both questions are concerned with the actual intensity of innovation measurement and management within Irish SME’s and specifically the medical device industry. This chapter will present the data which was gathered during an investigation of a small sample of Irish medical device SME’s and their use of innovation management techniques.

The study gathered innovation activity data from senior R&D managers in ten Irish medical device SME’s. The data was a mix of quantitative and qualitative information, all gathered while conducting an interview to ascertain the interviewee’s opinions on innovation management. The quantitative data was in the form of ‘innovation audits’ which scored the organisation on a range of ten topics. These topics or ‘factors’ have been identified as contributing to successful innovation management at organisational level. The qualitative data was in the form of recorded interviews during which the interviewee was asked about innovation management, linkages, strategy, culture and other aspects contributing to innovation.
5.0 Introduction (cont.)

This chapter will present these results, discuss the common patterns, outline best practices and detail how innovation management takes place in Irish medical device SME’s. The innovation audit questionnaire was divided into ten sections under the headings of Kuczmariskis innovation insights (Appendix 3). Each section had a series of related questions which were scored and tabulated to give a percentage value for that section.

The ten sections were separated into management (Sections 1-6) and measurement (Sections 7-10), which were scored separately. The total score for the audit was calculated and is presented as Innovation Activity.
5.1 Quantitative data – Innovation Measurement
(see appendices 1 and 4 for details)

The results from the innovation audits show that the four innovation measurement activities suffer from poor attention across the range of management disciplines. There is little attention paid to product tracking or success rates and most of the companies don’t manage their product portfolios to ensure adequate diversification. The mean score for measurement activity across the ten companies is 59% and this suggests that innovation measurement as a discipline should be improved.

The spread from 41.7% to 95.8% for VOC or ‘beginning the NPD process with lead user needs’ shows that some organisations simply don’t place any importance on this vital activity. Second-guessing which products or innovations to deliver to market is fraught with risk as it requires in-depth specialist knowledge and competitor data to ensure another company is not working on a similar product.

The activity of tying individual aspirations to organisational goals varies from 0.0% to 91.7% across the range of companies, with an average score of 51.7%. This concept was acknowledged during the interviews to be an administrative challenge for an SME, however Company N which scored 91.7% had a simple employee review process for assessing motivations and linking these to employee responsibilities.
5.2 **Quantitative data – Innovation Management**

(see appendices 1 and 4 for details)

The levels of the six innovation management activities as assessed during this study were found to vary greatly across the ten companies. Failure tolerance, which is acknowledged by many writers (Tidd, 2009, Utterback, 1995, Storey, 2004) to be an important aspect both for morale and performance of innovation teams was low for most companies. It could be expected in a traditional industry or manufacturing business model that mistakes and failures are directly linked to expense and waste; however in innovation companies which are designed to harvest knowledge and develop novel concepts, failure should be seen as an opportunity for learning. It is clear that this is not the case in the quantitative data. The data is presented in detail in appendices 1 – 4.

5.3 **Quantitative data – Innovation Activity**

(see appendices 1 and 4 for details)

Total innovation activity is the combination of measurement and management data. This data is intended as a snapshot to indicate the total score of the innovation audit. No correlation between innovation activity and the actual innovativeness of the organisation was carried out and it is recommended that any further or deeper study of innovation activity incorporates some validation mechanism to show the validity of the data.
5.4 Qualitative data – Innovation Measurement

During the interviews with R&D managers at the ten companies polled, a series of questions were asked to try and focus in on the organisations strengths and challenges in managing innovation.

None of the managers interviewed had ever carried out or participated in an innovation audit of their organisation, nor did they use or communicate any metric relating to the measure of innovation. During all of the interviews, the concept of spending time measuring such an intangible aspect such as innovation was deemed ‘a waste of time’ (Manager 8, Company K).

5.5 Qualitative data – Innovation Management

The feedback from the interviews carried out as part of this study was predominantly about how little actual innovation management took place.

Speaking about innovation management in general, Manager 7, Company H said; “Anyone who thinks they have everything right is in the wrong job”.

All of the managers admitted to finding challenges with delivering innovative solutions with the triple constraints of time, cost and quality. A contingency approach to all aspects of managing the SME was applied and as the company grew, the culture and management techniques changed,
5.6 Qualitative data – Innovation Activity

5.6.1 Senior management support
The dominant factor contributing to innovation at the organisations selected was the attitude and direction of the CEO. Almost all of the respondents described both positive and negative behaviours from senior management which had positive and negative effects on innovation and innovation management at the company. Three companies described their CEO’s as enigmatic leaders who gave clear direction and total support to innovation, one manager described the CEO as being closed to innovation beyond the immediate scope of the project in hand and that the only way to improve the innovation capability of the organisation was to, “replace the CEO” (R&D Manager of one of the companies in this study)

5.6.2 Access to lead users
Out of ten SME’s, only four had lead users employed or involved in the development process. These four companies had established medical review boards to carry out prototyping and product development which was relevant to the work of the company.

The remaining six companies depended on ‘technology push’ to establish the product specifications, using industrial designers to produce enhanced versions of existing products.

There is a direct correlation between the direct involvement of lead users and the level of innovation applied to the products being developed. The companies who depend on their marketing managers or CEO to provide concepts for the product pipeline have a foundation of incremental innovations and are not actively searching for radical uses for their technology.
5.6.3 Linkages (research institute)

Three of the ten companies had a direct link to the Royal College of Surgeons. Two of the companies admitted strong links with a local academic research institute; one company had links with more than two colleges and was funding/partnering breakthrough research at both. All of the companies had made contact with a college at one time or another but had found the lack of urgency frustrating. This is a common problem and is discussed in detail in Lester et al (2004) where the time horizons for industry is measured in days but in colleges it is measured in months. It is possible to get a fast response from an academic department if a pre-existing relationship has already built the networking contacts.

Manager 7, Company H, “From the perspective of intellectual property we have deliberately stayed away from involving the university in product development, instead focusing their expertise on process and test method development. Our IP is our soul and we are not prepared to share that”.

Manager 5, Company E, “The key point I would make here is that for the college to have any ownership of the company’s intellectual property whereby that company needs investment to develop the technology, it taints the attractiveness of the venture for an investor. It is unworkable that a college should share IP in a venture that is funded by investors.”

5.6.4 Linkages (government agency)

All of the ten SME’s polled had contact with Enterprise Ireland, most stating that the organisation had a strong relationship or were financially supported by them. All of the companies stated that the networking and business support provided by Enterprise Ireland was invaluable.

Manager 7, Company H was particularly impressed with the work of Enterprise Ireland in establishing foreign links, “Enterprise Ireland has a function which is often overlooked when they are judged as just a provider of local finance. There is much more to it and we benefited greatly from links which EI through their
strategic offices, particularly in the USA made into the US National Institute of Health”.

The reasons stated by eight of the companies for not establishing deeper links with a research institute were all due to intellectual property ownership.

### 5.6.5 Strategy

Seven out of the ten managers polled were unclear about overall company strategy in relation to the organisational goals. Innovation strategy or innovation management did not feature in the strategic plans of any of the companies investigated. A statement from Manager 9, Company L which displays some of the ambiguity around innovation and strategy; “Strategically, innovation is very important to us but we don’t specifically call it ‘Innovation’ and although it is inherent in everything we do it is not actively managed”.

Manager 5, Company E reinforced the findings of the quantitative data when he said, “We are very clear on our innovation strategy – it is something we work very hard on. It is part of what constitutes our value proposition and is central to it”. This is borne out to some extent in the organisations innovation activity score of 79.3%

Conversely, one R&D manager claimed that there was no innovation strategy at all at his organisation and his attempts to introduce it were met with obstruction from senior managers. “It wasn’t so much that there was little interest, there was absolutely no interest and there was no attempt to change coupled with strong resistance to the idea”.
5.6.6 Culture

The relative size of an SME means that its culture is an amorphous, intangible feature which defies clear definition. Most of the managers when asked about the culture at their organisations, described the atmosphere and the business model. “We have a strong desire to succeed and there is a desire to make this company a success for ourselves. We have to do things differently to the way a large multinational companies do them and it is innovative in nature how people think on their feet and effect change quickly to deliver value to the company and its shareholders. It is our desire to succeed is what drives a lot of innovation and makes us innovative – we don’t have the bandwidth a larger company has available to them”. (Manager 6, Company G.)

Manager 10, Company N expressed a lack of an innovation culture at the company despite its claims to be an innovation-intensive organisation, “There is a hard-working ethos in the company but beyond the R&D group there is no focus on innovation”.

5.6.7 Failure tolerance

This topic drew the greatest amount of discussion from the R&D managers interviewed. Almost all of them admitted that they had not implemented a formal information gathering or reviewing process in relation to failures during development. Most of the organisations did not tolerate failure well as seen in the quantitative data, and the interviewees reinforced this. Three of the managers admitted that they relied on traditional project planning techniques and simply adjusted the timelines when a failure resulted in a delay.

One of the managers made a very valid point about risk aversion when he said, “For an SME, the opportunity to be successful is a long and narrow path which doesn’t allow for alternative directions” (Interview with Manager 9, Company L). Failure is not viewed as a positive aspect of the organisational activity in most of the organisations polled.
5.6.8 Diversified portfolio

Manager 1, Company A described the organisation's efforts to find new and radical uses for the core technology: “We have a fundamental technology which we want to exploit and we have an advanced development group which constantly searches for new applications for it, but we probably don't manage it as pure innovation management – it is a marketing function.”

Manager 5, Company E, “We explore ideas widely, analysing, modelling and prototyping, even though they might seem unlikely in order to learn something about them. There is usually a tangible link between the idea and what we work on otherwise it results in a lack of focus both otherwise these ideas could be called ‘Blue-Sky’.”

5.6.9 New Product Development Process

Of the managers interviewed, only three described the NPD process as a robust and well managed aspect of the organisation. These three were very clear about where new ideas came from (lead users and marketing contacts), but also what gates and go/kill decisions the idea would encounter during the process.

5.7 Limitations within the findings

The use of a short audit such as the one in this study to calculate or score total innovation activity is admittedly a limitation. Measurement of all of the innovation activity within an SME would have to consider the strength of innovative practices at all levels within the company and possibly even beyond the organisation. An innovation audit must be designed appropriately and should be fit for the purpose. This audit was designed as an example of an initial step a company might take in embarking on a program of change.

More detailed information regarding innovation audits is contained in the OECD Oslo Manual (2005).
The measure of innovation activity was not compared to organisational success. Of the companies investigated, some had well established routines to support innovation and showed strong potential for success but were constrained by lack of funding. Linking habits, routines, culture and strategy to innovation activity can show research excellence, but it does not follow that organisational success is guaranteed.

The execution of an innovation audit by a third party to the organisation is limited to an extent by the sense of ownership the interviewee has for the data. Companies who claim innovation as a core competence or who aspire to great success may be more or less likely to admit that their core processes are deficient or flawed when a third party is carrying out the research. It would be an important factor for further research to carry out a closed-loop method for innovation measurement which prevents this type of bias and ensures consistency of method in gathering accurate data. It was not possible in the context of this study to adjust the results for this variability.
5.8 Conclusion

The research questions relating to innovation measurement and innovation management which were explored during the questionnaires, case studies and structured interviews have been presented in this chapter. The data shows variation between all of the companies despite their common size, business sector and structure.

All of the organisations can be seen to incorporate some aspects of best practice, but that it is not done in a formalised or engrained manner. The need for customised auditing mechanisms combined with a contingency approach to data gathering and a longitudinal study of these companies is evident in their lack of total incorporation of innovation management techniques.

This study was intended as an initial probe into the innovation management activities of Irish medical device SME’s, The qualitative data and quantitative data gathered during the interviews don’t give any indication as to the overall ‘innovativeness’ of each company and it is not possible to make direct comparisons between the results for each company. The Discussion chapter will lay out the qualitative data in greater detail.
6 Discussion

6.0 Introduction

This study into the innovation measurement and innovation management practices in Irish medical device SME’s has gathered a portion of quantitative and qualitative data from ten organisations. The data was gathered using a combination of a questionnaire and an interview, the interview portion was recorded and several quotes have been presented in the previous chapter. This chapter will discuss the findings from all of the data and offer explanations for the information which can be concluded from it.

6.1 Irish medical device SME’s

In understanding why it is important for an Irish medical device SME to implement appropriate innovation measurement and management systems and policies, it is necessary to have an understanding for the driving forces behind the organisation.

The majority of Irish medical device SME’s are spin-offs from larger companies. They bring aspects of MNC culture and integrate them into an SME which results in a particular style of company. The competitive forces which drive the SME are different from those driving the MNC and while each company has the same end customers (hospitals, doctors and patients), SME’s and MNC’s compete in very different ways.

All medical device MNCs are highly diversified and run high-cost and low-cost strategies in parallel to deliver technically advanced solutions under the same brand as low cost consumable products. Johnson and Johnson are a global MNC, synonymous with manufacturing medical care products. The company has everything from cotton buds to surgical implants on their portfolio and continues to develop and acquire new technologies.

At the other end of the scale, most SME’s have a single product or technology platform which they develop and extend until they have sufficient market share to
be able to fund the next product, technology or platform. Their competitors in the wider market are MNC’s but their offering is very different as they are also in the market for selling the technology or the company once it has been developed to a certain point.

![Venn Diagram](image)

**Fig 6.0** Commercial scope of technology SME vs. MNC

Given the success rates for new products in the market (Cooper, 2001) it is vital that Irish medical device SME’s understand the importance of managing innovation from an early stage. With figures for new product success (depending on market sector) varying between 10% and 50%, it is clear that an innovation strategy is crucial. Marketing of new products is a challenge due to the complexity of setting up distribution channels and innovation plays a huge part in being able to
look at possible diversification strategies, partnering with other companies or selling to OEM manufacturers for the purpose of assembling a kit of products.

SME’s are generally formed to exploit a single product, concept or technology. Discussions with R&D managers at Irish SME’s suggests that there are limited resources (human or financial) to develop diversification strategies, and the absence of dedicated innovation management specialists means that opportunities for alternative uses for the companies technology are not being explored.

6.2 Measuring Innovation

This study considered the tools and methods available to SME’s for measuring innovation and set out to assess whether these innovation measurement methods were in use in Irish medical device SME’s. The use of an audit questionnaire and interview sought to gain an insight into any use of innovation measurement, innovation auditing or innovation reporting at the company.

In all cases, the organisations polled did not use any innovation measurement techniques. Several of the managers were able to recall having completed innovation audits as part of investor due-diligence reports and when the concept was explained they understood the value of it. Few of the managers felt that they would have the resources or time to implement such a system in the near future and several said that it would be very difficult to implement due to opposition from senior management.
6.3 Managing Innovation

Of the companies investigated, all of them claimed to be innovative or to offer an innovative technology. This study found that while it was possible to carry out an assessment of the management aspects of innovation, it did not mean that companies were actively managing innovation.

Innovation management is a difficult concept to communicate as a standalone principle. When combined with strategic shifts or cultural considerations, it is possible to introduce innovation as an important aspect of a spectrum of activities. Of the managers who claimed that their company was innovative in providing solutions, deeper exploration suggested that these were individual incidents of innovation as opposed to long-term organisational habits.

This study has focussed on innovation management as a pure science, an aspect of the company which can be seen in everything it does. Occasional sparks of brilliance may deliver the core technology which an SME needs to supports its efforts but engrained innovative activity is much more than that and must be designed-in to the company business model, culture and strategy.

6.4 What do some companies do that others don’t

6.4.1 Lead users

Von Hippel (1986) researched the use by companies of lead users or expert customers. His work indicated that those companies who involve expert users at the earliest stage of product development are more likely to be successful in the long run. Several of the companies in this study have taken the time and effort to build very strong relationships with global lead users. Identifying them, meeting them and engaging them in the process.
One distinct advantage of early involvement of lead users is that they often wish to invest in the company. Their belief in the value of the technology provides both finance and knowledge at the time they are most needed.

### 6.4.2 Clear Innovation Strategy
Define innovation in the context of the organisation and its goals. Make sure everyone gets this message. Embed innovation in the culture of the organisation from the first day. Build the structure of the company around it – don’t try and force it onto an existing culture as this inevitably leads to failure. The companies in this study who had clear strategies stand out in a way the others simply don’t. The managers at the companies with clearly communicated strategy were able to state it in clear terms and understood how it applied to their short and long term objectives.

### 6.4.3 Front-End Innovation
Spending twice as much time on the ‘fuzzy front end’ to understand and define the problem you are trying to solve will deliver a better product and a more innovative solution in the long run. This phase is the least expensive to finance and will provide rich data when problems arise during the next stages. Don’t assume the organisation knows everything and prematurely move on to product development.

### 6.4.4 Create an atmosphere of innovation
This is the difference between truly innovative companies and companies who are following a pattern. Companies who formalise innovation teams, train their employees in the necessary skills and spread a message that innovation is of primary importance are going to be better at delivering innovative solutions. An innovation mindset is difficult to force on an existing organisation and change cannot be implemented overnight, however following the pattern of Irish SME’s and making the same mistakes over and over is not the solution.

Empowering cross-functional teams with the sole purpose of delivering innovative solutions and not just the R&D group is equally important. Companies who claim
not to be able to afford to do this should look at the long term cost of not doing it. An atmosphere of trust, openness and common sense of purpose will nurture innovative activity (Peters, 1990; Tidd, 2009; Sprenger, 2007).

Incentivise innovation by designing appropriate reward structures. There is no single correct method and often just recognising the contribution is sufficient reward. Reward failure in the same way as you reward success, the sooner your organisation starts making the first 5,000 mistakes, the sooner you can apply what has been learned and deliver the optimum solution.

6.5 The importance of business model design
Most Irish medical device SME’s use a traditional business model which is derived from the manufacturing sector. Regardless of size, the majority of companies polled for this study are arranged for an R&D phase which transitions to a manufacturing phase with insufficient resources available to run both concurrently. Two of the companies operated ‘outsource’ business models which utilise strategic partnerships to carry out many of the non-critical aspects of the business. These companies contracted their manufacturing, testing, logistics and support services (calibration, maintenance, facilities) to carefully chosen external companies. This has kept up-front costs low and allowed them to concentrate finance in the R&D areas which needed it most in the early development phase.

6.5.1 Size matters
Easy access to finance and personnel often means that a larger company can start a program of innovation more easily than a small one, but this doesn’t always mean that the actual level of innovation will be higher in the large organisation (Mohnen, 2002). Smaller companies are more agile and generally have the unified understanding of the concept being developed. Innovation cultures are easier to implement at smaller companies due to their size and generally lower levels of bureaucracy.
6.5.2 Use of consultants

Large corporations have used innovation consultants for years to model, measure and manage innovation within their organisations. Companies like futurethink (http://www.getfuturethink.com/) provide online innovation diagnostics to enable ranking of the four aspects of an innovation framework which they prioritised for success.

![Innovation business model](Adapted from getfuturethink.com)

This model leads to processes for measuring innovation success, fostering an innovation culture and rewarding smart risk-taking. It is part of a series of tools which any organisation can use to learn more about their company and its innovation processes but must be considered for suitability depending on the size, sector and structure of the company.

In Ireland there are few companies available to support SME’s in their search for better innovation management and often the task falls to senior managers to implement it from first principles. This can lead to incorrect assumptions which
can have detrimental effects on the process. In the UK, there are several consultancies specialising in innovation management, one of which is Sagentia (www.sagentia.co.uk).

6.6 Linkages and Triple Helix models

Problems with intellectual property ownership are the most commonly cited reasons for SME’s not establishing deeper links with academic institutes. Intellectual property policy at most Irish universities is clear and unambiguous; the university retains any patent rights to anything developed there, regardless of other stakeholder interests. In many cases the bulk of the value of an SME is in its technology portfolio. It must be able to raise finance against the value of its intellectual property and be able to sell or license patents in order to fund further growth. If intellectual property is shared with or owned by a university, the value to the SME of entering a partnership is limited. SME exit strategies often include the sale and transfer of technology to larger companies with the ability to commercially exploit it on a large scale. If patents are part-owned by universities it becomes difficult to sell the technology.

A shift in the business model of the technology transfer departments in Irish universities from generating spin-out companies to licensing patents has meant that the commercial focus on assisting SME’s has further reduced in the last five years. Access to research departments through a technology transfer office requires clear goals and a budget to cover the cost of the research. In many cases Enterprise Ireland innovation partnerships and innovation vouchers can be utilised to make initial contact, but much higher levels of funding are required to carry out major research projects. The Intertrade Ireland ‘Fusion Partnership’ has been successful in building links between industry and academia in Northern Ireland with several Irish SME’s.
Enterprise Ireland remains the strongest government agency for assisting SME’s to grow and make progress in developing technology. Through funding, networking and offering advice, the organisation has supported all of the SME’s in this study to some extent. The challenges to be met over the coming years will continue to be access to sufficient start-up and working capital, and while Enterprise Ireland has been instrumental in providing this, it is likely to become harder to access funds due to global financial pressure on local budgetary allocations.

6.7 Case Study of an Irish medical device SME

Zerusa Ltd is a medical device development company with an outsource business model. The company was formed in 2003 with the intention of developing novel medical device technologies based on unmet needs gathered from experts and lead users. The founders of the company had backgrounds in managing at several large MNC’s and understood the medical device market as well as the industry requirements for a medical device SME.

Using contractors where possible, the company developed its first product and delivered it to market in less then eighteen months from the formation of the company. Company funding was provided from a mixture of private and state-sponsored investment to ensure there was sufficient working capital until the first product developed a revenue stream. The outsource business model ensured costs stayed as low as possible and guaranteed the best chance for company survival. All manufacturing, logistics and testing functions were operated as they were needed and did not contribute to overhead costs when they were not needed.

The first product, a valve used to provide a surgeon with access to a patient’s vascular system during minimally invasive (keyhole) surgery was launched in the EU in summer 2005 and in the US in late 2005 following FDA approval.
The company used medical device special advisors to search for new product opportunities in US hospitals as well as seeking partnerships with lead users to develop their concepts in partnership. As information became available, they began placing these concepts in its product pipeline. The Stage Gate (Cooper, 2004) system in use had several go/kill stages for the concept however it was not applied as diligently as Cooper intended and pet projects tended to slip past the ‘kill’ stage and into the next phase.

Over time, the greatest constraint on the product pipeline has been access to funding. Concepts which required small amounts of feasibility study were shelved in favour of other financial commitments. Several attempts were made to develop links into academic research institutes and these have resulted in successful research programs, however the time taken to set them up and get results has far exceeded the organisations expectations.

The long term partnerships have yielded some success in developing processes but any of the short run projects or quick assessments were unsuccessful due to lack of focus and a lack of time. Our experience of colleges in providing answers to technical problems, even when these questions are within the scope of a particular departments expertise, is that the time taken far exceeds that which is available and that most college departments are not open to communicating with commercial entities.

Zerusa is an innovative company in many ways and has been successful as a result of many of its innovations. The initial business model design was innovative and has ensured that valuable finance was not used on costly overheads to set up manufacturing, logistics or test facilities. The outsource business model has engrained the use of appropriate resources only when they are needed. Technology innovation has produced a range of patent applications, a spectrum of incremental and radical innovations were implemented to produce a number of medical device development programs.
Innovation is not endemic in the company. The company slogan “Innovative Technology through Partnerships” communicates to others that the organisation will be innovative in developing technology but not in all aspects of its business. The use of as many of Kuczmarski's ten Innovation Insights at Zerusa is recommended for future consideration. Availability of funding remains the greatest barrier to radical innovation. Risk aversion in times of financial crisis means that everyone selects the lowest risk option, and this is always incremental innovation. Line extension, product upgrades and novel marketing promotions are all easily imitated by competitors so it is vital that more radical innovation is seen as the key to delivering long term competitive advantage.

6.8 Conclusion

Over the course of this study, it has become apparent through the use of interviews and innovation audits, but also using empirical data from case study research that innovation measurement and innovation management practices are not in common use in Irish medical device SME’s.

In order to implement these critical practices, a change in attitude must take place starting from the most senior level and must pervade the entire organisation.

There are ample methods and processes which are suitable for use in small companies and the selection of a series of diagnostic tools from a selection available is recommended.
7. Recommendations and Conclusion

7.0 Introduction

Innovation is defined as ‘using knowledge and experience to deliver something new which is of benefit to the organisation’. Invention is a ‘process which produces novel products and concepts’ however there is often no further development of an invention if it is of no use to anyone. Innovation is the next step; using an inventive step with knowledge or experience to produce something which benefits the organisation.

Innovation and fostering an innovation culture in an organisation are the key to sustaining the viability of the organisation. If competition in the marketplace means that competitors can offer similar products for similar prices, then only innovation of the product (to ensure the customer seeks it out), process (to improve quality, reduce price or reduce leadtime), service, marketing or organisational structure can differentiate the organisation in the marketplace.

7.1 Differentiation through innovation

The challenge faced by SME’s in the medical device sector is in fact a combination of challenges. Best investigated with a toolbox of assessments, it shows that each organisation has a mixture of common threats and specific threats to be addressed. The use of measurement techniques to quantify the innovative strength of the organisation and the acknowledgement that the implementation of policies to support innovation at senior management level are the first steps to differentiation through innovation.
7.2 **Fuzzy front end**

The complex ‘fuzzy front-end’ of the ideation process where a concept is investigated, tested, prototyped and developed is the point where most creativity is focussed. The danger is that once the design is frozen, all innovation ends and the organisation sets about repeating the same mistakes as its competitors, losing the edge it might have had as a result of its size and flexibility. The ‘fuzzy front-end’ is the least expensive phase of development to fund (Cooper, 2001). It requires few resources until the concept is proven and the actual product development phase begins. The difficulty for Irish SME’s in transitioning from early to mid-stage development comes in sourcing funding. The relative ease of funding the feasibility stages ends when the concept is proven and the product must be prepared for market. At this point, the availability of venture capital, government capital or other funding becomes almost impossible to secure. Risk aversion in investment markets forces companies to seek investment from abroad, or they take an immature concept to a large MNC only to be swallowed in bureaucracy trying to sell the idea.

7.3 **Toolbox of techniques to assess business model and innovation activity**

The use of a selection of tools to create a clear picture of the organisation within a mixture of contexts is vital to any improvement program. It is recommended that these tools be applied and repeated routinely to allow management to develop the companies culture and strategy to support long term innovative strength.

Being better at innovation requires a company-wide focus and it comes about when there are clear methods for measuring it, tied to techniques for managing it. Innovation is a creative process and it needs a different mindset to traditional management techniques. This study has shown that a contingency approach to measuring, followed by the use of simple insights to foster innovative attitudes will deliver long term competitive advantage at Irish SME’s.
7.3.1 Porters Five Forces model

Acknowledging that innovation measurement and consequently innovation measurement contribute to sustained competitive advantage (Tidd et al, 2009; Davila et al, 2006; Adams et al, 2006) bring Porters Five Forces model into consideration. The model highlights the competitive forces at work in all organisations and any innovation measurement program should take the action of these forces into account and work to counteract them.

![Porters Five Forces Model](image)

Fig 7.0 Porters Five Forces Model “The Five Forces That Shape Industry Competition” (HBR, 1979 & 2008)
7.3.2 Problem-Statement Matrix

Used to capture the challenges facing an organisation, this tool is a simple method for progressing root cause analysis of ingrained issues which have an effect on innovation measurement and performance.

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<th>Problem</th>
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<tbody>
<tr>
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<tr>
<td>Sales of existing products slowing down</td>
<td>Competitors catching up</td>
</tr>
<tr>
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<td>Products nearing end of life cycle</td>
</tr>
<tr>
<td></td>
<td>Disruptive technology taking hold</td>
</tr>
<tr>
<td>Cost of manufacturing rising</td>
<td>Manufacturing strategy flawed</td>
</tr>
<tr>
<td></td>
<td>Business model inappropriate</td>
</tr>
<tr>
<td>Ongoing product quality problems</td>
<td>Product launched before design completed</td>
</tr>
<tr>
<td></td>
<td>Manufacturing strategy flawed</td>
</tr>
<tr>
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<td>Ineffective quality system</td>
</tr>
<tr>
<td>Low level of employee involvement in NPD</td>
<td>Poor innovation culture</td>
</tr>
<tr>
<td></td>
<td>No ‘ownership’ of internal problems</td>
</tr>
<tr>
<td>Decision making in R&amp;D confined to ‘inner circle’</td>
<td>Select few charged with delivering results</td>
</tr>
<tr>
<td></td>
<td>Poor management of innovation effort</td>
</tr>
</tbody>
</table>

Fig 7.1 Problem-Statement Matrix
7.3.3 TOWS matrix

The TOWS matrix (Weihrich 1982) is a future planning tool to be used in conjunction with any change management or diagnostic tools. The TOWS matrix is designed to focus attention on the available resources and how they will interact with external forces to assist strategic planning. In order to use the matrix, match external opportunities and threats with the organisations internal strengths and weaknesses, systematically identifying relationships between these factors and basing innovation strategies on them.

<table>
<thead>
<tr>
<th>Internal Elements</th>
<th>Have and Want (Strengths)</th>
<th>Have and Don’t Want (Weaknesses)</th>
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</thead>
<tbody>
<tr>
<td>External Elements</td>
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<td></td>
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<tr>
<td>Don’t Have and Want (Opportunities)</td>
<td><strong>SO</strong>: Strengths can be used to capitalise or build upon existing or emerging opportunities</td>
<td><strong>WO</strong>: The options developed need to overcome weaknesses if existing or emerging opportunities are to be exploited</td>
</tr>
<tr>
<td>Don’t Have and Don’t Want (Threats)</td>
<td><strong>ST</strong>: Strengths can be used to minimise existing or emerging threats</td>
<td><strong>WT</strong>: The options pursued must minimise or overcome weaknesses and as far as possible cope with threats</td>
</tr>
</tbody>
</table>

Fig 7.2 TOWS Matrix (Weihrich, 1982)
The TOWS matrix is a tool which forces answers for difficult questions in relation to the strategic positioning of innovation within the organisation. The matrix provides answers to these questions and the results should support the organisations long term goals and objectives through a balanced scorecard or best-practice framework.

**Strengths and Opportunities (SO):** How can existing strengths be used to take advantage of real opportunities and contribute to long term innovative success

**Strengths and Threats (ST):** How can the organisation use inherent strengths to avoid both real and potential threats to the innovative capacity of the company.

**Weaknesses and Opportunities (WO):** How can organisational opportunities be leveraged to overcome perceived or known weaknesses?

**Weaknesses and Threats (WT):** How can weaknesses be strengthened or substituted so they can be used to avoid threats?

### 7.4 Innovation Measurement

As detailed in the previous chapters, there are numerous methods for measuring the innovation activity at an organisation. For SME’s, the use of an innovation audit based on the business model of the company is considered the best solution and it allows for longitudinal as well as cross-sectional study. In most cases, simply drawing attention to innovative practices on a regular basis will have a positive effect on the innovation activity at the company.

### 7.4.1 Innovation Audits

The use of a custom designed innovation audit is one of the best ways to measure innovation activity and innovation management techniques. As recommended in Cormican & O’Sullivan (2004), Tidd et al (2009) and in the OECD Oslo Manual the use of an audit will allow for cross-sectional and longitudinal studies of the organisations innovation strength.
7.5 Innovation Management
The innovation management techniques in place at the Irish medical device SME’s polled were found to be sub-optimal and poorly supported. The concept of failure tolerance in creative processes which has been in common knowledge for over a decade was alien to many of the managers in this study.

Training programs carried out by Enterprise Ireland, IMI, Forfás and others build on innovation management techniques and give valuable skills to managers in SME’s. It is important that managers see innovation management as an important aspect of their work as well as its overall contribution to the company.

7.5.1 Senior Management
Senior managements understanding of the benefit of innovation to the organisation is the most significant finding of this study. The most innovative companies had CEO’s who were involved on a daily basis and engaged in all of the organisations work. The companies where the CEO was focussed on launching a product and making sales, were less innovation focussed and less likely to become involved in advancing the cause of innovation management.

7.5.2 Culture
The cultural development of the organisation is a function of the management structure, the business sector, the geographical location and how the company interacts with its stakeholders. For innovation to thrive, a culture of openness, creativity and motivation is vital and must be supported by the organisations norms, beliefs and values.

Ireland’s national culture of innovation is not predisposed to innovative activity, and despite decades of industrial growth, Irish SME’s are still poor at carrying out pure research. Low level incremental innovation is within everyone’s grasp but the skills and attitudes to embrace radical innovation to support research will take focussed change programmes and a shift in the cultures at Irish SME’s.
7.5.3 Strategy
The strategic management and organisational development necessary to support innovation can only be fostered with long term commitment from the senior managers of the company. The organisations vision, mission, objectives, strategy and tactics must be clear to everyone who comes into contact with the company. Its employees must understand them and apply them to daily activities so that the strategy drives every decision at the company.

7.5.4 Customer focus (lead users)
Innovation management and the effective development of technology require the organisation to be customer focussed. The success of an organisation depends on it delivering solutions to its customers most common problems. Of the SME’s researched in this study, only some were deeply involved with their customers and the others who were still in the early development phase of R&D had not considered the influence a lead user might have.
7.6 Conclusion

Irish SME’s are at the centre of national economic success. Ireland is no longer the obvious choice of location for global MNC’s and there is little to be done in the short term to address this. Our national competitive advantage relies on the use of innovation to produce better products, process and services. The use of outmoded business models and reliance on local markets will not provide the momentum to deliver on government innovation strategy. It is of primary importance that SME’s implement innovation cultures and business models from the outset. This starts with systems to measure innovation activity in support of the organisations mission, strategy and objectives.

Innovation management has become a separate discipline in large organisations who understand the need to exploit their technology to the greatest extent, while searching for the next technology. SME’s may not have the resources to support a dedicated discipline, but they can no longer afford not to engage every member of the organisation in managing innovation.
Chapter 8 Bibliography and references


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Boston Consulting Group – Innovation 2009

FDA MAUDE database of medical device related adverse events
http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/search.CFM
Appendix 1. Innovation audit questionnaire results

Company A Innovation Audit

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<th>Result %</th>
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<td>FT</td>
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<tr>
<td>2</td>
<td>Clear NPD Strategy</td>
<td>NPD1</td>
</tr>
<tr>
<td>3</td>
<td>Dedicated Team members</td>
<td>DT</td>
</tr>
<tr>
<td>4</td>
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<td>NPD2</td>
</tr>
<tr>
<td>5</td>
<td>Motivation</td>
<td>MOT</td>
</tr>
<tr>
<td>6</td>
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<td>CEO</td>
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<tr>
<td>7</td>
<td>Product Success Tracking</td>
<td>ROI</td>
</tr>
<tr>
<td>8</td>
<td>Diversified Innovation Portfolio</td>
<td>RAD</td>
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<td>9</td>
<td>Voice Of Customer Needs research</td>
<td>VOC</td>
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<tr>
<td>10</td>
<td>HR management of team values</td>
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Company A - Overall result

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Company B Innovation Audit

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<td>VOC</td>
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Company B - Overall result

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Company C - Overall result

| Measurement Activity %  | 55.0 |
| Management Activity %   | 56.5 |
| Total Innovation activity % | 55.9 |

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| Number of employees | 10 |
| Number of R&D employees | 6 |
| Number of years in business | 3 |
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Company G - Overall result

| Measurement Activity % | 61.3 |
| Management Activity % | 75.0 |
| Total Innovation activity % | 69.1 |

Background information

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| Number of R&D employees | 7 |
| Number of years in business | 1 |
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Company H - Overall result

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Company K - Overall result

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Company L Innovation Audit

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<td>9 Voice Of Customer Needs research</td>
<td>VOC</td>
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<td>10 HR management of team values</td>
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Company L - Overall result

<p>| | |</p>
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<tbody>
<tr>
<td>Measurement Activity %</td>
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<tr>
<td>Management Activity %</td>
<td>40.7</td>
</tr>
<tr>
<td>Total Innovation activity %</td>
<td>45.2</td>
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Background information

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<tr>
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<td>Number of R&amp;D employees</td>
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<tr>
<td>Number of years in business</td>
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Company N Innovation Audit

<table>
<thead>
<tr>
<th>Key to Chart</th>
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<tbody>
<tr>
<td>Kuczmarski Innovation Insight</td>
</tr>
<tr>
<td>1   Failure Tolerance</td>
</tr>
<tr>
<td>2   Clear NPD Strategy</td>
</tr>
<tr>
<td>3   Dedicated Team members</td>
</tr>
<tr>
<td>4   Clear NPD Process</td>
</tr>
<tr>
<td>5   Motivation</td>
</tr>
<tr>
<td>6   Top Management Support</td>
</tr>
<tr>
<td>7   Product Success Tracking</td>
</tr>
<tr>
<td>8   Diversified Innovation Portfolio</td>
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<td>9   Voice Of Customer Needs research</td>
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<td>10  HR management of team values</td>
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Company N - Overall result

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<tbody>
<tr>
<td>Measurement Activity %</td>
<td>73.8</td>
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<tr>
<td>Management Activity %</td>
<td>67.6</td>
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<tr>
<td>Total Innovation activity %</td>
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Background information

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<td>Number of employees</td>
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<tr>
<td>Number of R&amp;D employees</td>
<td>9</td>
</tr>
<tr>
<td>Number of years in business</td>
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</table>
Appendix 2  Innovation Audit Questionnaire:

The aim of this questionnaire is to develop a scorecard for innovation. Information is being gathered from companies to assess their capacity for innovation. The results of this questionnaire will be kept confidential. Please answer all questions. Please circle the number which represents the strength of each answer.

1- Strongly agree, 5 – Strongly disagree

1. 

<table>
<thead>
<tr>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
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</thead>
<tbody>
<tr>
<td>Are you and your team specifically tasked to manage innovation?</td>
<td></td>
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<tr>
<td>Are there dedicated roles for R&amp;D team members?</td>
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<tr>
<td>Do team members share R&amp;D and organisational support responsibilities?</td>
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<tr>
<td>Have R&amp;D programs been compromised through lack of resources when members were busy elsewhere - supporting production, marketing or sales?</td>
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Additional comments: _______________________________________________

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<tbody>
<tr>
<td>Does your organisation have a new products strategy?</td>
<td></td>
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<td></td>
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<tr>
<td>Did you have input or contribute to developing it?</td>
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<tr>
<td>Do you know how the companies long-range goals affect your day-to-day work?</td>
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<tr>
<td>Do you have access to information on financial targets, strategic planning and the new product pipeline?</td>
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Additional comments: _______________________________________________

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<tbody>
<tr>
<td>Does your organisation tolerate failure in R&amp;D investigations?</td>
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<tr>
<td>Does company culture support failure tolerance?</td>
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<tr>
<td>Do existing innovation metrics measure progress in terms of failure rates?</td>
<td></td>
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<tr>
<td>Is there a formal information gathering process for when failures occur?</td>
<td></td>
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<tr>
<td>Is there a system for sharing knowledge to which all team members have access?</td>
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Additional comments: _______________________________________________

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<tbody>
<tr>
<td>Is there an NPD process (Stage-Gate, NPD funnel, other)?</td>
<td></td>
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<td></td>
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<tr>
<td>How well does the process work?</td>
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<tr>
<td>Are there clear metrics for showing the process at work?</td>
<td></td>
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<tr>
<td>Does everyone in the organisation know about the process?</td>
<td></td>
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<tr>
<td>Are project planning techniques used and communicated?</td>
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Additional comments: _______________________________________________
5.

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</thead>
<tbody>
<tr>
<td>Is there sufficient motivation in the form of bonuses to ensure members are incentivised?</td>
<td></td>
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<tr>
<td>Are the incentives worth individuals putting in extra effort to ensure the team succeeds?</td>
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<tr>
<td>Are the incentives so big that team members might take unnecessary risks to win them?</td>
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<tr>
<td>Do other employees outside R&amp;D have similar reward schemes?</td>
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Additional comments: _______________________________________________________

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</tr>
</thead>
<tbody>
<tr>
<td>Is there visible reinforcement for the work of R&amp;D from <strong>all</strong> senior managers?</td>
<td></td>
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</tr>
<tr>
<td>Are senior managers passionate about innovation?</td>
<td></td>
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<tr>
<td>Do senior managers get involved in day-to-day R&amp;D activities? Sometimes – never?</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Is there an open-door policy to ensure new ideas or radical innovations can be presented to senior management without fear of reprisal or ridicule?</td>
<td></td>
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<tr>
<td>Are personal projects encouraged or funded?</td>
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Additional comments: _______________________________________________________

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</thead>
<tbody>
<tr>
<td>Are product success rates tracked for several years after launch to assess how well the investment is paying for itself?</td>
<td></td>
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<tr>
<td>Is innovation or innovative effort measured?</td>
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</tr>
<tr>
<td>How effective is the innovation measurement process?</td>
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<tr>
<td>Is Return on Investment (ROI) for each product/technology monitored on an ongoing basis?</td>
<td></td>
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</tr>
<tr>
<td>Do R&amp;D team members know this information – is it shared?</td>
<td></td>
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<tr>
<td>Do most organisation employees have an ‘innovation mindset’?</td>
<td></td>
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<tr>
<td>Is the organisation ‘good at innovation’?</td>
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Additional comments: _______________________________________________________

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</thead>
<tbody>
<tr>
<td>Does the organisation as a whole view innovation as a source of competitive advantage?</td>
<td></td>
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<tr>
<td>Has the company experienced the failure of a product in the marketplace?</td>
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<tr>
<td>Does the company aim to have a proportion of its new product successes totally novel, truly innovative products?</td>
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<tr>
<td>Is there an internal metric for the ratio of product extensions vs. radical innovations which are being developed?</td>
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</tr>
</tbody>
</table>

Additional comments: _______________________________________________________

Page 126
9.

Is there a channel for customers to give feedback on their needs?  
Are R&D team members given access to lead users of the companies products?  
Are customers and/or lead users involved in product pipeline activities?  
Do product development activities begin with brainstorming, idea generation or prototyping?  
Do product development activities begin with unmet-needs research or customer-identified problem identification?  
Do existing customers have a clear communications channel with which to feed product likes/dislikes back to R&D teams?  

Additional comments: 

10.

Does the organisation gather information on the skills, hopes, fears and aspirations of each team member?  
Are individual members given clear goals and are there methods/metrics to track progress?  
Are performance indicators linked to the most appropriate team targets?  

Additional comments: 

Finally, a little information about the company

Number of employees__________  
Number of employees in R&D_______  
Number of years in business_______

Thank you for taking the time to complete this survey – the results will be compiled and presented as part of a Masters dissertation on technology management. Your contribution, name and company details will be kept confidential throughout.

David Ronan (2009)
Appendix 3  Kuczmarski, T (1996) - Ten Innovation Insights
(Adapted from Kuczmarski, 1996)

1) Failure is an intrinsic part of innovation.

2) Companies that have a new products strategy in place are more successful.

3) Using multi-functional teams with dedicated team members is critical to success.

4) A systematic, well defined and commonly understood new product development process is essential – don’t attempt innovation without it.

5) Compensation schemes must be designed to stimulate an entrepreneurial environment.

6) Top management commitment is the foundation on which successful innovation is built.

7) Companies which are successful innovators keep track of their results and know how innovation is contributing to company success.

8) Innovative companies develop a portfolio of new product types to diversify risk by combining radical and incremental (high and low risk) innovations.

9) Innovative companies should begin the new product development process with customer problem identification and need intensity research.

10) The company should identify innovation values by gathering individual team member goals and motivation, and use these to guide behaviour and communication at team level. Innovative companies engage their members at a very fundamental level where involvement at the exciting early creative stage is often highly motivating in itself.
<table>
<thead>
<tr>
<th>Appendix 4</th>
<th>Company individual Innovation Audit Scores (%) as compared to the Ten Innovation Insights (Kuczmarski, 1996)</th>
</tr>
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<tbody>
<tr>
<td><strong>1</strong></td>
<td><strong>2</strong></td>
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<tr>
<td>Dedicated Teams</td>
<td>45.0</td>
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<tr>
<td>New Product Development Process</td>
<td>87.5</td>
</tr>
<tr>
<td>Failure Tolerance</td>
<td>31.3</td>
</tr>
<tr>
<td>Clear NPD Process</td>
<td>65.0</td>
</tr>
<tr>
<td>Motivation</td>
<td>43.8</td>
</tr>
<tr>
<td>Srn Management commitment</td>
<td>70.0</td>
</tr>
<tr>
<td>Product Success</td>
<td>50.0</td>
</tr>
<tr>
<td>Diversified Portfolio of Innovation</td>
<td>50.0</td>
</tr>
<tr>
<td>VOC Needs First</td>
<td>95.8</td>
</tr>
<tr>
<td>HR tracking of Innovation values</td>
<td>41.7</td>
</tr>
</tbody>
</table>

| Innovation Measurement score % | 62.5 | 48.8 | 55.0 | 62.5 | 71.3 | 61.3 | 60.0 | 45.0 | 51.3 | 73.8 | 59.2 | 9.3 |
| Innovation Management score % | 57.4 | 63.0 | 56.5 | 73.1 | 85.2 | 75.0 | 65.7 | 52.8 | 40.7 | 67.6 | 63.7 | 12.6 |
| Innovation Activity score % | 59.6 | 56.9 | 55.9 | 68.6 | 79.3 | 69.1 | 63.3 | 49.5 | 45.2 | 70.2 | 61.8 | 10.4 |
## Appendix 5  Details of the interviewees; their organisation size and company age

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Company</th>
<th>Sector</th>
<th>Number of Employees in total</th>
<th>Number of R&amp;D employees</th>
<th>Number of years in business (company)</th>
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<tbody>
<tr>
<td>Manager 1</td>
<td>Company A</td>
<td>Medical device</td>
<td>36</td>
<td>10</td>
<td>10</td>
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<tr>
<td></td>
<td>(Galway)</td>
<td>Development</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager 2</td>
<td>Company B</td>
<td>Medical device</td>
<td>70</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(Galway)</td>
<td>Development</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Manager 3</td>
<td>Company C</td>
<td>Medical device</td>
<td>10</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(Galway)</td>
<td>Development</td>
<td></td>
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<tr>
<td>Manager 4</td>
<td>Company D</td>
<td>Medical device</td>
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<td>5</td>
<td>10</td>
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<tr>
<td></td>
<td>(Dublin)</td>
<td>Development</td>
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<tr>
<td>Manager 5</td>
<td>Company E</td>
<td>Medical device</td>
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<td></td>
<td>(Galway)</td>
<td>Development</td>
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<tr>
<td>Manager 6</td>
<td>Company G</td>
<td>Medical device</td>
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<td></td>
<td>(Galway)</td>
<td>Development</td>
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<tr>
<td>Manager 7</td>
<td>Company H</td>
<td>Medical device</td>
<td>8</td>
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<td></td>
<td>(Galway)</td>
<td>Development</td>
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<td>Manager 8</td>
<td>Company K</td>
<td>Medical device</td>
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<td>6</td>
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<tr>
<td></td>
<td>(Galway)</td>
<td>Development</td>
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<tr>
<td>Manager 9</td>
<td>Company L</td>
<td>Medical device</td>
<td>4</td>
<td>1</td>
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<td></td>
<td>(Galway)</td>
<td>Development</td>
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<tr>
<td>Manager 10</td>
<td>Company N</td>
<td>Medical device</td>
<td>48</td>
<td>9</td>
<td>3</td>
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<td></td>
<td>(Galway)</td>
<td>Development</td>
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</table>
Appendix 6  Interview notes

Company A

Uses a suggestion box in the office to gather ideas – an incentive scheme supports the results. New ideas come from senior managers with links to the medical profession.

Strong strategic focus with clear commercial goals and targets communicated regularly from the top down. CEO is focussed on radical innovation, blue sky thinking and ways to exploit existing technologies.

The company is focussed on innovation but day-to-day activities take up valuable research time (dualism of supporting operational tasks with R&D resources)

Training is heavily promoted, all employees are encouraged to participate in additional courses.

Company B

The companies strategy has evolved and been changed to suit the structure and product matrix of the organisation. Strategic innovation management is not a part of overall strategy but it is ‘implied’. The culture is a fast moving, customer focussed atmosphere, however there is no access to end users of the product for the design teams. All feedback comes from commercial organisations who distribute the finished product to the end users. This is a potentially dangerous disconnect when dealing with novel technologies as the development direction can divert and derail the innovation process.
**Company C**

The company is described as a low-level innovator by the R&D manager. It is operated by its owner manager CEO and the opinion of the R&D manager is that there is a very tight grip on the culture. All of the company’s new ideas are purchased spin-outs from other companies or enhancements of existing products. There is no clear strategic focus at the company and due to human resource limitations there are frequent delays and disruptions to the work of the development team. Attempts to build a relationship with universities have failed due to time pressures and unrealistic expectations on both sides.

**Company D**

The company has been in business for over ten years (which is an indicator of some success, either raising finance or developing technologies). Close links with academic institutes in several locations provide technical assistance, medical and marketing experts on staff provide new business ideas. Access to finance is cited as the primary reason for difficulties operating in Ireland, venture capital companies unwilling to get involved in risky or uncharted innovations. Resource planning and project planning a challenge due to company size. Larger companies with dedicated project managers are better managed.

**Company E**

Limited relationships with two colleges for some exploratory investigations. IP issues cited as reason for not progressing further. Company has a clear strategy as a technology exploitation organisation with medical professionals on staff to provide new product development assistance. Good access to surgical community for fast feedback on products in development, no product launched as yet and no commercial wing to bring products to market – deemed premature to have marketing involved at the early stages!!
Company G

The organisation is at the very early stage of product development and medical device R&D. Deep relationships with academic institutes but no intention to use them beyond finding solutions to short term problems. IP issues cited as the reason for not wanting to get involved. Strong contact with Enterprise Ireland, Intertrade Ireland and several other government agencies.

Strategy not developed, but cited during the interview as ‘implied at all levels’ (not on the immediate horizon). The culture of the company is supposed to be based on innovation, the intention that the company embrace innovation at all levels is implied but not evident.

Company H

A clinical advisory board which operates externally to the company provides market knowledge and feedback on development projects. Clear links to lead users and stated desire of company to deliver solutions to customers unmet needs.

Long running project with a university to develop a technological solution in partnership with the company. No stated IP issues – up front agreement with the university to pay for all research work so that IP is 100% company funded and owned.

Strategic focus is on monitoring all activities to ensure better performance than US counterparts. Perceived competitors in the US believed to have easier market entry due to geographical location. Some aspect of ‘Not Invented Here’ at play, not clearly explained. Company CEO communicates message that everyone must strive to ‘find ways to do everything better’.

Stated strong desire to succeed at the company with everyone contributing and prepared to ‘do different’ in order to deliver results. ‘Innovation must be part of culture to make success happen’.
Company K

In business for over five years, the company has several commercially successful products. Product success has started to finance further research and put the company in a better financial position than most surveyed. No links with academic institutes due to IP issues and a link with Enterprise Ireland as a result of early stage investment in the company. Innovation management not part of company vocabulary and no intention to consider any innovation measurement. Management metrics focussed on ‘time to market’, ‘return on investment’ and ‘profit on sale of goods’. Culture of company is market led and customer focussed but very traditional in approach to doing business.

Company L

The company has established some links into universities, an innovation partnership scheme and innovation voucher led to several bursts of activity but no major value perceived by the organisation. Strategic focus poor as a result of difficult market conditions. Technology is considered ‘low-end’ by customers and sales of initial product offering are slow to build. Access to lead users is good as a result of personal relationships between CEO and surgeons. New ideas come from marketing feedback rather than lead user contacts.
Company N

New ideas come from marketing, distribution and B2B contacts. A full time business development manager works to keep product concepts coming into the product pipeline. An innovation partnership programme funded by Enterprise Ireland has built a strong relationship between the company and an Irish university to develop a novel process. Despite some innovation activity there is no clear strategic focus at the company and the management team are not focussed on innovation.

The culture is one of problem solving and hard work to deliver technical solutions to customer problems. Senior management cited as reason for lack of innovation management. Product success has been slow and global market conditions have prevented significant sales volumes from being achieved. Current product development program considered to be incremental and easily copied despite enormous development cost.
### Appendix 7  List of Acronyms used and their meanings

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>Boston Consulting Group</td>
</tr>
<tr>
<td>HPSU</td>
<td>High potential start up</td>
</tr>
<tr>
<td>MNC</td>
<td>Multi-national company</td>
</tr>
<tr>
<td>NPD</td>
<td>New product development</td>
</tr>
<tr>
<td>SME</td>
<td>Small to medium enterprise</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
</tbody>
</table>